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Vertical Changes of Same Physico-Chemical Parameters in Tortum Lake (Erzurum/Turkey)

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Abstract: An intensive monthly sampling of water from three stations and five different layers (5, 10, 20 and 30 m) over 12 months covering wet and dry seasons the Tortum Lake was conducted during June 2012 to May 2013. Some physico-camical parameter and heavy metal consantration were researched change of seasonal and temproral. In this research measured mean Dissolved Oxygen (DO) 12.85±5.75 mg L^{-1}, pH 8.51±0.39, water temperature 13°C and Secchi depth 3.24 m. Mean value NH_3-N (Amonia-Nitrogen) 0.19±0.01 mg L^{-1}, NO_2-N (Nitrite-Nitrogen) 0.02±0.01 mg L^{-1}, NO_3-N (Nitrate-Nitrogen) 0.08±0.01 mg L^{-1}, TP (Total Phosphorus) 0.004±0.001 mg L^{-1}, Si (Silica) 0.60±0.003 mg L^{-1} and Total iron (TFe) 0.02±0.01 mg L^{-1} were calculated. In this study, results shows that in all the seasons only NO_2-N was found the second class water quality whereas Dissolved Oxygen (DO), pH, NH_3-N and NO_3-N were the first class water quality by Turkish Environmental Legislation inland water resources for surface water. Tortum Lake has been determinated mesotrophic level by using Secchi depth, oligotrophic level by total phosphorus.

Key words: Water quality, depth lake, Tortum Lake, Dissolve Oxygen (DO), parameters

INTRODUCTION

At the present time, human need to clear and quality fresh water for own life. Freshwater cover 2% in the world. From day to day, this ratio is reducing due to rapidly increasing world population and negative environmental impacts. The natural chemistry of lakes is influenced by factors such as geology, climate and vegetation and in part, determines what types of plants and animals will live and thrive there. Human activities can alter natural lake chemistry and biological communities. Water quality monitoring can provide you with an understanding of your lake's natural conditions and constraints as well as humancaused changes.

According to nutrient levels, classification of lakes and ponds is great importance for lake management strategies and restoration measure. Nutrient levels in the classification most commonly used parameters are turbitide, primer produce, chlorophyll a and total phosphorus. Nitrogen find form of nitrite and nitrate and phosphorus form of dissolved organic phosphorus in water stune or inorganic phosphorus in seston. The importance of the phosphorus in the cells is of fundamental importance in the power transmission system. Silica has two major forms such as silicates and silica dioxide in fresh waters. Silica are abundant in fresh water algae and diatoms are very important in terms of community (Wetzel, 2001).

Considerable attention has been focused on the sourse of nitrogen and phosphorus because nuisance algal growths in lakes have usually been attribute to excessive inputs of one or both of these nurtriends. Since, the late time numerous field studies have been concerned with the quantsfication of nutrient sources. These investigations include evalation of the nutrients from point sourse and nonpoind sources. Water quality monitoring programs conducted by state and federal agencies have generated data bases from which nutrient fluxes from watersheds to stream and lakes can be estimated (Clesceri *et al*., 1986).

The Tortum Lake is a large and was found different species fish such as *Salmo trutta*, *Barbus barbus*, *Cyprinus carpio* and *Capoeta capoeta* (Duman, 2009). The aim of in this study was estimated trophic status in Tortum Lake and was researched some heavy metal parameters. The study is important due to monitoring of changes of the lake.

MATERIALS AND METHODS

Study area: Tortum Lake which located in Northeast Anatolia Region and Tortum town is located in Eastern Anatolia Region (between 41°45'50"E, 40°10'54" and 40°41'47"N) far from 56 km away. This lake area is 6.625 km^2 which is Turkey's most extensive natural dam lake. The lake elevation of 8500, 2500 m in width and

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6.77 m^2 surface area, volume of about 223 million m^3 and the drainage area is 1820 km^2. Basin are characterized by micro-climate. The Tortum lake also is landslide-dammed lake. Tortum Lake's map and stations are given (Fig. 1). On the lake for the determination of the coordinates of the mobile phone navigation system was used.

Sampling and study sites: Water samples were collected monthly from June 2012 to May 2013 in three sampling station and they were taken at five depths, surface, 5, 10, 20 and 30 m using by Hydro-Bios water sampler (Ruttner) of 1 L capacity. Water sample was not taken in Augst due to could not find any vehicle (boat breakdown). Temperature and dissolved oxygen were measured using a oxygen meter (Termo type) as well as pH meter (Termo type) for pH value determination and water transparency was estimated using Secchi disk (Hydro-Bios type) *in situ*.

Fig. 1: Tortum lake and stations; site 1; coordinate: 40°37'10"K, 40°37'37"D; site 2; coordinate; 40°37'6"K, 41°37'35"D; site 3; coordinate: 40°39'7"K, 41°39'29"D

Analytical water quality procedures: The analyses were made in the laboratory of the Faculty of Fisheries at the Ataturk University in Erzurum. The nesslerisation method was applied to the water samples to determine the concentration of ammonia nitrogen (NH_3-N) calculated colorimetrically using the Nessler reactive reagent at a wavelength of 410 nm. The nitrite nitrogen (NO_2-N) was determinated by diazzotizing with sulfanilamide and coupling with N-1-naphthylenediamine dihydrochloride to form a color azo dye; colorimetric measurement was then performed by spectrophotometer at 520 nm. In the Nitrate Nitrogen (NO_3-N) analysis after the reaction between nitrate ion and brucine, the absorbance of the yellow color was determinated spectrophotometrically at 420 nm (APHA, 1995).

Water samples were analyzed for phosphorus fractions; Total Phosphorus (TP) as molybdate-reactive phosphorus. Total phosphorus concentration was analysed first by digestion using the persulphate fragmentation technique using the Ascorbic Acid Method according to the American Public Health Association (APHA, 1995). Total Silica (Si) analyses of water samples were done spectrophotometrically using the silicomolybdate method (Wetzel and Likens, 2001). Water sample was analyzed for total iron as Phenanthroline Method by spectrophotometric (APHA, 1995).

Statistical analyses: All the statistical and mathematical analyses were made using SPSS 20 and Excel 2007 programs. For the statistical analysis different tests were chosen. The data were first checked for normal distribution. ANOVA and Duncan test were used to evaluate differences in water samples month, station and depths.

RESULTS AND DISCUSSION

Water sources of Tortum Lake were consist of large and small creek and Tortum Stream and the lake occurs the Tortum Waterfall. The lake was measured average depth of 80 m, the Secchi depth 3.24 m, respectively (Fig. 2). This lake was classified the set and clear lake according to the physical structure by Tanyolac. The Secchi depth of the lake considered that lake was found both mesotrophic levels and 3 class quality waters and according to inland water resources (Anonymous, 1999, 1982; Lind *et al*., 1993).

Water temperature, dissolved oxygen and pH value of Tortum Lake according to the stratification of the lake were close to each other in a vertical direction. In this study, conducted in Lake Tortum, the lowest water temperature at the 2 and 3 stations in September (5°C)

the maximum water temperature value at 1 station in July (23.4°C) were measured. During the study period, the highest value of dissolved oxygen in February (14.13 mg L^{-1}) at 2 station (5 m) the lowest value in October (1.06 mg L^{-1}) was found at 1 station (10). pH value in the lake changes depend on the depth of the stations. In this research, researchers have conducted in the average pH was measured as 8.51±0.39 and HCO_3-ions is higher in lake as the pH value of 7 to 8.5 (Wetzel, 1983). Tortum Lake was found alkaline lakes as well as in the class I according to the average pH (Anonymous, 1999).

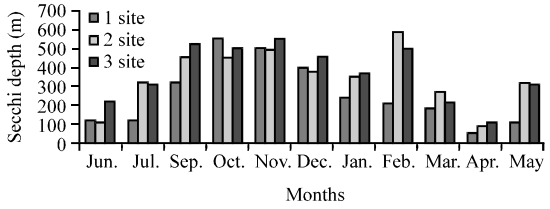

Fig. 2: Secchi depth of Tortum Lake tortum was changed with montly and station

Tortum Lake has been found weak thermal stratification. During the Summer, the lake was detected a significant stratification (Fig. 3). In addition, icing was not observed on the surface of the lake during the Winter months. With these characteristics which have in the hot monomik lake class, lake is located (Wetzel, 2001).

