Seasonal Variations of the Metal Concentrations in the Waters of Lake Gölbaşı in Northern East Mediterranean Area of Turkey

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Abstract

Seasonal variations of manganese, copper, cadmium, iron, lead, zinc, nickel, chrome, and cobalt were determined in water from Lake Gölbaşı in northern east Mediterranean area. The concentrations of the metals such as Cu, Fe and Zn in water were found higher than Turkish permissable concentrations. Besides, the metal levels in water were compared with national and international water quality criteria, background concentrations and permissible limits.

***Keywords*:** Metals, Seasonal Variations, Lake Gölbaşi, Water

Introduction

Metals are introduced into the aquatic ecosystems such as lakes, rivers and seas in a number of ways. They may be accumulated by aquatic organisms such as fish and mussels and may be a potential risk for ecosystem health and organisms. Industrial wastes, geochemical structure and mining of metals create a potential source of heavy metals pollution in the aquatic environment (Lee & Stuebing, 1990; Gümgüm, Ünlü, Tez, & Gülsün, 1994). Metals such as iron, copper, zinc and manganese, are essential metals since they play an important role in biological systems, whereas mercury, lead and cadmium are non-essential metals, as they are toxic, even in traces. The essential metals can also produce toxic effects when the metal intake is excessively elevated.

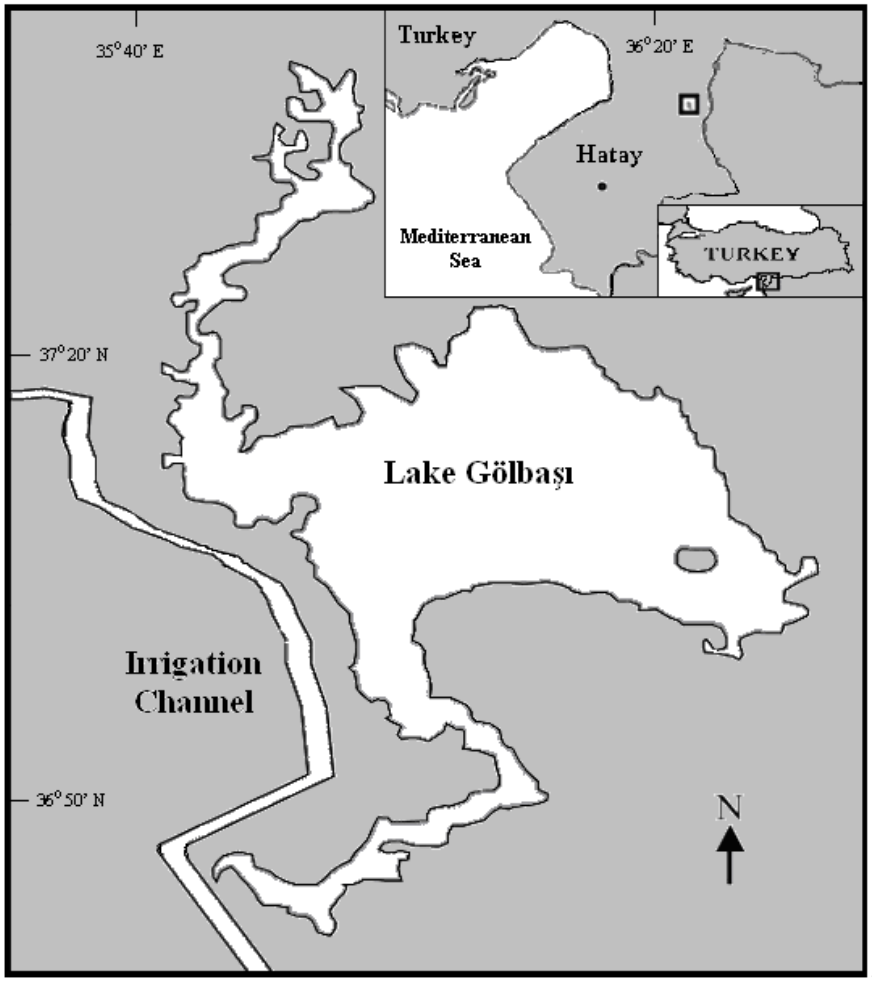
Lake Gölbaşı is a natural lake located in the southern east Mediterranean region of Turkey. Total area of this lake is about 1200 ha which consists of 400 ha with marshy area. In this region, lake is supported by underground water and used for irrigation. Flow rate of underground water is about 2.5-3.0 2,5-3 m^3/sn. In summer, the water level of the lake decrease until 4 meters because of irrigation or evaporation with average depths of 1 or 1.5 meters. On the other hand, in winter, maximum depth becomes 6 meters with average depths of 3.5 or 4.0 meters. The lake includes a number of economically valuable fish species such as *Clarias gariepinus, Cyprinus carpio*, *Leuciscus lepidus, Anguilla anguilla, Tilapia* sp., *Carasobarbus luteus, Mugil saliens*, and mussels species such as *Unio terminalis delicatus* and *Potamida littoralis delesserti*. These are important species for local people as a food and also sport fishing. The aim of present study was investigate the seasonal variations of cadmium, iron, copper, chrome, cobalt, zinc, lead, nickel and manganese in water of Lake Gölbaşı from Southern East Mediterranean Area of Turkey.

