Investigation of Toxic Effects of Heavy Metal Level in Atatürk Dam

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Abstract

This study was conducted on the water of the largest reservoir in Turkey, the Atatürk Dam on the Euphrates River in the South-eastern Anatolia Region. Although there is only one waste-water treatment plant in Adıyaman province, industrial and agricultural wastewater is discharged into streams from various points without being treated, and these streams flow into the Atatürk Dam. Between June and August 2019, the levels of some toxic heavy metals (Cd, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Se and Zn) were examined with an ICP-MS device in water samples taken from 5 stations of Atatürk Dam, contaminated by waste water from Adıyaman province. Sampling areas were selected considering the pollution conditions. The highest mean metal levels in µl / l were; 1108.77 ± 3506.23 (Zn), 1529.34 ± 558.39 (Cr), 1507.92 ± 592.9 (Ni), 905.56 ± 329.36 (Cu), 22.34 ± 70.66 (Se), 45.5 ± 50.43 (Co) , 4.43 ± 6.92 (Pb) and 0,016322.11 ± 0,017 (Al) ,Cd and As were not detected. The metal levels were affected by domestic and industrial activities in the study areas and the highest metal levels of all the samples were higher in the polluted areas where wastewater was discharged without treatment. A significant difference was found the in terms of P values between the Cu element and Zn (0,955), the element Al, Zn, Pb and Se (0.629; 0.821;0629), the element Cr, Zn and Se (0.631; 0.631), the Co and Zn, Se (0.821), the element Ni, Zn, Pb and Se (0.873; 0.531; 0.88739). From the metal values obtained, the classifications were determined as 4th quality water pollution of Cr, Se and Ni metals, 3rd quality water pollution of Co metal and other 2nd and 1st degree water pollution according to the criteria of the Intracontinental Water Pollution Control regulations. Leaving untreated wastewater in the Atatürk Dam has the potential to harm freshwater environments and the life attached to them.

Keywords: *Atatürk dam, Water, Sediment, Heavy metal, Pollution*

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Introduction

As a result of human activity such as urbanisation and industrialisation, there has been an increase in recent years in the deposition of heavy metals in water ecosystems and this can cause severe ecological damage because of toxicity and the bio accumulative properties in the food chain. High metal concentrations in water, sediment and organisms can be well above the defined legal values (1).

The toxic substances defined as the 20 most dangerous on earth include zinc (Zn), copper (Cu), mercury (Hg), nickel (Ni), chrome (Cr) and lead (Pb), and these are known to be extremely dangerous chemicals for the environment and show the most significant water pollution. Several human diseases are known to be related to increased heavy metal pollution. For example, Hg causes neurological effects, cadmium (Cd) and Pb cause carcinogenic effects, Cr leads to mutations in genetic material, and Cu causes anaemia (2, 3). One of the most significant dangers threatening human and animal health and the current natural balance is environmental problems originating from heavy metals, and these problems are seen to be emerging in ever increasing dimensions.

The Atatürk Dam was constructed on the Euphrates River in the Southeast Anadolu region of Turkey. As the largest reservoir in the country, the basic function is the provision of water and the production of hydroelectricity. Intensive trout farming is also conducted in the reservoir and recently mass fish deaths have been seen (4, 5).

The aim of this study was to determine the accumulated levels of heavy metals (Al, Cr, Co, Ni, Cu, Zn, As, Se, Cd, Pb) which could have caused these deaths in the Atatürk Dam, and to compare these analysis values with the values of the intracontinental water source quality of the Water Pollution Control Regulations published in the Official Gazette.

Method

Study Location

Water samples were taken from 5 different stations which flow into the Atatürk Dam within the borders of Adiyaman province in the South-east Anadolu region (Figure 1). The samples were taken between June and August 2019, taking the pollution conditions of the areas into consideration.