In this study, the average dissolved oxygen value were determined as 12.85±5.75 mg L^{-1}. According to the Turkish Environmental Legislation inland water resources, dissolved oxygen was classified as first class quality water (Anonymous, 1999). Lake morphometry and productivity is determined by the balance of the amount of dissolved oxygen. Given the body of water as determined by measuring Secchi disk photic zone, increasing production increases depending on the amount of dissolved oxygen (Kazanci *et al*., 2009). It has been observed that values of Secchi depth in the lake were mesured as low, although the dissolved oxygen values was not so much change between epilimnion and hypolimnion (Fig. 4).

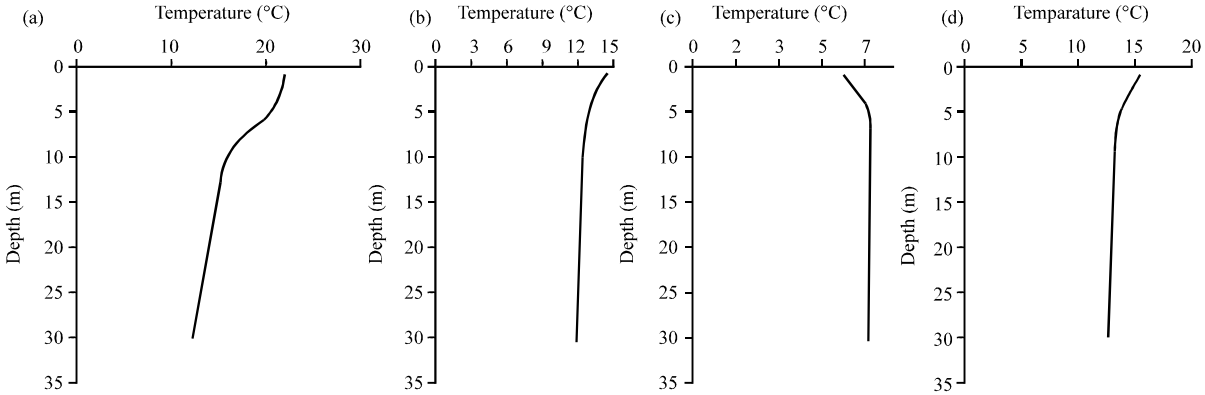

Fig. 3: The thermal stratification in Tortum Lake: a) Summer; b) Autumn; c) Winter and d) Spring

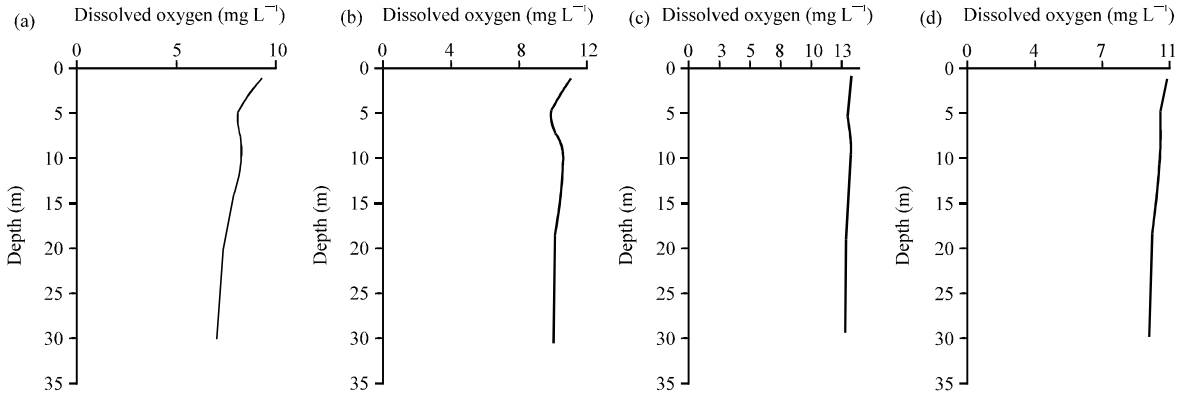

Fig. 4: Change of dissolved oxygen according to depth and seasonal in Tortum Lake: a) Summer; b) Autumn; c) Winter and d) Spring

This study, the average ammonia nitrogen, nitrite nitrogen, nitrate nitrogen and total phosphorus were determinated 0.19±0.01, 0.02±0.01, 0.08±0.01 and 0.004±0.00 mg L^{-1}, respectively. Tortum Lake had been conducted in between 2002 and 2003 years, water temperature from 6.5-23.5°C, dissolved oxygen from 7.3-8.5 mg L^{-1}, electrical conductivity from 254-362 S cm^{-1}, nitrite-nitrogen 0.003-0.012 mg L^{-1}, nitrate-nitrogen 0.3-0.65 mg L^{-1}, 0.015-0.075 mg L^{-1} of phosphate and the ammonia value in the range between the relatively high value was determined (Kivrak, 2006). Tortum Lake did not significant change period of the last 10 years.

As a result of this research conducted in Lake Tortum, ammonia nitrogen (NH_3-N) concentration average 0.19±0.01 mg L^{-1} have been identified (Table 1). This value as the vertical variations were examined the bottom and at a depth of 30 m at a depth of generally high in all stations while the surface was low. In this study, organic degradation was more than could be explained by the bottom portion. Average NH_3-N concentration when considered in terms, according to the classification of inland water resources, water quality of Tortum Lake was estimated as first class water (Anonymous, 1999).

In this study conducted in Lake Tortum, mean concentration of Nitrite Nitrogen (NO_2-N) were determined as second class water quality (0.02±0.01 mg L^{-1}) by classification of inland water resources. NO_2-N value of 20 and 30 m depth were higher than the other depths (Table 2). Dissolved oxygen is high denitrification and nitrification in freshwater environment events develops fast so the amount of nitrogen content is variable (Wetzel, 1983).

The mean concentration of Nitrate Nitrogen (NO_3-N) were determined as first class water quality (0.08±0.01 mg L^{-1}) according to the classification of inland water resources (Table 3). In Lake Tortum, vertical variation of NO_3-N values had been examined depend on depth, the bottom depth was very lower value while the both 20 and 30 m depth were higher value (Anonymous, 1999).

In this study, mean consantration of Total Phosphorus (TP) was found as 0.004±0.001 mg L^{-1} and the lake was estimated ultra-oligotrophic by both Anonymous (1982) and Wetzel (1983) whereas was as oligotrophic lake by Vollenweider and Dillon (Lind *et al*., 1993).

Table 1: Variation of ammonia concentration in the Tortum Lake according to months, stations and depth (Mean±Standard Deviation, mg L^{-1}) (n = 4)

