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An Approach for Trophic Gradient in Lake Mogan (Turkey): A Shallow Eutrophic Lake

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Abstract

Lakes become more productive as they accumulate nutrients with time and this process is called natural eutrophication which probably occurs very rarely. This natural eutrophication is generally fastened by antropogenic factors. Lake Mogan is a shallow lake with surface area 5.5 km^2 in the close vicinity of Ankara, Turkey. Lake is under the recreational use. Natural process of eutrophication gained a momentum due to anthropogenic effects in the last decade. Numerous studies and suggestions have been made as well as prevention, but process is continuing as represented in this study. Lake eutrophication assessment was done in order to illustrate trophic gradient changes and its impact on zooplankton and zoobenthos. Trophic state index (TSI) which consists three parameters; total phosphorus (orthophosphate), chlorophyll-*a* concentration and Secchi disc depth, is constructed. No possible trophic gradient change was observed in lake spatially but changes according to seasons are evaluated.

INTRODUCTION

Lakes become more productive as they accumulate nutrients with time and this process is called natural eutrophication which probably occurs very rarely [1]. In the last few decades man induced processes have tended to cause major changes in trophic status including changes in composition of living organisms.

Numerous attempts were made for understanding and management of eutrophication in lakes. Trophic state index (TSI) or Carlson index [2] , which is an easy to apply method for defining trends in lake ecosystems, was chosen to understand trophic status of Lake Mogan and if this trophic state can be correlated with zooplankton.

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MATERIALS AND METHODS

Study area and data collection

Mogan is a shallow lake with surface area 5.5 km^2 in the close vicinity of Ankara, Turkey. Lake and connected wetland in south part is decleared Special Environmental Protected Area (SPA) in 1990, and is also an Important Bird Area (IBA). Lake is under pressure of urban and industrial pollution, and it has a large basin (954 km^2) with agricultural runoffs. Generally, in winter lake is covered with ice

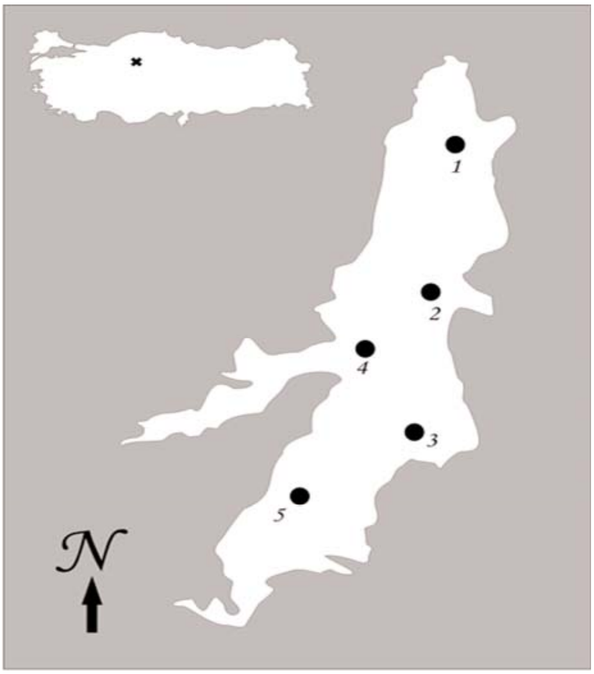

Figure 1. Location of Lake Mogan, Turkey and sampling stations (1/48000).

about 2 months and in spring and summer algal blooms distracts surrounding area and can cause oxygen deficits causing fish kills. Previous studies in lake showed that lake is in a meso-eutrophic state [3,4] but later studies showed that lake is showing hypertrophic tendency [5].

A large database is constructed with the samples collected from September 2006 to September 2007, in 5 stations (Figure 1). Physico-chemical properties of water, plankton and zoobenthos samples were collected at monthly intervals. Quantative and qualitative studies of water quality, zooplankton and zoobenthos were based on given literatures [6-8] respectively. Some references used in identification are [9-11]. Rotifera and Chironomidae taxa are used for decisive stages as these are considered as indicators of trophic status in previous studies [12].

Carlson index

Carlson index is a simple method of calculating and explaining trophic state using Secchi depth, chlorophyll-a and total phosphorus measurements. Index is given with the abbreviations in Table 1. which will be used in rest of this paper.

Each major division in Table 1 (10, 20, 30 etc.) can be explained as a doubling in algal biomass. Total phosphorus is reduced to ortho-phosphate in this study which is the most common form of phosphate in waterbodies [13]. Simplified equations used in constructing index are as follows;

$$TSI(SD) = 60 - 14.41 \ln(SD)$$
$$TSI(CHL) = 9.81 \ln(CHL) + 30.6$$
$$TSI(TP) = 14.42 \ln(TP) + 4.15$$

RESULTS AND DISCUSSION

TSI values are calculated for each season between years 2006 and 2007 and summarized in Table 2.

Table 1. Trophic State Index and associated parameters.

