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M. Sadiku,
orcid.org/0000-0002-9387-8124,
S. Kadriu,
orcid.org/0000-0001-6223-3342,
M. Kelmendi,
orcid.org/0000-0001-7002-2406,
D. Ibishi,
orcid.org/0000-0001-9307-1518

Faculty of Food Technology, Department of Technology, UMIB, Mitrovica, the Republic of Kosovo, e-mail: milaim.sadiku@umib.net

RESEARCH INTO ECOLOGICAL STATUS AND THE DEGREE OF HEAVY METAL CONCENTRATION IN THE WATERS OF THE DRENICA RIVER (KOSOVO)

Purpose. To reflect the impact of discharge waters from the ferronickel smelter and surface lignite mining on the pollution of the Drenica River with heavy metals. According to our estimation, the effect of mining on the river pollution is undeniable.

Methodology. The standard methods ISO 5667-6, ISO 5667-11, and ISO 5667-1.3 were used to determine the physical and chemical parameters of the Drenica River surface water. The EPA-3015A method was applied for sample preparation, while the AAS (Atomic Absorption Spectrophotometry) measurement technique was used to determine the concentration of heavy metals. Standard ISO methods were applied for determining the following parameters: pH, DO, BOD_5, COD, $N{-}NH_4$, NO_3^-, TN, $PO_4{-}P$, and TP.

Findings. From the obtained results, it can be concluded that the levels of heavy metals in the river Drenica have exceeded the allowed values as a result of industrial activities.

Originality. The paper supplies new additional information on the ecological status of the Drenica River, based on samples taken along the river, especially where the greatest impact of the ferronickel smelter and surface lignite mining could be. The problematic of this research is quite contemporary; river pollution affects the life chain.

Practical value. We believe that the content and problems in the focus of the research are topical and present significant interest to all those who deal with environmental issues.

Keywords: *Drenica River, pollution, urban and industrial discharges, ecological status, heavy metals*

Introduction. The Drenica River, which stems in Pjetershtice in the Caraleva Mountains, belongs to the group of small rivers in Kosovo. This river travels in a length of 50 km, while its basin includes 477 km^2. From its source to the vicinity of the city of Drenas, the river passes in a terrain that is characterized by low slope and is included in the group of plain rivers, while during the passage its slope increases to 10 m, but due to the terrain, the closer it gets to its discharge into the Sitnica River, the steeper its slope is again. Water in nature is important for the existence and health of humans and all other living beings, because it mediates the global processes of life, transports substances, and helps to carry out chemical reactions [1].

Before starting the work of the Feronikeli smelter in Drenas, it was possible to pollute the waters of this river, but with urban and household discharges not only from the city of Drenas but also from urban discharges of the villages through which the river has passed during its flow. However, despite this until 1984, when the Feronikeli smelter started working, the river was characterized by a high quality of purity and with a pronounced presence of aquatic creatures, fish, crabs, etc. After the commissioning of the Feronikeli smelter in Drenas and the exploitation and processing of ore rich in Fe and Ni as well as other associated metals, enormous pollution of the river begins, which directly affects the destruction of these creatures and the degradation of the surrounding environment. Heavy metal contamination in water environments has received considerable attention worldwide due to not only toxicity but also persistence, abundance, and biomagnification in the environment and their subsequent accumulation in aquatic habitats [2].

One of the ore basins, from where the smelter is supplied with raw material, is located in the village of Çikatovë e Vjetër near Drenas, while the other is located in the village of Magure. Mining by its nature consumes, diverts and can seriously pollute water resources [3]. Besides urban discharges, industrial discharges from the smelter, pollution from the exploitation of ore basins from which the raw material for the smelter is used, the waters of the Drenica River before adjoining the waters of the Sitnica River, are significantly polluted by the exploitation of lignite from surface mining located in the villages of Graboc and Shipitullë. A variety of pollutants are generated in the process of ore mining which diffuse into the surrounding environment and result in water, air and soil pollution problems [4]. Such pollution, urban and industrial, has directly affected the degradation of biodiversity, once magnificent Drenica River. Therefore, this degradation has motivated us to study and evaluate the ecological status and the degree of concentration of heavy metals in the waters of this river.

Monitoring of Drenica river waters. To have accurate information about the quality, respectively, the ecological status, and the degree of pollution of the waters of the Drenica River with heavy metals, we have seen fit to pinpoint six monitoring points marked with: S_1, S_2, S_3, S_4, S_5, and S_6, in different positions of the geographical extent of this river. The coordinates of the monitoring points are shown in Table 1, while the Drenica River monitoring network is presented in Fig. 1.

