Pol. J. Environ. Stud. Vol. 31, No. 4 (2022), 3163-3172

DOI: *10.15244/pjoes/146478*

Original Research

Evaluation of Water Quality and Its Potential Threats Along River Drini Bardh Using Analytical Instrumental Techniques

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Received: 5 October 2021
Accepted: 7 February 2022

Abstract

The safety of drinking water is compromised by a variety of pollutants, both chemical and microbial. The goal of this study is to evaluate the quantity of heavy metals in the water, sediment, and soil of aquatic sources in the Drini i Bardhë river. The study site is directly impacted by the geological composition of the rocks present (including: clastic, alluvium, proluvium, glacigene and lake sediments). Results indicate that there were significant changes in the concentrations of heavy metals at various sediment, soil and water sample locations.

Sampling and measurements took place in September 2018. We measured physical and chemical parameters, including temperature, pH, EC, TDS, and ions (Ca^{2+}, Mg^{2+}, Na^+, K^+, NH_4^+, NO_2^-, Cl^-, NO_3) to characterize environmental samples taken from the study site. The amounts of ten elements in water, sludge, and soil samples were determined using inductively coupled plasma optical emission spectroscopy (ICP-AES) (As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Zn).

The study indicates mild contamination from these elements in the river, posing potential risks to humans, but in order to further characterize environmental risks posed by this contamination, additional research at the study site is needed.

Keywords: water quality, pollution, heavy metals, ICP-AES technique

Introduction

Pollution of water and sediments with metals is one of the most serious environmental problems, and human activities have the potential to significantly alter the physical-chemical properties of aquatic sediments and water sources, including in the Drini i Bardhë river basin. [1-2]. The accumulation of heavy metals in excess of environmental standards can result in environmental and human health problems [3-4]. Characterization of metals in rivers, lakes, fish, and sediments has been a prominent focus of environmental research in recent decades [5].

Bottom sediments in aquatic habitats provide insight into the processes and mechanisms that occur in aquatic ecosystems [6-7]. Hydrological cycles, physical-chemical processes and intricate spatiotemporal variation all contribute to the remobilization of heavy

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metals from sediments into the water [1-7]. Sediments (silt and clay) containing ecotoxic heavy metals and other inorganic and organic chemicals are critical for investigating water pollution. Hence, they require multidisciplinary research to better understand various processes and the geochemical cycles of various trace elements [1-8].

Due to their environmental durability and potential toxicity, heavy metals are considered a major pollutant of aquatic ecosystems [9-10]. Trace elements are partitioned across numerous environmental components in the aquatic environment (water, suspended solids, sediments and biota) [9-10].

Heavy metals are most abundant in soil and aquatic environments and occur in trace amounts in the atmosphere as particulate or vapors [11-12]. Due to the high stability of heavy metals, they can accumulate in the food chain, thereby causing severe negative health effects in humans, while also disrupting the aquatic ecosystem's food chain [10-13]. Chemical elements (including heavy metals) can enter a natural system via either natural or anthropogenic sources, and are distributed between the aqueous phase and bed sediments. As a result of adsorption, hydrolysis and co-precipitation, only a small concentration of free metal ions remains dissolved in water, while the majority of them are deposited in the sediment [1-15]. Metallic elements are environmentally stable and can enter biota via an aqueous medium, causing acute toxicity in humans, animals and plants [9-10].

Water resources are critical to human life and economic development since they provide the primary source of drinking water [18], irrigation for agricultural land and industry [2-9]. As a result, water scarcity is viewed as a constraint on a country's socioeconomic progress and security. Additionally, population increase, environmental degradation and climate change are three main threats to water resources. Rapid industrialization and urbanization have contaminated the environment with these compounds [11-13], and studies have demonstrated that this is a significant problem for humans and the ecosystem in general [14]. This article provides an accurate collection of heavy metals in the Drini i Bardh`s water. Additionally, it has been stated in previous research that the presence of these elements is quite high in various areas of the country [4-6] and that heavy metals can cause a variety of diseases and anomalies [7-8], implying that this type of study and continuous water quality monitoring are prudent.

Materials and Methods

Study of the Area

Drini i Bardhë is a river that runs across western Kosovo, through the Dukagjini plain. The river travels north-south for approximately 122 kilometers. To obtain reliable data during water monitoring and analysis, we must also be aware of the temperature and climate, as they have a significant effect on the expected composition of the water. Kosovo's climate is classified as continental, with pleasant summers and cold snowy winters, with temperatures ranging from -10ºC to -26ºC in the winter and 20ºC to 37ºC in the summer. The dry season begins in March and lasts until September, whereas the wet season lasts until February [2-3].