		Months										
Sites	Depth	June	July	September	October	November	December	January	February	March	April	May
1	Surface	0.04±0.00^{Da,B}	0.06±0.00^{Ca,B}	0.00±0.00^{Ba,A}	0.09±0.00^{Ba,A}	0.10±0.00^{Aa,B}	0.03±0.00^{Ba,A}	0.02±0.00^{Da,B}	0.03±0.00^{Ba,A}	0.03±0.00^{Ba,A}	0.03±0.00^{Ba,A}	0.02±0.00^{Da,B}
	5 m	1.74±0.00^{Aa,A}	0.05±0.00^{Da,B}	0.00±0.00^{Ba,A}	0.09±0.00^{Ca,A}	1.51±0.00^{Ba,B}	0.02±0.00^{Da,B}	0.00±0.00^{Ec,C}	0.02±0.00^{Da,B}	0.03±0.00^{Ba,A}	0.03±0.00^{Ba,A}	0.03±0.00^{Ba,A}
	10 m	0.07±0.00^{Ba,A}	0.06±0.00^{Ca,B}	0.00±0.00^{Ba,A}	0.09±0.00^{Aa,A}	0.06±0.00^{Da,C}	0.02±0.00^{Da,A}	0.03±0.00^{Ba,A}	0.03±0.00^{Ba,A}	0.03±0.00^{Ba,A}	0.02±0.00^{Ea,A}	0.003±0.00^{Ea,A}
	20 m	0.08±0.00^{Ca,A}	0.06±0.00^{Da,B}	0.00±0.00^{Ba,A}	0.10±0.00^{Ba,A}	1.49±0.00^{Aa,A}	0.02±0.00^{Da,A}	0.02±0.00^{Da,B}	0.03±0.00^{Ca,A}	0.04±0.00^{Ba,A}	0.02±0.00^{Ea,A}	0.03±0.00^{Ba,A}
	30 m	0.39±0.69^{Aa,B}	0.05±0.01^{Da,B}	0.00±0.00^{Ba,A}	0.10±0.00^{Ba,A}	0.53±0.00^{Ca,A}	0.02±0.00^{Da,A}	0.03±0.00^{Ba,A}	0.03±0.00^{Ba,A}	0.03±0.00^{Ga,B}	0.23±0.00^{Ba,A}	0.02±0.00^{Da,A}
2	Surface	0.07±0.04^{Ba,A}	0.07±0.01^{Ca,A}	0.00±0.00^{Ba,A}	0.04±0.00^{Da,B}	0.10±0.00^{Aa,B}	0.02±0.00^{Ea,A}	0.02±0.00^{Da,B}	0.03±0.00^{Ba,A}	0.03±0.00^{Ba,A}	0.03±0.00^{Ga,A}	0.03±0.00^{Ba,A}
	5 m	0.04±0.00^{Ca,B}	0.07±0.02^{Ba,A}	0.00±0.00^{Ba,A}	0.00±0.00^{Fa,C}	1.59±0.00^{Aa,A}	0.02±0.00^{Ea,B}	0.01±0.01^{Da,B}	0.02±0.00^{Ga,B}	0.03±0.00^{Ba,A}	0.02±0.00^{Fa,B}	0.03±0.00^{Ba,A}
	10 m	0.03±0.00^{Da,C}	0.07±0.02^{Ba,A}	0.00±0.00^{Ba,A}	0.04±0.00^{Ca,B}	1.62±0.00^{Aa,A}	0.02±0.00^{Ea,A}	0.02±0.01^{Da,B}	0.03±0.00^{Ba,A}	0.03±0.00^{Ba,A}	0.02±0.00^{Ea,A}	0.03±0.00^{Ba,A}
	20 m	0.04±0.00^{Ca,B}	0.07±0.00^{Ba,A}	0.00±0.00^{Ba,A}	0.04±0.00^{Da,C}	0.09±0.00^{Aa,C}	0.02±0.00^{Ea,A}	0.01±0.01^{Fa,C}	0.03±0.00^{Ba,A}	0.04±0.00^{Ba,A}	0.01±0.00^{Ea,B}	0.02±0.00^{Ga,B}
	30 m	0.02±0.00^{Ha,C}	0.07±0.01^{Ba,A}	0.00±0.00^{Ba,A}	0.04±0.00^{Ca,C}	0.09±0.00^{Aa,C}	0.02±0.00^{Ea,A}	0.02±0.00^{Da,B}	0.03±0.00^{Da,A}	0.03±0.00^{Ba,A}	0.02±0.00^{Ga,B}	0.02±0.00^{Ga,A}
3	Surface	0.04±0.00^{Ca,B}	0.06±0.01^{Ba,B}	0.00±0.00^{Ba,A}	0.04±0.00^{Da,B}	1.74±0.00^{Aa,A}	0.02±0.00^{Ea,A}	0.03±0.00^{Ba,A}	0.02±0.00^{Ga,B}	0.03±0.00^{Ba,A}	0.02±0.00^{Ga,B}	0.02±0.00^{Ga,B}
	5 m	0.04±0.00^{Da,B}	0.07±0.01^{Ba,A}	0.00±0.00^{Ba,A}	0.06±0.00^{Ca,B}	0.09±0.00^{Aa,C}	0.03±0.00^{Ea,A}	0.03±0.00^{Ba,A}	0.03±0.00^{Ga,A}	0.02±0.00^{Ea,B}	0.02±0.00^{Ga,B}	0.02±0.00^{Ga,B}
	10 m	0.04±0.00^{Ca,B}	0.07±0.02^{Ba,A}	0.00±0.00^{Ba,A}	0.04±0.00^{Ca,B}	0.09±0.00^{Aa,A}	0.02±0.00^{Ea,A}	0.03±0.00^{Da,A}	0.03±0.00^{Da,A}	0.03±0.00^{Da,A}	0.02±0.00^{Ea,A}	0.02±0.00^{Ga,B}
	20 m	0.04±0.00^{Da,B}	0.07±0.01^{Ba,A}	0.00±0.00^{Ba,A}	0.05±0.00^{Ca,A}	0.99±0.00^{Aa,B}	0.01±0.00^{Ga,B}	0.03±0.00^{Ba,A}	0.03±0.00^{Ea,A}	0.03±0.00^{Ba,A}	0.01±0.00^{Ga,B}	0.02±0.00^{Ga,B}
	30 m	1.03±0.00^{Aa,A}	0.07±0.02^{Ca,A}	0.00±0.00^{Ba,A}	0.06±0.01^{Da,B}	0.48±0.00^{Ba,B}	0.01±0.00^{Ga,B}	0.03±0.00^{Ba,A}	0.03±0.00^{Ea,A}	0.04±0.00^{Da,A}	0.02±0.00^{Fa,B}	0.02±0.00^{Fa,A}

Table 2: Variation of nitrite-nitrogen concentration in the Tortum Lake according to months, stations and depth (Mean±Standard Deviation, mg L^{-1}) (n = 4)