S_1 represents the waters of the Drenica River from its source above Pjetershtica, the place where the water is clean and not affected by anthropogenic pollution.

S_2 marks the sampling site located in the village of Komoran and at a distance of 13 km from the monitoring point S_1. In this sampling site, we have the discharge of sanitary water from the villages which are located on both sides of the river banks, and the water discharged from the small town of Komorani. In addition to sanitary pollution, additional pollution occurs as a result of agricultural activities; such as the use of pesticides, livestock farms, activities of various restaurants, various mini concrete mixers, and others. The S_3 monitoring site is located at a distance of 7 km from the S_2 sampling site. This sampling site, located near the city of Drenas, includes the urban discharge waters of this city. S_4 site, Çikatovë e Vjetër, is of particular importance as in addition to urban discharges; it reflects wastewater from Ferronikel Company discharges (Fe-Ni smelter) and is located 1.8 km from the S_3 site.

The discharging of polluted, unprocessed, or insufficiently processed waters that contain considerable amounts of heavy metal ions cause major environment damages [5, 6]. Monitoring point S_5 presents the water situation in the village of Graboc and Shipitullë. We have targeted this sampling site because in this place the pumped water is discharged from the surface mine of the lignite mine and is located at a distance of 14 km from the sampling site S_4. The S_6 and last sampling site reflect

Table 1

Sampling points and their coordinates

Sampling point	Length	Width	Sea level, m
S_1	42°28'25.58"N	20°56'26.90"E	719.6
S_2	42°34'41.27"N	20°53'35.53"E	583.4
S_3	42°37'39.67"N	20°54'24.80"E	568.1
S_4	42°38'4.24"N	20°54'59.00"E	563.6
S_5	42°38'27.53"N	21°0'32.72"E	548.0
S_6	42°36'55.49"N	21°4'1.50"E	535.2

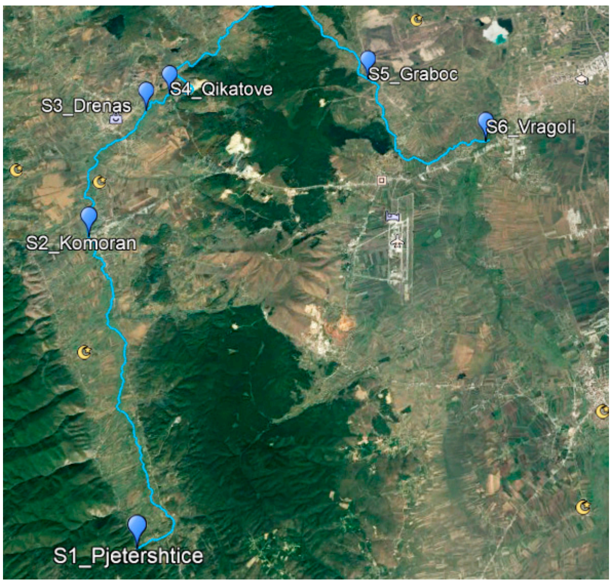

Fig. 1. Complete monitoring network

the waters of the Drenica River in the position before these waters touch (join) the waters of the Sitnica River. This sampling site is located at a distance of 9 km from the S_5 sampling site.

Materials and methods. To have a more realistic picture of the water quality of the Drenica River, we were focused on determining the ecological status of these waters, based on the physico-chemical parameters due to urban discharges and the degree of concentration of heavy metals caused by industrial activity. Testing of all chemical indicators of water quality is very rarely justified for economic and practical reasons, so in practice only a few characteristics are tested that give a general answer to the question of water quality, i. e. indicate in which direction Research is going on. Currently, there are various models for determining surface water quality, in order to simplify and reduce the cost of testing [7]. To be scrupulous and objective as possible in assessing the ecological status and the degree of concentration of heavy metals in the monitored waters of this river, we have relied on the standard, already internationally recognized and accepted for surface waters, ISO 5667-6 [8].

