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Monitoring of Zn and Cr in Downstream Water from Uzunçayır Dam in Turkey

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ABSTRACT: In this study, the concentrations of Zn and Cr in downstream waters from Uzunçayır Dam (Tunceli, Turkey) were monitored during spring (March, April, May) and summer (June, July, August) season. Zinc and Cr concentrations in surface water samples were detected using the ICP-MS device. According to the data obtained the lowest Zn and Cr concentrations in the spring season were 65.43±3.2 µg/L in March at 10th day for Zn and 0.28±0.02 µg/L in March at 10th and 20th day for Cr, the highest Zn and Cr concentrations were determined to be 83.12±4.1 µg/L in May at day 30 for Zn and 0.48±0.02 µg/L in May at day 30 for Cr. The lowest Zn and Cr concentrations in summer season were 55.48±2.7 µg/L at 30th day in August for Zn and 0.54±0.03 µg/L at 10th day in June for Cr. The highest Zn and Cr concentration in summer season were found as 69.48±3.5 µg/L in June at day 10 for Zn and 1.23±0.06 µg/L in August at day 30 for Cr. The Zn and Cr concentrations in the downstream of Uzunçayır Dam were found to be smaller than the Zn and Cr concentrations given by the Surface Water Quality Regulation (SWQR). As a result, it was determined that there was no harm in using water from the Uzunçayır Dam as irrigation water or drinking water in terms of Zn and Cr concentrations.

Keywords: Downstream, monitoring, water quality, Tunceli, Turkey.

INTRODUCTION

Water resources cover the essential part of the earth surface, eventhough clean water reserve may be very little in terms of amount within the globe (Javed et al., 2017; Ponsadailakshmi et al., 2018). The surface water bodies are among the most sensitive sources that are prone to impacts from human activities which may result in degradation of the resource in the future (Nasrabadi, 2015). Freshwater availability decreases day by day in the world due to contamination, specifically in developing countries (Uddin et al., 2018). Therefore, the issue of water pollution is an important problem for many developing countries. Water is a very important resource in the world and water resources need to be managed well. The management of water resources requires assessment of water quality.

Increased water scarcity often goes along with water quality deterioration since water quantity and quality are strongly interlinked. River basin water quality is highly dependent on the hydrological system, human interactions with water

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bodies and upstream diffuse- and point sources of pollution that can be difficult to predict and monitor (Martinsen et al., 2019).

Heavy metals/metalloids are among the most notorious threats for water and soil ecosystems (Nasrabadi et al., 2016). Potentially toxic metals like cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), nickel (Ni) and zinc (Zn), are of high concern due to their direct impact on human health and aquatic ecosystem (Marrugo-Negrete et al., 2017; Saran et al., 2018). Heavy metal pollution is a known cause of various diseases such as neurotoxicity, immunological problems carcinogenicity, genomic instability, endocrine disruption and also impaired psycho-social behavior (Dyer, 2007; Khan et al., 2013).

Chromium is the earth's 21st most abundant element (about 122 ppm). It is the sixth most abundant transition metal. Chromium compounds are widely used in various applications (leather tanning, electroplating, metal finishing, pigments, wood protection, magnetic tapes, chemical manufacturing, brass, electrical and electronic equipment, catalysis and so on) (Mohan et al., 2011). Zinc is one of the major common metals. It is an essential element and abundant in the earth's crust. Zinc is widely used in various industries such as construction, machinery, transportation, electricity. paper and cosmetics. Zinc is also found in surface and groundwater, and enters the environment from several sources including mine drainage, industrial and municipal wastes, urban runoff, and mainly from the erosion of soil particles containing Zn (Noulas et al., 2018). Therefore, monitoring of heavy metals from environmental pollutants in surface waters is very important.

For the above-mentioned environmental reasons, the purpose of this study is to investigate the heavy metals Zn and Cr in surface waters. In this context, in this study, the concentrations of Zn and Cr in the downstream water from Uzunçayır Dam (Tunceli, Turkey) were monitored during spring and summer season.

MATERIAL & METHODS

Uzunçayır Dam Lake is one of the important water resources of Tunceli province which is built on the Munzur River. The downstream waters from the Uzunçayır Dam are used as irrigation and/or drinking water and feed Keban Dam Lake. The basin is composed of volcanic and sedimentary rocks of Miocene-Pliocene age. The sedimentary rock units from these rock units show marl characteristics. Volcanic rocks show unmelting, rock media aquifer characteristics (Atabey, 2015). Uzunçayır Dam Lake which is one of the important water resources of Turkey is under pressure with many pollutants. When the Uzunçayır Dam Lake basin is examined, pollutant sources include effluents from domestic wastewater treatment plant, pollutants from agricultural activities and pollutants from industrial activities. For these reasons, the Munzur River, where Uzunçayır Dam Lake is located, was chosen as the study area. Surface water samples used as materials were taken from the downstream waters of Uzunçayır Dam during the spring and summer. On the 10th, 20th and 30th days of spring and summer in 2018, surface water samples were prepared for analysis.