		Months										
Sites	Depth	June	July	September	October	November	December	January	February	March	April	May
1	Surface	0.05±0.01^{Ia,B*}	0.58±0.40^{Ab,C}	0.22±0.00^{Ga,B}	0.10±0.00^{Fa,B}	0.06±0.00^{Ba,A}	0.17±0.00^{Ea,B}	0.07±0.00^{Aa,A}	0.07±0.00^{Ha,A}	0.09±0.00^{Ga,A}	0.21±0.00^{Da,A}	0.32±0.00^{Ba,A}
	5 m	0.22±0.00^{Ca,A}	0.94±0.25^{Aa,A}	0.26±0.00^{Ea,B}	0.10±0.00^{Da,A}	0.19±0.00^{Ca,A}	0.10±0.00^{Da,C}	0.06±0.00^{Fa,A}	0.06±0.00^{Fa,B}	0.08±0.00^{Ea,A}	0.07±0.01^{Ea,A}	0.28±0.00^{Ba,A}
	10 m	10.77±0.00^{Ba,A}	0.80±0.40^{Ba,A}	1.25±0.00^{Aa,A}	0.22±0.00^{Da,A}	0.05±0.00^{Ha,B}	0.10±0.00^{Ea,C}	0.04±0.00^{Ga,B}	0.06±0.00^{Ga,A}	0.08±0.00^{Ea,A}	0.08±0.00^{Fa,B}	0.31±0.00^{Ca,B}
	20 m	0.00±0.00^{Ha,A}	0.82±0.10^{Aa,B}	0.10±0.00^{Ha,B}	0.00±0.00^{Ic,C}	0.04±0.00^{Ha,B}	0.16±0.00^{Ca,C}	0.06±0.00^{Ea,A}	0.05±0.00^{Ha,A}	0.07±0.00^{Ea,B}	0.11±0.00^{Da,A}	0.20±0.00^{Ba,C}
	30m	0.24±0.02^{Ba,A}	0.56±0.42^{Aa,C}	0.02±0.00^{Ga,A}	0.10±0.00^{Da,B}	0.05±0.00^{Ga,C}	0.23±0.00^{Ca,A}	0.03±0.00^{Ha,A}	0.06±0.00^{Fa,B}	0.09±0.00^{Ea,A}	0.05±0.00^{Ga,B}	0.23±0.00^{Ca,A}
2	Surface	0.22±0.00^{Ba,A}	0.78±0.13^{Aa,A}	0.20±0.00^{Ca,C}	0.11±0.00^{Ea,A}	0.05±0.00^{Ha,B}	0.10±0.00^{Fa,C}	0.00±0.00^{Ib,C}	0.04±0.00^{Ha,C}	0.07±0.00^{Ea,C}	0.08±0.00^{Ga,B}	0.19±0.00^{Da,B}
	5 m	0.02±0.00^{Ga,B}	0.74±0.33^{Aa,C}	0.37±0.00^{Ba,A}	0.00±0.00^{Ha,B}	0.07±0.00^{Fa,B}	0.18±0.00^{Da,B}	0.00±0.00^{Ib,C}	0.05±0.00^{Ha,C}	0.07±0.00^{Ea,B}	0.07±0.00^{Ea,B}	0.22±0.00^{Ca,B}
	10 m	0.00±0.00^{Ha,B}	0.75±0.08^{Aa,B}	0.86±0.00^{Aa,B}	0.06±0.00^{Ea,C}	0.06±0.00^{Ea,A}	0.16±0.00^{Da,B}	0.00±0.00^{Ib,C}	0.06±0.00^{Ea,B}	0.07±0.00^{Ea,B}	0.09±0.00^{Ea,B}	0.26±0.00^{Ca,C}
	20 m	0.00±0.00^{Ha,A}	0.51±0.31^{Ab,C}	0.19±0.00^{Ea,A}	0.39±0.00^{Ba,A}	0.06±0.00^{Ea,A}	0.18±0.00^{Da,A}	0.01±0.00^{Ga,B}	0.05±0.00^{Ha,A}	0.07±0.00^{Ea,B}	0.06±0.00^{Ga,B}	0.08±0.00^{Ba,C}
	30 m	0.00±0.00^{Ha,B}	0.77±0.12^{Aa,A}	0.00±0.00^{Ba,B}	0.20±0.00^{Ba,A}	0.06±0.00^{Ea,B}	0.07±0.00^{Ea,B}	0.00±0.00^{Ib,B}	0.05±0.00^{Ga,C}	0.09±0.00^{Ea,A}	0.08±0.00^{Da,A}	0.06±0.00^{Ea,C}
3	Surface	0.05±0.00^{Ia,B}	0.63±0.35^{Aa,B}	0.30±0.02^{Ba,A}	0.08±0.00^{Ea,C}	0.04±0.00^{Ga,C}	0.19±0.00^{Ca,A}	0.02±0.00^{Ha,B}	0.05±0.00^{Ia,B}	0.08±0.00^{Ea,B}	0.05±0.00^{Fa,C}	0.16±0.00^{Da,C}
	5 m	0.00±0.00^{Ha,C}	0.77±0.17^{Aa,A}	0.03±0.00^{Ha,C}	0.10±0.00^{Da,A}	0.05±0.00^{Ga,C}	0.21±0.00^{Ba,A}	0.02±0.00^{Ha,B}	0.09±0.00^{Ea,A}	0.04±0.00^{Ga,C}	0.08±0.00^{Fa,A}	0.17±0.00^{Ca,C}
	10 m	0.00±0.00^{Ha,B}	0.50±0.33^{Ba,C}	0.63±0.00^{Aa,C}	0.17±0.00^{Ea,B}	0.06±0.00^{Ha,C}	0.21±0.00^{Da,A}	0.06±0.04^{Ea,A}	0.05±0.00^{Ia,B}	0.08±0.00^{Ea,A}	0.11±0.00^{Fa,A}	0.35±0.01^{Ca,A}
	20 m	0.00±0.00^{Ha,A}	0.85±0.16^{Aa,A}	0.10±0.00^{Ca,B}	0.03±0.00^{Ha,B}	0.04±0.00^{Ga,B}	0.08±0.00^{Ea,B}	0.00±0.00^{Ib,C}	0.05±0.00^{Ia,A}	0.09±0.00^{Ea,A}	0.05±0.00^{Fa,C}	0.13±0.00^{Da,B}
	30 m	0.00±0.00^{Ga,A}	0.59±0.31^{Ab,B}	0.02±0.00^{Ba,A}	0.00±0.00^{Ga,C}	0.09±0.00^{Ca,A}	0.03±0.00^{Ea,C}	0.00±0.00^{Ga,B}	0.07±0.00^{Da,A}	0.09±0.01^{Ca,A}	0.02±0.00^{Fa,C}	0.12±0.00^{Ba,B}

*$^{A-L}$The different capital letters in the same row show the differences between the stations and month and different capitalization is statistically significant ($p<0.05$), **$^{a-k}$The different lower-case letters in the same column show the differences between the stations and depth and different capitalization is statistically significant ($p<0.05$); $^{A-C}$The different ithalic letters in the same row show the differences between the depth and month and different capitalization is statistically significant ($p<0.05$)

Table 3: Variation of nitrate-nitrogen concentration in the Tortum Lake according to months, stations and depth (Mean±Standard Deviation, mg L^{-1}) (n = 4)

		Months										
Sites	Depth	June	July	September	October	November	December	January	February	March	April	May
1	Surface	0.08±0.00^{Cc,d,*}	0.08±0.00^{Cc,c}	0.07±0.00^{Db,g}	0.04±0.00^{Da,g}	0.05±0.00^{Db,g}	0.02±0.00^{Fa,g}	0.03±0.00^{Ea,g}	0.02±0.00^{Fa,g}	0.03±0.00^{Eb,g}	0.16±0.00^{Ba,c}	0.22±0.00^{Aa,c}
	5 m	0.03±0.00^{Eb,g}	0.14±0.01^{Cd,e}	0.04±0.00^{Da,c}	0.08±0.00^{Db,g}	0.05±0.00^{Db,c}	0.02±0.00^{Fb,g}	0.03±0.00^{Ea,c}	0.02±0.01^{Gb,g}	0.05±0.00^{Bb,d}	0.24±0.00^{Ab,g}	0.28±0.00^{Aa,c}
	10 m	0.03±0.00^{Ga,g}	0.33±0.01^{Bb,d}	0.13±0.00^{Da,d}	0.09±0.00^{Eb,d}	0.06±0.00^{Ea,g}	0.02±0.00^{Fb,d}	0.03±0.00^{Ea,g}	0.02±0.00^{Fb,c}	0.04±0.00^{Ea,c}	0.23±0.00^{Cc,g}	0.49±0.00^{Aa,c}
	20 m	2.97±0.00^{Aa,d}	0.19±0.02^{Da,c}	0.30±0.00^{Bb,c}	0.37±0.00^{Ca,d}	0.38±0.00^{Ca,d}	0.01±0.00^{Ga,g}	0.04±0.00^{Ea,g}	0.03±0.00^{Fa,c}	0.06±0.00^{Ea,d}	0.34±0.00^{Cc,d}	0.43±0.00^{Bb,c}
	30 m	0.14±0.00^{Db,d}	0.42±0.03^{Aa,d}	0.38±0.00^{Ba,d}	0.37±0.00^{Ba,g}	0.30±0.00^{Bb,g}	0.03±0.00^{Fa,g}	0.06±0.00^{Ea,d}	0.02±0.00^{Gb,c}	0.06±0.00^{Ea,g}	0.17±0.00^{Cd,c}	0.43±0.00^{Ab,c}
2	Surface	0.04±0.00^{Gc,c}	0.10±0.00^{Ca,g}	0.07±0.00^{Db,g}	0.06±0.00^{Eb,d}	0.10±0.00^{Cc,d}	0.02±0.00^{Ha,g}	0.04±0.00^{Fb,d}	0.02±0.00^{Ha,g}	0.05±0.00^{Eb,d}	0.23±0.00^{Bc,g}	0.44±0.00^{Ab,g}
	5 m	0.07±0.00^{Eb,d}	0.14±0.00^{Cd,e}	0.05±0.00^{Da,g}	0.08±0.00^{Da,g}	0.06±0.00^{Fb,g}	0.03±0.00^{Ga,d}	0.05±0.00^{Eb,d}	0.04±0.00^{Fb,d}	0.05±0.00^{Gb,d}	0.23±0.00^{Bc,c}	0.34±0.00^{Aa,g}
	10 m	0.02±0.00^{Hb,g}	0.30±0.00^{Ba,g}	0.10±0.00^{Da,g}	0.08±0.00^{Ea,g}	0.07±0.00^{Fb,d}	0.02±0.00^{Hb,d}	0.05±0.00^{Eb,d}	0.05±0.00^{Eb,d}	0.07±0.00^{Fb,d}	0.23±0.00^{Cc,g}	0.54±0.00^{Aa,g}
	20 m	0.10±0.00^{Da,g}	0.24±0.02^{Cb,g}	0.31±0.00^{Ba,d}	0.11±0.00^{Db,c}	0.32±0.00^{Ba,g}	0.04±0.00^{Gb,d}	0.05±0.00^{Fb,d}	0.04±0.00^{Gb,g}	0.06±0.00^{Eb,d}	0.24±0.00^{Cb,g}	0.51±0.00^{Aa,g}
	30 m	0.01±0.00^{Hc,c}	0.20±0.00^{Cc,d}	0.30±0.00^{Ba,g}	0.41±0.00^{Ba,d}	0.32±0.00^{Ba,d}	0.04±0.00^{Eb,d}	0.04±0.00^{Eb,d}	0.04±0.00^{Eb,g}	0.06±0.00^{Da,g}	0.32±0.00^{Ba,d}	0.59±0.00^{Aa,d}
3	Surface	0.06±0.00^{Eb,g}	0.13±0.00^{Cc,d}	0.11±0.00^{Db,d}	0.06±0.00^{Eb,d}	0.10±0.00^{Cc,d}	0.03±0.00^{Fb,d}	0.03±0.00^{Fb,g}	0.04±0.00^{Gc,d}	0.05±0.00^{Eb,d}	0.28±0.00^{Bb,d}	0.45±0.00^{Ac,d}
	5 m	0.07±0.00^{Db,d}	0.09±0.00^{Da,g}	0.07±0.00^{Db,d}	0.11±0.00^{Cc,d}	0.09±0.00^{Db,d}	0.02±0.00^{Gb,g}	0.04±0.00^{Fb,g}	0.04±0.00^{Fb,d}	0.05±0.00^{Eb,d}	0.27±0.00^{Bb,d}	1.42±0.00^{Aa,d}
	10 m	0.13±0.00^{Cc,d}	0.24±0.02^{Ba,c}	0.09±0.00^{Db,c}	0.08±0.00^{Da,g}	0.05±0.00^{Bb,c}	0.02±0.00^{Gb,d}	0.05±0.00^{Fb,d}	0.04±0.00^{Gb,g}	0.05±0.00^{Eb,g}	0.24±0.00^{Bb,d}	1.30±0.00^{Aa,d}
	20 m	0.05±0.00^{Hc,c}	0.20±0.00^{Cb,g}	0.32±0.00^{Ba,g}	0.35±0.00^{Ba,g}	0.33±0.00^{Ba,c}	0.04±0.00^{Gb,d}	0.05±0.00^{Fb,d}	0.05±0.00^{Fb,d}	0.06±0.00^{Eb,d}	0.13±0.00^{Dc,c}	0.80±0.00^{Aa,d}
	30 m	0.09±0.00^{Eb,g}	0.20±0.00^{Dc,c}	0.30±0.00^{Ba,d}	0.32±0.00^{Bb,c}	0.32±0.00^{Ba,d}	0.04±0.00^{Eb,d}	0.06±0.00^{Da,d}	0.06±0.00^{Da,d}	0.07±0.00^{Ca,d}	0.25±0.00^{Cc,g}	0.57±0.00^{Aa,g}