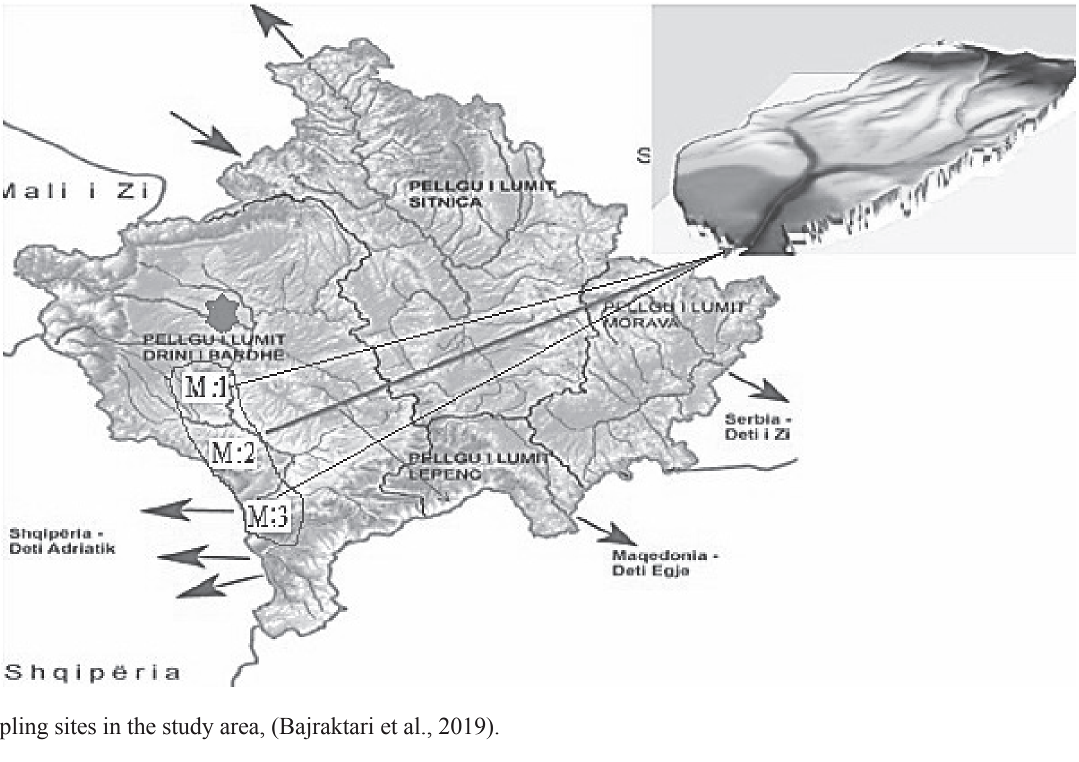

Fig. 1. Sampling sites in the study area, (Bajraktari et al., 2019).

Table 1. Physical and chemical properties of water samples in Drini i Bardhë River, Kosovo.

Parameters	M.1	M.2	M.3	Parameters	M.1	M.2	M.3
Temp	19ºC	23ºC	25 ⁰C	PO_4^{3-}	0.049	0.061	0.071
DO mg/l	8.2	7	6.3	P_{tot}	0.119	0.111	0.123
O_2%	100	90	76	SO_4^{2-}	7.12	8.43	8.91
EC (19ºC)	361 μScm^{-1}	388 μScm^{-1}	380 μScm^{-1}	Cl^-	3.43	4.66	5.28
pH	8.55	8.72	8.24	F^-	0.2	0.3	0.2
TDS	174	187	183	FP d⁰H	10.03	10.06	10.05
TMS	15	23.8	47.5	F_{Ca} d⁰H	12	12.1	12.6
COD	26.3	39.5	61	F_{Mg} d⁰H	16.1	15.9	16.3
BOD	14.4	22.5	38.2	Ca	109	103	101
TOC	8.8	12.9	21.6	Mg	23.01	18.9	19.8
NO_3^-	4.2	6.5	7.8	M_A	11.18	11.23	11.26
SUR	<0.1	<0.1	<0.1	HCO_3^-	684.1	668.7	679.4
NH_4^+	0.448	0.517	0.922	TUR	3.2	3.1	3.6
NO_2^-	0.096	0.125	0.248	$KMnO_4$	11.059	11.037	11.083
N_{in}	0.259	0.248	0.253	N_{tot}	0.269	0.271	0.273

The sediments of the rivers in Kosovo are generally made of unconsolidated to semi-consolidated sand and gravel elements [7-16]. The samples for this investigation were obtained in September 2018 during the dry season. Water samples were composited from: Ura Rogov, M.1, Ura Gjonaj, M.2 and Dobrushe, M.3.

The present investigation sampled throughout the morning hours and collected all water samples in plastic bottles. Three different depths of water were sampled to ensure that the sample was representative.

