

ON PHYSICAL LIMNOLOGY OF ABU ZA'BAAL LAKES, EGYPT

BY

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ABSTRACT

Abu Za'baal Lake, circuitous man-made basins, are formed by the fracture and extract rocks. This study is a pioneer, on the light on physical properties of Abu Za'baal Lakes. The Lakes, inland closed basins, receive their water from the ground and -seepage waters. Recently Abu Za'baal consists of three Lakes and filling phase Lake. They occupy the area between Latitudes $30^{\circ} 16.62'$ and $30^{\circ} 17.58'$ N & Longitudes $31^{\circ} 20.90'$ and $31^{\circ} 21.69'$ E. The Lakes waters cover an area of $608.050 \times 10^3 m^2$. The water storage in the Lakes is $5234.075 \times 10^3 m^3$. The highest surface area, water depth and water storage are in the First Lake, while their lowest values are in the Third Lake. The difference in physico-chemical properties and their correlation coefficients in Abu Za'baal Lakes are obvious. Abu Za'baal basins are brackish waters. The lower -water conductivity, salinity and density are in the Second Lake. The pH is always alkaline. The higher Hydrogen ion concentration is in the Third Lake. The change in bathymetry, ages and separated macophytes from basin to another causes the change in their characteristics.

INTRODUCTION

Abu Za'baal basins, man-made lakes, are located in north of AlQalyobiyah Governorate (Egypt). The Lakes were formed, during last century, probably due to fracture and extract the Pasalt rocks. They are inland closed basins. The basins were gradually fill up by seepage -and ground waters. The Lakes were formed and filling as follows, in the fifth decade (the First Lake), in the eighth decade (the Second Lake) and ninth decade (the Third Lake), while the small lake is filling phase in the present time. Rocks border them unless the east southern of the Second Lake; cultivated land nearby. The knowledge, in future Projects or Schemes, of these Lakes is based on observation of the dimensions and characteristics of their waters. Therefore the present work (first attempt) aims to determine the bathymetry and know some physico-chemical characteristics of water in Abu Za'baal Lakes.

DATA AND METHODS OF ANALYSIS

Data and water samples of Abu Za'baal Lakes were collected during the period from November 2002 to December 2002. 260 positions (surface area line) were taken in shorelines of the lakes. 411 positions (contour depth chart) were taken in the Lakes (226 positions in the First Lake, 98 positions in the Second Lake and 87 positions in the Third Lake). 42 hydrographic stations were established to cover whole surface of the Lakes (24 stations in the First Lake, 9 stations in the Second Lake and 9 stations in the Third Lake). Magellan Global Positioning System (GPS, NAV 5000 PRO) was used to determine the positions and hydrographic stations (Latitudes & Longitudes). The water depth was determined by Portable Eco- sounder (Lowrance Sonar- X- 25 model). Conductivity, Salinity, Density and pH values were measured at the surface water of the Lakes. Electrical conductivity of the water was measured using YSI (Yellow Spring Instrument) conductivity meter. Water salinity and density were determined by the direct gravimetric method (APHA, 1992). The density factor (δ_t) = [(density-1)x1000]. The pH was measured using Portable Electrochemistry Analyses Model 3405.