Station 1: Adıyaman Gerger District, Budaklı Village Reservoir
Station 2: Adıyaman Centre, Boğazözü Village Girik Stream
Station 3: Adıyaman Burmapınar Village Kahta Stream
Station 4: Adıyaman Centre, İnceBağ Village (Miroğlu) Reservoir
Station 5: Adıyaman Çelikhan

Sample Collection and analysis

The water was taken from each point, as one container for each of the elements-heavy metals to be analysed (4). The process of straining solid particles in waste-water samples was applied using Whatman (No. 42) filter paper. To prevent organisms in the water starting a chemical reaction by fragmenting the heavy metals, 2 ml pure HNO_3 was added to the samples, and a pH <2 was obtained in the water. Heavy metal analyses of the water samples performed in the Advanced Technology Training, Research and Application Centre laboratory of Mersin University using an Agilent 7500 ce series ICP-MS device (Tokyo, Japan) (6).

Figure 1: Study Area and Station locations

The concentrations of Cu, Fe, Zn, Cr, Ni, Cd, As and Pb elements were determined in the samples. The heavy metal calibrations of the ICP-MS device and device accuracy were applied with international certificated standards (NIST standards). Each analysis was made 3 times on the ICP-MS device, and the mean value of these 3 repetitions was calculated. If the relative standard deviation of these three repetitions was >3, the analyses were repeated. By taking a standard reading of every 10 samples during the analyses, accuracy of the device was maintained until the end of the analyses.

Results

The highest mean levels of metals determined in the water samples of this study were (µl/l) ; 1108.7 (Zn), 0.016 (Al), 1529.4 (Cr), 1507.92 (Ni), 905.56 (Cu), 22.3 (Se), 45.5 (Co) and 4.43 (Pb). Cd and as were not determined. Cd, As were not determined in any sample. Zn and Se were determined in samples from Station 4 (11087.68 ppb) (Table 1, 2, 3).

Table 1: Heavy metal values (ppb) determined in the water according to the sampling stations. Values are given as mean ± standard deviation (SD).

	Al	Cr	Co	Ni	Cu	Zn	Cd	Pb	As	Se
Station 3	37318±22	2804±52	52 ±3	2909±81	1545±43	0	0	0	0	0
Station 2	28418 ±92	1999±9	48±11	2041±24	1142±13	0	0	3±1	0	0
Station 2	9570±41	1770±91	43±43	1782±62	931±91	0	0	17±94	0	0
Station 1	0	1132±6	19±94	1145±18	562±42	0	0	0	0	0
Station 1	0	1065±33	18±52	1063±11	535±02	0	0	0	0	0
Station 4	1535±01	1329±14	183±7	1383±38	780±16	0	0	15±12	0	0
Station 5	50897±66	1269±12	21±67	1295±81	954±07	0	0	0	0	0
Station 4	121303±9	1114±22	17±43	1033±88	825±75	0	0	81±8	0	0
Station 5	17689±3	1732±49	33±72	1368±49	1228±6	11087±68	0	0	0	223±44
Station 3	5661±2	1075±16	16±.2	1055±65	550±11	0	0	0	0	0

Table 2: Descriptive statistics for the heavy metal values determined in the water (ppb).

	N	Minimum	Maximum	Mean ± SD
Al	10	0.00	50897.66	16322.11 ± 17361.51
Cr	10	1065.33	2804.52	1529.34 ± 558.39
Co	10	16.20	183.70	45.5 ± 50.43
Ni	10	1033.88	2909.81	1507.92 ± 592.9
Cu	10	535.02	1545.43	905.56 ± 329.36
Zn	10	0.00	11087.68	1108.77 ± 3506.23
Cd	10	0.00	0.00	0 ± 0
Pb	10	0.00	17.94	4.43 ± 6.92
As	10	0.00	0.00	0 ± 0
Se	10	0.00	223.44	22.34 ± 70.66

Table 3: Correlations between the heavy metal measurements determined in the water. r; Spearman rank correlation coefficient, n: sample number, *; 0.05 significance level and **; 0.01 significance level.