The sampling points' positions were established using the global positioning system (GPS), and their locations are detailed below. The study region and sampling point sections are depicted in Fig. 1 and more information about the sites is provided in Table 1.

The samples were combined and the merged one was analyzed. Chemical preservatives were added to the water samples and the temperature was lowered. Water temperature, pH, and TDS were determined immediately following collection, whereas the remaining parameters were determined in the laboratory (Table 1 and table 3).

Water samples were collected by inserting the glass bottle vertically into the direction of the flow of water, carefully removing contaminants that float on the surface of the water on both sides of the riverbed. Two-liter glass bottles were used to collect samples. Additionally, another container was filled and treated with 2 ml of HNO_3 for the purpose of determining heavy metals using the ICP-AES method. The same approach was followed at all three sampling locations.

Water samples were treated in accordance with the EPA standard 6010C [14]. Sludge samples weighing approximately 250 mg were collected and delivered to a laboratory for additional treatment and testing in accordance with the EPA 3051A standard [16]. Soil samples were collected in the river's vicinity.

Reagents: Chemicals used in this study were of analytical MERCK grade purity. Multielement standard solution for ICP, ACS reagents 37% HCl, 69% HNO_3, 37% H_2O_2), and deionized water of high purity was used (conductivity 0.05 µS/cm).

Each sample was collected in a polyethylene bag weighing approximately 1-2 kg. They were initially allowed to dry at ambient temperature for a few days before grinding and treating them according to the EPA 3051A standard [16].

All analyzed elements (As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn) were determined by atomic emission spectrometry with inductively coupled plasma, ICP-AES technique. Calculation and presentation of statistical charts was done using Minitab 19 software.

Results and Discussion

The present study was carried out for three sampling points of water, sludge and three soil samples in the vicinity of the river. The following table (Table 1) presents the water sampling points, physical and chemical properties of the water samples.

While physical and chemical qualities provide some insight into water quality, they do not provide a complete picture of water pollution. The water classification of this basin (river) was determined by comparing many

Table 2. Classification of river quality by UNECE (content, mg/L).

Category	P. Total	NO_3^-	OT	BOD_5	COD	NH_4^+
I	<10	<5	>7	<3	<3	<0.1
II	10–25	5–25	7–6	3–5	3–10	0.1–0.5
III	25–50	25–50	6–4	5–9	10–20	0.5–2
IV	50–125	50–80	4–3	9–15	20–30	2–8
V	>125	>80	<3	>15	>30	>8

water quality indicators at several sampling locations to the UNECE-recommended parameters in Table 2.

On the basis of the results obtained from three sampling locations in the Drini i Bardhë River, the physical and chemical parameters values varied as follows: The concentration of hydrogen ions (pH value), are in normal range for three sampling points. The electrical conductivity (which ranged from 361 to 380 $\mu S/cm^3$) of the water indicates a high dissolved ion content, which is typical for surface water.

The water temperature ranged from approximately 19 to approximately 25ºC, which categorizes them as warm waters. Chemical Oxygen Demand – COD (26.3, 39.5 and 61 mg/dm^3) and Biochemical Oxygen Demand – BOD (14.4, 22.5 and 38.2 mg/dm^3) measurements signify a low load of organic material in these samples. The titration results by $KMnO_4$ are in range 11.05, 11.03 and 11.08 mg/dm^3, a value slightly larger than BOD/COD, [18-22] this parameter determines the content of organic compounds in water but also in the majority of the cases, the content of the inorganic compounds, because the potassium manganese is a highly potent oxidizing compound which can also oxidize iron salts leading to higher values than COD/BOD, [18-22]. Both the alkalinity (11.18, 11.23 and 11.26 mmol), the concentration of ions such as chlorides (3.43, 4.66 and 5.28 mg/dm^3) sulphates (7.12, 8.43 and 8.91 mg/dm^3).

Nitrates constitute a higher degree of oxidation of the nitrogen in nature. Drinking water must not contain more than 15 mg/L of nitrate as nitrogen. In surface waters, they are present in small quantities [18-22], whereas in groundwater they are found in larger amounts. Nitrates are the final product of biological oxidation of organic pollution. This indicates for these samples do not demonstrate evidence of organic pollution, per UNECE guidelines (Table 2). The minimum value was 4.2 mg/L (M.1-Ura Rogovë), the maximum value was 7.8 mg/L (M.2.-Ura Gjonaj) and the average value is 6.5 mg/L (M.3-Dobrushe).

Nitrites are toxic and the maximal acceptable amount in drinking water is 0.005 mg/L of nitrite [18-22]. The obtained results at the sampling place of Drini i Bardhë River, showed the following values: at Sampling place (Ura Rogovë) the minimum value was 0.09 mg/L, while the maximum value was 0.24 mg/L, obtained at Sampling place (Dobrosht) and the average value was 0.12 mg/L (Ura Gjonaj) and phosphates, etc, fall in normal value for such types of waters.

