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EVALUATION OF WATER QUALITY IN EUTROPHIC SHALLOW LAKES: CASE STUDY ON LAKE ULUABAT, TURKEY

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ABSTRACT

Lake Uluabat is one of the most important shallow lakes in Turkey. The lake is located 15 km south of the Marmara Sea and 30 km west of the city of Bursa. The lake is very important in terms of biodiversity, but knowledge of its water quality is somewhat limited. The objective of this study was to assess water quality in Lake Uluabat and provide information for future management decisions. The temperature (T), pH, electrical conductivity (EC), dissolved oxygen (DO), alkalinity, chemical oxygen demand (COD), nitrogen species, phosphorus species, and chlorophyll-a (Chl-a) concentrations were monitored monthly at ten sampling points in the lake between August 2013 and July 2014. As a result, it was determined that the lake water has the characteristics of class 4 waters according to the Turkish Surface Water Quality Management Regulations (SWQMR). Also it was determined that Mustafakemalpaşa Brook carries significant amount of pollution loads into the lake. According to qualitative and quantitative observations, the effects of human impact and current status of the lake were determined. The physical and chemical characteristics of the lake water have changed according to human activities and nutrient loadings. According to the trophic level values and concentration values, the Lake exceeded the regulation limits.

Keywords: Lake Uluabat, Monitoring, Pollution, Trophic State, Water Quality

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INTRODUCTION

Physical and chemical characteristics of lake waters and their variations govern the environmental, ecological, and biological status of the lakes. Lakes are also subjected to a high human impact. Many studies examined the physical and chemical status of the lake water and demonstrated which factors controlled the water quality, ecologic status and eutrophication patterns [1-6]. Lake Uluabat is one of the most important wetland area in Turkey and is increasingly threatened by pollution [1]. Organic and inorganic pollution has also affected the nutrient status of the lake, and in this respect, the greatest concern deals with eutrophication [7-8]. Intensive agricultural activities, industrial activities, and mining in the lake basin have adversely influenced the water quality in the lake. Water quality of the lake is somewhere limited. It is therefore essential to prevent and control water pollution and to implement regular monitoring programs for water quality management [9]. Lake Uluabat is one of the richest lakes in terms of aquatic plants besides fish and bird populations in Turkey. For this reason, the Lake was placed under protection by the RAMSAR agreement in 1998 and the living lakes partnership program of 2002. The aim of this study was to examine water quality variables in Lake Uluabat each month between August 2013 and July 2014, to classify the lake water quality according to the "SWQMR". Also, eutrophic level of the lake has also been identified. This study will provide baseline data for future water quality and management studies.

MATERIALS AND METHODS

Study Area

Lake Uluabat is located between 40°10' N and 28°36' E in northwestern Turkey (Figure 1), near the southern part of the Sea of Marmara, 30 km away from Bursa. The lake is the most important part of the Susurluk basin. It is a large but shallow lake with a mean depth of 1.5-2 m, and maximum depth 4.5 m in winter season [10]. The surface area of the lake was measured between 161 and 138 km^2 [1]. The lake is recharge principally by the Mustafakemalpaşa (MKP) Brook from the southwest and has its only outlet in the northwest, where it drains into the Kocasu Brook [11]. The location of Lake Uluabat and the sampling points are shown in Figure 1.

Sampling Methods and Analysis

Water samples were collected from 10 different sampling points marked S1-S10 in Figure 1. The sampling points were selected according to their distances from the contaminant sources in the lake and their hydrodynamic characteristics. Samples were also taken from the MKP Brook. Water samples were taken monthly between August 2013 July 2014 and they were collected from 0.5 m below the surface using dark polyethylene bottles. During sampling in situ temperature (T), pH, electrical conductivity (EC), dissolved oxygen (DO), and chlorophyll-a (Chl-a) were measured using Hach brand OTT-Hydrolab DS5 device. The device was calibrated with appropriate solutions prior to every field work. Alkalinity, orthophosphate (PO_4-P), total phosphorus (TP), ammonium nitrogen (NH_4-N), nitrate nitrogen (NO_3-N), total nitrogen (TN), total kjeldahl nitrogen (TKN), and chemical oxygen demand (COD) parameters measured according to the American Public Health Association standard methods [12]. The results were evaluated in comparison with "SWQMR".