		Cr	Co	Ni	Cu	Zn	Pb	Se
Al	R	0.608	0.316	0.450	0.857**	0.175	-0.082	0.175
	P	0.062	0.374	0.192	0.002	0.629	0.821	0.629
	N	10	10	10	10	10	10	10
Cr	R	1.000	0.842**	0.939**	0.867**	0.174	0.273	0.174
	P		0.002	0.000	0.001	0.631	0.445	0.631
	N	10	10	10	10	10	10	10
Co	R		1.000	0.915**	0.600	0.058	0.376	0.058
	P			0.000	0.067	0.873	0.285	0.873
	N			10	10	10	10	10
Ni	R			1.000	0.709*	0.058	0.225	0.058
	P				0.022	0.873	0.531	0.873
	N				10	10	10	10
Cu	R				1.000	0.406	0.020	0.406
	P					0.244	0.955	0.244
	N					10	10	10
Zn	R					1.000	-0.261	
	P						0.466	
	N						10	

Discussion

In this study were (µl/l) ; 1108.7 (Zn), 0.016 (Al), 1529.4 (Cr), 1507.92 (Ni), 905.56 (Cu), 22.3 (Se), 45.5 (Co) and 4.43 (Pb) determined , Cd and As were not determined. In a study by Fırat et al (4), in the muscle tissue of fish caught in Atatürk Dam in the Adıyaman Sitilce District, the maximum values of Zn, Cu, Pband Cr were 22.58, 0.75, 0.29, and 0.13 µl/g dry weight, respectively. In the current study, the values obtained of these metals were lower, which was thought to be due to the positive effect of the waste-water treatment plants having come into operation. In another study, accumulated levels of heavy metals were

examined in water samples taken from the freshwater Çıldır Lake, and the results obtained determined Mn>Fe>Zn>Pb>Cu>Cd in the water (7). Şahin et al (8) investigated the heavy metal levels in the Karakaya Reservoir from the two different stations of Arguvan and Battalgazi. In the samples taken from the Arguvan area, the metal ratios were determined as As> Fe> Cd> Mn> Pb> Cr> Ni>Zn>Cu>Co, and in the Battalgazi area as As>Cd>Fe>Mn>Pb>Cr>Co>Ni>Cu>Zn (8). In the current study, Cd and as were not determined in any sample, and Zn and Se were determined in the samples from Station 4 (11087.68 ppb).

Metal levels in the study areas are affected by domestic and industrial activities, and the highest metal levels of all the samples were seen to be higher in the polluted areas where waste-water is discharged without treatment (9).(9). According to the Intracontinental Water Pollution Control Management criteria, the metal values obtained were classified as 4th quality water pollution for Cr, Se and Ni, 3rd quality water pollution for Co, and 2nd and 1st quality water pollution for the other metals.

As a result of natural or human activities such as urbanisation and industrialisation, there has been an increase in recent years of the concentrations of heavy metals in water ecosystems (rivers, lakes, seas) and these cause severe ecological damage because of the bio accumulative property and toxicity in the food chain. The high metal concentrations in water, sediment and organisms can be much higher than the defined legal values (1, 10-12).

The toxic substances defined as the 20 most dangerous on earth include zinc (Zn), copper (Cu), mercury (Hg), nickel (Ni), chrome (Cr) and lead (Pb), and these are known to be extremely dangerous chemicals for the environment and show the most significant water pollution (13). Several human diseases are known to be related to increased heavy metal pollution. For example, Hg causes neurological effects, cadmium (Cd) and Pb cause carcinogenic effects, Cr leads to mutations in genetic material, and Cu causes anaemia (2, 3, 14).

Environmental problems formed because of modern-day industrial activities threaten the balance of nature and human and animal health, and these problems are seen to be emerging in ever increasing dimensions. The Atatürk Dam was constructed on the Euphrates River in the Southeast Anadolu region of Turkey As the largest reservoir in the country, the basic function is the provision of water and the production of hydroelectricity. Intensive trout farming is also conducted in the reservoir and recently mass fish deaths have been seen (15-18).

In conclusion ,the results of this study have demonstrated that waste-water discharged without being treated to Atatürk Dam creates a high rate of heavy metal pollution and has the potential to harm the freshwater environment and the life in it.

Conflict of interests:

The author(s) declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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