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Assessment of the Current State of Environment Around the Construction of Veduchi ASTRC (Chechen Republic)

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Abstract – Ski tourism began to develop rapidly in Russia in recent years. A variety of trails and recreational facilities provide an opportunity to have good rest both for professionals and beginners. Currently, the JSC Resorts of the North Caucasus is designing the objects of the north-oriented slope of the Veduchi All-Season Tourist and Recreational Complex. As part of the first phase of the project (until 2022), three cable cars, a gondola and two chairlifts, and 8 km of ski slopes will be built. Due to the intensive development of the ski resort, the current state of the environment was monitored to ensure the safety of tourists. Veduchi is the resort of the future. This project will be a new impetus to the development of the Chechen economy, as well as the development of the tourism cluster throughout Russia.

Keywords – ***climate; maximum permissible concentrations; chemical pollution; heavy metals; total indicator of pollution.***

I. Introduction

The Chechen Republic is the southern region of Russia occupying a special geostrategic position in the European territory. The Republic is located in the junction zone of Europe and Asia, at the junction of the Caucasus Mountains and the East European Plain. In the north-west the Chechen Republic borders with the Stavropol Territory, in the east with the Republic of Dagestan, in the west with the Republic of Ingushetia, and in the south along the dividing ridge of the Greater Caucasus, the republic borders with Georgia [1]. The purpose and objectives of this work is to obtain the necessary and sufficient data on the natural conditions of the studied territory for a qualitative assessment of the current state of the components of the natural environment in a given territory. The site of the proposed construction of the *Veduchi* All-Season Tourist and Recreational Complex (Veduchi ASTRC) is located in the southern part of the Chechen Republic – on the territory of the Itum-Kale dry arid and is part of the Argun river. Most of the construction site is located in the zone of mountain forests, which occupies the lower part of the northern slope of the Daneduk ridge, separate areas on the Hacha-Royduk ridge (southern slope).

The climate of the Itum-Kalinsky region of the Chechen Republic is continental, but, despite a relatively small territory, Chechnya is characterized by a significant variety of climatic conditions. All transitional climatic types occur here ranging from the arid climate of the Terek-Kuma semi-desert to cold, humid climate of the snowy peaks of the Bokovoy Range.

The temperature conditions of Chechnya are very diverse. The main role in the distribution of temperatures here is played by the altitude above sea level. A noticeable decrease in temperature due to an increase in height is already observed on the Chechen plain [2, 3].

Fig. 1. Entry into the territory of the Veduchi ASTRC

The vegetation in the studied area is very rich. The slopes at altitudes up to 2300 m are covered with wood and sod. Above 2300 m there is herbaceous vegetation. Alder, willow, oak, elm, hazel, birch, aspen, alder, willow grow on the slopes. There are extensive thickets of rose hips, rhododendrons, raspberries, blackberries. There is a variety of herbs [4, 5].

Soils of the territory of construction of the Veduchi ski resort are located mainly in the mountain-forest soil-geographic zone. The main types of soils for this area are dark humus and dark brown.

The surveyed area of the planned construction of the Veduchi all-season ski resort occupies the south-western slopes of the Hacha-Royduk ridge and the north-eastern slopes of the Daneduk ridge near the village of Veduchi. The highest point of the object is Mount Kestinkort, 3524 meters above sea level. The smallest point of the object location is the bank of the river Khacharoyahk, 981 meters above sea level.

Fig. 2. View of the north-oriented slope of Veduchi ASTRC

The Chechen Republic has a very extensive river network. The total number of rivers is 3198, the total length of 6508.8 km. All rivers belong to the Terek and Sulak river systems. All streams in the study area belong to the river Argun basin. The mouth of the river Khacharoyahk is located 88 km along the right bank of the river Argun. The length of the river is 17 km [6-9]. Design objects are located in the valley of the river Khocharoyahk (Fig. 3) and its tributaries.

The rivers of the region are typically mountainous, with steep sides abound in deep canyons and waterfalls. The rivers are fed by melting snow, rain and groundwater.

Fig. 3. The bed of the river Khacharoyahk

II. Study of Chemical Pollution of Soil

According to various studies, the sharp variability of morphological and physical properties of soils, especially their genesis affects the nature of the accumulation of toxicants and their distribution across the profile. In most cases, when at atmospheric technogenic pollution the main accumulation occurs in the upper twenty-centimetric layer [10].