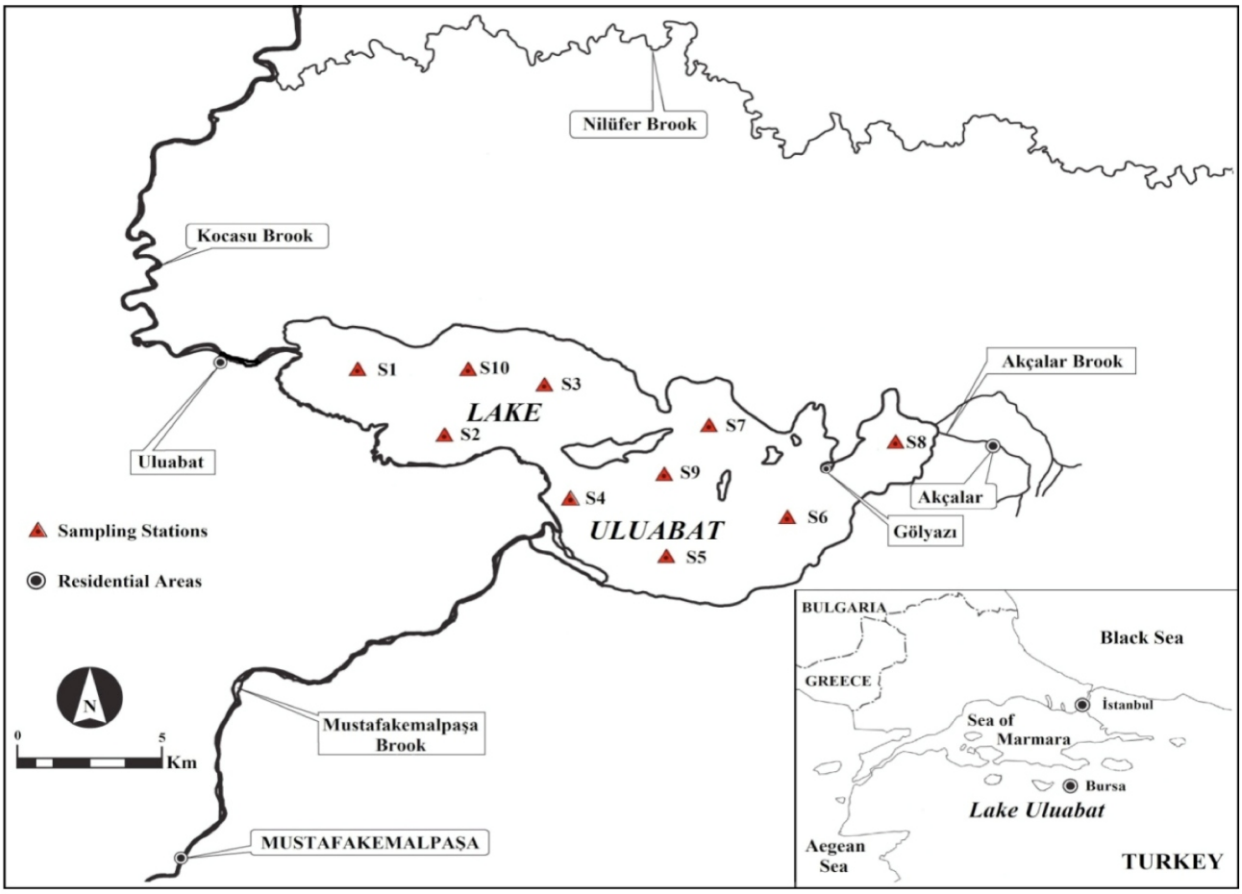


Figure 1. Location of Lake Uluabat and Sampling Points

The "Surface Water Quality Management Regulations" (SWQMR) divides inland waters into four classes; class 1. high quality water; class 2. slightly polluted water; class 3. polluted water; and class 4. highly polluted water [13]. Table 1 shows the SWQMR classifications [14]. Trophic state of the Lake Uluabat has been determined in accordance with Carlson (1977). Statistical tests were performed using the SPSS 22.0 program. ANOVA was performed to determine the variability of the water quality variables within and between both 10 sampling points and 12 months in Table 2. As shown in Table 2, spatial variations of water quality variables exception of pH, EC, TKN, and TP were not significant (ANOVA, $p>0.05$), but temporal variations of all parameters were significant (ANOVA, $p<0.05$).

Therefore, the mean values of all water quality variables of all sampling points were evaluated. Also, TSI values were calculated using mean values of all sampling points.

RESULTS AND DISCUSSION

Water Quality

After one year monitoring processes, the average values of water quality parameters were given in Figure 2, some statistic values of the water quality parameters are summarized in Table 3 and correlation matrix for these parameters are shown in Table 4.