The ED50 3^{o} coordinates of the sampling points are given in Table 1. Figure 1 shows the location of Uzunçayır Dam and a map showing the sampling point.

Table 1. Coordinates of sampling points

Sampling Points	Coordinates* X	Coordinates* Y
P-1	547201	4313890
P-2	547178	4313911
P-3	547176	4313886
P-4	547151	4313876
P-5	547135	4313894

* The coordinates were obtained by using the Magellan eXplorist 510 (Santa Clara, USA).

Fig. 1. Uzunçayır dam and sampling point

The downstream water samples from Uzunçayır Dam were taken from the sampling point shown in Figure 1. Surface water samples from a depth of about 20 cm were taken into sample containers in order to represent the different points of the sampling point (5 separate points). Water samples were acidified with 0.01 N HCl to pH below 2. After acidification, Zn and Cr concentrations in water samples were determined in a laboratory accredited with ICP/MS (ISO 9001: 2008).

RESULTS AND DISCUSSION

Zinc concentrations obtained in this study are between about 55 and 83 µg/L. Nasrabadi (2015) reported that Zn concentration in water collected from Haraz River was in the range between 30 and 82 µg/L, in accordance with our results. Bidhendi et al. (2007) reported significantly higher Zn concentrations (between 1.29 and 1.5 mg/L in July and Zn concentrations between 0.05 and 0.19 mg/L in November) for surface water samples.

The Zn concentrations determined during the spring season (March, April and May) in the downstream waters from the Uzunçayır Dam are given in Figure 2.

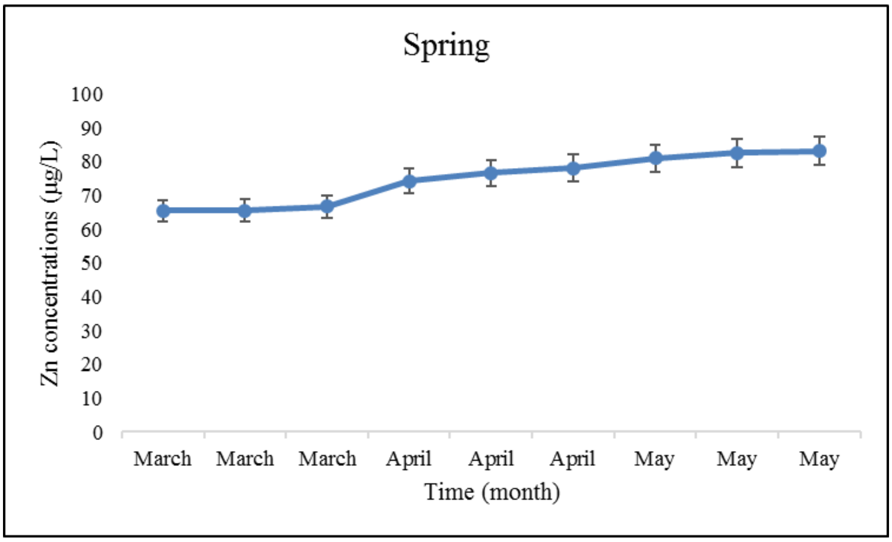

Fig. 2. The Zn concentrations determined during the spring season

According to Figure 2, Zn concentrations increased in spring season from March to May. The lowest Zn concentrations in the spring season were 65.43±3.2 µg/L in March at 10th day, the highest Zn concentrations were determined to be 83.12±4.1 µg/L in May at day 30. The mean Zn concentrations in March, April and May were 65.87±3.3 µg/L, 76.35±3.8 µg/L, 82.24±4.1 µg/L, respectively. The mean Zn concentration in spring season was calculated as 74.82±3.7 µg/L. Ahmed et al. (2017) reported Zn concentrations as 19.777–43.289 µg/L in lake water samples collected bimonthly around Kampar, Perak during the rainy season between November and December. Zinc concentrations monitored in our study (about 65-83 µg/L) in the rainy season were higher than the values recorded in the study of Ahmed et al. (2017). They reported that the high concentrations of Zn in lake samples are expected to originate from soil dust and forest-clearing activities using burn methods.

The Zn concentrations determined during the summer season (June, July and August) in the downstream waters from the Uzunçayır Dam are given in Figure 3.

