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HEAVY METALS - LEAD AND CADMIUM DISTRIBUTION IN THE ADJACENT AREA OF THE BOLNISI AND DMANISI REGIONS

Abstract: The presented work refers to the contamination of the environment with heavy metals, including lead and cadmium to study the risk factors for environmental pollution. The expedition was held in the Kvemo Kartli region: particularly Bolnisi, Dmanisi, and Tetritskaro municipalities. In 2022, the lead and cadmium concentrations in 58 soil samples and 22 surface water samples were examined to determine the extent of environmental contamination and the risks associated with potential food chain contamination. Total Sample Analysis was performed at the Chemical Risk Factors Research Laboratory of the National Center for Disease Control and Public Health (NCDC).

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Introduction

The research focuses on assessing lead and cadmium concentrations in soil and surface waters as well as environmental contamination. The provision of good living circumstances for the populace, the smooth operation of the economy, and the protection of the environment all depend heavily on the availability of water supplies. Providing water to the

population, industry, energy, and agricultural sectors is one of the top priorities for the sustainable growth of the country. Fresh water is frequently in short supply in many nations around the world [1]. The causes of this include inadequate removal of wastewater and industrial waste from water bodies, a decrease in natural watersheds, logging of large tracts of forest, improper farming practices, etc. [2].

In the circulation of air and water, anthropogenic contaminants extend throughout the earth, significantly changing climate, soil, water and chemical condition of the atmosphere, biodiversity decreases and ecosystems are polluted. Consequently, the problem of pollution has become global and its resolution has become a global challenge [3-4-5]

One of the sources of emission of technogenic substances in the environment is mining production. If necessary precautions are not taken, the environment can severely deteriorate during the extraction of raw materials, particularly in open quarries. The Bolnisi region is home to mining operations for gold and copper. Polymetric mine and production, located 80 kilometers southeast of Tbilisi, is considered to be the first non-ferrous metal production facility. Around the 1940s, the field of deposits started to be explored. [3].

One of Georgia's biggest non-ferrous mining operations began to take shape in 1959.

The facility has been mining copper, barite, and quartzites containing silver, gold, and polymetric ores since 1975 [2]. Primary processing, enrichment, and sale of the mined copper and barite resources are also carried out. Particularly in the vicinity of Kvemo Kartli, the Bolnisi-Dmanisi municipalities' land has long been renowned for its mineral deposits, including those that are barite-polymetic, copper-colchedanic, and quartzites that contain gold, among other types of deposits. All of the above may have a significant negative impact on the environment and then on human health [3].

The research paper deals with the determination of lead and cadmium contents in surface waters and soils in Kvemo Kartli region. [6-7-8]. In particular, three target groups were investigated using samples from environmental matrices (soil and surface water).

1. Settlements located near production - Bolnisi and Dmanisi municipalities;

2. Presumably the settlements living on the mine - Bolnisi Municipality;

3. Control district - Tetri Tskarko municipality.

Water samples were taken from the following rivers: Partskhisi, Geta, Algeti, Dvaltakhevi, Asuretistskali, Ktsia Khram, and Mashavera to assess the impact of technogenic load. The soil sample was taken from the following villages: Kazreti, Balichi, Didi Dmanisi, Kianeti, Senebi, Orbeti, Berthakari, Geta, Mushevani, Tandzia, Darbazi, Kveshi, Old Kveshi, Javshniani, Akaura, Ratevani, Koda, Ghoubani, Vashlovani, Pantiani, Didgori, Big Toneti,

Manglisi, Algeti. Environmental monitoring was carried out during 2022. [9-10]

The above -mentioned research is extremely timely and necessary.

Research methods

One of the directions of the research was to conduct chemical analyses on soil and surface water samples to ascertain the presence of heavy metals and to study the regularity of distribution of toxic metals in pre-selected target groups.

