

Trophic Level Determination of Acı Lake, Meke Lake and Suğla Lake

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Abstract: Acı Lake, Suğla Lake and Meke Lake which is included in Ramsar contract are one of the most important wetlands of Turkey. Acı Lake and Meke Lake are the volcanic and brackish lakes which are within the borders of Karapınar district 110 km away from Konya. Suğla Lake, on the other hand, is a fresh-water lake which is fed by the sources coming out of Beyşehir Lake and Kızıldağ hillsides. Trophic index, which indicates the enrichment amount of lakes with nutrients in the water, is an indicator of lake water quality. Trophic index is used in order to evaluate the variations in trophic situation within time. In these three different lakes, the trophic levels are found by using physical, chemical and biological parameters (Turbidity, total Phosphor, Total nitrogen, Chlorophyll-a) and are compared with trophic index calculations and Water Pollution Control Regulations (WPCM). As a result of this research, it was determined that Acı Lake is an oligotrophic lake according to trophic situation index (TSI) results and WPCM. It was also determined that Meke and Suğla Lakes are eutrophic lakes.

Key words: Trophic situation • Phosphor • Chlorophyll • Water quality

INTRODUCTION

This research was carried out in 3 study areas being Suğla Lake, Meke Lake and Acı Lake. First study area, Suğla Lake, is within the borders of Yalıhüyük and Seydişehir districts of Konya city. The lake is locked by Toros mountains from southwest. It covers an area of 135 km² being at 1040 m height and 10 km away from Seydişehir district (Figure 1) [1, 2]. The lake constitutes of

water from its own drainage area, water released from Beyşehir Lake and formed in Suğla Plain. The lake completely dries up in some summer months due to leaking of water from rock cracks called swallow holes in the south hillsides of the plain and due to evaporation of water [3, 4]. Although Suğla Lake is a small one, it has a rich microflora and is an important one from the ecological point of view. This lake which has fresh-water is also very important in terms of aquaculture and irrigation.



Fig. 1: The locations of the investigated areas on the maps (adapted from [2]).

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Table 1: Feeding situations of the lakes [9]

Parameter	Olygotrophic	Mezotrophic	Eutrophic
Total phosphor ($\mu\text{g/l}$)	<10	10-20	>20
Chlorophyll-a ($\mu\text{g/l}$)	<4	4-10	>10
Turbidity NTU	<25	25-30	>30
Hypolimnetic oxygen (%)	>80	10-80	<10

Meke Lake, which is the second study area in Karapınar district of Konya, occurred by filling up extinct volcano craters with water and has holms in the middle of it. It's within 2 km inside from the turnout at 7th km of Karapınar-Ereğli main road. The length and the width of the lake and the primary crater hole is 800 m and 500 m, respectively. Meke Lake has a 3 meter depth and is at 981 m height from the sea level [5]. Meke crater Lake and its environment is a bird heaven which is called "blue bead of the world" and occurred after a crater explosion millions of years ago. It was determined that there are approximately one hundred kinds of birds in the region. Meke Lake was declared as a natural site area in 1989 due to endemic bird kinds [6]. Meke Lake was included in the list of Ramsar contract in 2005 and now it's one of the most important lakes of Turkey in terms of ecotourism.

Our third study area, Acı Lake is a crater lake on the main road of Konya-Adana within the borders of Karapınar district and is 108 km away from Konya. Since the water of the lake which is at 985 m altitude is salty and carbonated, it's called as 'Acı Lake'. It is 300 m deep and it's fed from the depth.

Trophic situation represents the enrichment amount of lakes with the nutrients in the water. When trophic situation is investigated, either nutrient or organic matter source is taken into consideration. However, since an index depending on just a single criterion can be confusing, it's necessary to evaluate it with several parameters. In the determination of trophic situation, many criteria in terms of quality such as nutrient loading, nutrient concentration, efficiency, species composition of phytoplankton, fauna and flora amounts are used [7, 8]. The varieties that might occur in the determination of trophic levels of lakes among them, on the other hand, are sorted by taking more than one parameter into consideration. Trophic situation presents a new approach for the trophic classification of the lakes. This new approach gives information about the present nature of the lake at that moment and the situation that might occur after an application [7].