Whereas, for the way of sampling, transport, and maximum time of stay of the sample before the chemical analysis, we are based on the method ISO 5667-1.3 [9, 10]. The conservation of samples for the determination of certain parameters was done under the APHA conservation procedure [11]. The assessment of ecological status, based on physico-chemical parameters, such as pH, OT, BOD_5, COD, $N-NH_4$, NO_3^-, NT, PO_4-P, PT, and are determined based on the standard ISO methods presented within the results (Tables 3, 4) for each parameter separately. The method of mineralization of samples, EPA 3015A [12] was applied to extract metals (Cr, Cd, Ni, Zn, Mn, Cu, Fe, and Pb) from aqueous samples, while the degree of concentration of heavy metals was determined based on the standard method EPA 6020A [13]. The analysis for all the parameters researched in this study was done at the Hydro-meteorological Institute of Kosovo (KHMI) in Prishtina.

Results and discussion. Driven by the gist to have a more precise and representative assessment, we started based on the results obtained from the detailed analysis of samples taken at six locations marked in the course of the river Drenica and we have marked them as S_1, S_2, S_3, S_4, S_5, and S_6.

We took samples for analysis during April and August 2020. The focus of our study was the determination of ecological status, analysing the physico-chemical indicators and the degree of concentration of heavy metals in the waters of the Drenica River.

The use of indicators is highly relevant when assessing the ecological status of a river bed and its evolution with time [14]. For the evaluation of physico-chemical indicators, we compared the obtained results with the reference values of the Administrative Instruction, which has to do with the Classification of Water and Surface Bodies of Kosovo – MESP-AI 16/2017 [15] and is based on appendix 4 and table 4.1 of this appendix, which deals with the parametric values for determining the ecological status of rivers (Table 2). Whereas, the results obtained referring to the degree of concentration of heavy metals were compared with the reference values of the Legislative Decree of Kosovo of 1999, with no. 15232, relating to the Provision for the Protection of Waters against Pollution, which was drafted in correlation with Directive 91/271/EEC on the treatment of urban wastewater [16]. The obtained results for the Physico-chemical parameters in April and August are presented in Tables 3, 4, where the colors reflect the ecological status, based on Table 2.

In terms of size and geographical extent, the Drenica River belongs to the type of rivers T2 (Plain river; small; medium and large). Tabular results, also given through colors, reflect the state of water quality detected in six sampling sites. Sampling sites S_1, S_2, and S_3 are located outside the industrial area, and reflect monitoring points affected by urban discharges,

Table 2

Physico-chemical parameters for determining the ecological status of rivers in mg/L

Type	Status	pH	Dissolved oxygen, DO	BOD_5	COD	Amonium NH_4–N	Nitrates NO_3	Total Nitrogen TN	Orthophosphate PO_4–P	Phosphorus Total, PT
T_1	G	7.0–8.6	> 8.0	< 1.50	< 4.0	< 0.10	< 1.50	< 2.0	< 0.05	< 0.09
	Md	< 7.0; > 9.0	8.0–7.0	1.50–5.00	4.0–7.0	0.10–0.20	1.50–3.00	2.0–3.5	0.05–0.10	0.09–0.15
	P	< 7.0; > 9.0	7.0–5.0	5.00–6.00	7.0–12.0	0.20–0.80	3.00–6.00	3.5–10.0	0.10–0.20	0.15–0.30
T_2	G	7.0–8,6	> 7.0	< 4.0	< 4.0	< 0.10	< 1.00	< 1.5	< 0.05	< 0.10
	Md	< 7.0 > 9.0	7.0–6.0	4.0–6.0	4.0–7.0	0.10–0.25	1.00–2.00	1.5–3.0	0.05–0.10	0.10–0.20
	P	< 7.0 > 9.0	6.0–5.0	6.0–8.0	7.0–12.0	0.25–0.70	2.00–5.00	3.0–10.0	0.10–0.20	0.20–0.40

MESP-AI 16/2017 – Administrative Instruction "Classification of Surface Water Bodies"

T_1 – Small Mountain River and Medium River; *T_2* – Small, medium and large Lendin River; *G* – good (*green); *Md* – moderate (**yellow); *P* – poor (***red)

Table 3

Results of physico-chemical parameters (mg/L) and assessment of the ecological status of the Drenica River, April 2020