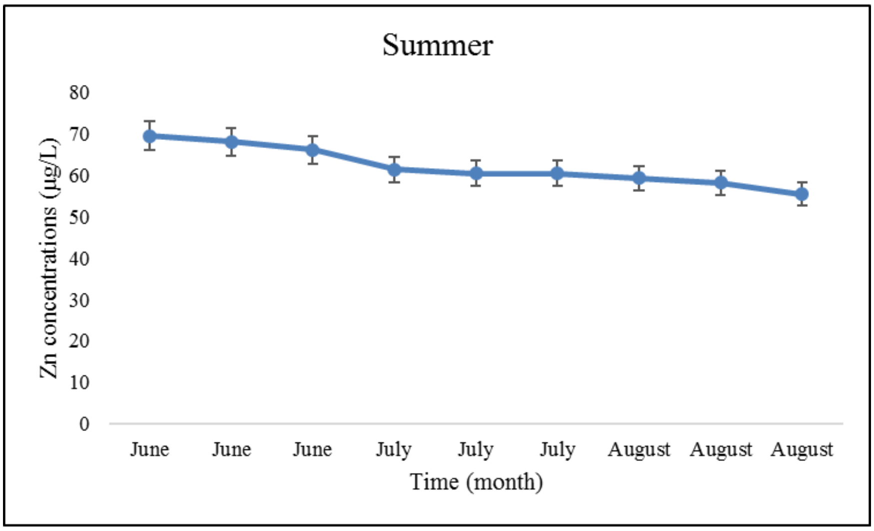

Fig. 3. The Zn concentrations determined during the summer season

According to Figure 3, Zn concentrations decreased in summer season from June to August. According to the data obtained the lowest Zn concentrations in summer season were 55.48±2.7 µg/L at 30th day in August. The highest Zn concentration in summer season were found as 69.48±3.5 µg/L in June at day 10. The mean Zn concentrations in June, July and August were 67.92±3.4 µg/L, 60.77±3.0 µg/L, 57.67±2.8 µg/L, respectively. The mean Zn concentration in summer season was calculated as 62.12±3.1 µg/L.

In our study, Zn concentrations in the spring season were generally high in comparision with summer season. Different results from our results have also been reported. Nasrabadi et al. (2016) reported that Zn concentrations in samples collected during rainy season were only slightly higher than the samples from the dry season. In the study of Bidhendi et al. (2007), Zn concentrations detected in July were higher than the ones in November for surface water samples.

Our results obtained for Cr were between about 0.28 and 1.23 µg/L. Higher results than the values obtained in our study were reported by some researchers for various waters. Bidhendi et al. (2007) reported significantly higher Cr concentrations (between 0.39 and 0.41 mg/L in July and Cr concentrations between 0.04 and 0.07 mg/L in November) for surface water samples. Kamala-Kannan et al. (2008) reported that Cr concentration in water collected from Pulicat Lake was in the range between 1.4 and 11.4 µg/L. These values are significantly higher than the values obtained in our study. The probable cause of these high values in Pulicat Lake is the discharge of effluents from the industries located in the region.

The Cr concentrations determined during the spring season (March, April and May) in the downstream waters from the Uzunçayır Dam are given in Figure 4.

In Fig.4, the lowest Cr concentrations in the spring season was 0.28±0.02 µg/L in March at 10th and 20th day, the highest Cr concentrations was determined to be 0.48±0.02 µg/L in May at day 30. The mean Cr concentrations in March, April and May were 0.28±0.01 µg/L, 0.32±0.02 µg/L, 0.42±0.02 µg/L, respectively. The mean Cr concentration in spring season was calculated as 0.34±0.02 µg/L. Bazimenyera et al. (2014) analyzed the seasonal variation of the concentrations of Cr in South Lake Cyohoha water samples taken monthly. The results showed that the concentrations of Cr were high during the raining season and low during the dry season, contrary to our results.

The Cr concentrations determined during the summer season (June, July and August) in the downstream waters from the Uzunçayır Dam are given in Figure 5.