RESULTS

Morphometry and bathymetry of the Lakes

Recently Abu Za'baal region consists of three man - mad Lakes and filling phase Lake (Figs., 1& Tab., 1). They occupy the area between Latitudes $30^{\circ} 16.62'$ and $30^{\circ} 17.58'$ N & Longitudes $31^{\circ} 20.90'$ and $31^{\circ} 21.69'$ E. The First Lake locates between Latitudes $30^{\circ} 16.84'$ and $30^{\circ} 17.58'$ N & Longitudes $31^{\circ} 20.94'$ and $31^{\circ} 21.53'$ E ($375.816 \times 10^3 \text{m}^2$). The Second Lake extends between Latitudes $30^{\circ} 16.78'$ and $30^{\circ} 17.15'$ N & Longitudes $31^{\circ} 20.90'$ and $31^{\circ} 21.22'$ E ($151.848 \times 10^3 \text{m}^2$). The Third Lake lies between Latitudes $30^{\circ} 16.62'$ and $30^{\circ} 16.82'$ N & Longitudes $31^{\circ} 21.09'$ and $31^{\circ} 21.29'$ E ($80.386 \times 10^3 \text{m}^2$). The filling Phase Lake (no water till now) extends between Latitudes $30^{\circ} 16.71'$ and $30^{\circ} 16.82'$ N & Longitudes $31^{\circ} 21.59'$ and $31^{\circ} 21.69'$ E. The Lakes waters cover an area of $608.050 \times 10^3 \text{m}^2$. The water depth in the First Lake (Figs., 1& Tab., 1), was sharply increased northward (0.6m- 20.0m, with average of 10.219m). The water depth oscillation in the Second Lake has small amplitude (2.9m-7.6m, with average of 6.112m). In the Third Lake water depth increased northeast direction (0.8m - 7.1m, with average of 5.791m). The highest water storage (Figs., 1& Tab., 1) was $3840.464 \times 10^3 \text{m}^3$ in the First Lake, while the lowest water storage was $465.516 \times 10^3 \text{m}^3$ in the Third Lake. The water storage in the Second Lake was $928.095 \times 10^3 \text{m}^3$. The total water storage was $5234.075 \times 10^3 \text{m}^3$.

Table 1: Morphometry of Abu Za'baal Lakes

	First Lake	Second Lake	Third Lake
Latitudes	From: 30° 16.84' To: 30° 17.58'	From: 30° 16.78' To: 30° 17.15'	From: 30° 16.62' To: 30° 16.82'
Longitudes	From: 31° 20.94' To: 31° 21.53'	From: 31° 20.90' To: 31° 21.22'	From: 31° 21.09' To: 31° 21.29'
Length (m)	1239.5	555.0	333.0
Mean Width (m)	303.2	273.6	241.4
Mean depth (m)	10.219	6.112	5.791
Max. depth (m)	20	7.6	7.1
Surface area (m ²)	375.816 x10 ³	151.848 x10 ³	80.386 x10 ³
Volume (m ³)	3840.464 x10 ³	928.095 x10 ³	465.516 x10 ³

