TRACE – TOXIC ELEMENT ACCUMULATIONS IN WATER OF ATİKHİSAR DAM LAKE (ÇANAKKALE, TÜRKİYE)

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Abstract

Atikhisar Dam Lake is located in the west part of Marmara Region and meets the drinking water needs of Çanakkale Province of Türkiye. Therefore, it has a direct and critical impact on the health of many people. In the present research, toxic and trace element concentrations in water of Atikhisar Dam Lake were investigated and the results were compared with the drinking water standards. For this purpose, surface water samples were collected from 3 stations selected on the Atikhisar Dam Lake in winter (rainy) season of 2022. Boron (B), sodium (Na), magnesium (Mg), potassium (K), chromium (Cr), manganese (Mn), nickel (Ni), copper (Cu), zinc (Zn), arsenic (As), cadmium (Cd) and lead (Pb) accumulations in water samples were measured by using an ICP-MS device in the laboratory of Technology Research Development Application and Research Centre of Thrace University an internationally accredited centre. In addition, Cluster Analysis (CA) was applied to the data to classify the investigated stations in terms of similar water quality characteristics. According to the data obtained, it was determined that the toxic and essential element accumulation levels in the waters of Atikhisar Dam Lake did not exceed the limit values reported for drinking water.

Keywords: Atikhisar Dam Lake, Çanakkale, Drinking Water, Trace – Toxic Elements.

INTRODUCTION

About 3/4 of the earth's crust is covered by water and contamination of these water ecosystems are a threat to life in the biosphere today. One of the major contaminants of the freshwater ecosystems are toxic metals and they emanate from mainly pesticides from agricultural lands and wastes from industrial areas. So, freshwater quality assessment is very significant for an health ecosystem [1 – 6].

Atikhisar Dam Lake is located in the Çanakkale Province of Türkiye and it meets the drinking water needs of the region. Therefore, the reservoir has a very critical impact on the health of many people living in the Çanakkale Province. The reservoir, which has a capacity of approximately 53 million m³, was built on the Sarıçay Stream in 1975 by State Hydraulic Works (DSİ). The body volume of the Atikhisar Dam Lake, which is a soil body fill type, is 1.990.000 m³ and its height from the riverbed is 43 meters. The reservoir volume is about 40 hm³ and the reservoir area is about 3.30 km² at the normal water level [7 – 9].

The aim of this research was to (1) evaluate the water quality of Atikhisar Dam Lake in terms of trace and toxic element accumulations and (2) compare the data with the drinking water standards.

MATERIAL AND METHODS

Water Collection

Surface water samples were collected from 3 locations selected on the reservoir in the winter (rainy) season of 2022 with a telescopic water sampling device approximately 3 meters from the shore into the pre – cleaned polyethylene bottles. The map of Atikhisar Dam Lake and the selected stations is given in Figure 1.