Target groups were selected in advance and sampled (using GPS) periodically (twice in a year) in 2022. Methods for determining toxic elements in surface water and soil specimens and subsequently the results are given below: 1.

After the field work, chemical analyzes were carried out, the laboratory defined the overall forms of heavy metals - Pb, Cd;

Analysis of soil samples were carried out by using modern methods and equipment that fully comply with European standards, namely:

1. Agilent 8900 ICP-MS/MS;

2. Analytic Jena AAS ContrAA 800D;

3. Milestone ETHOS UP high performance MW Digestion System;

4. pH-meter VioLab PC 50;

In 2022, 58 soil sand 22 superficial water samples were analyzed at the National Center for Disease Control and Public Health (NCDC) Chemical Risk Factors Research Laboratory. In the soil, lead and cadmium research was conducted by: EPA 3051A (see Table 1.) The permissible concentration (MPC) was indicated, methodical instructions in accordance with MM 2.1.7.004-03.

Analyzes of surface water samples were performed in accordance with EPA Method 200.8. The evaluation of the results was carried out according to the legislation of Georgia, the Resolution of the Government of Georgia No. 425 (December 31, 2013, Tbilisi) on the approval of the technical regulations for the protection of surface waters of Georgia from pollution.

Epidemiological investigations were launched in 2021 in order to research the health status of the population in all three target categories in addition to the environmental sample studies (1. Settlements located near production - Bolnisi and Dmanisi municipalities; 2. Settlements likely to live on the mine - Bolnisi municipality; 3. Control area - Tetri Tskaro municipality.).

Research on the health status of the population in the target groups is carried out randomly, using the survey method. The study also examines the levels of lead and cadmium in the blood of various age groups of the population in a laboratory setting.

The examination and analysis of the data gathered from the epidemiological research, which is now underway and set to end by the beginning of

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2023, will servey as the foundation for more thorough findings and conclusions.

Results

Table 1 shows the results of chemical analysis of surface water and soils:

Table 1. The results of analysis of soil patterns

N	N of Target groups	Sampling location	GPS coordinates	Soil			
				Pb mg/kg	MPC, Pb mg/kg	Cd, ∂ mg/kg	OPC mg/kg
1.	I	Village Balichi, (Kvemo Ubani), V. B. garden (0-5cm)	41.376232/44.398838	24.12	32	0.48	2
2.	I	Village Balichi, (Kvemo Ubani), V. B. garden (20cm)		22.06		0.32	
3.	I	Village Didi Dmanisi N. N. garden (0-5cm)	41.376246/44.398791	24.11		0.36	
4.	I	Village Didi Dmanisi N. N. garden (20cm)		24.09		0.3	
5.	I	Village Kianeti M. O. garden (0-5cm)	41.421506/44.426915	18.03		0.28	
6.	I	Village Kianeti M. O. garden (20cm)		22.11		0.48	
7.	I	Village Kianeti Kh. A. garden (0-5 cm)	41.42716/44.431929	50.18		0.32	
8.	I	Village Kianeti Kh. A. garden, (20cm)		36.19		1.15	
9.	I	Village Senebi J. B. garden (0-5cm)	41.470282/44.409776	18.11		0.79	
10.	I	Village Senebi J. B. garden (20cm)		14.17		0.13	
11	I	Daba Kazreti, Corp. 60/4, "Five District", (0-5 cm)	41.377127/44.420166	144.52		0.98	
12	I	Daba Kazreti, Corp. 60/4, "Five District", (20 cm)		142.71		0.66	
13.	I	Village Bertakari T. A. garden (0-5cm)	41.472191/44383182	36.07		0.22	
14.	I	Village Bertakari T. A. garden (20cm)		26.23		0.53	
15.	I	Village Mushevani A. A. garden (0-5cm)	41.4373/44.460223	12.04		0.3	
16.	I	Village Mushevani A. A. garden (20cm)		18.05		1.34	
17.	I	Village Tandzia R. G. garden (0-5cm)	41.453396/44.367262	18.03		0.36	
18.	I	Village Tandzia R. G. garden (20cm)		20.17		0.08	
19.	II	Village Geta Z. N. garden (0-5cm)	41.425251/44.379249	30.25		0.42	
20.	II	Village Geta Z. N. garden (20cm)		22.28		0.2	
21.	II	Village Darbazi A. G. garden (0-5cm)	41.419963/44.336902	36.17		0.38	
22.	II	Village Darbazi A. G. garden (20cm)		28.25		0.28	
23.	II	Village Darbazi M. B. garden (0-5cm)	41.412289/44.319629	36.22		1.28	
24.	II	Village Darbazi M. B. garden (20cm)		32.24		1.14	
25	II	Village Kveshi, I. M. Corn field (0-5 cm)	41.440013/44.458921	28.28		3.63	
26.	II	Village Kveshi, I.M. Corn field (20 cm)		30.1		1.14	
27.	II	Village Kveshi B. B. garden (0-5cm)	41.435986/44.44839	32.09		0.34	
28.	II	Village Kveshi B. B. garden (20cm)		34.12		0.64	
29.	II	Village Potskhveriani S. J. garden (0-5cm)	41.436319/44.391674	64.26		0.44	
30.	II	Village Potskhveriani S. J. garden (20cm)		34.38		0.26	
31.	II	Village Old Kveshi Sh. M. garden (0-5cm)	41.448301/44.425528	12.05		0.38	
32.	II	Village Old Kveshi Sh. M. garden (20cm)		14.08		0.22	
33.	II	Village Javshniani B. Z. garden (0-5cm)	41.433111/44.438195	62.15		0.58	
34.	II	Village Javshniani B. Z. garden (20cm)		40.19		0.52	
35.	II	Village Akaurta M. M. garden (0-5cm)	41.453413/44.453356	22.08		1,45	
36.	II	Village Akaurta M. M. garden (20cm)		22.09		1,45	
37.	II	Village Ratevani M. R. Corn field (0-5cm)	41.446502/44.504776	24.05		1.64	