The mean temperature in Lake Uluabat was found to be 16.31°C, with a maximum of 26.4°C in August and minimum of 5.8°C in December. In terms of temperature, Lake Uluabat can be classified as class 1, according to SWQMR. The temperature was found to have significant negative correlations with EC (r -0.475), and DO (r -0.796) and significant positive correlations with COD (r 0.429), NO_3-N (r 0.565), NH_4-N (r 0.259), TKN (r 0.466), TN (r 0.498), PO_4-P (r 0.419), TP (r 0.623), Chl-a (r 0.317). The pH is an important variable in water quality assessment as it influences many biological and chemical processes within a water body [15]. Also pH value is one important factor to control eutrophication in a lake [16]. The mean pH was 8.54, the lowest pH was 8.1 in June, the highest pH was 9.1 in July. In terms of pH, the Lake can be classified as class 3, according to the SWQMR. pH was significantly and negatively correlated with alkalinity (r -0.359). The lowest EC measured in Lake Uluabat was 530 µS/cm, in June; the highest EC was 766 µS/cm in January, and the mean EC was 624.41 µS/cm. In terms of EC, Lake Uluabat was in class 2, according to the SWQMR. EC was significantly and negatively correlated with T (r -0.475), NO_3-N (r -0.231), TKN (r -0.224), TN (r -0.226), PO_4-P (r -0.336), and TP (r -0.522), and significant positive correlations with DO (r 0.380), and Alkalinity (r 0.253). The lowest DO measured in Lake Uluabat was 7.3 mg/l, in August; the highest DO was 12.3 mg/l, in March, and the mean DO was 10.12 mg/l. Dissolved oxygen values dropped to low levels in summer with the increase in the temperature, also reached high levels during winter months. The reason for the measurement of low dissolved oxygen concentration in August, the algae population reached maximum values in this month. In terms of DO, Lake Uluabat is in class 1, according to the SWQMR. DO is significantly negatively correlated with T (r -0.796), COD (r -0.609), NO_3-N (r -0.560), NH_4-N (r -0.357), TKN (r -0.492), TN (r -0.516), PO_4-P (r -0.641), TP (r -0.763), Chl-a (r -0.454), and significantly positively correlated with EC (r 0.380). The mean alkalinity in Lake Uluabat was found to be 238.45 mg $CaCO_3$/l, with a maximum of 257 $CaCO_3$/l in May, and minimum of 193 $CaCO_3$/l in December. High alkalinity is observed in the water bodies with eutrophication particularly spring season [17]. Also high alkalinity of lake water might be due to the use of detergents and wash off from area having calcite and dolomite minerals could also partly contribute to alkalinity [17, 18]. There is no SWQMR classification for this parameter. Alkalinity is significantly negatively correlated with pH (r -0.359), PO_4-P (r -0.349), and TP (r -0.228), and significantly positively correlated with EC (r 0.253). The mean COD was 71.95 mg/l, the lowest COD was 16 mg/l in January, the highest COD was 192 mg/l in August. In terms of COD, the Lake is in class 4 (highly polluted water), according to the SWQMR. COD is significantly negatively correlated with DO (r -0.609), and significantly positively correlated with T (r 0.429), NO_3-N (r 0.400), NH_4-N (r 0.366), TKN (r 0.440), TN (r 0.451), PO_4-P (r 0.487), TP (r 0.465), and Chl-a (r 0.565). In summer, as the microbial activities increase, the degradation rate of the organic matters increases. Therefore, the DO level decreases where COD increase [2, 10].

Table 1. Water Quality Classifications based on SWQMR [14]