Table 4: Variation of total phosphorus concentration in the Tortum Lake according to months, stations and depth (Mean±Standard Deviation, mg L^{-1}) (n = 4)

		Months										
Sites	Depth	June	July	September	October	November	December	January	February	March	April	May
1	Surface	0.06±0.01^{Ba,*}	0.10±0.00^{Aa,c}	0.00±0.00^{Db,g}	0.01±0.00^{Ea,g}	0.01±0.00^{Ba,d}	0.03±0.00^{Da,c}	0.01±0.00^{Ea,c}	0.01±0.00^{Ea,d}	0.00±0.00^{Fa,g}	0.04±0.00^{Cc,d}	0.04±0.00^{Cc,d}
	5 m	0.06±0.00^{Ba,d}	0.13±0.00^{Aa,g}	0.01±0.00^{Da,d}	0.00±0.00^{Eb,d}	0.01±0.00^{Da,g}	0.04±0.00^{Cb,d}	0.01±0.00^{Da,c}	0.01±0.00^{Da,d}	0.04±0.00^{Cc,d}	0.01±0.00^{Db,d}	0.04±0.00^{Cc,d}
	10 m	0.01±0.00^{Da,d}	0.11±0.01^{Ab,g}	0.01±0.00^{Da,g}	0.00±0.00^{Eb,g}	0.00±0.00^{Db,g}	0.04±0.00^{Bb,g}	0.02±0.00^{Cb,c}	0.00±0.00^{Eb,d}	0.02±0.00^{Cb,g}	0.01±0.00^{Db,d}	0.04±0.00^{Bc,d}
	20 m	0.01±0.00^{Da,g}	0.11±0.01^{Ab,g}	0.01±0.00^{Da,d}	0.00±0.00^{Eb,d}	0.01±0.01^{Da,g}	0.05±0.00^{Ba,d}	0.02±0.00^{Cb,c}	0.00±0.00^{Eb,d}	0.02±0.00^{Cb,g}	0.00±0.00^{Ec,d}	0.04±0.00^{Cc,d}
	30 m	0.03±0.00^{Db,d}	0.10±0.01^{Aa,c}	0.01±0.00^{Ba,d}	0.01±0.00^{Ba,d}	0.01±0.00^{Ba,g}	0.05±0.00^{Ba,d}	0.04±0.00^{Cb,g}	0.00±0.00^{Gb,d}	0.02±0.00^{Eb,d}	0.00±0.00^{Dc,d}	0.04±0.00^{Cc,d}
2	Surface	0.00±0.00^{Eb,c}	0.13±0.00^{Ab,g}	0.01±0.00^{Ba,d}	0.00±0.00^{Da,c}	0.01±0.00^{Ba,d}	0.05±0.00^{Ba,d}	0.03±0.00^{Cb,g}	0.00±0.00^{Fb,g}	0.02±0.00^{Db,d}	0.00±0.00^{Fb,g}	0.03±0.00^{Cb,g}
	5 m	0.01±0.00^{Da,c}	0.18±0.01^{Aa,d}	0.01±0.00^{Da,d}	0.00±0.00^{Da,d}	0.01±0.00^{Da,g}	0.04±0.00^{Cb,d}	0.06±0.00^{Ba,d}	0.00±0.00^{Eb,g}	0.01±0.00^{Db,g}	0.00±0.00^{Eb,g}	0.04±0.00^{Cc,d}
	10 m	0.01±0.00^{Da,d}	0.08±0.00^{Ad,c}	0.01±0.00^{Da,g}	0.00±0.00^{Da,g}	0.01±0.00^{Da,d}	0.03±0.00^{Cc,c}	0.04±0.00^{Bb,g}	0.00±0.00^{Eb,d}	0.02±0.00^{Db,d}	0.00±0.00^{Eb,g}	0.04±0.00^{Bc,d}
	20 m	0.01±0.00^{Eb,g}	0.18±0.01^{Aa,d}	0.01±0.00^{Ba,d}	0.00±0.00^{Ea,d}	0.01±0.00^{Ba,g}	0.05±0.00^{Ba,d}	0.04±0.00^{Cb,c}	0.00±0.00^{Eb,d}	0.03±0.00^{Da,d}	0.00±0.00^{Eb,d}	0.04±0.00^{Cc,d}
	30 m	0.01±0.00^{Eb,c}	0.11±0.00^{Ab,g}	0.01±0.00^{Ba,d}	0.00±0.00^{Ea,g}	0.04±0.00^{Cc,d}	0.03±0.00^{Db,g}	0.05±0.00^{Ba,g}	0.00±0.00^{Gb,d}	0.01±0.00^{Eb,g}	0.00±0.00^{Gc,d}	0.03±0.00^{Dc,g}
3	Surface	0.02±0.00^{Db,g}	0.23±0.01^{Aa,d}	0.00±0.00^{Eb,g}	0.04±0.04^{Ca,d}	0.01±0.00^{Ba,d}	0.04±0.00^{Cb,g}	0.05±0.00^{Ba,d}	0.00±0.00^{Fb,g}	0.00±0.00^{Fb,g}	0.00±0.00^{Fb,g}	0.04±0.00^{Cc,d}
	5 m	0.02±0.00^{Eb,g}	0.11±0.00^{Ad,c}	0.01±0.00^{Ba,d}	0.00±0.00^{Ga,d}	0.03±0.00^{Da,d}	0.04±0.00^{Cb,d}	0.05±0.00^{Bb,g}	0.00±0.00^{Ga,g}	0.01±0.00^{Eb,g}	0.00±0.00^{Ga,d}	0.04±0.00^{Cc,d}
	10 m	0.01±0.00^{Eb,d}	0.33±0.00^{Aa,d}	0.02±0.00^{Da,d}	0.02±0.00^{Da,d}	0.01±0.00^{Eb,d}	0.01±0.00^{Eb,c}	0.06±0.00^{Ba,d}	0.00±0.00^{Fb,d}	0.00±0.00^{Fb,g}	0.00±0.00^{Fb,d}	0.04±0.00^{Cc,d}
	20 m	0.02±0.00^{Da,d}	0.11±0.00^{Ad,g}	0.00±0.00^{Eb,g}	0.00±0.00^{Ea,d}	0.02±0.00^{Da,d}	0.02±0.00^{Db,c}	0.05±0.00^{Bb,d}	0.00±0.00^{Ea,d}	0.00±0.00^{Eb,c}	0.00±0.00^{Ea,d}	0.03±0.00^{Dc,g}
	30 m	0.02±0.00^{Cc,g}	0.19±0.01^{Aa,d}	0.01±0.00^{Db,g}	0.00±0.00^{Eb,g}	0.01±0.00^{Db,g}	0.01±0.00^{Dc,c}	0.05±0.00^{Bb,d}	0.00±0.00^{Ea,d}	0.01±0.00^{Db,g}	0.00±0.00^{Ea,d}	0.01±0.00^{Dc,c}