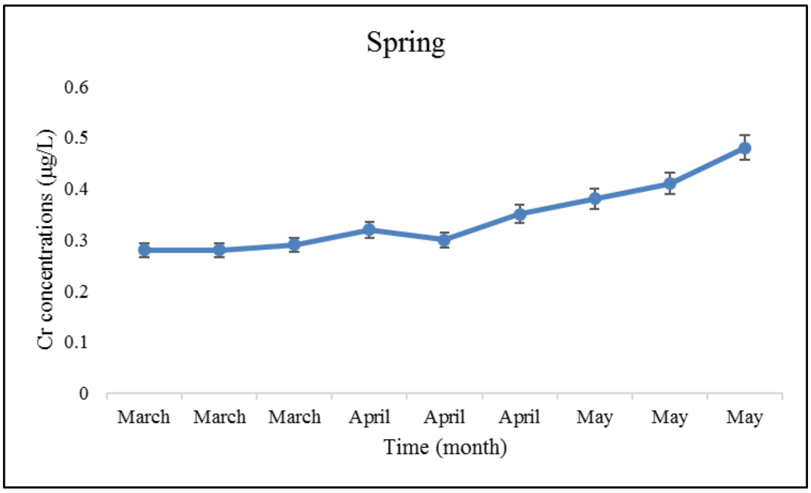

Fig. 4. The Cr concentrations determined during the spring season

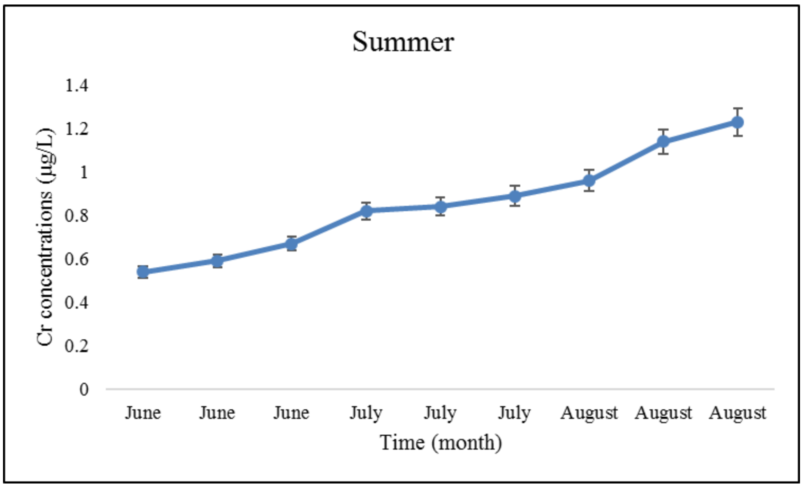

Fig. 5. The Cr concentrations determined during the summer season

In Fig.5, the lowest Cr concentration in summer season was 0.54±0.03 µg/L at 10th day in June. The highest Cr concentration in summer season was found as 1.23±0.06 µg/L in August at day 30. The mean Cr concentrations in June, July and August were 0.6±0.03 µg/L, 0.85±0.04 µg/L, 1.11±0.05 µg/L, respectively. The mean Cr concentration in summer season was calculated as 0.85±0.04 µg/L. Kamala-Kannan et al. (2008) reported the minimum level of Cr 1.4 µg/L during monsoon and maximum level 11.4 µg/L during premonsoon. In general, the highest mean value (7.78 µg/L) was observed during premonsoon and lowest (3.53 µg/L) during postmonsoon. Similarly, in our study, Cr concentrations in spring season that includes rainy months in Turkey were lower than the Cr concentrations monitored in summer that includes dry months in Turkey (in Tunceli city; mean precipitation in spring season: 301.4 mm, mean precipitation in summer season: 28.55 mm). A possible reason for this is the dilution of Cr concentrations because of rain. Masresha et al. (2011) sampled water from the The Ethiopian Rift Valley Lakes during the dry and wet seasons. In the dry season the concentrations of Cr were varied substantially (Cr = 1.1–27.8 µg/L). These values are higher than the concentrations monitored in our study. Contrary to our results, in the wet season relatively higher concentrations of trace elements were determined by Masresha et al. (2011) in Lake Koka, compared to the dry season. The probable reason could be due to the leaching of the elements into the rivers and reaching of them into the lake. They reported that the main inflows of the lake showed high concentrations of metals during wet season, leading to the increase in metal concentration in the lake. Quite high Cr values than the results monitored by us have been reported by Mansour and Sidky (2003) in the water samples collected from Lake Qarun (Egypt). The water from Lake Qarun appeared to have detectable concentrations of Cr. On average, Cr concentration was 0.36 mg/L.

CONCLUSION

The Zn and Cr concentrations in the downstream waters of Uzunçayır Dam were monitored in the 10th, 20th and 30th days of March, April, May, June, July and August in 2018. The obtained data were compared with some standard values found in Turkey and in the world. Standard values for Zn and Cr are given in Turkey by Surface Water Quality Regulation SWQR (30.11.2012 date and 28483 Official Gazette), the drinking water standard (TS-266). Also, standard values for Zn and Cr are given by the World Health Organization (WHO) and the EPA.

In Turkey, Zn concentrations in the standards of specific pollutants for surface water sources and environmental quality should not exceed 231 µg/L and Cr concentrations should not exceed 142 µg/L as regulated by SWQR. Cr and Zn concentrations in drinking water standards of Turkey, WHO and USEPA should not exceed 50 µg/L and 5000 µg/L (USEPA, 2017), respectively. In this context, the Zn and Cr concentrations determined in the present study were found to be lower than the mentioned standard values. As a result, it was determined that there was no harm in using water from the Uzunçayır Dam as irrigation water or drinking water in terms of Zn and Cr concentrations.

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