To draw correct conclusions regarding the quality of the waters studied in this river, it is not sufficient to simply study one physicochemical parameter. Additional physicochemical characteristics, such as heavy metals, must be included in water quality monitoring efforts. As a result, we measured several „heavy metals," including As, Cd, Co, Cr, Cu, Fe, Mn,

Table 3. The measured results of the heavy metals in water (mg/L), sludge and soil samples (mg/kg).

Elements	M1. Water	M2. Water	M3. Water	M1. Sludge	M2. Sludge	M3. Sludge	M1. Soil	M2. Soil	M3. Soil
As	nd	nd	nd	nd	nd	nd	Nd	nd	nd
Cd	nd	nd	nd	nd	nd	nd	Nd	nd	nd
Co	0.016	0.014	0.012	0.086	0.038	0.029	0.023	0.031	0.019
Cr	0.032	nd	nd	0.069	nd	nd	0.047	nd	nd
Cu	0.023	0.01	nd	0.088	0.031	nd	0.036	0.021	nd
Fe	0.876	0.451	0.769	0.978	0.625	0.898	0.984	0.685	0.896
Mn	0.062	0.024	0.223	0.095	0.071	0.485	0.087	0.046	0.245
Ni	nd	0.013	nd	nd	0.011	nd	Nd	0.017	nd
Pb	nd	nd	nd	nd	nd	nd	Nd	nd	nd
Zn	0.394	0.345	0.302	0.684	0.711	0.898	0.564	0.549	0.413

nd*- under limit detection.

Ni, Pb, and Zn. The concentration levels for the tested heavy metals are listed in (Table 3). When comparing the samples, it is obvious that there is some variation in concentration. Still, all of the heavy metals are present in concentrations far below than the permitted levels in water (World Health Organization), [18-22].

The following table (Table 3), summarizes the results of water, sludge and sediment samples. Water results are expressed in mg/L, while those of soil and sludge in mg/kg.

The following table (Table 3) is a summary of all results in the form of statistical analyzes of measurements made on water, soil and sludge samples in three sampling points (M1-M3). The results are presented as mean, standard deviation, variance, minimum, maximum, Q1, Q3, median and range for Co, Cr, Cu, Fe, Mn, Zn.

The elements analyzed (Table 3) indicated that As, Cd, and Pb concentrations were below the detection limit. Similar results were found for Ni in the samples, where it was detected only in one sampling point (M2) and was below the limit of detection in sampling points M1 and M3. Nickel levels in drinking water should not exceed 0.2 mg/day, according to the World Health Organization [18-22]. Additionally, the World Health Organization report notes that the amounts of this element in groundwater vary according to soil type, pH, and sampling depth. In the Netherlands, the average concentration in groundwater ranges from 7.9 g/L (urban areas) to 16.6 g/L (rural areas). Nickel concentration in our water samples is 0.013 mg/L, which is below the applicable drinking water requirements.

Cobalt is found in trace amounts in the environment, and exposure via air, water, or food is likely for all humans. Cobalt concentrations in the air are typically relatively low (less than 2 ng/m^3), particularly in areas with adjacent industry. The amount of air we inhale is negligible in comparison to the amount we can obtain via meals and drinking water [22].

In populated areas of the United States, the concentration of this element in surface and groundwater is reported to be low, ranging between 1 and 10 parts of cobalt per billion parts of water (ppb), but these concentrations may vary in zones rich in cobalt-containing minerals, near mining or smelting. Cobalt levels in the majority of drinking water sources are less than 1–2 parts per billion [18-22]. This element was present in all samples at very low concentrations, ranging from 0.012 to 0.016 mg/L in water.

Chromium is the seventh of twenty additional hazardous metals to be designated as a primary carcinogen. This classification is assigned by the Agency for Toxic Substances and Disease Registry (ATSDR) and the International Agency for Research on Cancer (IARC) [18, 19]. It is vital that this element occurs naturally in the environment. In comparison to Cr (III), Cr (VI) is more mobile in soil and is toxic to living organisms [19-22]. Our samples included chromium concentrations ranging from 0.032 mg/L in water to 0.069 mg/kg in sludge and 0.047 mg/kg in soil. The EPA has established a 0.1 mg/L limit for drinking water. Thus, when the concentration of this element in water samples is compared, it is found to be less than the limit permitted by this American Organization.

Copper concentrations in water vary according to geography. For example, various studies discovered that this element was present in the United States of America at concentrations ranging from 0.0005 to 1 mg/L [18], the United Kingdom at concentrations ranging from 0.003 to 0.019 mg/L, and India at concentrations ranging from 0.0008 to 0.01 mg/L [18, 22, 23]. Copper concentrations in drinking water vary according to the World Health Organization, depending on the water's qualities such as pH, hardness, and copper availability in the distribution system [2-18]. As with our study, trace levels of this element were detected in water samples ranging from 0.01 mg/L to 0.023 mg/L.