38.	II	Village Ratevani M. R. Corn field (20cm)		32.17	1.79	
39.	II	Village Ratevani, N. L. garden (0-5cm)	41.445873/44.506637	26.18	0.48	
40.	II	Village Ratevani, N. L. garden (20cm)		26.06	0.54	
41.	III	Village Koda Z. M. garden (0-5cm)	41.581096/44.769420	14.03	0.3	
42.	III	Village Koda Z. M. garden (20cm)		14.06	0.24	
43.	III	Village Ghoubani E. S. garden (0-5cm)	41.609141/44.721275	22.08	1.18	
44.	III	Village Ghoubani E. S. garden (20cm)		18.16	0.24	
45.	III	Village Vashlovani N. M. garden (0-5 სმ)	41.613980/44.741009	32.12	1.39	
46.	III	Village Vashlovani N. M. garden (20cm)		18.07	1.07	
47.	III	Village Orbeti E. N. garden (0-5cm)	41.664258/44.53113	20.12	0.91	
48.	III	Village Orbeti E. N. garden (20cm)		22.09	0.58	
49.	III	Village Pantiani S. garden (0-5cm)	41.657204/44.600725	16.1	1.17	
50.	III	Village Pantiani S. garden (20cm)		16.06	0.58	
51	III	Village Didgori F. S. garden (0-5cm)	41.695529/44.514783	12.07	0.44	
52.	III	Village Didgori F. S. garden (20cm)		10.04	0.2	
53.	III	Village Big Toneti V. M. garden (0-5cm)	41.687736/44.420117	32.13	0.32	
54.	III	Village Big Toneti V. M. garden (20cm)		18.1	0.36	
55.	III	Village Manglisi, G. Ch. garden (0-5cm)	41.692797/44.384442	28.12	0.42	
56.	III	Village Manglisi, G. Ch. garden (20cm)		16.05	1.08	
57.	III	Village Algeti T. V. garden (0-5cm)	41.620608/44.387862	36.18	0.72	
58.	III	Village Algeti T. V. garden (20cm)		28.08	0.52	
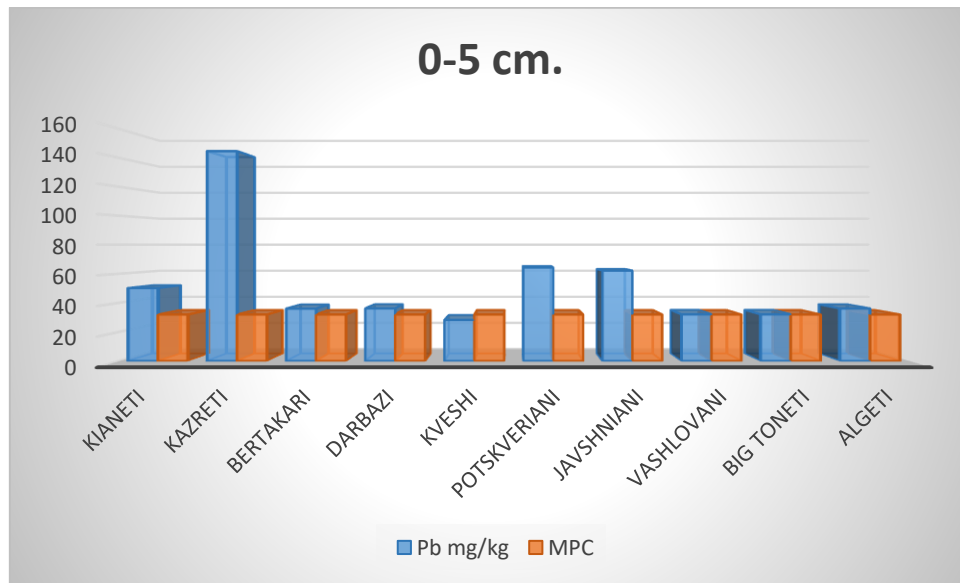
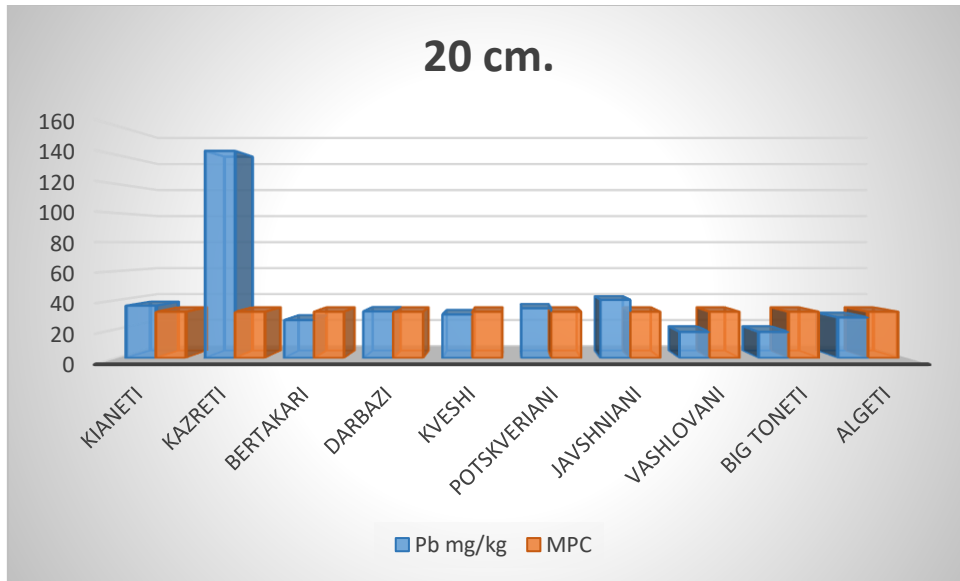**Figure 1. Lead content 0-5 cm in the soils of Kvemo Kartli region**