Different micro-elements are necessary for the functioning of all living organisms. Excess or lack of individual chemical elements or their compounds in the body often leads to various diseases. Heavy metals are particularly pathogenic in this case. They are among the priority pollutants, the monitoring of which is mandatory in the components of ecosystems [10, 11].

Sampling for soil studies for chemical contamination with heavy metals (cuprum, zinc, plumbum, cadmium, hydrargyrum, nickel) and arsenic was carried out in accordance with Methodical Instructions 2.1.7.730-99, one combined sample was taken from an area of 1 ha (100 m x 100 m). The research area is typical for the area under natural conditions, the soil cover is homogeneous. In this regard, to determine the content of chemicals in the soil, we selected 16 samples from a depth of 0.0-0.2 m and 16 samples from a depth of 0.2-1.0 m on a total area of 25 hectares.

The concentration of heavy metals and arsenic was defined via inversion voltammetry.

The results of determining the concentration of heavy metals and arsenic obtained in soil analyses are shown in Table 1.

TABLE I. CONCENTRATION OF HEAVY METALS, ARSENIC (MG / KG DRY SOIL) IN SOIL SAMPLES

n/n	**Depth of selection, m**	**Element**						
		Hydrargyrum, mg/kg	***Plumbum, mg/kg***	***Arsenic, mg/kg***	***Cadmium, mg/kg***	***Zinc, mg/kg***	***Nickel, mg/kg***	***Cuprum, mg/kg***
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1	0.0-0.2	0.128±0.064	0.587±0.205	0.112±0.045	<0.1	<1.0	0.536±0.241	<1.0
	0.2-1.0	< 0.1	0.523±0.205	< 0.1	<0.1	<1.0	<0.5	<1.0
2	0.0-0.2	0.136±0.069	0.595±0.208	0.121±0.048	0.11±0.04	<1.0	0.542±0.244	<1.0
	0.2-1.0	< 0.1	0.535±0.187	< 0.1	<0.1	<1.0	<0.5	<1.0
3	0.0-0.2	0.147±0.073	0.588±0.208	< 0.1	0.131±0.04	<1.0	<0.5	<1.0
	0.2-1.0	< 0.1	0.514±0.18	< 0.1	0.106±0.042	<1.0	<0.5	<1.0
4	0.0-0.2	0.128±0.064	< 0.5	0.136±0.054	0.117±0.047	<1.0	0.577±0.26	<1.0
	0.2-1.0	<0.1	< 0.5	<0.1	<0.1	<1.0	0.524±0.236	<1.0
5	0.0-0.2	0.131±0.065	0.617±0.216	0.12±0.05	<0.1	<1.0	0.524±0.236	<1.0
	0.2-1.0	0.115±0.057	< 0.5	<0.1	<0.1	<1.0	<0.5	<1.0
6	0.0-0.2	0.135±0.065	0.546±0.216	0.127±0.05	0.142	<1.0	0.576±0.236	<1.0
	0.2-1.0	0.106±0.053	0.52±0.18	<0.1	<0.1	<1.0	<0.5	<1.0
7	0.0-0.2	0.158±0.079	0.625±0.219	0.145±0.058	0.122±0.049	<1.0	0.544±0.245	<1.0
	0.2-1.0	0.123±0.061	0.582±0.204	0.1±0.04	<0.1	<1.0	<0.5	<1.0
8	0.0-0.2	0.165±0.082	0.563±0.197	0.134±0.054	<0.1	<1.0	0.517±0.233	<1.0
	0.2-1.0	<0.1	< 0.5	<0.1	<0.1	<1.0	<0.5	<1.0
9	0.0-0.2	0.139±0.069	0.645±0.226	0.158±0.063	<0.1	<1.0	0.584±0.263	<1.0
	0.2-1.0	<0.1	0.556±0.195	0.121±0.048	<0.1	<1.0	0.525±0.236	<1.0
10	0.0-0.2	0.145±0.072	0.615±0.215	0.116±0.046	0.127±0.051	<1.0	0.547±0.246	<1.0
	0.2-1.0	<0.1	0.536±0.187	<0.1	<0.1	<1.0	<0.5	<1.0
11	0.0-0.2	0.186±0.093	0.574±0.201	0.134±0.054	<0.1	<1.0	<0.5	<1.0
	0.2-1.0	0.152±0.076	< 0.5	<0.1	<0.1	<1.0	<0.5	<1.0
12	0.0-0.2	0.154±0.077	0.596±0.209	<0.1	<0.1	<1.0	0.618±0.278	<1.0
	0.2-1.0	<0.1	< 0.5	<0.1	<0.1	<1.0	0.521±0.234	<1.0
13	0.0-0.2	0.121±0.06	< 0.5	0.133±0.053	<0.1	<1.0	0.526±0.237	<1.0
	0.2-1.0	<0.1	< 0.5	<0.1	<0.1	<1.0	<0.5	<1.0
14	0.0-0.2	<0.1	0.642±0.225	0.141±0.056	0.162±0.065	<1.0	0.584±0.263	<1.0
	0.2-1.0	<0.1	0.552±0.193	<0.1	0.125±0.05	<1.0	<0.5	<1.0
15	0.0-0.2	0.128±0.064	0.575±0.201	<0.1	<0.1	<1.0	0.655±0.295	<1.0
	0.2-1.0	<0.1	<0.5	<0.1	<0.1	<1.0	0.523±0.235	<1.0
16	0.0-0.2	0.12±0.06	0.61±0.213	0.144±0.058	<0.1	<1.0	0.581±0.261	<1.0
	0.2-1.0	<0.1	0.546±0.191	<0.1	<0.1	<1.0	0.51±0.232	<1.0