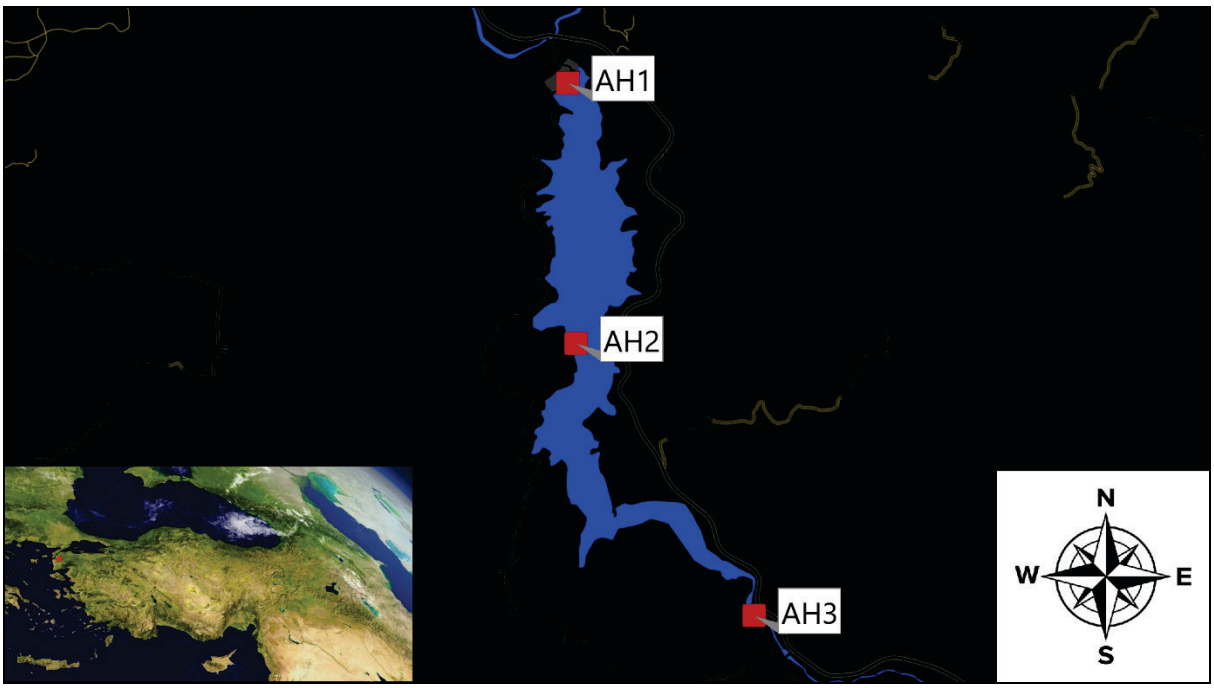


Fig. 1. *Atikhisar Dam Lake and selected station of the reservoir*

Element Analysis

pH values of water samples were decreased to 2 by adding about 2 ml of nitric acid per 1 L into each. The samples were filtered by using a 0.45 µm – cellulose nitrate filter. The volumes of samples were made up to 50 ml with ultrapure water. In the acidic – filtered water samples, a total of 12 metal(loid)s (B, Na, Mg, K, Cr, Mn, Ni, Cu, Zn, As, Cd and Pb) were determined with an inductively coupled plasma – mass spectrometry (ICP – MS) in the laboratory of Technology Research Development Application and Research Centre of Trakya University – an international accreditation certificated institution.

All the element analyses were determined as means of triplicate reads (TS EN / ISO IEC 17025) [10, 11]. The accuracy of analytical method was controlled by using a certified reference material (CRM) (CPAchem – Ref Num: 110580.L1).

Statistical Analysis

Cluster Analysis (CA) was applied to the detected chemical data in order classify the investigated locations in terms of their similar water quality characteristics by using “PAST” package statistical program.