Figure 2. Lead content 20 cm in the soils of Kvemo Kartli region
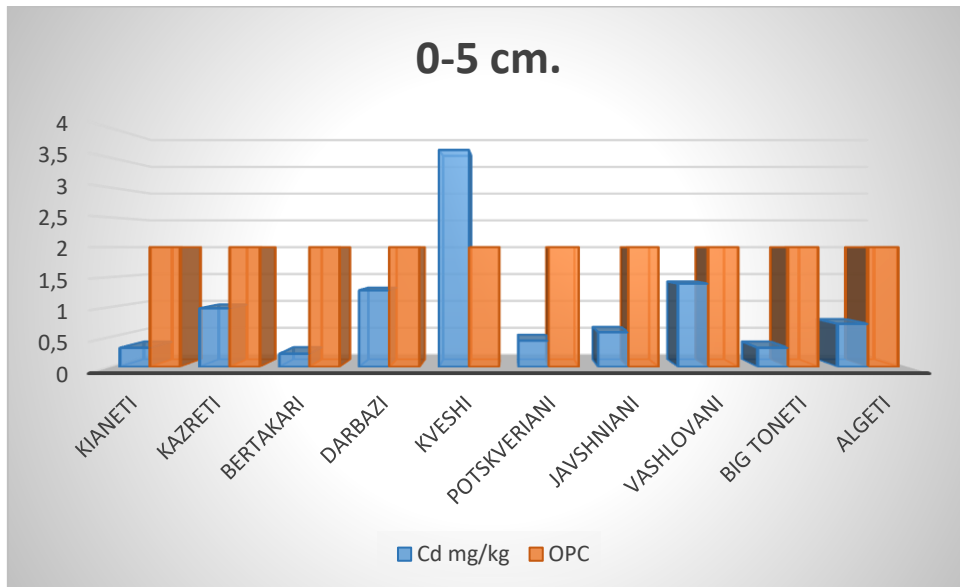
Figure 3. Cadmium content 0-5 cm in the soils of Kvemo Kartli region
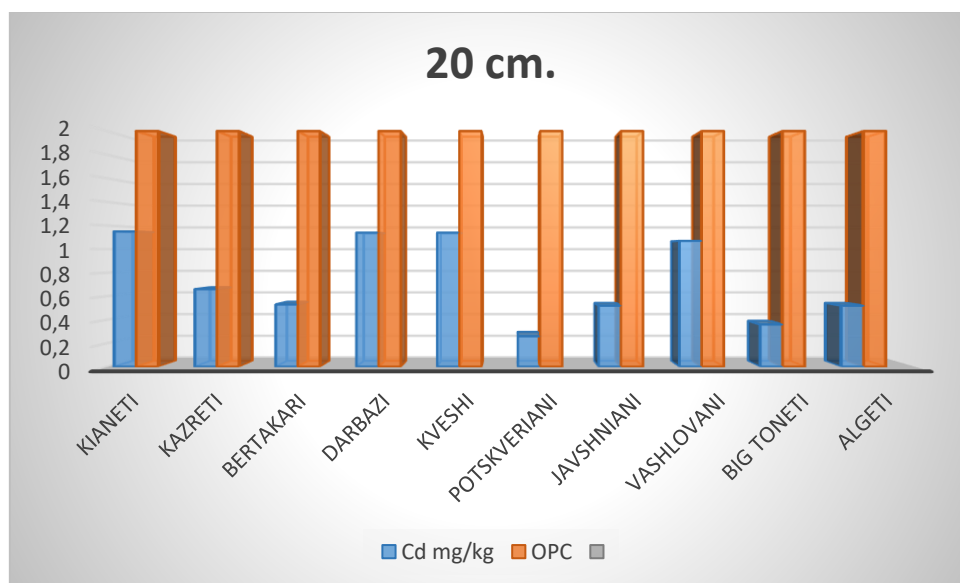
Figure 4. Cadmium content 20 cm in the soils of Kvemo Kartli region