Sampling site	pH	DO	BOD_5	COD	N-NH_4	NO_3	TN	PO_4-P	PT	Final Classification
Methods standard	ISO 10523:2008	ISO 5814:2012	ISO 815-2:2003	ISO 15705:2002	ISO 150-1:1984	DIN 8405-9:2011	ISO 11905-1:1997	ISO 6878:2004	ISO 6878:2004	
S_1	8.06*	8.25*	0.4*	1.2*	0.047*	0.7*	0.245*	0.007*	0.018*	G*
S_2	7.94*	7.74*	17.3**	32.8***	0.083*	0.9*	1.275*	0.008*	0.492***	P***
S_3	7.98*	7.19*	24.4***	64.4***	0.978*	3.2***	3.742***	0.289***	0.972***	P***
S_4	7.88*	6.56**	31.3***	59.4***	0.924***	4.1***	3.712***	0.303***	1.178***	P***
S_5	7.89*	6.22**	25.5***	48.4***	1.176***	5.5***	4.024***	0.434***	1.147***	P***
S_6	8.19*	7.64*	14.6***	26.2***	1.027***	5.2***	3.099***	0.349***	0.758***	P***

MESP-AI 16/2017 - Administrative Instruction "Classification of Surface Water Bodies"

Explanations: status: *DO* – dissolved oxygen; *BOD5* – five-day biological oxygen demand; *COD* – chemical demand; *TN* – total nitrogen; *TP* – total phosphorus; *G* – good (*green); *Md* – moderate (**yellow); *P* – poor (***red)

Table 4

Results of physico-chemical parameters (mg/L) and assessment of the ecological status of the Drenica River, August 2020

Sampling site	pH	DO	BOD_5	COD	N-NH_4	NO_3	TN	PO_4-P	TP	Final Classification
Methods standard	ISO 10523:2008	ISO 5814:2012	ISO 5815-2:2003	ISO 15705:2002	ISO 7150-1:1984	DIN 8405-9:2011	ISO 11905-1:1997	ISO 6878:2004	ISO 6878:2004	
S_1	8.15*	7.33*	3.6*	8.2***	0.054*	1.0**	0.555*	0.009*	0.110**	P***
S_2	8.07*	6.15*	43.2***	78.5***	0.174**	1.8**	2.974**	0.063**	1.273***	P***
S_3	8.22*	5.21***	82.1***	152.0***	2.788***	3.9***	8.436***	0.470***	2.769***	P***
S_4	8.15*	5.08***	70.4***	133.7***	2.337***	5.1***	7.689***	0.493***	2.463***	P***
S_5	7.96*	4.18***	43.6***	82.8***	2.027***	7.2***	6.407***	0.577***	1.797***	P***
S_6	7.84*	3.68***	27.8***	49.0***	1.979***	6.6***	5.126***	0.538***	1.317***	P***

while the other three points S_4, S_5, and S_6 are sampling sites in the industrial area domain. Regarding the parameters reflected in tabular form (Tables 3, 4) for April and August, the situation is presented as follows.

At the S_1 sampling site until April, for all parameters, the condition indicates good ecological status, in August, the condition results in poor status based on chemical oxygen demand (COD), which exceeds the reference value.

At the S_2 sampling site for April, as a result of exceeding the reference values with COD and PT, the waters of this river are classified with poor ecological status. The same status is repeated during August, but we encountered exceeding the reference values with the indicators BOD_5, COD, and PT. The analysis made for the S_3 sampling site for both months reflects poor ecological status. During April we have exceeded the reference values with BOD_5, COD, NO_3^-, NT, PO_4–P, PT, while in August, except with pH, all other parameters result in exceeding the reference values. At the S_4, S_5, and S_6 sampling sites, as a result of the industrial activity of the ferronickel smelter in Drenas and the surface mining of Graboc and Shipitulla, the tabular results reflect poor ecological status for both months. In April except for pH and DO and August except for pH, all other physico-

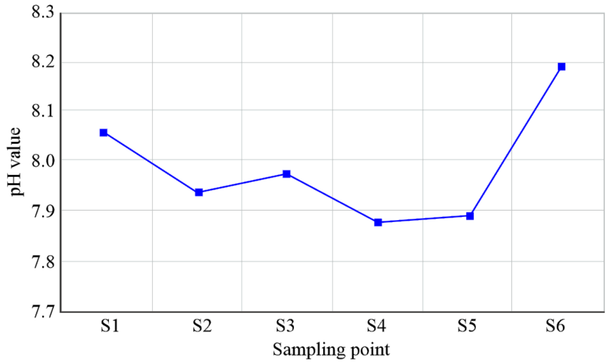

Fig. 2. pH values according to sampling points

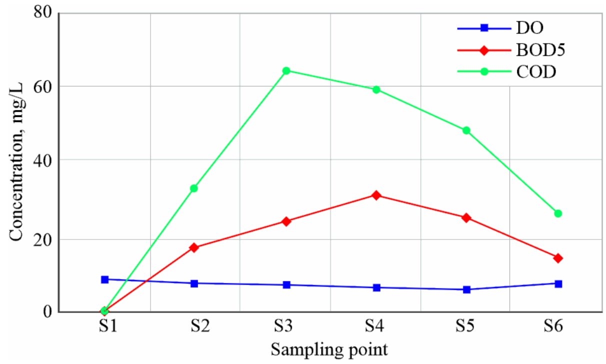

Fig. 3. DO, BOD$_5$, COD concentration according to sampling point

chemical indicators exceed the reference values.