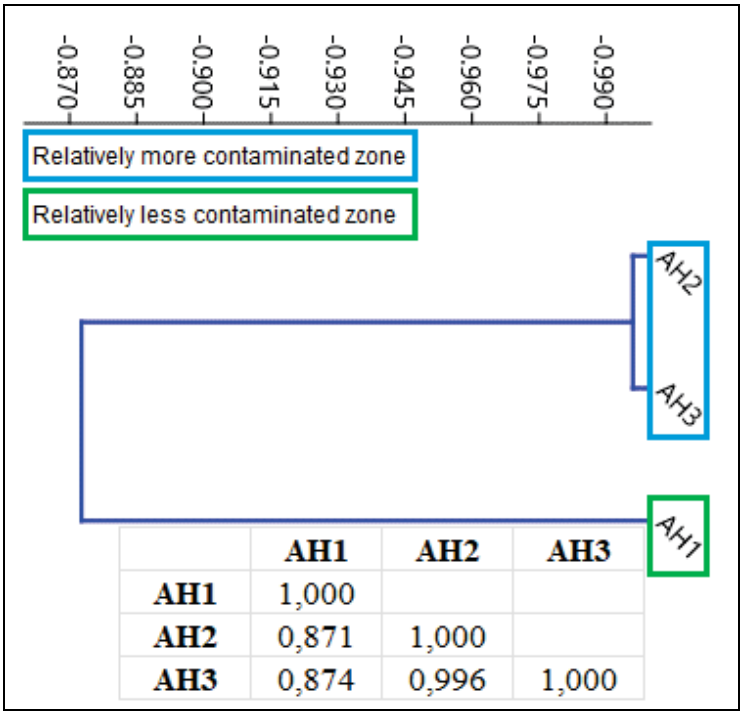
RESULTS AND DISCUSSIONS

Cluster Analysis (CA), which enables to classify the objects according to similar characteristics, is one of the most widely used statistical techniques to assess the surface water quality [12 – 15]. CA was used to obtain the similarity groups among the investigated stations selected on the Atikhisar Dam Lake according to similar water quality characteristics.

The diagram of CA calculated by using all the investigated metal(loid)s in water of Atikhisar Dam Lake is given in Figure 2.

As a result of applied CA, 2 statistically significant clusters were formed. Cluster 1, which was named as "Relatively more contaminated zone", corresponded to the stations of AH2 and AH3 that were the input locations of the reservoir; and Cluster 2, which was named as "Relatively less contaminated zone", corresponded to the station of AH1 that was the output location of the reservoir.

In research conducted in the Sakarya River Basin in Türkiye, water qualities of the basin components were investigated. As similar to the present research, Porsuk Dam Lake constructed on the Porsuk Stream has recorded as a significant cleaning capacity and water quality of the dam lake were significantly rising at the stations, which were close to the output of the reservoir [16].



	AH1	AH2	AH3
AH1	1,000		
AH2	0,871	1,000	
AH3	0,874	0,996	1,000

Fig. 2. *CA diagram of Atikhisar Dam Lake*

Levels of investigated trace and toxic elements in water of Atikhisar Dam Lake are given in Figure 3 as GIS based distribution maps.

The order of investigated metal(loid)s in water of Atikhisar Dam Lake in terms of average concentrations were as follows: Na (649.46362 ppm) > Mg (432.07694 ppm) > K (400.39413 ppm) > Mn (4.81625 ppm) > Zn (1.73647 ppm) > As (1.43195 ppm) > Cu (1.36726 ppm) > Ni (0.82911 ppm) > B (0.30033 ppm) > Pb (0.26668 ppm) > Cr (0.08109 ppm) > Cd (0.03299 ppm).

According to the Water Pollution Control Regulation criteria in Türkiye [17], all the investigated stations in the Atikhisar Dam Lake have 1. Class water quality in terms of all the investigated trace and toxic element accumulations in water.

According to the data obtained in the present research, it was also determined that the toxic and essential element accumulation levels in the waters of Atikhisar Dam Lake did not exceed the limit values reported for drinking water by World Health Organization [18], European Communities [19] and Turkish Standards Institute [20].

CONCLUSION

In the present investigation, toxic and trace element concentrations in water of Atikhisar Dam Lake were investigated and the results were compared with the drinking water standards. Also, Cluster Analysis (CA) was used to classify the investigated stations in terms of their similar water quality characteristics.

As a result of this research, water of the Atikhisar Dam Lake has recorded as 1. Class water quality in terms of all the investigated elements and the toxic – essential element accumulation levels in the waters of Atikhisar Dam Lake did not exceed the limit values reported for drinking water.

As a result of applied CA, 2 statistically significant clusters were formed. Cluster 1 was named as "Relatively more contaminated zone" and it was corresponded to the input locations of the reservoir; and Cluster 2 was named as "Relatively less contaminated zone" and it corresponded to the station of output location of the reservoir.

ACKNOWLEDGEMENTS

The present study was funded by the Trakya University, Commission of Scientific Research Projects (Project No. 2022/63).