Zinc is a naturally occurring element in the environment, although anthropogenic sources can increase its concentration. Zinc is a relatively benign element whose toxicity is limited to extremely high quantities. In the United States of America, the concentration of this element in air samples is less than 1g/m^3, but it fluctuates significantly around cities, ranging from 0.1 to 1.7 g/m^3 [22-23].

According to the Environmental Protection Agency (EPA), [15-23], zinc is a nuisance chemical in drinking water, which should have no more than 5 mg/L (5 ppm) due to taste concerns. Zinc values were consistently low in all our samples. Its concentration in water samples was consistently less than the EPA's recommended level (less than 5 parts per million) [23].

Table 4. Descriptive statistics of heavy metals presented in water, sludge and soil samples.

Variable	Mean	StDev	Variance	Min	Q1	Median	Q3	Max	Range
Co	0.02978	0.02277	0.00052	0.012	0.015	0.023	0.0345	0.086	0.074
Cr	0.0493	0.0186	0.0003	0.032	0.032	0.047	0.069	0.069	0.037
Cu	0.0348	0.0275	0.0008	0.01	0.0182	0.027	0.049	0.088	0.078
Fe	0.7958	0.1791	0.0321	0.451	0.655	0.876	0.938	0.984	0.533
Mn	0.1489	0.1476	0.0218	0.024	0.054	0.087	0.234	0.485	0.461
Zn	0.54	0.1971	0.0389	0.302	0.3695	0.549	0.6975	0.898	0.596

The final elements in our analysis were iron and manganese. Both of these elements are considered vital nutrients that the body requires to function effectively. These elements are frequently found together due to their similar valence in physical conditions, ionic radius, and other shared properties [20-21]. According to the US EPA's division of toxicants, both Fe and Mn are considered non-carcinogenic.

The World Health Organization (WHO) adopted a water standard of 0.3 mg/L for iron and 0.4 mg/L for manganese [18-22]. Iron concentrations in our samples are slightly higher than those suggested by the World Health Organization, [15, 20, 21] ranging from 0.451 to 0.876 mg/L in water samples, about double the permissible level. Manganese contents are lower than recommended levels, ranging from 0.024 mg/L to 0.223 mg/L.

The figures above (Fig. 2 - Fig. 5) are constructed using the elements' concentrations in water, sludge, and soil samples. The diagrams are separated into sections for each scenario, displaying the greatest concentration of each element in the tested samples. The following figures illustrate the levels of heavy metals detected in water samples (Fig 2), sludge samples (Fig 3), and soil samples (Fig 4). (Fig 4). Additionally, Fig. 5 presents and compares these data.

If we compare the highest concentrations of elements in water, we observe that concentration of Fe is maximum in the measured samples, followed by Zn, Mn, continuing with a very small difference to the other elements.

Fe is the highest presented element in our samples, with concentrations ranging from 0.876 to 0.451 mg/L. Zn ranges from 0.394-0.302 mg/L, Mn from 0.024 to 0.223 mg/L, Co from 0.012-0.016 mg/L, Cu from 0.1-0.023 mg/L. Chromium and nickel were present in only one sample, at concentrations of 0.032 mg/L for Cr, and 0.013 mg/L for Ni. Lead, arsenic, and cadmium were under the limit of detection in all of the water samples.

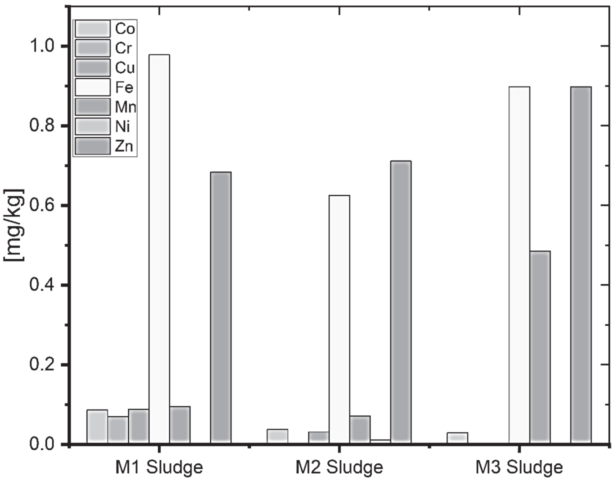

Fig. 3. The presence of heavy metals in sludge samples (mg/kg).

Results for sludge samples were comperable to those from water samples: the highest concentration element is Fe, followed by Zn, Mn, Cu, Co, Cr, Ni. The highest concentration of Fe is in sample M1.