In conclusion, the tabular results presented through colours, except in April at the S_1 sampling site, in all other sampling sites, during the two months, the waters of the Drenica River reflect poor ecological status (Figs. 3, 4).

Regarding environmental pollution, scientists Chehregani and Malayer have reported that high concentrations of heavy metals have strong toxic effects and they constitute an important component of environmental pollution [17, 18]. One of the most worrisome problems, which arise in recent years and which concerns humanity in general, is the contamination with heavy metal of aquatic environments, as these metals fail to disintegrate and most of them have toxic effects on living organisms [19].

The performed analysis regarding the degree of concentration of heavy metals for April and August 2020 is presented in Tables 5, 6.

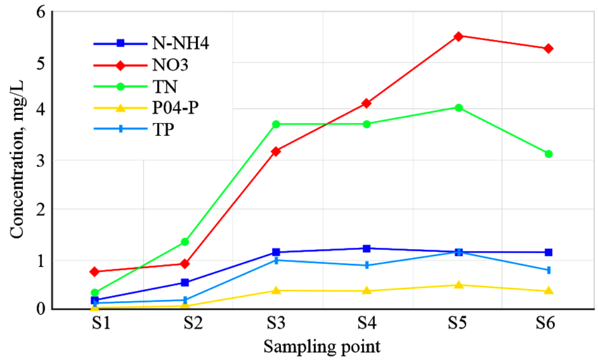

Fig. 4. N–NH$_4$, NO$_3^-$, *TN,* PO$_4$–P, *TP concentration according to sampling points*

Table 5

Concentration of heavy metals by sampling sites in the Drenica River, April 2020

Heavy metals	Standard method	Unit	Reference values, MAV	S_1	S_2	S_3	S_4	S_5	S_6
Chrome (Cr^{3+})	EPA 6020A	mg/L	0.05	0.005	0.012	0.011	0.017	0.015	0.006
Cadmium (Cd^{2+})	EPA 6020A	mg/L	0.005	nld	0.008	0.010	0.021	0.018	0.013
Nickel (Ni^{2+})	EPA 6020A	mg/L	0.02	nld	nld	0.009	0.029	0.026	0.021
Zink (Zn^{2+})	EPA 6020A	mg/L	3	0.006	0.009	0.013	0.025	0.024	0.018
Manganese (Mn^{2+})	EPA 6020A	mg/L	0.05	0.013	0.015	0.019	0.038	0.033	0.022
Copper (Cu^{2+})	EPA 6020A	mg/L	1	0.011	0.012	0.018	0.026	0.021	0.014
Iron (Fe^{2+})	EPA 6020A	mg/L	0.2	nld	0.017	0.25	0.058	0.049	0.041
Lead (Pb^{2+})	EPA 6020A	mg/L	0.01	0.005	0.008	0.011	0.023	0.021	0.018

MAV-Maximum allowed values for some heavy metals in surface waters according to Legislative Decree 11 May 1999 no.15232.

32 LEGISLATIVE DECREE 11 MAY 1999, NO. 152, Provisions on the protection of water against pollution, Directive 91/271/EEC on the treatment of urban waste water; *Nld* – below the detection limits of the instrument

Table 6

Concentration of heavy metals by sampling sites in the Drenica River, August 2020