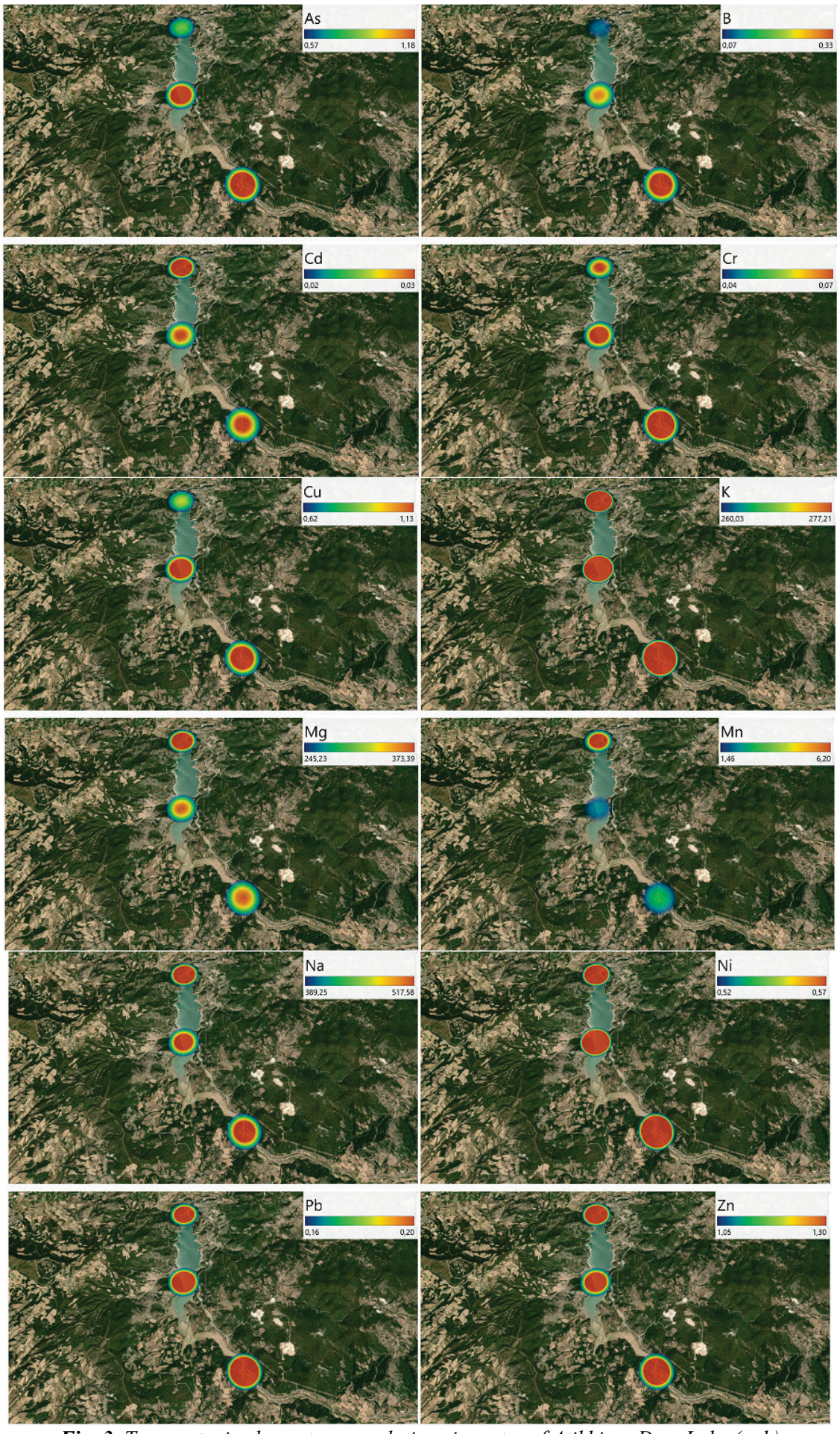


Fig. 3. *Trace – toxic element accumulations in water of Atikhisar Dam Lake (ppb)*

REFERENCE

[1] Isiuku, B. O. & Enyoh, C. E. (2019). Water pollution by heavy metal and organic pollutants: Brief review of sources, effects and progress on remediation with aquatic plants. Analytical Methods in Environmental Chemistry Journal, 2, 5–38.