Table 2. Research results of superficial water samples

N	Target groups	Water sampling locations	GPS Coordinates	Surface waters		Surface waters	
				Pb mg/l	MPC, Pb mg/l	Cd, mg/l	MPC, Cd mg/l
1	I	Kazreti Riv. Near Kazretula Bridge	41.39029/44.417978	0,005	0,03	<0.0002	0,001
2	I	Village Balichi Riv. Mashavera	41.37694/44.394776	0,005		<0.0002	
3	I	Village Didi Dmanisi Riv. Mashavera	41.377683/44.386906	0,004		<0.0002	
4	I	Village Kianeti Riv. Mashavera	41.419885/44.428386	0,003		<0.0002	
5	I	Village Mushevani Riv. Mashavera	41.437532/44.460731	0,006		0,0003	
6	I	Village Tandzia Riv. Khrami	41.459009/44.360667	<0.0002		<0.0002	
7	I	Village Kianeti Riv. Mashavera	41.423491/44.435399	0,005		0,0003	
8	I	Village Javshniani Riv. Mashavera	41.429235/44.438231	0,007		0,0003	
9	I	Big Dmanisi, Riv. Mashavera	41.36234/44.377793	0,001		<0.0002	
10	II	Village Geta Riv. Geta	41.424584/44.379633	0,0014		<0.0002	
11	II	Village Darbazi Riv. Geta (1)	41.42299/44.33036	<0.0002		<0.0002	
12	II	Village Darbazi Riv. Geta (2)	41.412444/44.330705	0,003		<0.0002	
13	II	Village Kveshi Riv. Mashavera	41.412289/44.319629	0,004		0,0003	
14	II	Village Potskhveriani Riv. Geta	41.433696/44.391678	<0.0002		<0.0002	