The concentration of Fe ranges from 0.984 mg/kg -0.625 mg/kg, Zn from 0.898 - 684 mg/kg, Mn from 0.485-0.071 mg/kg, Cu from 0.088-0.031 mg/kg, Co from 0.086-0.038 mg/kg, followed by Cr that was presented only in one sample with concentration of 0.069 mg/kg and Ni 0.011 mg/kg. Similarly, lead, arsenic and cadmium were under the limit of detection in all sludge samples.

Soil is a known accumulator of various environmental toxicants. Therefore, it is necessary to monitor soil quality constantly [24].

The concentration of elements observed in soil samples in the vicinity of Drini i Bardhe river are

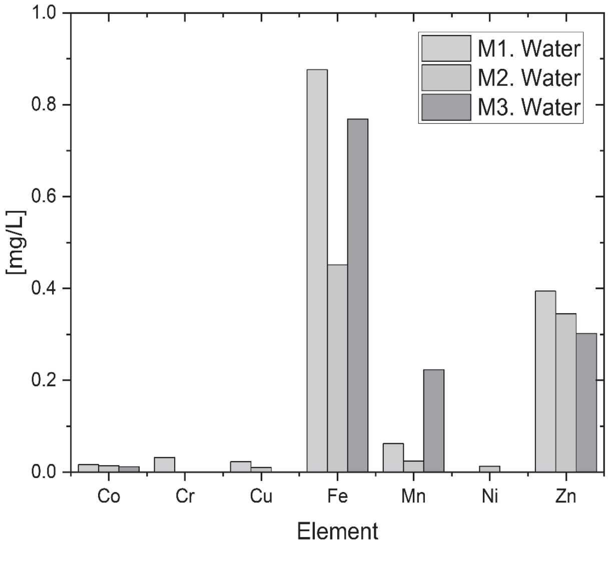

Fig. 2. The presence of heavy metals in water samples (mg/L).

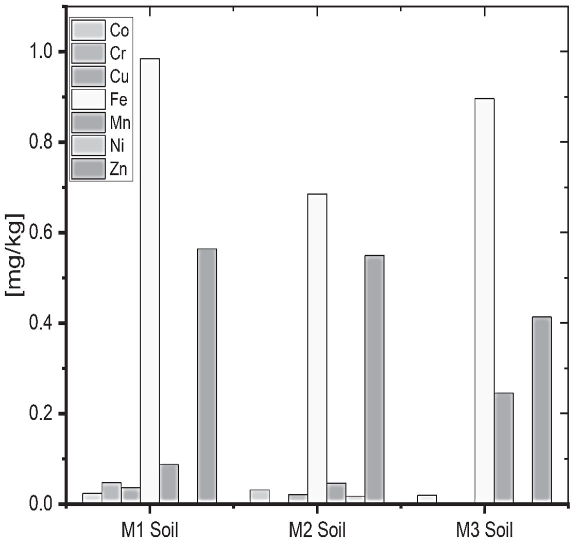

Fig. 4. The presence of heavy metals in soil samples (mg/kg).

Table 5. Classification of heavy metals in sludge and in soils according to Dutch Intervention. Values [23].

Elements in sludge	Non polluted (ppm)	Moderate polluted (ppm)	Heavily polluted (ppm)	Elements in soil	Target value (mg/kg)	Intervention value (mg/kg)
Cu	>25	25-50	>50	Cu	36	190
Zn	>90	90-200	>200	Zn	140	720
Ni	>20	20-50	>50	Ni	35	210
Cd	-	-	-	Cd	0.8	12
Pb	-	-	-	Pb	85	530

*The target values indicate the level at which there is a sustainable soil quality.

**The soil remediation intervention values indicate when the functional properties of the soil for humans, plant and animal life, is seriously impaired or threatened.

presented above in Fig 4. The elements are arranged in decreasing concentration: Fe>Zn>Mn>Cr>Cu> Co> Ni. In the soil samples take, concentrations of Pb, As and Cd are below the detection limit, while the concentrations of Ni and Cr were detected in only in one sample each.

Iron varied in soil samples from 0.685- 0.984 mg/kg, Zn ranged from 0.413- 0.564 mg/kg, Mn from 0.046- 0.245 mg/kg, and Co 0.019- 0.031 mg/kg. The concentration of Cu was observed in two soil samples at 0.021 and 0.036 mg/kg, Cr was present at 0.047 mg/kg, and Ni up to 0.017 mg/kg.

Fig. 5 shows the concentration of the measured elements in three sample types (water, sludge, and soil), across the three sample sites (M.1, M.2 and M.3).

From this figure, we see that elements are present at similar concentrations in all samples (Fig. 2 - Fig. 4), with iron dominating as the richest element, followed by zinc, manganese [25] and so on. The table below (Table 5) summarizes the maximum permitted concentrations of Cu, Zn, Ni, Cd, and Pb in soil and sludge samples in mg/kg according to Dutch Intervention. These guidelines are categorized into non-polluted, moderately polluted, and heavily polluted.