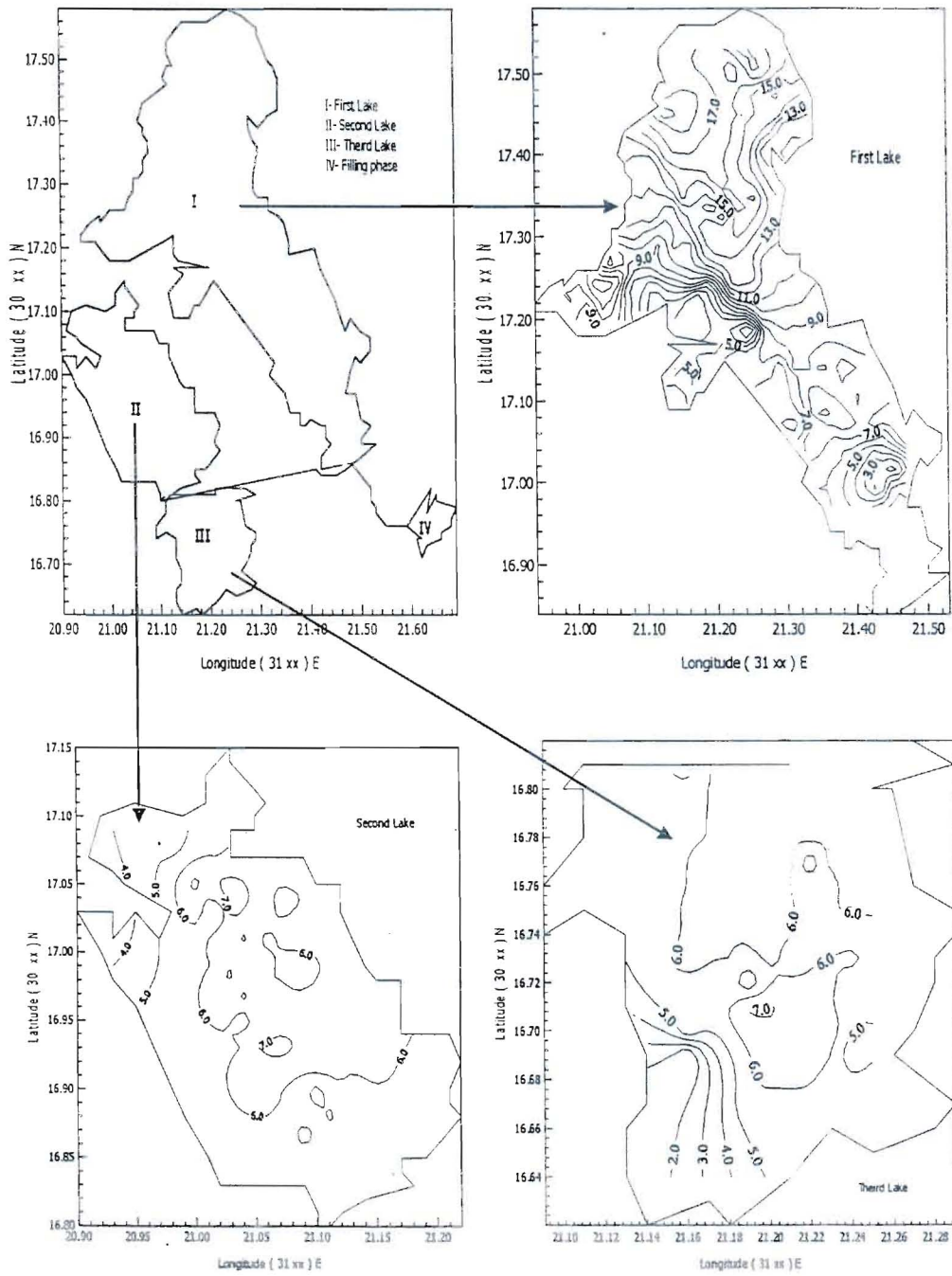


Fig. 1 Bathymetric charts (m) of Abu Za'baal Lakes

Physical characteristics of the Lake waters

The horizontal variations of conductivity (milli Siemens/cm, mS), water salinity (practical salinity units, psu), density factor (δ_t) and Hydrogen ion concentration in Abu Za'baal Lakes waters were shown in Fig. (2, 3 and 4). The water conductivity in the First Lake does not vary appreciably from zone to another; it ranged between 6.93 mS/cm and 6.98 mS/cm, with average of 6.95 mS/cm. This phenomenon also occurred in the Second Lake; it ranged between 4.44 mS/cm and 4.46 mS/cm, with average of 4.5 mS/cm. In the Third Lake, it ranged between 6.56 mS/cm and 6.95 mS/cm, with average of 6.62 mS/cm. The water salinity in the First Lake increased from 3.944 psu to 5.081 psu, with average of 4.800 psu. In the Second Lake it ranged between 3.270 psu and 3.555 psu, with average of 3.408 psu. In the Third Lake it varied between 4.513 psu and 5.122 psu, with average of 4.933 psu. The density factor in the First Lake extended between 3.53 and 4.68, with average of 4.15. In the Second Lake, it ranged between 0.630 and 1.89, with average of 1.29. In the Third Lake it varied between 2.35 and 5.58, with average of 3.95. The Hydrogen ion concentration in the First Lake (small variation) ranged between 7.91 and 7.97, with average of 7.942. It varied between 7.79 and 7.95, with average 7.836) in the Second Lake. In the Third Lake it varied between 8.06 and 8.18, with average of 8.107.