Table 5: Variation of total iron concentration in The Tortum Lake according to months, stations and depth (Mean±Standard Deviation, mg L^{-1}) (n = 4)

		Months										
Sites	Depth	June	July	September	October	November	December	January	February	March	April	May
1	Surface	0.00±0.00^{Ga,*}	0.02±0.00^{Ea,d}	0.01±0.00^{Db,d}	0.01±0.00^{Bb,d}	0.00±0.00^{Ga,d}	0.05±0.00^{Ba,d}	0.04±0.00^{Cb,d}	0.02±0.00^{Eb,d}	0.04±0.00^{Cc,d}	0.10±0.06^{Aa,d}	0.03±0.00^{Db,d}
	5 m	0.00±0.00^{Ga,d}	0.02±0.00^{Ea,d}	0.00±0.00^{Da,g}	0.01±0.00^{Bb,d}	0.00±0.00^{Ga,g}	0.03±0.00^{Db,d}	0.03±0.00^{Db,d}	0.06±0.00^{Ba,d}	0.05±0.00^{Cb,d}	0.08±0.00^{Aa,d}	0.03±0.00^{Db,d}
	10 m	0.00±0.00^{Ga,d}	0.01±0.00^{Eb,g}	0.02±0.00^{Da,d}	0.06±0.00^{Ba,d}	0.00±0.00^{Ga,d}	0.03±0.00^{Cb,d}	0.03±0.00^{Cb,d}	0.02±0.00^{Db,d}	0.02±0.00^{Da,g}	0.21±0.00^{Aa,d}	0.06±0.00^{Ba,d}
	20 m	0.00±0.00^{Ga,g}	0.02±0.00^{Da,d}	0.01±0.00^{Eb,d}	0.03±0.00^{Ca,d}	0.00±0.00^{Ga,d}	0.03±0.00^{Cb,c}	0.03±0.00^{Cb,d}	0.01±0.00^{Eb,d}	0.03±0.00^{Ca,g}	0.12±0.00^{Aa,d}	0.05±0.00^{Ba,d}
	30 m	0.00±0.00^{Ga,d}	0.01±0.00^{Eb,g}	0.02±0.00^{Da,d}	0.04±0.00^{Cb,g}	0.00±0.00^{Ga,d}	0.02±0.00^{Db,c}	0.04±0.00^{Cb,d}	0.01±0.00^{Eb,d}	0.06±0.00^{Ba,d}	0.12±0.00^{Aa,d}	0.04±0.00^{Cc,d}
2	Surface	0.00±0.00^{Eb,d}	0.02±0.00^{Cc,d}	0.00±0.00^{Eb,g}	0.00±0.00^{Eb,g}	0.00±0.00^{Ea,d}	0.02±0.00^{Cb,c}	0.02±0.00^{Cb,g}	0.01±0.00^{Db,g}	0.03±0.00^{Bb,g}	0.05±0.00^{Aa,g}	0.02±0.00^{Cb,g}
	5 m	0.00±0.00^{Eb,d}	0.01±0.00^{Db,g}	0.00±0.00^{Eb,g}	0.01±0.00^{Db,d}	0.01±0.00^{Da,d}	0.03±0.00^{Bb,d}	0.02±0.00^{Cb,g}	0.00±0.00^{Eb,g}	0.03±0.00^{Bb,g}	0.04±0.00^{Aa,g}	0.02±0.00^{Cb,g}
	10 m	0.00±0.00^{Eb,d}	0.03±0.00^{Cb,d}	0.01±0.00^{Ea,g}	0.02±0.00^{Db,g}	0.00±0.00^{Ea,d}	0.03±0.00^{Cb,d}	0.02±0.00^{Db,g}	0.00±0.00^{Eb,g}	0.03±0.00^{Cb,g}	0.11±0.00^{Aa,g}	0.04±0.00^{Ba,g}
	20 m	0.00±0.00^{Eb,d}	0.01±0.00^{Eb,g}	0.01±0.00^{Ea,d}	0.01±0.00^{Ea,g}	0.00±0.00^{Ea,d}	0.06±0.00^{Ba,d}	0.02±0.00^{Db,g}	0.01±0.00^{Eb,d}	0.04±0.00^{Cb,d}	0.07±0.00^{Aa,g}	0.00±0.00^{Fb,c}
	30 m	0.01±0.00^{Db,d}	0.04±0.00^{Ba,d}	0.01±0.00^{Da,g}	0.05±0.00^{Aa,d}	0.00±0.00^{Ea,d}	0.04±0.00^{Bb,d}	0.02±0.00^{Cb,g}	0.01±0.00^{Db,d}	0.04±0.00^{Ba,g}	0.05±0.00^{Aa,g}	0.01±0.00^{Dc,c}
3	Surface	0.00±0.00^{Db,d}	0.00±0.00^{Da,g}	0.00±0.00^{Db,g}	0.00±0.00^{Db,g}	0.00±0.00^{Db,d}	0.03±0.00^{Aa,g}	0.02±0.00^{Ba,g}	0.00±0.00^{Db,c}	0.02±0.00^{Bb,c}	0.03±0.00^{Aa,c}	0.01±0.00^{Db,c}
	5 m	0.00±0.00^{Eb,d}	0.00±0.00^{Ea,c}	0.00±0.00^{Eb,g}	0.00±0.00^{Eb,g}	0.00±0.00^{Ea,g}	0.02±0.00^{Cb,c}	0.02±0.00^{Cb,g}	0.00±0.00^{Eb,g}	0.03±0.00^{Ba,g}	0.04±0.00^{Aa,g}	0.01±0.00^{Db,c}
	10 m	0.00±0.00^{Db,d}	0.00±0.00^{Da,c}	0.00±0.00^{Db,c}	0.00±0.00^{Db,c}	0.00±0.00^{Da,d}	0.01±0.00^{Cb,c}	0.02±0.00^{Ba,g}	0.00±0.00^{Eb,g}	0.02±0.00^{Bb,g}	0.05±0.00^{Aa,c}	0.02±0.00^{Ba,c}
	20 m	0.00±0.00^{Eb,d}	0.00±0.00^{Ea,c}	0.01±0.00^{Da,d}	0.01±0.00^{Ea,g}	0.00±0.00^{Ea,d}	0.04±0.00^{Bb,d}	0.02±0.00^{Cb,g}	0.01±0.00^{Db,d}	0.03±0.00^{Ba,g}	0.05±0.00^{Aa,d}	0.02±0.00^{Cb,d}
	30 m	0.00±0.00^{Eb,g}	0.00±0.00^{Ea,c}	0.00±0.00^{Eb,c}	0.00±0.00^{Eb,g}	0.00±0.00^{Ea,d}	0.03±0.00^{Bb,g}	0.01±0.00^{Db,c}	0.00±0.00^{Eb,g}	0.02±0.00^{Cb,c}	0.04±0.00^{Aa,c}	0.02±0.00^{Ca,g}

*A-LThe different capital letters in the same row show the differences between the stations and month and different capitalization is statistically significant ($p<0.05$), a-dThe different lower-case letters in the same column show the differences between the stations and depth and different capitalization is statistically significant ($p<0.05$), A-eThe different ithalic letters in the same row show the differences between the depth and month and different capitalization is statistically significant ($p<0.05$)

Tortum Lake were examined the vertical variation of the total phosphorus values and 5, 10 and 20 m were found high value (Table 4) while in the surface was low value. The amount of total phosphorus concentration depends on the compounds of phosphorus in the lake basin morphometry and organic matter metabolism in the water (Wetzel, 2001).