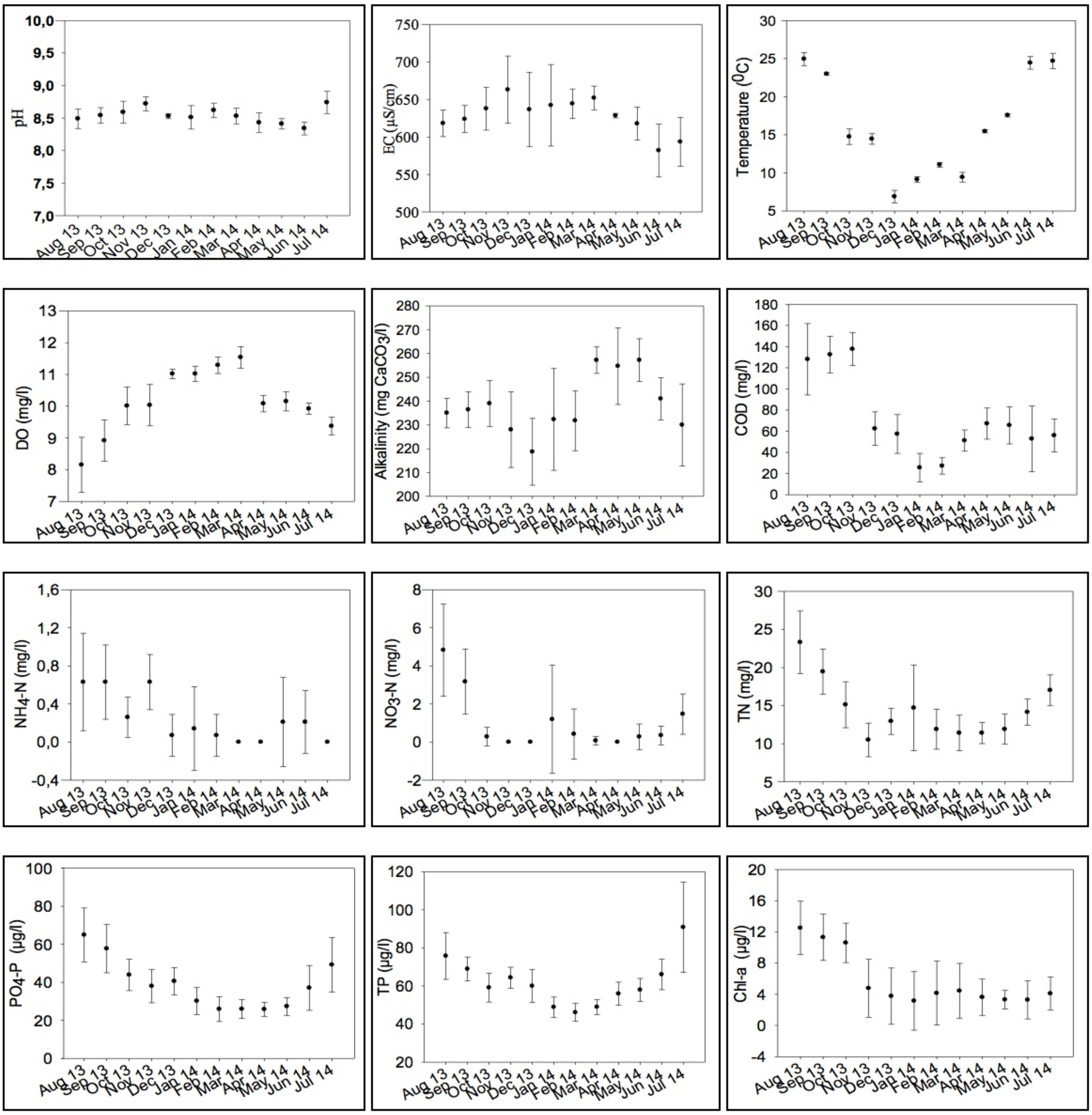
	Water Quality Classes			
Parameters	1	2	3	4
T (ºC)	≤25	≤25	≤30	>30
pH	6.5-8.5	6.5-8.5	6.0-9.0	<6.0 or >9.0
EC (µs/cm)	<400	400-1000	1001-3000	>3000
DO (mg/l)	>8	6-8	3-6	<3
COD (mg/l)	<25	25-50	50-70	>70
NO_3-N (mg/l)	<5	5-10	10-20	>20
NH_4-N (mg/l)	<0.2	0.2-1	1-2	>2
TKN (mg/l)	0.5	1.5	5	>5
TP (mg/l)	<0.03	0.03-0.16	0.16-0.65	>0.65

Table 2. ANOVA (Between Groups) of water quality variables in Lake Uluabat

ANOVA(The factor is sampling month)	Sum of Squares	df	Mean Square	F	Sig.
Temperature	4787.7	11	435.25	957.44	0.000
pH	1.5	11	0.13	7.490	0.000
EC	59876.6	11	5443.33	5.283	0.000
DO	109.6	11	9.96	47.250	0.000
Alkalinity	16457.2	11	1496.11	8.984	0.000
COD	166740.9	11	15158.26	41.866	0.000
NO_3-N	252.9	11	22.99	13.261	0.000
NH_4-N	16.6	11	1.51	2.822	0.003
TKN	645.7	11	58.70	13.410	0.000
TN	1600.8	11	145.53	17.543	0.000
PO_4-P	18878.0	11	1716.18	19.581	0.000
TP	17507.0	11	1591.54	17.051	0.000
Chl-a	1358.3	11	123.49	12.939	0.000
ANOVA(The factor is sampling point)					
Temperature	7.6	9	0.84	0.019	1.000
pH	0.5	9	0.05	2.143	0.032
EC	31796.5	9	3532.95	2.789	0.006
DO	6.2	9	0.69	0.608	0.788
Alkalinity	3650.7	9	405.63	1.449	0.176
COD	3261.3	9	362.37	0.197	0.994
NO_3-N	21.0	9	2.33	0.613	0.784
NH_4-N	4.18	9	0.46	0.729	0.682
TKN	173.77	9	19.30	2.248	0.024
TN	290.0	9	32.22	1.606	0.122
PO_4-P	3873.6	9	430.41	1.935	0.054
TP	4385.7	9	487.30	2.310	0.020
Chl-a	179.3	9	19.93	0.992	0.451