One of the most important stages while undertaking a water environment in terms of eutrofication is the determination of the trophic level correctly. Three basic parameters such as total phosphor, Chlorophyll-a and turbidity are used in order to determine the trophic levels

of the lakes. Apart from these, other parameters such as hypolimnetic oxygen demand, alkalinity and the rates of living things in the sludge are also present.

A classification sample which can be used in the determination of trophic level of a water environment is given in Table 1.

Trophic index which represents the enrichment amount of lakes with the nutrients in the water is an indicator for the water quality of the lake. In order to evaluate the variations in trophic situation with time, trophic index is used. Trophic situation index generates valuable data for the lake management. These data are a complete and alive indicator of the relationship within lake ecosystem and its components. These indicators are used in order to evaluate the variations in trophic situation with time and to compare the lakes in the region [8].

The relations between three index variables (seci disc, chlorophyll-a and total phosphor) are used to determine the trophic situation index [10];

Seci Depth: is a measurement of water permeability in the lake. Generally, the increase in the nutrient levels decreases the water permeability. The color of water and suspended materials are the other factors which affect the permeability.

Phosphor: is a limiting factor for the development of algae. Total phosphor amount is used in order to predict the eutrofication and productivity levels in the lake. The increase in the amount of phosphor with time is an indicator of nutrient enrichment in the lake. When Seci depth is at its lowest level, the maximum amount of total phosphor is observed and just the opposite is also true.

Chlorophyll-a: is a pigment which is present in all green plants and is used to measure the density of algae. High chlorophyll-a values represent high planktonic algae density which is formed due to excess nutrients in the water. There is a logarithmic relationship between total phosphor and chlorophyll [11].

In this study, the trophic levels of Suğla Lake in the lake district and Meke Lake and Acı Lake in Karapınar in the years 2005 and 2006 were compared in terms of their 6-month measurement values and trophic classification of the lakes was performed.

MATERIALS AND METHODS

The samples in this study were collected periodically from 5 different stations selected for each lake between September 2005 and May 2006. Effects of parameters such as amount of chlorophyll-a, turbidity, total nitrogen, total phosphor and dissolved oxygen were examined.

The samples taken in order to determine the trophic situation of Acı Lake, Meke Lake and Suğla Lake were collected in September, October and November in 2005 and March, April and May in 2006. The samples in this research were collected from 5 different stations determined for each lake to increase the confidence level of the study. Thereby, all characteristic properties of the lakes interpreted correctly. During the station selection of Suğla Lake, the places which are close to channels feeding the lake and the points which are different from each other were selected. Since Acı Lake and Meke Lake are fed by underground spring water, station selection was carried out at different points provided that they are not close to each other. The parameters such as chlorophyll-a, total phosphor, turbidity and nitrate were measured in the samples taken from different stations of these three lakes.

Surface water samples taken from different points were put in closed plastic bottles. The content of chlorophyll-a was found by standart spectrophotometric method [12], total phosphor and nitrate were determined by experimental kits and finally turbidity analysis was carried out by turbidimeter.

RESULTS

The average measurement values of samples taken from each lake in 6 different months of the years 2005 and 2006 are given in Table 2. When the results given in Table 2 were examined, the maximum turbidity was observed in Acı Lake in March 2006, in Meke Lake in November 2005 and in Suğla Lake in March 2006.

The maximum amounts of total phosphor, nitrate and chlorophyll-a in Acı Lake were observed in October 2005. Since nitrogen was excess in amount in this month, it was determined that it also increased the number of living things and so lead to an increase in the amount of chlorophyll-a.

In Meke Lake, the maximum amount of total phosphor was observed in October 2005, that of nitrate in September 2005 and that of chlorophyll-a in May 2006. The maximum density in terms of organisms in Meke Lake was observed in May 2006.

In Suğla Lake, the maximum amounts of total phosphor and nitrate were observed in March and April 2006 and that of chlorophyll-a in September 2005.

DISCUSSION

According to Water Pollution Control Regulations [13], the limit values for eutrofication are given in Table 3. When this table is examined, Acı Lake is not at the limit of eutrofication in terms of total phosphor (0,05) and total nitrogen (0,175). On the other hand, it's within the limits in terms of chlorophyll-a (18,41).