There are two approaches to the assessment of land cover pollution. In the first approach, the assessment is made in comparison with the value of the maximum permissible concentrations (MPC) of pollutants in the soil cover (Table 2).

The MPC pollutant should be understood as a concentration that does not cause any pathological changes or anomalies in the course of biological soil processes, and does not lead to the accumulation of toxic elements in crops and thus cannot violate the biological optimum for animals and humans with prolonged exposure to soil and growing plants [11].

TABLE II. MPC VALUES OF HEAVY METALS AND ARSENIC (MG/KG DRY SOIL) IN SOIL AND SOIL SAMPLES

n/n	**Determined indicators**	**Hygienic standard**
1	**2**	**3**
1	Hydrargyrum, mg/kg	2.1
2	Plumbum, mg/kg	32.0
3	Arsenic, mg/kg	2.0
4	Cadmium, mg/kg	2.0
5	Zinc, mg/kg	23.0
6	Nickel, mg/kg	4.0
7	Cuprum, mg/kg	3.0

The degree of chemical contamination is assessed on the value of the coefficient K_0=C/MPC, is equal to the ratio of the concentration of the i-th pollutant to the magnitude of the MPC. The risk of chemical contamination is higher, the greater the actual content of the pollutant in the soil exceeds the MPC, or the greater the value of K_0 exceeds one. The concentrations of heavy metals in all samples were compared with their MPC values.

According to the data obtained (Table 1), the concentrations of all test substances in all samples do not exceed MPC in the layer 0.0- 0.2 m and the layer 0.2-1.0 m in samples No. 1-16.

The second approach is based on the determination of the level of chemical pollution of soils as an indicator of adverse effects on human health indicators developed in associated geochemical and hygienic studies.

Such indicators are the concentration factor of the chemical (Kc_i), which is determined by the ratio of the actual content of the substance to be determined in the soil (C_i, mg/kg) to the regional background (C_f, mg/kg):

$$K_{ci} = C_i / C_f \quad (1)$$

C_i – actual content of the i-th chemical element in soils, mg/kg;

C_{fi} – background content of the i-th chemical element in soils, mg/kg.

The total pollution index Z_c characterizes the influence of the group of elements. The total pollution index is equal to the sum of the concentration coefficients of chemical elements-pollutants and is expressed by the following formula:

$$Z_c = K_{ci} + \ldots + K_{cn-(n-1)} \quad (2)$$

where n – qualifying chemical elements;

K_{ci} – concentration ratio of the i-th component of pollution that exceed one.

When the value of the total index of chemical pollution Z_C <16 according to Sanitary and Epidemiological Rules and Regulations 2.1.7.1287, the level of soil pollution is considered acceptable.

As can be seen from Table 3 and Figure 4, the index of chemical contamination of the soil Zc in all studied samples, both from the depth of 0.0-0.2 m and from the depth of 0.2-1.0 m, is less than 16. The results showed that the values of the total index of chemical pollution in all samples, taken from a depth of 0.2-1.0 m is lower than in the upper soil layer. Therefore, soil contamination of the study area can be considered "permissible".