Heavy metals	Standard method	Unit	Reference values, MAV	S_1	S_2	S_3	S_4	S_5	S_6
Chrome (Cr^{3+})	EPA 6020A	mg/L	0.05	0.006	0.018	0.016	0.023	0.018	0.011
Cadmium (Cd^{2+})	EPA 6020A	mg/L	0.005	nld	0.011	0.013	0.027	0.025	0.015
Nickel (Ni^{2+})	EPA 6020A	mg/L	0.02	nld	0.005	0.006	0.039	0.035	0.028
Zink (Zn^{2+})	EPA 6020A	mg/L	3	0.007	0.011	0.018	0.035	0.029	0.019
Manganese (Mn^{2+})	EPA 6020A	mg/L	0.05	0.015	0.017	0.022	0.045	0.039	0.026
Copper (Cu^{2+})	EPA 6020A	mg/L	1	0.013	0.017	0.024	0.031	0.030	0.017
Iron (Fe^{2+})	EPA 6020A	mg/L	0.2	nld	0.024	0.031	0.071	0.066	0.046
Lead (Pb^{2+})	EPA 6020A	mg/L	0.01	0.006	0.009	0.016	0.031	0.023	0.015

MAV-Maximum allowed values for some heavy metals in surface waters according to Legislative Decree 11 May 1999 no.15232.

32 LEGISLATIVE DECREE 11 MAY 1999, NO. 152, Provisions on the protection of water against pollution, Directive 91/271/EEC on the treatment of urban waste water; *Nld* – below the detection limits of the instrument

Regarding the concentration of heavy metals (Cr, Cd, Ni, Zn, Mn, Cu, Fe, and Pb), in the waters of this river, the situation according to the sampling sites is as follows.

Unlike the physico-chemical parameters, in the S_1 sampling site, we did not encounter exceeding the reference values with any of the heavy metals investigated in this study.

It has to be emphasized that none of the aforementioned sampling sites we observed showed concentration beyond the reference values of Cr, Zn, Mn, and Cu (Figs. 5–8).

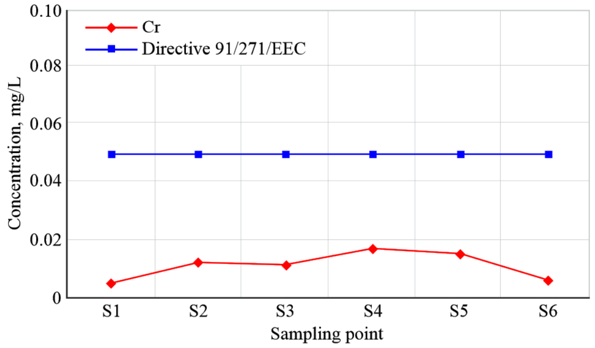

Fig. 5. Cr concentration according to sampling points

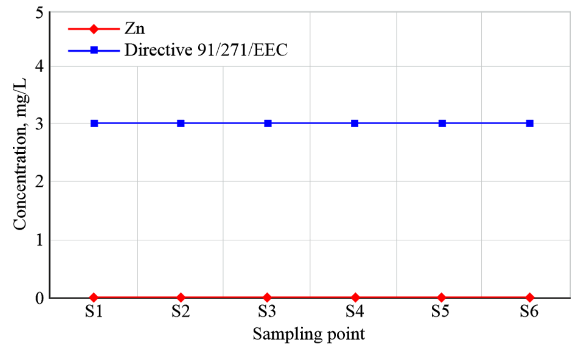

Fig. 6. Zn concentration according to sampling points

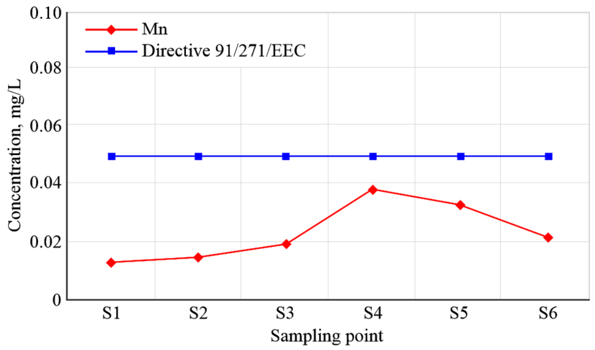

Fig. 7. Mn concentration according to sampling points

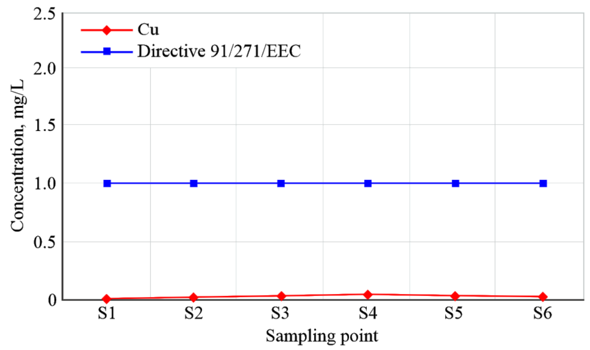

Fig. 8. Cu concentration according to sampling points

In the S_2 (Komoran) sampling site, concentration beyond the reference values with cadmium (Cd) was encountered during the two months: in April at 0.008 mg/L and in August 0.011 mg/L (Fig. 9).