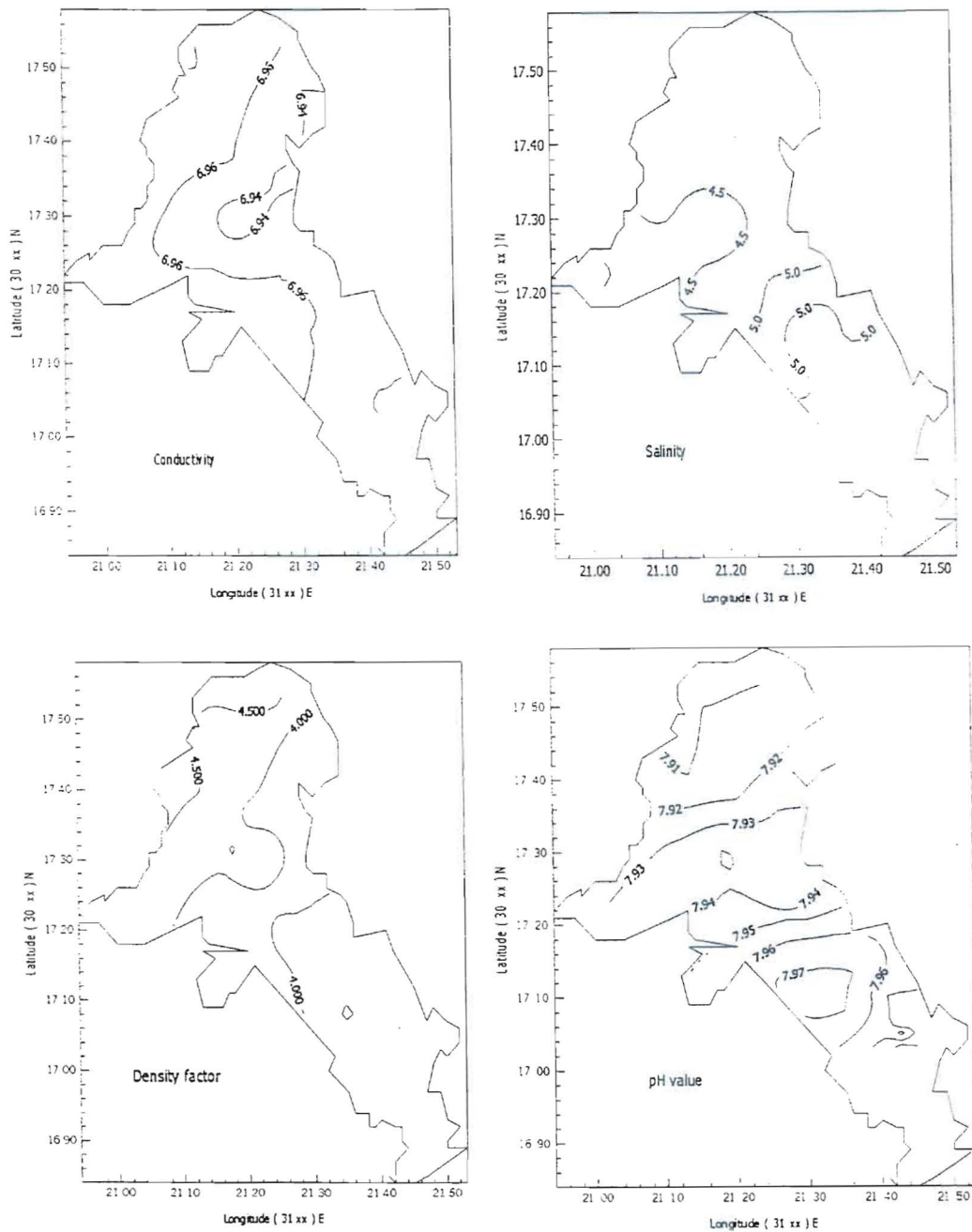


Fig. 2: Conductivity (mS), salinity (psu), density factor and pH value in the First Abu Za'baal Lake water