TABLE III. TOTAL INDEX OF CHEMICAL POLLUTION OF SOIL

n/n	**Depth of sampling, m**		**Element**						
			Hg	**Pb**	**As**	**Cd**	**Zn**	**Ni**	**Cu**
1	K	0.0-0.2	1.28	0.04	0.05	0.83	0.02	0.03	0.07
		0.2-1.0	1.00	0.03	0.05	0.83	0.02	0.03	0.07
	Z_c	0.0-0.2	1.28						
		0.2-1.0	1.00						
2	K	0.0-0.2	1.36	0.04	0.06	0.92	0.02	0.03	0.07
		0.2-1.0	1.00	0.04	0.05	0.83	0.02	0.03	0.07
	Z_c	0.0-0.2	1.36						
		0.2-1.0	1.00						
3	K	0.0-0.2	1.47	0.04	0.05	1.09	0.02	0.03	0.07
		0.2-1.0	1.00	0.03	0.05	0.88	0.02	0.03	0.07
	Z_c	0.0-0.2	1.56						
		0.2-1.0	1.00						
4	K	0.0-0.2	1.28	0.03	0.06	0.99	0.02	0.03	0.07
		0.2-1.0	1.00	0.03	0.05	0.83	0.02	0.03	0.07
	Z_c	0.0-0.2	1.28						
		0.2-1.0	1.00						
5	K	0.0-0.2	1.31	0.04	0.05	0.83	0.02	0.03	0.07
		0.2-1.0	1.15	0.03	0.05	0.83	0.02	0.03	0.07
	Z_c	0.0-0.2	1.31						
		0.2-1.0	1.15						
6	K	0.0-0.2	1.35	0.04	0.06	1.18	0.02	0.03	0.07
		0.2-1.0	1.06	0.03	0.05	0.83	0.02	0.03	0.07
	Z_c	0.0-0.2	1.53						
		0.2-1.0	1.06						
7	K	0.0-0.2	1.58	0.04	0.07	1.02	0.02	0.03	0.07
		0.2-1.0	1.23	0.04	0.05	0.83	0.02	0.03	0.07
	Z_c	0.0-0.2	1.60						
		0.2-1.0	1.23						
8	K	0.0-0.2	1.65	0.04	0.06	0.83	0.02	0.03	0.07
		0.2-1.0	1.00	0.03	0.05	0.83	0.02	0.03	0.07
	Z_c	0.0-0.2	1.65						
		0.2-1.0	1.00						
9	K	0.0-0.2	1.39	0.04	0.07	0.83	0.02	0.03	0.07
		0.2-1.0	1.00	0.03	0.06	0.83	0.02	0.03	0.07
	Z_c	0.0-0.2	1.39						
		0.2-1.0	1.00						
10	K	0.0-0.2	1.45	0.04	0.05	1.06	0.02	0.03	0.07
		0.2-1.0	1.00	0.04	0.05	0.83	0.02	0.03	0.07
	Z_c	0.0-0.2	1.51						
		0.2-1.0	1.00						
11	K	0.0-0.2	1.86	0.04	0.06	0.83	0.02	0.03	0.07
		0.2-1.0	1.52	0.03	0.05	0.83	0.02	0.03	0.07
	Z_c	0.0-0.2	1.86						
		0.2-1.0	1.52						
12	K	0.0-0.2	1.54	0.04	0.05	0.83	0.02	0.03	0.07
		0.2-1.0	1.00	0.03	0.05	0.83	0.02	0.03	0.07
	Z_c	0.0-0.2	1.54						
		0.2-1.0	1.00						
13	K	0.0-0.2	1.21	0.03	0.06	0.83	0.02	0.03	0.07
		0.2-1.0	1.00	0.03	0.05	0.83	0.02	0.03	0.07
	Z_c	0.0-0.2	1.21						
		0.2-1.0	1.00						
14	K	0.0-0.2	1.00	0.04	0.06	1.35	0.02	0.03	0.07
		0.2-1.0	1.00	0.04	0.05	1.05	0.02	0.03	0.07
	Z_c	0.0-0.2	1.35						
		0.2-1.0	1.05						
15	K	0.0-0.2	1.28	0.04	0.05	0.83	0.02	0.03	0.07
		0.2-1.0	1.00	0.03	0.05	0.83	0.02	0.03	0.07
	Z_c	0.0-0.2	1.28						
		0.2-1.0	1.00						
16	K	0.0-0.2	1.20	0.04	0.07	0.83	0.02	0.03	0.07
		0.2-1.0	1.00	0.04	0.05	0.83	0.02	0.03	0.07
	Z_c	0.0-0.2	1.20						
		0.2-1.0	1.00						