Sampling site S_3 (Drenas) although polluted only by urban discharges of the city, however, reflects exceeding the reference values with some of the heavy metals: for April with Cd = = 0.010 mg/L, Fe = 0.25 mg/L (Fig. 10) and Pb = 0.011mg/L, while in August we have excesses with Cd = 0.013 mg/L and Pb = 0.016 mg/L. It is possible that this concentration beyond the reference values with these metals occurred due to the proximity of this sampling site to the ore basin located in the village of Çikatovë e Vjetër.

Unlike sampling sites S_1, S_2, and S_3, sampling site S_4 is located within the industrial zone, where the waters of the Drenica River are contaminated with heavy metals from the industrial discharges of the Feronikel smelter. The results obtained from the samples taken for analysis, reflect the excess of reference values; for April with Cd = 0.021 mg/L, Ni = 0.029 mg/L and Pb = 0.023 mg/L, while in August the concentration increased and resulted as follows: Cd = 0.027 mg/L, Ni = = 0.039 mg/L and Pb = 0.031 mg/L (Fig. 11).

Recently, anthropogenic activities have steadily increased the amount of heavy metals in aquatic ecosystems, and by this,

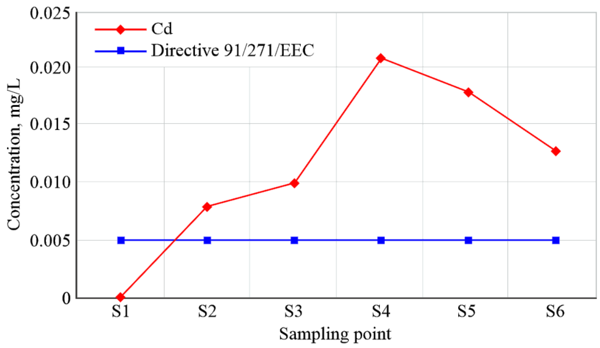

Fig. 9. Cd concentration according to sampling points

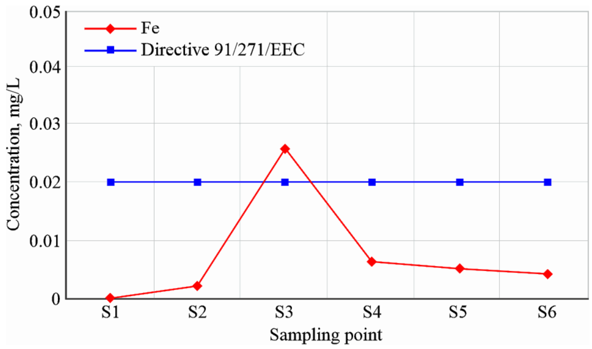

Fig. 10. Fe concentration according to sampling points

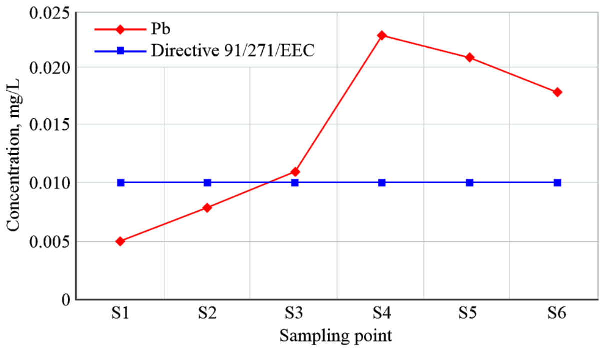

Fig. 11. Pb concentration according to sampling points

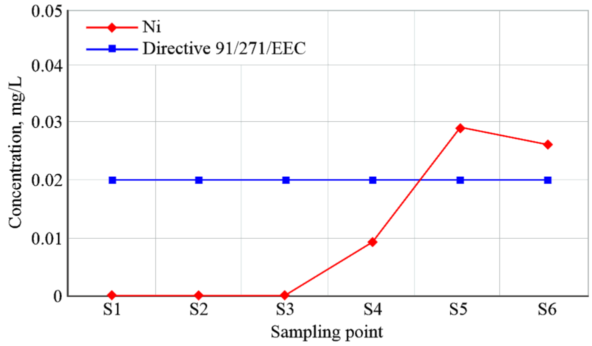

Fig. 12. Ni concentration according to sampling

the heavy metal pollution in the water system is growing at an alarming rate and has become an important problem around the world [20, 21].