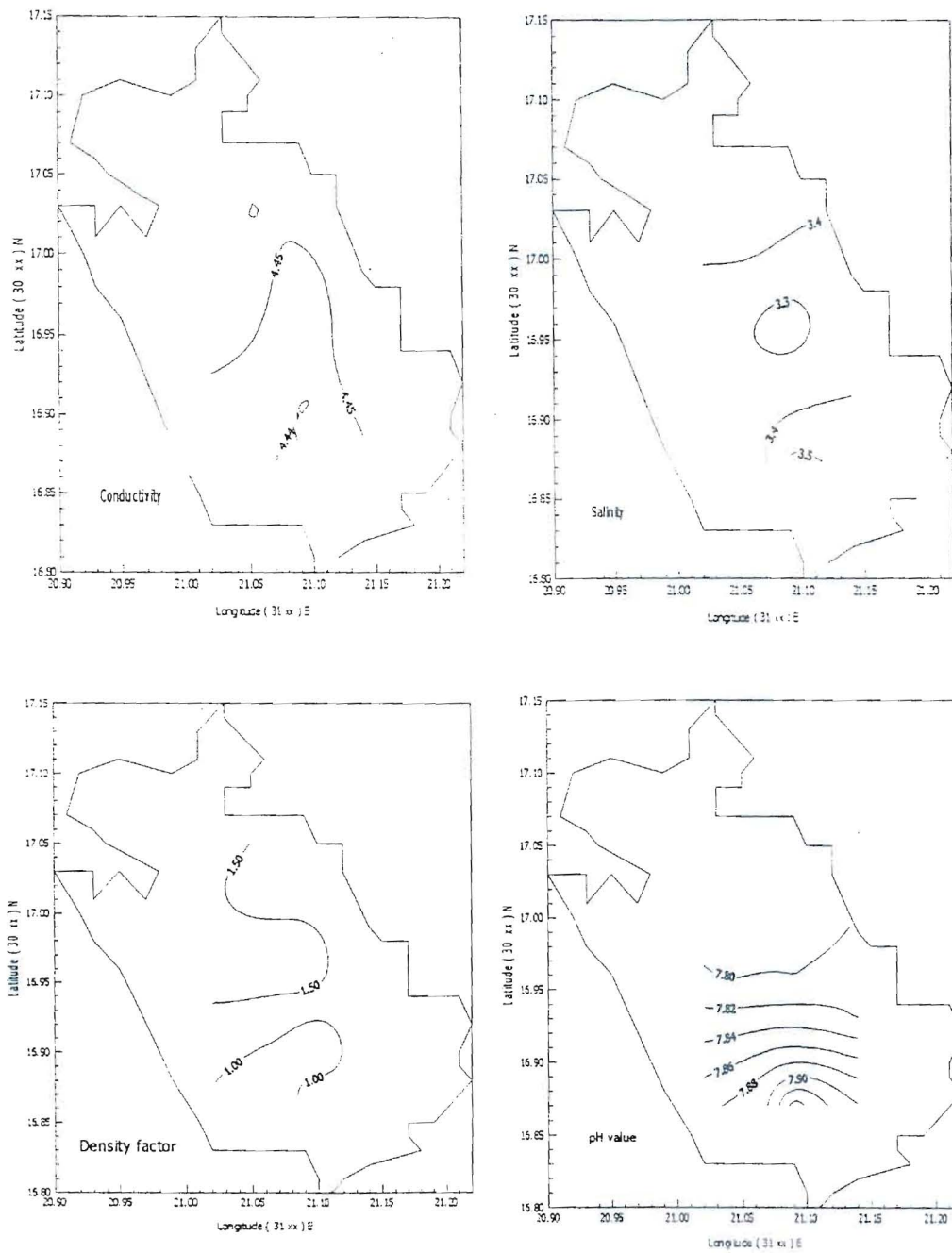


Fig. 3 Conductivity (mS), salinity (psu), density factor and pH value in the Second Abu Za'baal Lake water