TSI	Secchi Disk (SD) (m)	Surface Phosphorus (TD) (mg/m^3)	Surface Chlorophyll (CHL) (mg/m^3)
0	64	0.75	0.04
10	32	1.5	0.12
20	16	3	0.34
30	8	6	0.94
40	4	12	2.6
50	2	24	6.4
60	1	48	20
70	0.5	96	56
80	0.25	192	154
90	0.12	384	427
100	0.062	768	1183

Table 2. TSI values in correspondence with seasons.

SEASON	Autumn	Winter	Spring	Summer	2006-2007
TSI	n:3	n:2	n:3	n:2	n:10
SD	56	56	51	57	55
TP	67	73	73	95	77
CHL	52	46	41	53	53
Overall	58	58	55	68	60

Phosphorus is the key limiting nutrient in Lake Mogan [3], so TSI values equally effect overall [2]. For year values, chlorophyll of summer and average values of other parameters are used as advised by author of index.

Another question in this study rather than defining its status was to determine if any zooplankton taxa can identify trophic state of lake. Trophic state differences between stations were examined and no polarity was found between them in sampling period. This can be due to size of lake and drainage basin. Lake has a large basin where as it is shallow and has a narrow surface area. Multiple regression is conducted using TSI_{SD}, TSI_{TP}, TSI_{CHL} and month as independent variables, and separately abundance and quantity of 4 rotifer species (*Keratella quarata*, *Hexarthra* sp., *Asplanchna* sp., *Brachionus urceolaris*) as dependent variables. After that analysis it is understood that none of index values shows similarity with biological data. Changes in rotifer abundance is directly related to months ($p<0.001$) and seasonal variance is a known fact for rotifers. Zooplankton species didn't show any corelation with index values but zoobenthic species *Chironomus* sp. corelated with month ($p<0.001$) and TSI_{CHL} ($p<0.01$) values. However, long term data is needed for more clear results.

Many rotifers have a wide range of temperature tolerance [14] so it is not thought to be the reason of monthly differences. And high trophic degree and high production can lead to high oxygen concentrations due to photosynthetic activity, but may also cause oxygen depletion by high respiration rates [15] so this species are thought to show wide O_2 toleration and seasonal oxygen concentration differences was not thought to effect them this much. Effects of catastrophic like shifts in shallow lakes, which is previously mentioned for Lake Mogan [16], can effect zooplankton succession but this needed to be studied in detail. Lake Mogan is a shallow lake with a muddy bottom, this bottom cause extreme turbidities when disturbed. Wind and fish induced turbidity can be seen especially in non-vegetated period.

In a study done in 39 lakes (Florida), has shown there is a positive relation between zooplankton and lake trophic state [17]. But in another study done in Lake Meive (Poland), according to abundance and biomass of zooplankton lake is considered as mesotrophic but according to TSI_{SD} it is mesoeutrophic [18]. As mentioned before, long term data or bigger sampling is needed to get a more clear picture.

According to literature [19]; five factors seem to influence species' abundance and cause species succession: 1) physical and chemical limitations, 2) food and exploitative competition, 3) mechanical interference competiton, 4) predation, 5) parasitism. It is obvious that to get a more clear vision of Lake Mogan rather than physico-chemical properties of water, intraspecific relations are needed to be studied in detail to understand species succession.

Database is constructed from this study with a main goal of monitoring the trophic status of the lake. As a conclusion Carlson index is an easy tool for determining trophic state with few variables and can be used especially for comparing trophic state of other lakes of Turkey. But dominant species in eutrophic lakes and their interactions are needed to be studied in detail, perhaps with bioassay experiments, to find indicator species for lakes.

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REFERENCES

1. Moss, B., Ecology of fresh waters: Man and Medium, 2nd edition. Blackwell Scientific Publications, Oxford, 417pp., 1988.
2. Carlson, R.E., A trophic state index for lakes. Limnology and Oceanography 22(2), 361-369, 1977.
3. Pulatsü, S., Aydın, F., Water quality and phosphorus budget of Mogan Lake, Turkey. Acta Hydrochim. Hydrobiol., 25(3), 128, 1997.
4. Manav, E., Yerli, S.V., An Assesment on the trophic status of Lake Mogan, Turkey. Fresenius Envir. Bull., 17(1), 3, 2008.
5. Mangıt, F., Monitoring of the trophic status of Lake Mogan. MSc Thesis, Turkey: Hacettepe University, 44 pp., 2008.
6. Greenberg, A.E., Trussel, R., Clesceri, L.S., Standard Methods, (Ed.), APHA, AWWA, WPCF, American Health Association 1015 Fifteenth Street NW Washington, DC 2005, 1272 pp., 1985.
7. ICES, Zooplankton methodology manual, (Ed.) Harris R.P., Wiebe, P.H., Lenz, J., Skjoldal, H.R., Huntley, M., Academic Press, 684 pp., 2000.
8. Welch, P.S., Limnological methods, McGraw-Hill Book Company, 381pp., 1948.
9. Edmondson, W.T. , Freshwater Biology. 2nd Editon. John Wiley and Sons Inc. New York, 420, 1959.
10. Kolisko, R.A., Plankton rotifers, biology and taxonomy, Science Publishers, Stuttgart 146 pp., 1974.
11. Koste, W., Rotatoria. Die Rädertiere Mitteleuropas begründet von Max Voigt, 2. Gebrüder Borntraeger, Berlin, Stuttgart, 637 pp., 1978.
12. Yerli, S.V., Gündüz, E., Akbulut, A., Trophic status of Sultan Marshes, Turkey. Fresenius Envir. Bull. 6, 97, 1997.
13. Wetzel, R.G., Limnology, 2nd edition. CBS College Publishing, 767pp., 1983.
14. Berzins, B., Pejler, B., Rotifer occurrence in relation to temperature. Hydrobiologia, 175, 223, 1989.
15. Berzins, B., Pejler, B., Rotifer occurrence in relation to oxygen content. Hydrobiologia, 183, 165, 1989.
16. Burnak, S.L., Beklioğlu, M., Macrophyte-dominated clearwater state of Lake Mogan. Turk. J. Zool., 24, 305, 2000.
17. Bays, J.S., Zooplankton/trophic state relationships and the potential for prediction of ecosystem structure in reclaimed Florida lakes. Proceedings of the tenth annual conference on wetlands retoration and creation, Proceed (Ed.), 17, 1983.
18. Szlauer, B., Zooplankton based assessment of the Lake Miedwie (North-Western Poland) trophic status. EJPAU, 2(1), 1999.
19. Herzig, A., The Analysis of planktonic rotifer populations: A plea for long term investigations. Hydrobiologia, 147, 163, 1987.