Meke Lake exceeds the eutrofication limit in terms of total phosphor (0,34), total nitrogen (0,44) and chlorophyll-a (53,835).

Suğla Lake also exceeds the eutrofication limit in terms of total phosphor (0,150), total nitrogen (0,11) and chlorophyll-a (11,504).

By means of using trophic situation index, lake management programmes can be estimated. If total phosphor value is found with respect to nutrient increase, TSI can be calculated easily. Thereby, it can be calculated that how much nutrient should be decreased to obtain trophic conditions [7].

The index can be calculated with 3 equations including chlorophyll-a concentration TSI (CHL), total phosphor concentration TSI (TP) and seci disc depth TSI (SD) [12].

$$TSI(CHL) = 9.81 \ln(CHL) + 30.6$$

$$TSI(TP) = 14.42 \ln(TP) + 4.15$$

In TSI calculation for Acı Lake by using the above equation, the result was found as 31,16. When this result was evaluated according to the values in Table 4, the situation of the lake was determined as olygotrophic. This evaluation was found according to both WPCR and trophic index. When trophic index calculation of Meke Lake was performed with respect to Chlorophyll-a, the lake was found as eutrophic as a result of the calculation (558,72). This calculated result is also favorable with WPCR [13].

When trophic index calculation of Suğla Lake was performed with respect to Chlorophyll-a, the lake was found as eutrophic as a result of the calculation (1124, 45). This result is also favorable with WPCR.

When this study was compared with other studies performed in Turkey, it was determined that Kızılırmak delta is Mezotrophic and Eutrophic according to trophic index.

Table 2: Various Parameter values of Acı Lake, Meke Lake and Suğla Lake

LAKES	Months	Turbidity, NTU avg.	Tot. Phosphor, mg/L avg.	Nitrate, mg/L avg.	Chlorophyll-a, µg/m3 avg.
Acı Lake	September 05	8.87	0.01	0.02	0.58
	October 05	2.82	0.14	0.16	79.43
	November 05	1.61	0.02	0.02	1.87
	March 06	11.53	0.07	0.09	23.83
	April 06	5.40	0.05	0.03	2.24
	May 06	6.20	0.06	0.04	2.53
Meke Lake	September 05	11.03	0.28	0.69	7.18
	October 05	26.26	0.65	0.61	16.07
	November 05	49.48	0.31	0.48	11.31
	March 06	36.65	0.19	0.31	106.83
	April 06	13.23	0.10	0.10	51.14
	May 06	34.13	0.51	0.45	130.48
Suğla Lake	September 05	74.00	0.06	0.082	105.60
	October 05	24.80	0.46	0.102	96.44
	November 05	14.66	0.12	0.126	13.464
	March 06	30.96	0.108	0.166	29.76
	April 06	30.92	0.108	0.166	29.76
	May 06	26.66	0.046	0.076	394.00

Table 3: Limit Values of Eutrophication Control for Lakes, Ponds, Swamps and Barrage Reservoirs [13]

Required properties	Natural protection area and recreation For various usage	Area of usage
		(including naturally salty, brackish and carbonated lakes)
Total nitrogen (mg/L)	0.1	1
Total phosphor (mg/L)	0.005	0.1
Chlorophyll-a (mg/L)	0.008	0.025

Table 4: Trophic Classification [7]

Trophic situation	TSI	Seci disc (m)	TP (mg/m ³)	Chlorophyll-a (mg/m ³)
Olygotrophic	0-40	>4	<12	<2.6
Mezotrophic	50-60	2-4	12-24	2.6-6.4
Eutrophic	60<	<2	>24	>6.4

When Kılıçkaya Barrage Lake was evaluated according to water pollution control regulations as in the cases of Suğla, Meke and Acı Lakes, it was determined that its water quality is in high water quality class, i.e. 1st class. According to this result, it was also determined that Kılıçkaya Barrage Lake has well assumed water quality and no significant pollution problem [14].

The presence of food chain with undetermined trophic level in Yenisehir Lake which has eutrophic properties showed that there was no overall pollution. As a result of different parameter measurements (total nitrate and total phosphor) in the lake, the seasonal increase in these rates exposed that the lake has eutrophic character as in the cases of Meke and Suğla Lakes [15].