df degree of freedom, F frequency, Sig. level of significance

Figure 2. Temporal variations in water quality parameters of Uluabat Lake (Mean±SD)



In spring and winter months, as the volume of the rains and winds increase, circulation occurs in the lake and the flow rates which recharge the lake increase, and as a result of these mixings the lake water gains oxygen again [1, 10, 17]. The mean NO_3-N concentration was 1 mg/l, the lowest NO_3-N was 0 mg/l, and the highest NO_3-N was 9.8 mg/l in August. When the results evaluated, it has been found nitrate levels are higher in summer than other seasons. In terms of NO_3-N concentration, the Lake is in class 1, according to SWQMR. NO_3-N concentration is significantly negatively correlated with EC (r -0.231), and DO (r -0.560), and significantly positively correlated with T (r 0.565), COD (r 0.400), NH_4-N (r 0.225), TKN (r 0.639), TN (r 0.753), PO_4-P (r 0.472), TP (r 0.461), and Chl-a (r 0.382). The mean NH_4-N concentration was 0.32 mg/l, the lowest NH_4-N was 0 mg/l, and the highest NH_4-N was 6.3 mg/l in October. In general, NH_4-N concentrations were higher in rainy months and summer. In terms of NH_4-N concentration, the Lake is in class 2, according to SWQMR. NH_4-N concentration is significantly negatively correlated with DO (r -0.357), and significantly positively correlated with T (r 0.259), COD (r 0.366), NO_3-N (r 0.225), TKN (r 0.359), TN (r 0.345), PO_4-P (r 0.343), TP (r 0.261), and Chl-a (r 0.304).

The mean TKN concentration was 13.48 mg/l, the lowest TKN was 8.4 mg/l in February and March, and the highest TKN was 23.1 mg/l in August. In terms of TKN concentration, the Lake is in class 4, according to SWQMR. TKN concentration is significantly negatively correlated with EC (r -0.224), DO (r -0.492), and significantly positively correlated with T (r 0.466), COD (r 0.440), NO_3-N (r 0.639), NH_4-N (r 0.359), TN (r 0.980), PO_4-P (r 0.520), TP (r 0.387), and Chl-a (r 0.463). The mean TN concentration was 14.48 mg/l, the lowest TN was 8.4 mg/l in February and March, and the highest TN was 32.9 mg/l in August. There is no SWQMR classification for TN. TN concentration is significantly negatively correlated with EC (r -0.226), DO (r -0.516), and significantly positively correlated with T (r 0.498), COD (r 0.451), NO_3-N (r 0.753), NH_4-N (r 0.345), TKN (r 0.980), PO_4-P (r 0.528), TP (r 0.407), and Chl-a (r 0.466). In this study it has been found all nitrogen forms were higher in summer and autumn. Nitrogen and phosphorus forms are assessed due to their limiting role in the primary production of the phytoplankton [19]. Primary production high in spring and summer, and agricultural activities in the region start same seasons, so the transport of nitrogen forms from agricultural areas into the lake increase at that time [1]. Also main sources of nitrogen forms in Uluabat Lake basin were domestic wastewater, agricultural activities and stockbreeding [20].