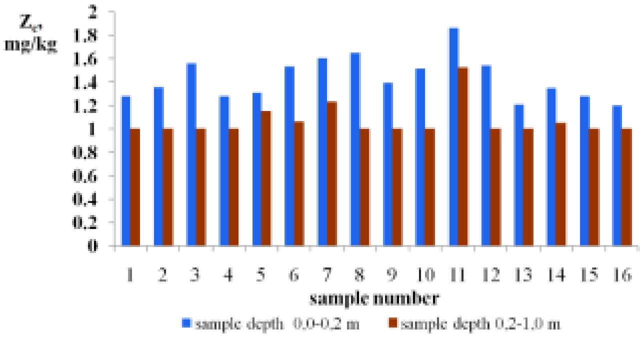

Fig. 4. Indicator of chemical pollution

III. Surface Water Inspection Regarding Chemical Pollution

The modern valley of the river Khacharoyahk, which flows near the site of the projected construction, is geomorphological, the development and formation of which took place, apparently, during the Pleistocene time. Valley – erosion accumulative. The Khocharoyahk tributaries are small streams ranging in length from 1 km to 3 km, with groundwater and rainwater. From the left slope 4 streams flow into the river, from the right slope – 3 streams.

Taking into account the peculiarities of the location of the territory, its functional use, geological structure, etc., to assess the level of chemical pollution in the studied area, 3 samples of surface water were taken. Samples were taken from the river Khacharoyahk and the streams flowing into it through the territory of the site.

The power of surface water bodies of the territory of the work site is carried out mainly due to surface runoff. In this regard, the assessment of the level of chemical pollution of surface waters was carried out in accordance with [12, 13].

The results of quantitative chemical analysis of surface waters are presented in Table 4.

TABLE IV. CONCENTRATIONS OF POLLUTANTS IN SURFACE WATER SAMPLES

n/n	Determined indicators	Units of measure	Hygienic standard	Contents in a sample No 1	Contents in a sample No 2	Contents in a sample No 3
1	2	3	4	5	6	7
1	Phenol	mg/l	≤0.001	< 0.0002	< 0.0002	< 0.0002
2	Nickel	mg/l	≤0.02	< 0.003	< 0.003	< 0.003
3	Chrome (6)	mg/l	≤ 0.05	< 0.001	< 0.001	< 0.001
4	Aluminum	mg/l	≤ 0.1	< 0.02	< 0.02	< 0.02
5	Molybdenum	mg/l	≤ 0.07	< 0.0025	< 0.0025	< 0.0025
6	Ferrum	mg/l	≤ 0.3	< 0.05	< 0.05	< 0.05
7	Phosphates	mg/l	≤ 3.5	< 0.25	< 0.25	< 0.25
8	Manganese	mg/l	≤ 0.1	< 0.01	< 0.01	< 0.01
9	Calcium	mg/l	-	19.7 ± 1.97	19.9 ± 1.99	51.4 ± 5.14
10	Plumbum	mg/l	≤ 0.01	< 0.0005	< 0.0005	< 0.0005
11	Arsenic	mg/l	≤ 0.01	< 0.001	< 0.001	< 0.001
12	Cadmium	mg/l	≤ 0.001	< 0.0005	< 0.0005	< 0.0005
13	Hydrargyrum	mg/l	≤ 0.0005	< 0.0005	< 0.0005	< 0.0005
14	Cuprum	mg/l	≤ 1	< 0.0005	< 0.0005	< 0.0005
15	Zinc	mg/l	≤ 1	< 0.001	< 0.001	< 0.001

According to the results of quantitative chemical analysis of surface waters (Table 4), the samples exceeding the permissible standards are not revealed.

IV. Conclusion

As a result of the study of the natural environment at the Veduchi ASTRC it was found that:

1. The results of soil and soil studies showed that chemical contamination with heavy metals (copper, zinc, plumbum, cadmium, hydrargyrum, nickel) and arsenic concentrations in all samples from the depth of 0.0-0.2 m and 0.2-1.0 m in the studied area exceed the maximum permissible concentration. The total concentration factor of chemical pollutant elements (Z_c) in all samples is less than 16. Accordingly, the level of chemical pollution, as an indicator of adverse effects on the health of tourists, in all the samples refers to the “acceptable” category of pollution.