TSI index was also applied to Laguna Lake in

Philippines and it was determined that this lake has hypereutrophic character [16].

The trophic structure of Çernek Lake was investigated within this research. As a result of this, the lake has eutrophic character together with a hypertrophic tendency according to chlorophyll-a, primary productivity and plankton composition [17].

The trophic situation of Seyfe Lake was determined as eutrophic/hypereutrophic in the light of studies including trophic situation, Seci depth, basic water quality parameters, dominant plankton and zoobentoz taxons [18].

Consequently, Meke and Suğla Lakes are similar to each other in terms of trophic levels and they are at eutrophic level. It was also determined that Acı Lake is an olygotrophic lake from both trophic index and WPCR point of view.

REFERENCES

1. Tuncez, S., E. Candan, A.H. Kartal and N. Kunt, 2006. 'Konya İl Çevre Durum Raporu', Çevre ve Orman Bakanlığı, Çevre ve Orman İl Müdürlüğü, Konya, pp: 1-60.
2. <http://www.cografya.biz/html>, 2005.
3. <Http://www.konya.gov.tr/konya/cografi.html>, 2005.
4. <Http://www.su-dunyasi.com.tr/ekim> 2004-15/konya.htm, 2004.
5. Http://tr.wikipedia.org/wiki/Meke_Krater_, 2009.
6. Önder, S. And A.T. Polat, 2004. 'Konya İli Karapınar İlçesi'nin Ekoturizm Yönünden Görsel Kalite Degerlendirmesi ve Swot Analizi', S.Ü. Ziraat Fakültesi Dergisi, 18(33): 80-86.
7. Carlson, R.E., 1977. 'A Trophic State Index For Lakes', Limnology And Oceanography, 22, 361-369.
8. <http://www.mashpeemec.us.html> (8.03.2005).
9. Thoman, W., W. David, J. Sutcliffe and J. Gwynfryn, 1987. 'Eutrophification: Research and Application to Water Suply', D.M.Imboden, The impact of physical processes on algal growth, pp: 30-43.
10. Carroll, J.H., S.L. Nolen and L. ve Peterson, 1996. 'Water Quality Changes, from 1987 to 1991 in Broken Bow Lake', Oklahoma. Proc. Okla. Acad Sci., 76: 35-38.
11. Haggard, B.E., P.A. Moore, T.C. Daniel and D.E. Edwards, 1999. Trophic Conditions and Gradients of the Headwater Reaches of Beaver Laka, Arkansas. Oklahoma Academy of Sci., 79: 73-84.
12. APHA/AWWA/WEF, 1995. Standard Methods for the Examination of Water and Wastewater, 19th ed. APHA/AWWA/WEF, Washington, D.C.
13. Çevre ve Orman Bakanlığı, 2004. 'Su Kirliliği Kontrolü Yönetmeliği', Yayımlandığı Resmi Gazete: 31 Aralık Cuma, Sayı: 25687.
14. Dirican, S., 2008. 'Kılıçkaya Baraj Gölü (Sivas-Türkiye)'nün Su Kalitesinin Değerlendirilmesi', HR.Ü.ZF. Dergisi, 12(4): 25-31.
15. Tekinalp, O., 2005. 'Yenişehir Gölü (Reyhanlı/Hatay)'Nün Kirliliği Ve Kirletici Faktörlerin Araştırılması', Doktora tezi.
16. Lohani, B.N. and T.M.A. Roblo, 1984. 'Trophic State Index for Laguna Lake in the Philippines', International J. Water Resources Development, 2(4): 43-54.
17. Demirkalp, F. Yıldız, Çağlar, S. Selim, Y. Başbuğ Saygı, E. Gündüz, S. Kaynaş and S. Kılınç, 2003. 'Ulusal Su Günleri', 1-3 Ekim, Ankara.
18. Yerli, S.V., A. Altındag, S. Yigit, B.A. Çiçek and A.F. Canbolat, 2004, Seyfe Gölü'nün Trofik Durumunun Belirlenmesi, Türk Sucul Yaşam Dergisi 2. Cilt 2. Sayısı.