The mean PO_4-P concentration in Lake Uluabat was 38.88 µg/l, the lowest PO_4-P was 20.6 µg/l in February, and the highest PO_4-P was 74.4 µg/l in August. PO_4-P concentration is significantly negatively correlated with EC (r -0.336), DO (r -0.641), Alkalinity (r -0.349), and significantly positively correlated with T (r 0.419), COD (r 0.487), NO_3-N (r 0.472), NH_4-N (r 0.343), TKN (r 0.520), TN (r 0.528), TP (r 0.760), and Chl-a (r 0.360). The mean TP concentration in Lake Uluabat was 61.87 µg/l, the lowest TP was 38.7 µg/l in February, and the highest TP was 131.7 µg/l in August. In terms of TP concentration, the Lake is in class 2, according to SWQMR. TP concentration is significantly negatively correlated with EC (r -0.522), DO (r -0.763), Alkalinity (r -0.228), and significantly positively correlated with T (r 0.623), COD (r 0.465), NO_3-N (r 0.461), NH_4-N (r 0.261), TKN (r 0.387), TN (r 0.407), PO_4-P (r 0.760), and Chl-a (r 0.246). Phosphorus is the most significant factor limiting for the primary production [1]. The highest PO_4-P concentrations were generally measured in summer, and this could be related to the lower water level in the lake during this period. Levels of microbial activity rise at high temperatures, so the release of phosphorus from sediment is quite dependent on temperature. The activity of the macrophytes found over much of the bottom of the Lake increase in summer, which in turn increases the amount of phosphorus released from the sediment. Macrophytes do not actually release phosphorus, but they lead to an increase in the release of phosphorus from the sediment by decreasing the DO through respiration or by increasing the pH of the water by photosynthesis [21, 22]. The mean Chl-a concentration in Lake Uluabat was 5.75 µg/l, the lowest Chl-a was 0.14 µg/l in April, and the highest Chl-a was 16.07 µg/l in August. There is no SWQMR classification for this parameter. Chl-a concentration is significantly negatively correlated with DO (r -0.454), and significantly positively correlated with T (r 0.317), COD (r 0.565), NO_3-N (r 0.382), NH_4-N (r 0.304), TKN (r 0.463), TN (r 0.466), PO_4-P (r 0.360), and TP (r 0.246). Chl-a concentrations are useful for evaluating the concentrations of phytoplankton biomass [4]. In summer, temperature increase also photosynthesis increase, algae reproduce in the Lake and the concentration level of Chl-a increase [23]. In this study, results show that high levels of Chl-a concentrations in spring and summer, when the temperature is high. As shown in Table 3, the coefficients of variation (CVs) for the pH, EC, DO, Alkalinity, NO_3-N, NH_4-N were 1.92-10.37 %, and the CVs for T, TKN, TN, PO_4-P, TP were 22.7-39.68 %, while COD (57.8 %) and Chl-a (77.9 %) varied considerably.

Water Quality of MKP Brook

MKP Brook is the major flowing into Lake Uluabat. The Brook has got the drainage area of 10414 km^2 [1]. Water quality of this brook was determined during sampling period. Flow measurement of the Brook was obtained from the Regional Directorate of State Hydraulic Works (DSI). Annual average flow rate value of the Brook was determined to be 6.99 m^3/s in sampling period. The highest flow was measured in October (11.1 m^3/s), the lowest in July (1.84 m^3/s).

MKP Brook carries significant amount of suspended solids to lake [1]. In a study of Aksoy and Özsoy in 1998, it is observed that surface area and volume of the lake decreased to a ratio of 12% between the years of 1984, 1993, and 1998. This was caused by the lignite plants and the sand pits around the lake [24]. In addition there are many residential areas around the Brook. Some of these areas are discharge wastewater to MKP Brook, and finally to Lake Uluabat [1,11]. Figure 3 has shown the daily average flow of MKP Brook, and Table 5 has shown water quality and loads of some water quality parameters of the Brook. The loads were calculated using data from analyses and flow data from DSI.

As shown in Table 5, the Brook was carried excessive amount of COD, TKN, and TN (tone/month) into the Lake. Also, it was carried phosphorus forms, and nitrogen forms into the Lake.

Table 3. Some statistic values of the water quality parameters in Lake Uluabat

Parameters	N	Mean	Median	SD	CV (%)	Maximum	Minimum
T (^{0}C)	12	16.31	15.3	6.37	39.05	26.4	5.8
pH	12	8.54	8.5	0.17	1.99	9.1	8.1
EC (µs/cm)	12	628.4	627.5	37.92	6.03	766	530
DO (mg/l)	12	10.12	10.1	1.05	10.37	12.3	7.3
Alk. (mg /l)	12	238.4	238	17.01	7.13	257	193
COD (mg/l)	12	71.95	64	41.59	57.80	192	16
NO_3-N (mg/l)	12	1.00	0	1.92	1.92	9.8	0
NH_4-N (mg/l)	12	0.32	0	0.79	2.46	6.3	0
TKN (mg/l)	12	13.48	12.6	3.06	22.70	23.1	8.4
TN (mg/l)	12	14.48	13.3	4.58	31.63	32.9	8.4
PO_4-P (µg/l)	12	38.88	34.5	15.43	39.68	74.4	20.6
TP (µg/l)	12	61.87	60.4	15.22	24.59	131.7	38.7
Chl-a (µg/l)	12	5.75	3.9	4.48	77.90	16.07	0.14