This research have been conducted in the Tortum Lake, the average Total iron (TFe) concentration of 0.02±0.01 mg L^{-1} have been identified (Table 5). When the algae shows good growth was found iron with form of ferric oxide in water. The value changed in a surface layer in which the development of algae was found in Tortum Lake. Mogan Lake variations in Total Dissolved Phosphorus (TDP), Soluble Reactive Phosphorus (SRP) and Total iron (TFe) concentrations and pH values in the littoral sediment porewater of macrophyte-dominated eutrophic Mogan Lake (Turkey) were determined depth wise (0-20 cm on a basis of 5 cm depths) over a period of 11 months. Additionally water temperature, dissolved oxygen, redox potential, TDP, SRP and TFe levels in the overlying water were measured. Especially in the Spring

Table 6: Variation of silica concentration in the Tortum Lake according to months, stations and depth (Mean±Standard Deviation, mg L^{-1}) (n = 4)

Sites	Depth	Months										
		June	July	September	October	November	December	January	February	March	April	May
1	Surface	0.01±0.00^{Ih,i}	0.05±0.04^{Ib,c}	1.57±0.00^{Bh,i}	1.54±0.00^{Gd,i}	1.68±0.00^{Fa,g}	1.99±0.00^{Dh,i}	2.08±0.00^{Ce,i}	1.99±0.00^{Dd,i}	2.10±0.00^{Bb,c}	2.14±0.00^{Ab,i}	1.92±0.00^{Ec,c}
	5 m	0.02±0.01^{Ie,i}	0.07±0.01^{Ie,i}	1.17±0.00^{Bf,c}	1.35±0.00^{Ga,g}	1.62±0.00^{Fb,c}	1.81±0.00^{Dd,i}	1.92±0.00^{Ae,c}	1.80±0.00^{Ec,c}	1.88±0.00^{Bc,c}	1.86±0.00^{Ce,c}	1.86±0.00^{Ce,c}
	10 m	0.00±0.00^{Ei,g}	0.05±0.03^{Ih,g}	1.36±0.00^{Bi,g}	1.68±0.00^{Ga,i}	1.59±0.00^{Fd,c}	2.01±0.00^{Dh,i}	1.95±0.00^{Fa,g}	2.12±0.00^{Aa,g}	2.06±0.00^{Bd,g}	2.05±0.00^{Ce,i}	1.99±0.00^{Dh,c}
	20 m	0.01±0.00^{Eh,i}	0.07±0.01^{Ie,i}	1.50±0.00^{Bi,g}	1.71±0.00^{Ga,g}	1.99±0.00^{Dh,c}	1.70±0.00^{Fa,c}	2.06±0.00^{Cf,g}	2.21±0.00^{Aa,i}	2.08±0.00^{Be,g}	1.98±0.00^{Dg,g}	2.01±0.00^{Ch,c}
	30 m	0.00±0.00^{Ei,g}	0.05±0.04^{Ih,g}	1.60±0.00^{Bi,g}	1.70±0.00^{Eh,i}	2.23±0.00^{Aa,i}	1.85±0.00^{Dc,g}	1.93±0.00^{Cf,c}	2.13±0.00^{Ch,i}	2.12±0.00^{Ba,g}	2.19±0.00^{Ba,i}	1.91±0.00^{Ef,c}
2	Surface	0.00±0.00^{Eh,g}	0.07±0.01^{Ie,i}	1.30±0.00^{Bf,c}	1.51±0.00^{Ea,g}	1.62±0.00^{Fb,c}	1.71±0.00^{Fa,g}	2.04±0.00^{Ce,g}	1.82±0.00^{Ec,c}	2.15±0.00^{Ab,g}	2.08±0.00^{Bb,c}	2.06±0.00^{Cc,g}
	5 m	0.00±0.00^{Ei,g}	0.05±0.04^{Ih,g}	1.37±0.00^{Gi,g}	1.36±0.00^{Eh,i}	1.90±0.00^{Fa,i}	1.37±0.00^{Ga,c}	2.17±0.00^{Aa,i}	1.91±0.00^{Ea,g}	2.11±0.00^{Bd,g}	2.09±0.00^{Cc,i}	2.03±0.00^{Dd,g}
	10 m	0.01±0.00^{Eg,i}	0.07±0.00^{Ie,i}	1.38±0.00^{Bc,i}	1.51±0.00^{Ga,g}	1.88±0.00^{Dd,i}	1.70±0.00^{Fa,g}	2.08±0.00^{Ce,i}	1.44±0.00^{Hc,c}	2.14±0.00^{Ab,i}	1.92±0.00^{Dc,c}	2.10±0.00^{Be,g}
	20 m	0.00±0.00^{Ei,g}	0.04±0.03^{Hi,g}	1.80±0.00^{Bh,i}	1.23±0.00^{Gc,c}	2.03±0.00^{Ce,i}	1.80±0.00^{Eh,g}	2.07±0.00^{Bf,i}	1.81±0.00^{Ed,c}	2.08±0.00^{Ae,g}	1.93±0.00^{Dd,c}	2.08±0.00^{Ah,i}
	30 m	0.01±0.00^{Eg,i}	0.07±0.00^{Ie,i}	1.60±0.00^{Bi,g}	1.13±0.00^{Hf,c}	1.99±0.00^{Dh,c}	1.92±0.00^{Fa,i}	2.10±0.00^{Bh,i}	1.90±0.00^{Gb,c}	2.16±0.00^{Aa,i}	2.01±0.00^{Dd,g}	2.05±0.00^{Cd,g}
3	Surface	0.00±0.00^{Ei,g}	0.06±0.03^{Ih,g}	1.41±0.00^{Bi,g}	1.45±0.00^{Eh,c}	1.71±0.00^{Fa,g}	1.52±0.00^{Ga,c}	1.98±0.00^{Dh,c}	1.97±0.00^{Da,g}	2.17±0.00^{Aa,i}	2.10±0.00^{Bb,g}	2.09±0.00^{Cc,i}
	5 m	0.00±0.00^{Ai,g}	0.07±0.01^{Ie,i}	1.40±0.00^{Bd,i}	1.08±0.00^{Hc,c}	1.79±0.00^{Fa,g}	1.53±0.00^{Ga,g}	1.99±0.00^{Dd,g}	2.19±0.00^{Ba,i}	3.36±0.00^{Aa,i}	1.99±0.00^{Dd,g}	2.11±0.00^{Cc,i}
	10 m	0.00±0.00^{Ei,g}	0.03±0.02^{Hi,c}	1.23±0.00^{Bc,c}	1.25±0.00^{Eh,c}	1.79±0.00^{Fa,g}	1.67±0.00^{Fa,c}	1.53±0.00^{Ga,c}	2.33±0.00^{Aa,i}	2.14±0.00^{Bb,i}	2.00±0.00^{Dd,g}	2.11±0.00^{Cc,i}
	20 m	0.00±0.00^{Ei,g}	0.04±0.03^{Ti,g}	1.80±0.00^{Bh,i}	1.30±0.00^{Ie,g}	2.02±0.00^{Da,g}	1.97±0.00^{Fa,i}	1.83±0.00^{Gd,c}	2.14±0.00^{Ba,g}	2.18±0.00^{Aa,i}	2.12±0.00^{Cc,i}	2.05±0.00^{Dd,g}
	30 m	0.00±0.00^{Ei,g}	0.07±0.00^{Ie,i}	1.65±0.00^{Bh,i}	1.96±0.00^{Fa,i}	2.00±0.00^{Da,g}	1.69±0.00^{Eh,c}	1.94±0.00^{Ce,g}	2.12±0.00^{Ba,g}	2.01±0.00^{Dd,c}	1.97±0.00^{Ea,c}	2.16±0.00^{Aa,i}