Materials and Methods

Water samples were collected from selected three stations in Lake Gölbaşı from Southern East Mediterranean Area of Turkey, in October 2003 and January, April and July 2004 (Figure 1). Samples were collected from a depth of 0.5-1.0 m in 1 liter polyethylene bottles, which had previously had been washed with detergent, deionized water, 2 M concentrated nitric acid, deionized water again and finally medium water. Then were acidified with 0.5 ml high-purity concentrated HNO_3 (Merck), brought to laboratory by

placing on ice, filtered through a 0.45 μm filter. Standard solutions were prepared from stock solutions (Merck, multi element standard). Samples were analyzed three times for Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn by ICP-AES Varian Liberty Series-2. The absorption wavelengths for Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn were 228.8, 238.9, 267.7, 324.8, 259.9, 257.6, 231.6, 220.4, and 213.9 in nm, respectively. Metal contents were expressed as $\mu g\ l^{-1}$.

To determine the differences between months at same site and sites in total for water samples, one way ANOVA were performed. Post hoc test (Duncan) was tested to determine statistically significant differences following ANOVA. Possibilities less than 0.05 were considered statistically significant ($p<0.05$). All statistical calculations were performed with SPSS 13.0 for Windows.



3.

Figure 1. Map of Lake Gölbaşı

Results

This study examined the seasonal variations of the concentrations of Cd, Fe, Cu, Zn, Cr, Co, Mn, Ni and Pb in water from the Lake Gölbaşı in Northern East Mediterranean Area of Turkey. Iron was found in the highest concentrations ranging from 226 to 7707 μg l^{-1}, and its concentrations were also higher than those of other metals in all stations and months (Table 1). Following Fe; Zn generally showed the second highest levels except Mn in July at stations A, B and C (also April), Cu in January and April at station B. In October, except Zn (maximum at station A) other metals were maximum at station C. On the other hand, Co, Ni and Pb at station A, Cr, Cu, Fe, Mn and Zn at station B were minimum. In January, although Co, Cr, Fe, Mn, Ni and Zn at station C, Cu and Pb at station B were maximum, Co, Fe, Mn and Zn at station B, Cr, Cu and Ni at station A, Pb at station C were minimum. In April, although Fe, Mn and Pb at station A, Co, Cu and Zn at station C, Cr at station B were minimum, Cr, Cu and Zn at station A, Co and Pb at station B, Fe and Mn at station C were maximum. In July, although Co, Cr, Fe, Ni, Pb and Zn at station A, Mn at atation B, Cu at station C were minimum, Mn at station A, Cu and Ni at station B, Co, Cr, Fe, Pb and Zn station C were maximum. There are statistically differences between the metal levels in different stations except Co, Cu and Pb ($p<0.05$). In addition, there are differences between the metal levels in different months from the same stations except Co at all stations, Cu and Pb at station A and B ($p<0.05$).

The concentrations of metals in the water of Lake Gölbaşı were compared with other studies, world average and water quality criteria in Table 2. When compared with Turkish water quality criteria, the lake is acceptable as polluted water for Fe, as less polluted water for Cu and Co, and as clean water for Cd, Co, Cr, Mn, Pb and Zn (TEG, 1988). Although the concentrations of Cu, Fe and Zn measured in this were higher than Turkish permissible concentrations, others were lower than those (TKB, 2002).

Table 1. The seasonal variations of the mean metal concentrations in the water from the Lake Gölbaşı (three water samples in each month for each station)