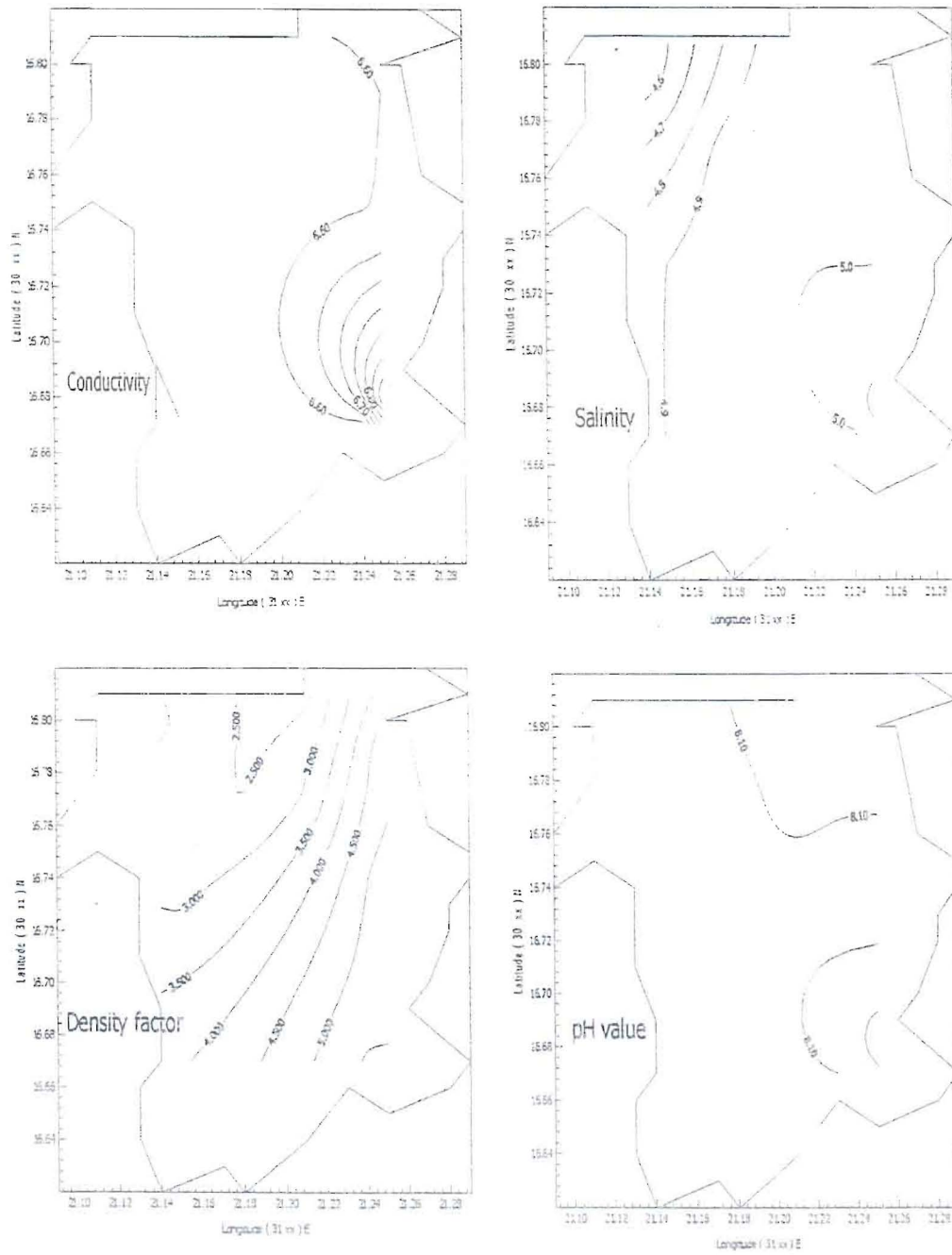


Fig. 4: Conductivity (mS), salinity (psu), density factor and pH value in the Third Abu Za'baal Lake water

DISCUSSION

From the fix-data file and bathymetric charts in Abu Za'baal Lakes, the First Lake is the wider (61.81% from the total water surface area), deeper and larger (73.38% from the total water storage) basin. The Third Lake is narrower (13.22% from the total water surface area), shallower and smaller (8.89% from the total water storage) basin. The high gradient in water depth is obvious in First Lake (Std. dev. of 4.3319). The low variation of the water depth is in Second Lake (Std. dev. of 0.7422) and Third Lake (Std. dev. of 1.0796).