15	II	Village Old Kveshi Riv. Geta	41.446005/44.423154	0,003		<0.0002	
16	III	Village Koda Riv. Algeti (iriigation water)	41.577225/44.763917	0,0005		<0.0002	
17	III	Vil. Asureti Riv. Asureti water	41.596138/44.671467	<0.0002		<0.0002	
18	III	Village Algeti Riv. Algeti (1)	41.667980/44.391517	<0.0002		<0.0002	
19	III	Village Algeti Riv. Algeti (2)	41.668462/44.390805	0,003		0,0004	
20	III	Riv. Dvalta Khevi	41.644678/44.447048	0,0003		<0.0002	
21	III	Riv. Algeti (3)	41.64103/44.446192	<0.0002		<0.0002	
22	III	Village Partskhisi. Riv. Partskhisi	41.579763/44.567376	<0.0002		<0.0002	
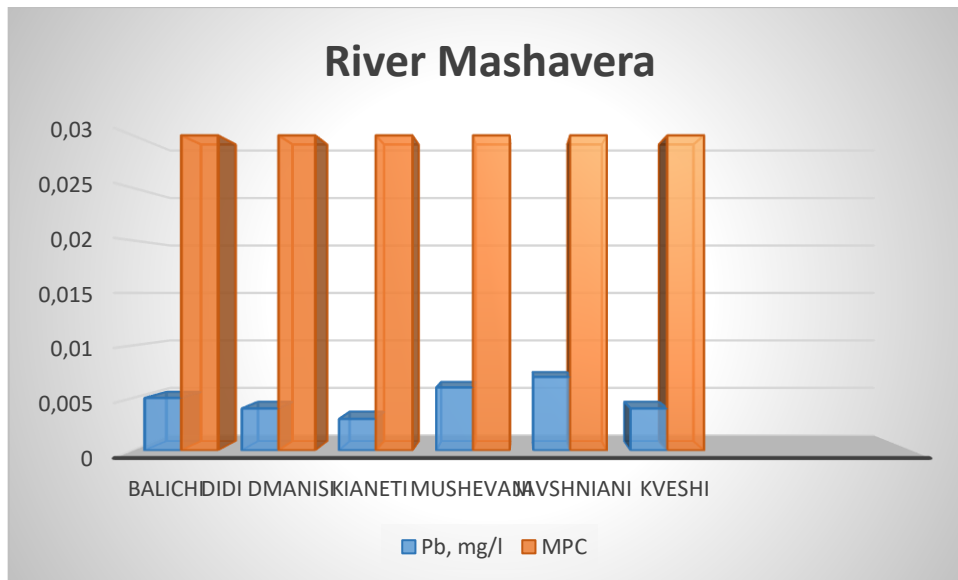
Figure 5. Lead concentration on the river. Mashavera
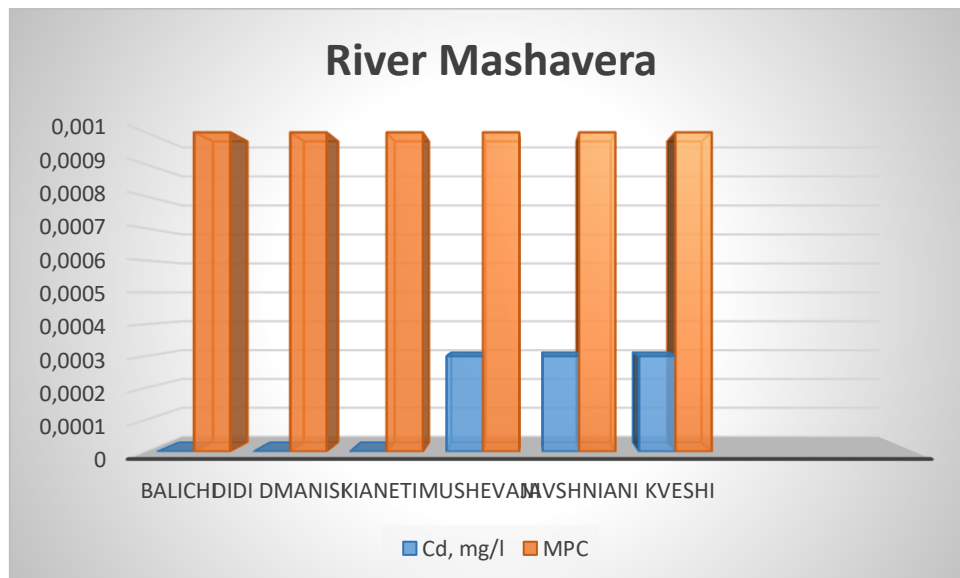
Figure 6. Cadmium concentration on the river. Mashavera

Conclusions

According to the analysis from 2022, no excessive heavy metal contamination has been observed in the surface waters of Partskhisi, Geta, Algeti, Dvaltakhevi, Asuretistskali, Khrami, and Mashavera.

In the soil samples, the maximum concentration of lead was observed in Kazreti (town of Kazreti, Corp. 60/4, "Five District", (0-5 cm)) and amounted to 144.52-4.5 times; Cadmium concentration was 3,63 (in the village of Mashavera (0-5 cm)) and 1.8 times the corresponding OPC.

Based on the analysis of the received data and various scientific and public information, we may conclude that the measures taken at the enterprise in recent years have reduced the technogenic impact of the environment, which was reflected in the results of the study, namely:

- An environmental program was developed in 2018;
- RMG-Gold implemented 97 mitigating measures under the environmental program, most of which are aimed at improving water, air and soil quality;

The conducted studies have shown that the situation in terms of environmental and especially surface water pollution in the Bolnisi and Dmanisi regions has improved compared to previous years. As for soil quality studies, it is necessary to constantly monitor and evaluate quality parameters; Establish specific corrective actions systematically to further reduce the potential for contamination.

Acknowledgment

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