Stations/ months	Metal concentrations, in μg l^{-1*}								
	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn
A									
October-2003	-[nd]	10.5^{a}	2.89^{a}	23.7^{a}	574^{a}	55.1^{a}	1.00^{a}	0.19^{a}	189^{a}
January-2004	-	10.1^{a}	4.38^{a}	21.7^{a}	1126^{b}	17.9^{a}	4.70^{a}	2.18^{a}	26.9^{bc}
April-2004	-	9.77^{a}	2.07^{a}	24.8^{a}	226^{c}	7.02^{a}	-	1.05^{a}	66.2^{b}
July-2004	-	8.45^{a}	7.59^{b}	22.4^{a}	2303^{d}	201^{b}	9.00^{a}	1.39^{a}	16.4^{c}
Total	-	*9.7^{x}*	*4.23^{x}*	*23.1^{x}*	*1057^{x}*	*70.2^{x}*	*3.67^{x}*	*1.20^{x}*	*74.5^{x}*
B									
October-2003	-	10.9^{a}	2.07^{ab}	21.0^{a}	520^{a}	9.89^{a}	6.88^{a}	0.89^{a}	58.4^{a}
January-2004	-	8.78^{a}	5.48^{b}	23.8^{a}	631^{b}	8.18^{a}	6.75^{a}	6.47^{a}	20.9^{b}
April-2004	-	11.2^{a}	0.72^{a}	22.4^{a}	492^{a}	21.8^{b}	0.10^{b}	1.71^{a}	5.81^{c}
July-2004	-	11.5^{a}	9.79^{c}	22.8^{a}	2499^{c}	73.5^{c}	14.5^{a}	5.14^{a}	30.1^{b}
Total	-	*10.6^{x}*	*4.52^{x}*	*22.5^{x}*	*1036^{x}*	*28.4^{y}*	*7.06^{x}*	*3.55^{x}*	*28.8^{y}*
C									
October-2003	-	13.5^{a}	19.8^{a}	27.1^{a}	2197^{a}	57.1^{a}	12.8^{a}	1.21^{a}	135^{a}
January-2004	-	11.3^{a}	40.5^{b}	22.3^{b}	7707^{b}	27.4^{b}	88.3^{b}	1.13^{a}	48.3^{b}
April-2004	-	9.59^{a}	1.40^{c}	22.3^{b}	505^{c}	28.3^{c}	-	-	4.24^{c}
July-2004	-	12.0^{a}	15.2^{a}	20.9^{b}	3267^{d}	133^{d}	12.2^{a}	41.3^{b}	37.6^{b}
Total	-	*11.6^{x}*	*19.2^{y}*	*23.2^{x}*	*3419^{y}*	*122^{z}*	*28.3^{y}*	*10.9^{x}*	*56.3^{z}*

[*] Vertically, letters a, b and c show differences among different months at same stations; x, y and z between stations. Within columns, means with the same letter are not statistically significant, $p>0.05$

[nd] not detected.

When compared with US EPA recommended water quality criteria, the metal concentrations measured in this study were lower than it except Cu, and Pb for CCC (US EPA, 1999). On the other hand, if compared with world average back ground concentrations, the concentrations of all metals measured in this river were higher (Klavins et al., 2000). When other studies are considered, Co, Cr, Fe, Mn and Ni levels in Lake Toxema (LT), Cr, Fe, Mn and Zn levels in Gomti River (GR), Cr and Cu levels in Küçük Menderes River (KMR), and Fe and Mn levels in Atatürk Dam Lake (ADL) were lower than those obtained in this study (Table 2). On the other hand, Co, Cr, Cu, Fe, Pb and Zn levels in Dil Stream, Cu, Mn and Zn levels in Beyşehir Lake, Cu and Zn levels in ADL, Cu, Pb and Zn levels in LT, and Pb level in GR were higher than those found in this study.

Table 2. Comparison of the overall metal concentrations in the water of Lake Gölbaşı with other studies and water quality criteria (μg l^{-1})

Studies and guidelines	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn
This study[a]	-	10.6	9.31	22.9	1837	73.5	13.1	5.21	53.2
TKB (2002)[b]	10	1000	100	10	700	1000	300	100	3.0
TEG (1988)[c]									
Class I	3.0	10	20	20	300	100	20	10	200
Class II	5.0	20	50	50	1000	500	50	20	500
Class III	10	200	200	200	5000	3000	200	50	2000
Class IV	>10	>200	>200	>200	>5000	>3000	>200	>50	>2000
US EPA (1999)[d]									
CMC*	4.3	-	16	13	-	-	470	65	120
CCC*	2.2	-	11	9.0	-	-	52	2.5	120
An & Kampbell (2003)[e]	20	<2.0	4.0	24	119	7.0	5.0	15	59
Singh et al. (2005)[f]	-	-	1.3-5.7	-	34-117	1.3-5.3	9-17	19-39	11-32
Turgut (2003)[g]	0.81	-	0.093	13.1	-	-	2.27	0.59	249
Pekey et all. (2004)[h]	8.0	21	42	37	4030	-	-	120	700
Klavins et all. (2000)[I]	0.02	0.08	-	1.0	-	6.0	0.3	0.2	10
Tekin-Özan (2008)[j]	-	-	-	100	100-2740	20-520	-	-	20-420
Karadede & Ünlü (2000)[k]	-	-	-	25-220	62	3.9-4.1	11-15.4	-	64-197

[a] Mean

[b] Turkish Permissible Concentrations

[c] Turkish Water Quality Criteria

(Class I: clean water, Class II: less polluted water, Class III: polluted water, Class IV: heavily polluted water)

[d] US EPA Recommended Water Quality Criteria

[e] Lake Texoma, border of Oklahoma and Texas

[f] Gomti River, India

[g] Küçük Menderes River, Turkey

[h] Dil Deresi (Stream), Turkey

[I] Background concentrations, world average

[j] Beyşehir Gölü, Turkey

[k] Atatürk Baraj Gölü, Turkey

* CMC and CCC: Criteria Maximum Concentration and Criterion Continuous Concentration.

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