N number of samples, *SD* standard deviation, *CV* coefficient of variation

Table 4. Correlation matrix between water quality parameters

Pearson's rho	T	pH	EC	DO	Alk.	COD	NO_3-N	NH_4-N	TKN	TN	PO_4-P	TP	Chl-a
T	1.000												
pH	-0.140	1.000											
EC	**-0.475**	0.098	1.000										
DO	**-0.796**	0.050	**0.380**	1.000									
Alk.	0.107	**-0.359**	**0.253**	0.094	1.000								
COD	**0.429**	-0.046	-0.094	**-0.609**	0.054	1.000							
NO_3-N	**0.565**	0.030	**-0.231**	**-0.560**	-0.045	**0.400**	1.000						
NH_4-N	**0.259**	0.069	0.114	**-0.357**	-0.127	**0.366**	**0.225**	1.000					
TKN	**0.466**	0.061	**-0.224**	**-0.492**	-0.093	**0.440**	**0.639**	**0.359**	1.000				
TN	**0.498**	0.047	**-0.226**	**-0.516**	-0.081	**0.451**	**0.753**	**0.345**	**0.980**	1.000			
PO_4-P	**0.419**	0.026	**-0.336**	**-0.641**	**-0.349**	**0.487**	**0.472**	**0.343**	**0.520**	**0.528**	1.000		
TP	**0.623**	0.010	**-0.522**	**-0.763**	**-0.228**	**0.465**	**0.461**	**0.261**	**0.387**	**0.407**	**0.760**	1.000	
Chl-a	**0.317**	0.071	0.179	**-0.454**	0.138	**0.565**	**0.382**	**0.304**	**0.463**	**0.466**	**0.360**	**0.246**	1.000

In bold, correlation significant at the $p<0.05$ level (two tailed), all cells show the correlation coefficient (r)

Table 5. Water quality and loads of some water quality parameters in MKP Brook

Parameters	Mean±SD	Load (t/month)
Flow Rate (m^3/s)	6.99±2.89	
T (^0C)	17.2±5.9	
pH	8.22±0.21	
EC (µs/cm)	729.5±94.6	
DO(mg/l)	10.3±1	
Alkalinite (mg/l)	292±21	
COD (mg/l)	90.3±73.6	1636.06
NO_3-N (mg/l)	1.17±1.94	21.19
NH_4-N (mg/l)	1.11±1.45	19.93
TKN (mg/l)	15.63±5.8	283.18
TN (mg/l)	16.8±6.95	304.38
PO_4-P (µg/l)	61.5±10.9	1.11
TP (µg/l)	81.86±12.91	1.48
Chl-a (µg/m^3)	3.39±2.28	