Sampling site S_5 (Graboc e Shipitullë) reflects the pollution of the waters of this river from the surface lignite mine. The situation of pollution and concentration of heavy metals from April to August is as follows: Cd from 0.018–0.025 mg/L; Ni from 0.026–0.035 (Fig. 12) and Pb from 0.021–0.023 mg/L.

In the S_6 sampling site (Vragoli, downstream of the Drenica River) as in the S_4 and S_5 sampling sites, in this sampling site the results obtained reflect concentration beyond the reference values of heavy metals, from April to August, with Cd from 0.013–0.015mg/L; Ni from 0.021–0.028 mg/L and Pb 0.018–0.015 mg/L.

During the research phase, we noticed that in contrast to April, in August, the concentration of heavy metals is more pronounced. This situation has changed because the water level drops to the peak of summer, while the highest concentration of heavy metals emerges.

Conclusion. Until the 1980s, the waters of the Drenica River were considered clean and oligotrophic. The presence of diverse creatures in these waters was the best indicator of the high water quality of this river.

After the '70s and '80s, the increase in the birth rate of the population in the geographical area on both sides of the banks of the river Drenica, affected the increase of urban and household discharges, affected the increased use of various chemicals for agricultural needs and in the establishment of small economies for the finalization of concrete products, activities which, each in its way, began to affect the urban pollution of this river. Since 1984, with the commissioning of the Feronikeli smelter in Drenas, the exploitation of raw material from the ore basins in Çikatovë e Vjetër and Magure for the needs of the smelter and the use of lignite from surface mining, located between the villages of Graboc and Shipitullë, the lack of plants for wastewater treatment and their discharge without criteria, not only has degraded the quality of water but has also resulted in the extinction of living things, which were once the wealth of this river. Based on the Legislative Decree of Kosovo, of 1999 No. 152 and the Administrative Instruction of Kosovo MESP-UA 16/2017, we have concluded that the presence beyond the standard values of heavy metals and physicochemical parameters, the waters of this river are classified with poor ecological status. Therefore, before the institutions at the municipal level, the administration of the Feronikel smelter and especially the Ministry of Environment and Spatial Planning, it is a primary obligation to take appropriate measures to return the waters of this river to aquatic life – biodiversity.

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Дослідження екологічного статусу та рівня концентрації важких металів у водах річки Дреніца (Косово)

М. Садіку, С. Кадріу, М. Кельменді, Д. Ібіші

Факультет технологій харчового виробництва, Кафедра технології, УМІБ, м. Митровиця, Республіка Косово, e-mail: milaim.sadiku@umib.net

Мета. Встановити вплив стічних вод феронікелевого заводу й відкритої розробки бурого вугілля на забруднення річки Дреніца важкими металами. За нашими оцінками, вплив видобування корисних копалин на забруднення річки незаперечний.

Методика. Стандартні методи ISO 5667-6, ISO 5667-11 та ISO 5667-1.3 використовувалися при визначенні фізико-хімічних параметрів поверхневих вод річки Дреніца. Для підготовки проб застосовувався метод EPA-3015A, а для визначення концентрації важких металів – метод вимірювання SAA (атомно-абсорбційна спектрофотометрія). Параметри pH, DO, BOD_5, COD, $N-NH_4$, NO_3^-, TN, PO_4-P, TP були визначені за допомогою стандартних методів ISO.

Результати. Із отриманих даних можна зробити висновок, що промислова діяльність призвела до того, що допустимі значення вмісту важких металів у річці Дреніца були перебільшені.

Наукова новизна. У статті представлена нова додаткова інформація про екологічний статус річки Дреніца, на основі проб, узятих уздовж ріки, особливо там, де може спостерігатися найбільший вплив феронікелевого заводу та відкритого видобування бурого вугілля. Проблематика даного дослідження вельми актуальна, так як забруднення річки призводить до порушення життєдіяльності її флори та фауни.

Практична значимість. Ми вважаємо, що проблеми, які стали предметом розгляду в даному дослідженні, актуальні та представляють інтерес для всіх, хто займається питаннями охорони навколишнього середовища.

Ключові слова: *річка Дреніца, забруднення, міські та промислові скиди, екологічний статус, важкі метали*

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