Regarding the physico- chemical characteristics of the Lakes (water salinity, electrical conductivity and water density) Abu Za'baal Lakes can be considered as brackish water basins.

The lower water conductivity is in the Second Lake, comparing with remaining Abu Za'baal Lakes. In the First Lake (Std. dev. of 0.01406) and the Second Lake (Std. dev. of 0.00876) the horizontal variations of water conductivity are slight, while the variation in specific conductance is obvious in the Third Lake (Std. dev. of 0.11770), especially in the east southern region.

The Second Lake is characterized by low water salinity, whereas First and -Third Lakes has high water salinity. There is occurring variation in water salinity in First Lake, where extreme lowest of salinity appears in west region, and increase everywhere (Std. dev. of 0.30031). In Second Lake the low water salinity is in middle part increase everywhere (Std. dev. of 0.08224). In Third Lake the Low Salinity is in northwest region increase east south direction (Std. dev. of 0.15778).

The higher density factor is in the First Lake and the Third Lake, while the lower density is in Second Lake. There are slightly density variations in the First Lake (Std. dev. of 0.00030) and the Second Lake (Std. dev. of 0.00047), while its obvious variation is in the Third Lake (Std. dev. of 0.00129).

The pH values of the Lakes water lies in the alkaline side ($\text{pH} > 7.0$), (Goldman and Horne, 1983). The higher Hydrogen ion concentration is in the Third Lake comparing to the First and the Second Lake. They are horizontal variations of Hydrogen ion concentration in the Three Lake. Where pH is increased from north to south in the First Lake (Std. dev. of 0.02041) and the Second Lake (Std. dev. of 0.05317), while pH is increased from west to east in the Third lake (Std. dev. of 0.31686). The pH of the Lakes water lies with the optimum level for most fish species (Haraguchi et al, 2003).

In general, the correlation coefficients, in the Third Lake, between the four parameters are always positive values. Their values are as follows; conductivity - salinity (0.4808), conductivity- density (0.4910), conductivity- pH (0.7987), salinity- density (0.3383), salinity- pH (0.5280) and density- pH (0.2505). The correlation coefficients, in the First Lake and the Second Lake, between the four parameters are changed between positive and negative values. The correlation coefficients, in the First Lake are as follows; conductivity -salinity (0.1973), conductivity- density (0.2128), conductivity- pH (-0.1842), salinity-density (-0.0393), salinity- pH (0.2224) and density- pH (-0.0634). The correlation coefficients, in the Second Lake are as follows; conductivity -salinity (-0.2179), conductivity- density (0.3705), conductivity- pH (-0.6080), salinity-density (-0.2981), salinity- pH (0.5126) and density- pH (-0.6279).

CONCLUSION

The changes in the conductivity, salinity, density and pH value of Abu Za'baal Lakes, may be, related to change in bathymetry, consequently rate of evaporation in these basins. On the other side, the ages (formed periods) of the water bodies, and widespread macrophytes from basin to another, may be, the reason (Moran et al, 1986 and Wolanski and Gereta, 2001). This study is the first attempt to light the physical properties of Abu Za'baal Lakes. Generally, studying the morphometry and physical characteristics are contributed a solid basin whereupon to found management design on the Lakes (Bridgeman et al, 2000 and Bonacina, 2001). The study is the first concerning Limnology and Environment Impacts Assessment (EIA) of Abu Za'baal Lakes.

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