Table 3. Seasonal means of physicochemical parameters of stations for 2006-2007.

	Fall					Winter					Spring					Summer				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Nitrite, mg/L	0.04	0.05	0.05	0.02	0.05	0.02	0.01	0.02	0.03	0.01	0.01	0.01	0.02	0.03	0.02	0.04	0.05	0.02	0.02	0.01
			0.04					0.02					0.02					0.02		
Nitrate, mg/L	0.02	0.01	0.02	0.01	0.03	0.16	0.03	0.02	0.08	0.07	0.1	0.1	0.08	0.1	0.04	0.08	0.05	0.06	0.06	0.11
			0.04					0.07					0.09					0.07		
Ammonia, mg/L	0.47	0.43	0.3	0.39	0.15	0.38	0.26	0.48	0.27	0.2	0.37	0.39	0.42	0.34	0.56	0.25	0.28	0.7	0.26	0.31
			0.04					0.32					0.42					0.36		
o-Phosphate, mg/L	0.09	0.06	0.06	0.06	0.11	0.13	0.13	0.09	0.14	0.1	0.12	0.11	0.11	0.15	0.11	0.73	1.09	0.39	0.21	0.27
			0.08					0.12					0.12					0.54		
Temperature, °C	26.17	21.91	22.35	21.66	21.75	5.67	5.2	5.11	5.56	5.14	15.7	15.52	15.15	15.11	14.47	24.68	25.12	25.79	25.27	25.5
			22.77					5.34					15.19					25.27		
Depth, m	3.13	2.3	2.63	2.13	2.13	3.13	2.6	2.5	2.55	1.95	3.13	2.88	3.03	2.96	2.06	2.25	2.05	1.88	2.63	1.5
			2.46					2.55					2.81					2.06		
Secchi Depth, m	1.78	1.43	1.33	1	1	1.8	1.25	1.13	1.3	0.95	2.44	1.88	1.94	2.06	1	1.38	1.3	1.25	1.55	0.83
			1.31					1.29					1.86					1.26		
Turbidity	6.15	8.97	11.88	4.2	7.79	4.25	18.57	3.66	5.54	4.44	0.75	3.29	4.63	4.07	2.22	8.72	7.71	2.76	3.5	5.17
NTU			7.8					7.29					2.99					5.57		
Chl-a, µg/L	11.08	10.55	8.69	4.4	8.7	1.27	5.22	5.21	6.2	5.19	0.62	2.44	2.46	4.99	4.21	13.26	11.06	4.16	10.8	9.3
			8.68					4.61					2.94					9.73		
Surface Chl-a, µg/L	10.5	2.9	4.41	2.9	5.49	0.32	1.1	1.4	2.73	2.46	0.38	0.56	2.6	1.96	2.02	5.35	0.46	0.42	6.02	1.64
			5.24					1.6					1.5					2.78		
pH	8.59	8.55	8.59	8.58	8.64	8.34	8.29	8.46	8.51	8.49	8.7	8.62	8.61	8.63	8.63	9.23	9.4	9.55	9.44	9.47
			8.59					8.42					8.64					9.4		
Conductivity, mS/cm	3.65	3.24	3.4	3.29	3.4	2.23	2.17	2.19	2.23	2.21	2.88	2.87	2.85	2.84	2.79	3.95	3.95	4.16	4.28	4.19
			3.4					2.21					2.85					4.11		
Salinity	1.87	1.81	1.89	1.85	1.91	1.85	1.83	1.85	1.86	1.87	1.84	1.85	1.85	1.85	1.84	2.11	2.09	2.17	2.26	2.21
ppt			1.87					1.85					1.85					2.17		