Dutch Standard are environmental pollutant reference values, that are usually used in environmental remediation, investigation, and cleanup processes. In order to generalize our results for comparison with other studies and samples, we referred to Dutch soil and sludge standard, as the most used standard values for soil quality.

When we compare our results (Table 2) to the recommended maximum concentrations of these elements in sludge and soils (Table 4) [24, 26], we see that our samples fall below the recommended maximum

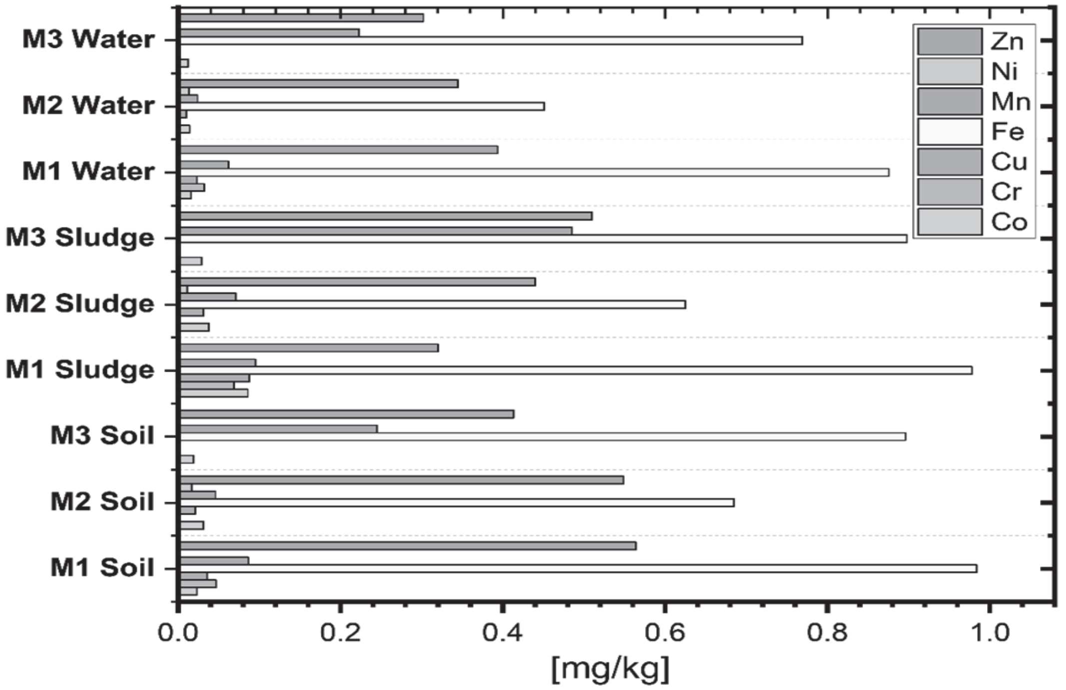

Fig. 5. The presence of heavy metals in all of the samples water (W-mg/L), sludge (SL-mg/kg) and soil (So-mg/kg).