[2] Tokatlı, C. & Ustaoğlu, F. (2020). Health risk assessment of toxicants in Meriç River Delta Wetland, Thrace Region, Turkey. Environmental Earth Science, 79: 426.

[3] Varol, M. & Tokatlı, C. (2021). Impact of paddy fields on water quality of Gala Lake (Turkey): An important migratory bird stopover habitat. Environmental Pollution, 287: 117640.

[4] Varol, M., Ustaoğlu, F. & Tokatlı, C. (2022). Ecological risks and controlling factors of trace elements in sediments of dam lakes in the Black Sea Region (Turkey). Environmental Research, 205: 112478.

[5] Yüksel, B., Ustaoğlu, F., Tokatlı, C. & İslam, S. (2022). Ecotoxicological risk assessment for sediments of Çavuşlu Stream in Giresun, Turkey: association between garbage disposal facility and metallic accumulation. Environmental Science and Pollution Research, 29: 17223–17240.

[6] Tokatlı, C., Titiz, A. M., Uğurluoğlu, A., İslam, S., Ustaoğlu, F. & Islam, A. R. T. (2022). Assessment of the effects of Covid-19 lockdown period on groundwater quality of a significant rice land in an urban area of Türkiye. Environmental Science and Pollution Research, https://doi.org/10.1007/s11356-022-20959-8.

[7] Anonymous (2020). 2020 Environmental status report of Çanakkale Province. Republic of Türkiye, Çanakkale Governorship, Provincial Directorate of Environment and Urban Management.

[8] http://suyonetimiormansu.gov.tr.

[9] http://tr.wikipedia.org/wiki/Atikhisar_Barajı.

[10] Environmental Protection Agency (EPA) METHOD 200.7. (2001). Determination of Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry.

[11] APHA (1999). Standard methods for examination of water and wastewater. American Public Health Association.

[12] Tokatlı, C., Köse, E. & Çiçek, A. (2014). Assessment of the effects of large borate deposits on surface water quality by multi statistical approaches: A case study of the Seydisuyu Stream (Turkey). Polish Journal of Environmental Studies, 23 (5): 1741-1751.

[13] Tokatlı, C., Köse, E., Arslan, N., Çiçek, A., Emiroğlu, Ö. & Dayıoğlu, H. (2016). Ecosystem quality assessment of an aquatic habitat in a globally important boron reserve: Emet Stream Basin (Turkey). International Journal of Environment and Pollution, 59 (2/3/4): 116-141.

[14] Tokatlı, C., Mutlu, E. & Arslan, N. (2021). Assessment of the potentially toxic element contamination in water of Şehriban Stream (Black Sea Region, Turkey) by using statistical and ecological indicators. Water Environmnet Research, 93: 2060–2071.

[15] Köse, E., Emiroğlu, Ö., Çiçek, A., Tokatlı, C., Başkurt, S. & Aksu, S. (2018). Sediment quality assessment in Porsuk Stream Basin (Turkey) from a multi-statistical perspective. Polish Journal of Environmental Studies, Vol. 27, No. 2, 747-752.

[16] Köse, E., Çiçek, A., Uysal, K., Tokatlı, C., Emiroğlu, Ö. & Arslan, N. (2015). Heavy metal accumulations in water, sediment and some cyprinidae fish species from Porsuk Stream (Turkey). Water Environment Research, 87 (3): 195-204.

[17] Turkish Regulations (2015). Regulation on Surface Water Quality Management. Official Gazette Dated April 15, 2015. Number: 29327,

[18] WHO (World Health Organization) (2011). Guidelines for Drinking-water Quality. World Health Organization Library Cataloguing-in Publication Data. NLM classification: WA 675.

[19] EC (European Communities) (2007). European Communities (drinking water) (no. 2), Regulations 2007, S.I. No. 278 of 2007.

[20] TS 266 (Turkish Standards) (2005). Waters – Waters Intended for Human Consumption. Turkish Standardization Institute. ICS 13.060.20.