2. According to the results of quantitative chemical analysis of surface water pollution, there were no exceedances of maximum one-time concentrations of chemical pollutants.

References

[1] I.A. Kerimov, A.A. Daukaev et al., “Natural-recreational potentialthe mountainous part of the Chechen Republic as a factor of sustainable development region”, Sustainable mountain development territory, vol. 9, no. 3, pp. 211–215, 2017. DOI: 10.21177/1998-4502-2017-9-3-211-218.

[2] M.B. Sedieva, U.T. Gayrabekov, D.A. Islamov, E.A. Abubakarova, A.A. Daukaev, Kh.Sh. Zaburaeva, S.V. Badaev, R.Sh. Akhmatkhanov, “Environmental Pollution Monitoring of the Chechen Republic (within the period of 2015-2017)”, Proceedings of the International Symposium “Engineering and Earth Sciences: Applied and Fundamental Research” (ISEES 2018), pp. 68–73. Retrieved from: https://doi.org/10.2991/isees-18.2018.14.

[3] Kh.Sh. Zaburayeva, L.S. Gatsayeva, U.T. Gayrabekov, S.-E.M. Dzhabrailov, Asl.A. Daukayev, M.B. Sediyeva, I.A. Abumuslimova, “Unique Natural Objects of Mountain Landscapes of the Chechen Republic”, Proceedings of the International Symposium “Engineering and Earth Sciences: Applied and Fundamental Research” (ISEES 2018), pp. 42–47. Retrieved from: https://doi.org/10.2991/isees-18.2018.9.

[4] I.A. Bayrakov, E.B. Bolotkhanov, A.I. Avtorkhanov, Kh.E. Taymaskhanov, I.Ya. Shakhtamirov, Chechen Republic: nature, economy and ecology. Grozny, 2006, 375 p. Retrieved from: https://elibrary.ru/item.asp?id=19497513.

[5] M.U. Umarov, K.S. Akhmedov, “From the history of botanical research in the Chechen Republic (1963–2007) and the priorities of their development” History of science and technology, no. 3, pp. 31–34, 2008. Retrieved from: https://elibrary.ru/item.asp?id=12329954.

[6] M.U. Elipkhanov, “Assessment of technogenic load on surface water bodies of the Chechen Republic”, Bulletin of the North Caucasus State Technical University, no. 2, pp. 118–122, 2011. Retrieved from: https://elibrary.ru/item.asp?id=16381772.

[7] M. H. Saitovitch, “The ecological situation in the Chechen Republic”, Materials of the International scientific and practical conference of young scientists, graduate and students. Rostov-on-don, pp. 131–135. April 2016. Retrieved from: https://elibrary.ru/item.asp?id=16376842.

[8] S.M. Abdurzakov, “Water resources of the Republic of Chechen Republic and their ecological state”, Problems of regional ecology, no. 2, pp. 184–188. 2011. Retrieved from: https://elibrary.ru/ item.asp?id=16376842.

[9] M.Sh. Saidova, Kh.N. Askhabova, M.S.Ozdyhanov, K.A.-B. Shuaipov, “Monitoring of the ecological state of the rivers of the Chechen Republic”, South of Russia: ecology, development. vol. 7, no. 4, pp. 113–115. 2012. Retrieved from: https://elibrary.ru/ item.asp?id=18932078.

[10] A.M. Abduazhitov, “Adsorption of heavy metals in mono- and polyelemental pollution of soils”, International journal of applied and fundamental research, no. 8-2, pp. 142–143. 2014. Retrieved from: https://applied-research.ru/ru/article/view?id=5600.

[11] N.A. Nedelin, M.V. Chizhevskaya, N.V. Fomina, “Biological diagnostics of soils of technogenic-contaminated landscape”, Actual problems of aviation and cosmonautics, no. 9, pp. 278–279, 2013. Retrieved from: https://elibrary.ru/item.asp?id=22602358.

[12] SN 2.1.5.1315-03. Maximum permissible concentrations (MPC) of chemicals in the water of water bodies of household drinking and cultural and domestic water use.

[13] SN 2.1.5.22880-07. Maximum permissible concentrations (MPC) of chemical substances in the water of water bodies of drinking and household water use.