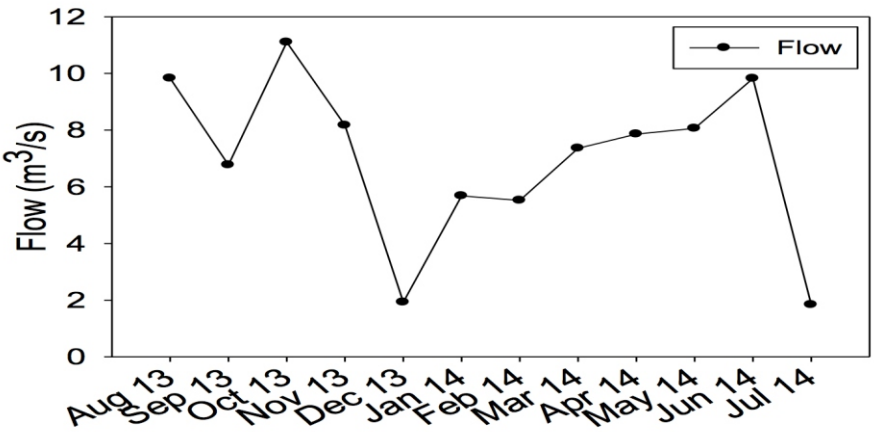


Figure 3. Daily average flow of MKP Brook

Trophic State of Lake Uluabat

The relationship between biotic and abiotic factors, the determination of the trophic level is important in lakes [25]. Point and non-point sources within the watershed area of lakes contribute to high nutrient concentrations. Algal growth in nearly all eutrophic lakes is limited by the concentration of phosphorus rather than nitrogen [26, 27]. Trophic state indices are effective methods in determining the trophic states of the lakes. Various classification criteria have been considered in order to assess the trophic condition and water quality of coastal ecosystems and freshwater lakes through the use of specific indices based on environmental factors [28]. Trophic state of the Lake Uluabat has been determined in accordance with Carlson (1977)[29]. TSI value is calculated by using the chlorophyll-a (µg/l), total phosphorus (µg/l) and total nitrogen (mg/l) concentrations. In the numeric scale which is created in accordance with the TSI formulas based on Carlson (1977), 0-40 is oligotrophic; 40-50 is mesotrophic, 50 and above is eutrophic. The oligomesotrophic level ($30<TSI<40$), passage from the mesotrophic level to the eutrophic level ($40<TSI<60$), passage from the eutrophic to the hypereutrophic level ($60<TSI<70$) and the hypereutrophic levels ($TSI>70$) have been determined in order to determine the interim passages [31]. Monthly trophic state indices for TN, TP, Chl-a were presented in Figure 4.

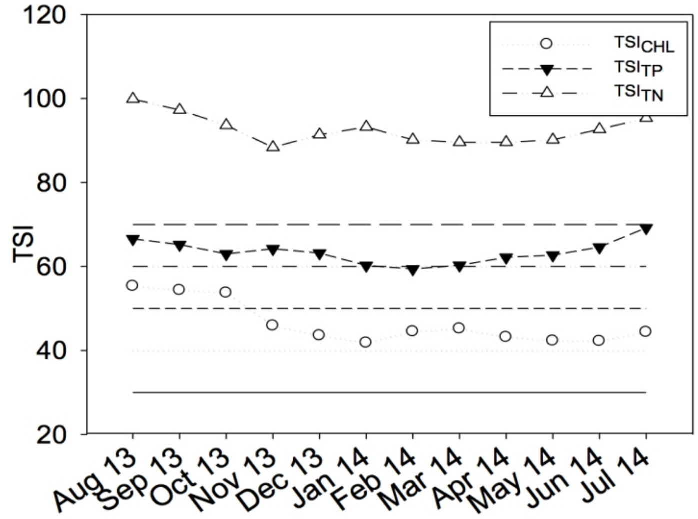


Figure 4. Monthly trophic state indices (TSIs) for Lake Uluabat (the threshold values for the oligomesotrophic (30), mesotrophic (40), eutrophic (50), eutrophic to hypereutrophic (60), and hypereutrophic (70) states)

As shown in Figure 4, the TSI_{TN} values show hypereutrophic levels, TSI_{TP} values lay between eutrophic to hypereutrophic, and hypereutrophic levels. TSI_{Chl-a} values lay between eutrophic and eutrophic to hypereutrophic levels. The trophic levels of lakes determine their intended use. The excessive nutrient increases, which stem from the canalization of waste waters where animal and human excrements are discharged, not only causes the increase in algae, but also the bacteria that are hazardous for health. When this is taken into consideration, Lake Uluabat has exceeded the limit values for drinking water and recreation oriented use [8]. Nitrogen could be very effective to algae growth as the consequence of discharging the domestic waste water to fresh water. Untreated domestic waste waters and chemical fertilizers from agricultural lands in the Lake Uluabat basin precipitate into the Lake. Therefore, there is a large amount of nitrogen input to the lake [30]. It was determined that Lake Uluabat has become useless for drinking water and other recreational uses since all of Lake Uluabat has reached the hypereutrophic level and that the increase in phosphorus and nitrogen caused the eutrophication in the lake.

CONCLUSIONS

Lake Uluabat was designated by the Ministry of Environment as a RAMSAR site in 1998 and also it was chosen as a partner of International Living Lakes Network in 2000. The Lake, which is a member of this network, has worldwide significance. It provides a habitat for a wide variety of fauna and flora, making it a very important part of the ecosystem. The results of the study clearly demonstrate that the concentrations of water quality parameters undergo temporal changes. This situation was also tested by ANOVA test. According to the SWQMR, the lake should be classified as highly polluted water, and in general, at the eutrophic to hypereutrophic level according to its TSI values. There should be more effort to protect the lake from pollution. In order to prevent pollution problem in the lake, we must keep waste water loads under control. The temporal variation in the concentration of nitrogen and phosphorus was largely due to changes in land and water management practices within the lake basin as well as changes in the treatment of wastewater discharges. According to all findings we emphasize that the trophic status of Lake Uluabat is endangering the lake balance, which is going to be disturbed, and some measures must be taken to prevent these circumstances. As a result, the long term monitoring and control of domestic and industrial wastewaters, restricted uses of agricultural pesticides and fertilizers are the important factors have to be taken into consideration in lake management.

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