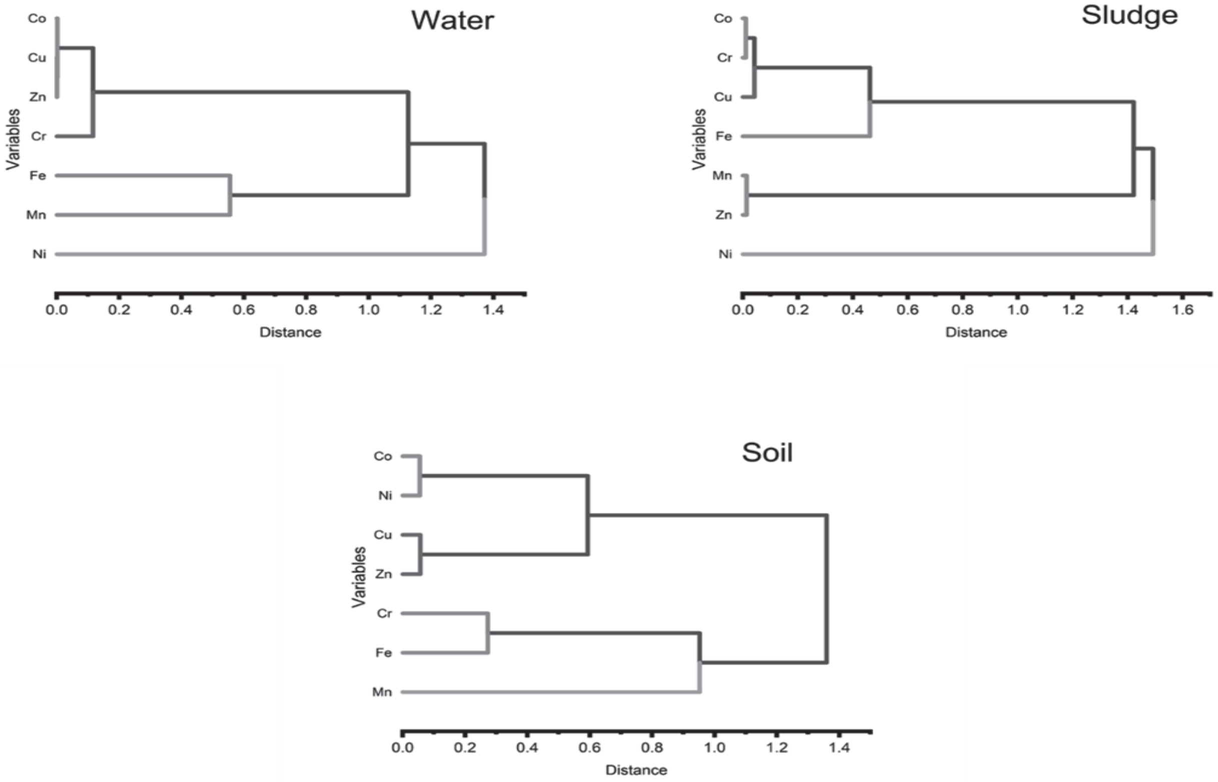

Fig. 6. Hierarchical cluster analysis for: water, sludge and soil samples.

amounts. When compared to Table 4, our data indicate that we are dealing with significantly lower concentrations than the maximum allowable target for each element, and significantly lower than would necessitate an intervention.

We see comparable results with sludge samples, where elemental concentrations are significantly lower than the cutoff values for moderate or severe pollution in the table above [24, 26]. In each of our cases, sludge results are classified as non-polluted.

The hierarchical cluster analysis (sometimes referred to as hierarchical clustering) is a generic approach in which the goal is to group objects or records that are „near" to one another. This method is frequently used in environmental studies. The results from this analysis for water, soil and sludge are presented in Fig. 6.

For the water samples, there are three distinctive groups: a) Co, Cu Zn||Cr, b) Fe, Mn and c) Ni. In this case the presence of Ni in water samples is of anthropogenic origin. The same features are observable also for the sludge samples. The presence of Ni from the soil has no linkage to water or sludge, confirming its anthropogenic origin from industry. Regardless of how it ends up in the environment, this element should be carefully monitored to prevent it from becoming a serious hazard and end up in the food chain, or impact agricultural soils [29, 31].

Conclusion

According to many studies, the water in Kosovo is contaminated with a variety of toxicants and is unfit for human consumption without sufficient treatment.

The present study establishes the presence of heavy metals (As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Zn) in water, soil, and sludge samples, through ICP AES analysis, whereas the physico-chemical parameters, are in accordance with the Water Framework Directive (DKU-WFD) 2000/60 and classification of river quality by UNECE (content, mg/L).

Results indicated that As, Cd, and Pb concentrations were below the detection limit. Similar results were found for Ni in the samples, where it was detected only in sampling point (M2) and was below the limit of detection in sampling points M1 and M3. Nickel concentration in our water samples is 0.013 mg/L, which is below the applicable drinking water requirements. Cobalt was found in all of our observed cases at very low concentrations, ranging from 0.012 to 0.016 mg/L in water. Our samples included chromium concentrations ranging from 0.032 mg/L in water to 0.069 mg/kg in sludge and 0.047 mg/kg in soil.

The EPA has established a 0.1 mg/L limit for copper in drinking water. In our study, trace levels of copper element were detected in water samples ranging from 0.01 mg/L to 0.023 mg/L. Zinc values were consistently low in all of our samples. Its concentration in water samples was consistently less than the EPA's recommended level (less than 5 parts per million). Iron concentrations in our samples are slightly higher than those suggested by the World Health Organization, ranging from 0.451 to 0.876 mg/L in water samples, about double the permissible level. Manganese contents are lower than recommended levels, ranging from 0.024 mg/L to 0.223 mg/L.

To feel more at ease with these data and to avoid any health risks associated with water pollution, it is necessary to monitor the zone continuously by analyzing and monitoring the pollution on a frequent basis, and finally, according to the obtained results, it can inferred that the Drini i Bardhë river it's not contaminated with heavy metal and another physic-chemical parameters.

Acknowledgement

The present work is the science research, from: Assoc. Prof. Bardha Korça and Assoc. Prof. Skender Demaku. The authors are thankful to the University of Prishtina „HASAN PRISHTINA" for support during the research work and analysis.

Conflict of Interest

The authors declare no conflict of interest.

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