Table 7: Variation of sulfate concentration in the Tortum Lake according to months, stations and depth (Mean±Standard Deviation, mg L^{-1}) (n = 4)

Sites	Depth	Months								
		September	October	November	December	January	February	March	April	May
1	Surface	20.69±0.00^{Aa,i}	20.55±0.00^{Ad,i}	21.22±0.03^{Aa,i}	22.94±0.03^{Aa,i}	22.77±0. 12^{Aa,c}	21.58±0. 00^{Ae,g}	21.87±0.07^{Aa,g}	20.91±0.03^{Ae,c}	17.21±0.06^{Bd,i}
	5 m	19.71±0.03^{Dh,g}	18.95±0.03^{Dg,g}	16.29±0.06^{Fe,c}	21.24±0.00^{Ce,g}	23.44±0. 00^{Ba,g}	19.90±0.04^{De,c}	20.70±0.03^{Ce,c}	24.54±0.06^{Aa,g}	16.05±0.05^{Fe,g}
	10 m	18.42±0.00^{Fe,c}	22.68±0.00^{Ae,i}	17.29±0.04^{Fd,c}	22.89±0.00^{Aa,g}	23.21±0. 00^{Aa,g}	21.91±0. 03^{Ab,c}	20.67±0.03^{Ad,c}	22.41±0.06^{Aa,g}	17.52±0.05^{Fe,c}
	20 m	23.04±0.03^{Bb,i}	22.99±0.04^{Bb,g}	18.11±0.09^{Ge,c}	22.34±0.00^{Ba,i}	24.05±0.03^{Aa,g}	21.03±0. 00^{Ce,c}	20.43±0.09^{Ce,g}	23.49±0.10^{Bb,i}	21.50±0.09^{Ce,c}
	30 m	23.72±0.00^{Ba,i}	23.02±0.00^{Ba,c}	20.00±0.06^{Eb,c}	21.24±0.00^{Ce,c}	23.50±0. 04^{Ba,g}	22.49±0. 03^{Ba,i}	21.22±0.07^{Bb,c}	22.48±0.11^{Ba,g}	24.02±0.08^{Aa,c}
2	Surface	14.83±0.03^{Ce,c}	18.33±0.03^{Ce,c}	20.26±0.03^{Ce,g}	22.61±0.04^{Ce,g}	32.20±0. 06^{Aa,i}	19.31±0. 00^{De,c}	18.26±0.03^{Ce,c}	24.09±0.06^{Ba,g}	17.06±0. 00^{Ee,g}
	5 m	19.81±0.03^{Bd,i}	18.76±0.00^{De,c}	20.14±0.00^{Be,g}	20.84±0.03^{De,c}	21.82±0. 00^{Bd,c}	21.79±0. 06^{Ba,i}	23.44±0.00^{Ba,i}	25.50±0.00^{Aa,i}	18.14±0. 14^{Cd,i}
	10 m	22.56±0.36^{Cc,i}	22.32±0.03^{Cd,g}	19.35±0.04^{Cd,g}	21.31±0.00^{Dd,c}	23.96±0.03^{Ba,i}	23.06±0. 04^{Ba,i}	20.79±0.09^{De,g}	24.29±0.05^{Aa,i}	20.88±0.08^{Be,i}
	20 m	21.88±0.00^{Dh,c}	18.45±0.04^{Dd,c}	18.99±0.07^{De,g}	21.51±0.06^{De,c}	24.18±0. 03^{Ba,i}	21.43±0. 03^{De,g}	22.75±0.06^{Ce,i}	22.75±0.08^{Ce,g}	27.57±0.09^{Aa,i}
	30 m	21.58±0.03^{De,c}	25.36±0.00^{Ba,i}	21.19±0.07^{De,g}	23.48±0.18^{Ce,i}	21.12±0. 05^{De,c}	22.41±0. 00^{Ch,g}	22.29±0.17^{De,i}	23.39±0.06^{Ce,i}	33.73±0.08^{Aa,i}
3	Surface	18.59±0.04^{Ce,g}	19.79±0.00^{Ce,g}	17.20±0.03^{Ce,c}	21.55±0.04^{De,c}	24.15±0. 06^{Aa,g}	22.39±0. 03^{Ba,i}	22.18±0.03^{Bb,i}	24.20±0.04^{Aa,i}	17.01±0. 13^{De,c}
	5 m	18.63±0.00^{De,c}	20.02±0.03^{De,i}	25.21±0.09^{Aa,i}	21.46±0.07^{Ce,i}	23.90±0. 03^{Ba,i}	21.10±0. 00^{Ce,g}	22.51±0.09^{Ba,g}	20.22±0.10^{De,c}	15.74±0. 06^{Fe,c}
	10 m	21.37±0.00^{Be,g}	21.37±0.10^{Be,c}	22.97±0.03^{Bb,i}	27.51±0.16^{Aa,i}	22.77±0. 05^{Ba,c}	22.68±0. 00^{Ba,g}	21.87±0.07^{Ba,i}	21.82±0.05^{Be,c}	19.58±0.05^{Be,g}
	20 m	22.54±0.00^{Dh,g}	29.56±0.00^{Aa,i}	21.60±0.07^{De,i}	21.56±0.03^{De,g}	23.47±0. 05^{Ce,c}	23.14±0. 17^{Ce,i}	20.02±0.09^{Be,c}	20.76±0.06^{Ce,c}	26.57±0.08^{Ah,g}
	30 m	23.58±0.03^{Ba,g}	23.13±0.03^{Bb,g}	21.29±0.09^{Be,i}	22.92±0.09^{Bb,g}	23.97±0. 00^{Ba,i}	19.93±0. 00^{De,c}	21.48±0.03^{Be,g}	21.98±0.04^{Ce,c}	29.98±0.05^{Aa,g}

$^{A-L}$The different capital letters in the same row show the differences between the stations and month and different capitalization is statistically significant ($p<0.05$); $^{a-i}$The different lower-case letters in the same column show the differences between the stations and depth and different capitalization is statistically significant ($p<0.05$); $^{a-c}$The different ithalic letters in the same row show the differences between the depth and month and different capitalization is statistically significant ($p<0.05$)

and Summer months constituting a large portion of the research period, seasonal variation of SRP at depths between 0-5 and 15-20 cm were not found to be statistically significant ($p>0.01$). However, in the fall and Winter months, surface sediment (0-5 cm) SRP values were elevated in comparison with deeper sediment depths. As for Tfe values, no clearseasonal variation was evident at different depths. Due to the fact that Tfe concentrations in the overlying water (101.25-511.67 mg/m^3) were lower than iron concentrations in the porewater (104.00-783.00 mg/m^3) positive phosphorus release remained at low levels. In this eutrophic lake in which action is continuing to reduce the external phosphorus load, monitoring SRP variations in the overlying water and driking water would be beneficial (Pulatsu and Topcu, 2009).

In this study, the average concentration Silica (Si) was calculated 0.60±0.03 mg L^{-1} (Table 6). Although, dissolved silicates are plenty of fresh waters, the other chemical reactions affect the silicate concentration by diatoms. Silicates value varies depending on the pH for example, pH value is to be between 3 and 7, a high concentration of dissolved silicate in water but when pH value is 9, silicate is influenced concentration of carbonic acid (Wetzel and Likens, 2001).

As a result of in this study was identified mean sulfate concentration 0.31±0.00 mg L^{-1}. Dissolved sulfate is the dominant form of sulfur in the water by the action of bacterial metabolism and the pH is converted to hydrogen sulfide (Wetzel, 2001). In the study, sulfate concentrations were found the highest at 30 m among the other deeps. Because it was measured that both nitrification and decay were much more than surface in the lake (Table 7).

CONCLUSION

Tortum Lake has deep lake status and the deep lake affected by self-forming rocks. Tortum Lake was estimated as first class water quality for dissolved oxygen, pH, ammonia-nitrogen, nitrate-nitrogen as nitrite-nitrogen concentration was found second class water quality. Lake was classified mezotrofik by Secchi depth, whereas total phosphorus concentration was found oligotrophic level.

Tortum Lake is clean water class but the results demonstrated that long-term monitoring programs are needed due to the irrigational and recreational use of this lake system. Moreover, further researches should be conducted that changes of phytoplankton composition is estimated as well as the effect of sediment characteristics on water quality.

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