ФИЗИЧЕСКАЯ ГЕОГРАФИЯ И БИОГЕОГРАФИЯ, ГЕОГРАФИЯ ПОЧВ И ГЕОХИМИЯ ЛАНДШАФТОВ / PHYSICAL GEOGRAPHY AND BIOGEOGRAPHY, SOIL GEOGRAPHY AND LANDSCAPE GEOCHEMISTRY

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MONITORING OF THE HEAVY METALS CONTENT IN THE SOIL ON THE TOURIST COMPLEX ”VEDUCHI” TERRITORY (TRANSLATION OF THE ORIGINAL PUBLICATION INTO ENGLISH)

Research article

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Abstract

Translation of the original publication Теунова Н.В. Мониторинг содержания тяжелых металлов в почве на территории туристического комплекса «Ведучи» / Н.В. Теунова, Л.А. Кешева, А.А. Ташилова // Международный научно-исследовательский журнал. — № 1 (127). — DOI: https://doi.org/10.23670/IRJ.2023.127.71.

The problem of soil contamination is an acute one for mankind. Soil is one of the main components of the natural environment, plants grow and ripen in it, suitable for food for animals, these same plants feed on useful substances from the soil layer. Soil is also the basis for human life and recreation. Among the many pollutants of the soil cover, a special place belongs to heavy metals, which are among the most dangerous substances.

This article examines the content of heavy metals in the soil of the All-Season Tourist and Recreational Complex "Veduchi" (ASTRC “Veduchi“), which is located in the southern part of the Chechen Republic. Thirty-two soil samples taken at the depths of 0.0-0.2 m and 0.2-1.0 m were examined. Based on the results of the analysis, a total pollution index was calculated.

Keywords: maximum permissible concentration, chemical pollution, heavy metals, total pollution index.

МОНИТОРИНГ СОДЕРЖАНИЯ ТЯЖЕЛЫХ МЕТАЛЛОВ В ПОЧВЕ НА ТЕРРИТОРИИ ТУРИСТИЧЕСКОГО КОМПЛЕКСА «ВЕДУЧИ»

Научная статья

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Аннотация

Перевод статьи Теунова Н.В. Мониторинг содержания тяжелых металлов в почве на территории туристического комплекса «Ведучи» / Н.В. Теунова, Л.А. Кешева, А.А. Ташилова // Международный научно-исследовательский журнал. — № 1 (127). — DOI: https://doi.org/10.23670/IRJ.2023.127.71.

Проблема загрязнения почвы остро стоит перед человечеством. Почва является одним из главных компонентов природной среды, в ней растут и созревают растения, пригодные для пищи животным, эти же растения питаются полезными веществами из почвенного слоя. Почва также является основой для жизни и отдыха людей. Среди многочисленных загрязнителей почвенного покрова особое место принадлежит тяжелым металлам, которые относятся к группе наиболее опасных веществ.

В данной статье рассматривается содержание тяжелых металлов в почве на территории Всесезонного туристического рекреационного комплекса «Ведучи» (ВТРК «Ведучи»), который находится в южной части Чеченской Республики. Было исследовано 32 образца почвы, отобранных на глубине 0,0-0,2 м и 0,2-1,0 м. На основе результатов анализа был рассчитан суммарный показатель загрязнения.

Ключевые слова: предельно-допустимые концентрации, химическое загрязнение, тяжелые металлы, суммарный показатель загрязнения.

Introduction

The Chechen Republic is the southern region of Russia, which occupies a special geostrategic position on European territory. The republic is located on the border of Europe and Asia, in the central part of the northern slope of the Greater Caucasus [1].

The Chechen Republic has great tourism potential. There are a lot of beautiful places in the republic that attract tourists. The development of a tourism destination contributes to socio-economic growth in the region. Currently, the all-season tourist recreational complex “Veduchi” is intensively developing, located in the southern part of the Chechen Republic, on the territory of the Itum-Kalin arid basin, and is part of the Argun River basin. Most of the territory of the resort complex is located in the mountain forest zone, occupying the lower parts of the northern slope of the Daneduk ridge, and separate areas on the Khacha-Royduk ridge (southern slope).

To assess the current ecological state of the natural environment, soil pollution was monitored to comply with sanitary and hygienic standards for the safety of tourists. The territory of the Veduchi complex is mainly located in the mountain-steppe and mountain-forest soil-geographical zones. According to the 1976 soil classification, these soils belong to the mountain-meadow steppe soils [2]. According to the 2004 soil classification, the main type of soil for this territory is humus petrosem, thin, strongly washed away on rocky soils [3]. At the same time, the relief features in the area of the site suggest more powerful humus horizons in places of local depressions due to the deposition of washed away soils.

According to various studies, sharp variability in the morphological and physical properties of soils and the features of their genesis are reflected in the nature of the accumulation of toxicants and their distribution along the profile. In most cases, with atmospheric anthropogenic pollution, the main accumulation occurs precisely in the upper twenty-centimeter layer [4], [5].

For the functioning of all living organisms, various microelements and chemicals are required, the excess or deficiency of which can lead to various diseases. Soils are an indicator of adverse effects on human health. The main sources of soil pollution in the ASTRC area are emissions vehicles, construction and road dust, unauthorized dumps, etc.

Contaminated soil in turn affects ground air, surface and groundwater and plant root systems.

Heavy metals (HMs) in soils are the most dangerous pollutants and are highly pathogenic [4], [6].

This paper presents the results of an analysis of the content of heavy metals in the soil, which is necessary for a qualitative assessment of the current state of the components of the natural environment on the territory of the ASTRC “Veduchi“.

Research methods and principles

Soil sampling to study soils for heavy metal contamination was carried out in accordance with methodological instructions [7], where, with a homogeneous soil cover, it is necessary to take 1 combined sample from an area of 1 hectare (100 m x 100 m). The research site is typical for this area in terms of natural conditions, the soil cover is homogeneous, and therefore, to conduct soil tests for the content of heavy metals, 16 samples were taken from the upper twenty-centimetre layer and 16 samples in the soil layer at a depth of up to 1 meter.

The concentrations of heavy metals and arsenic in the studied samples were determined by stripping voltammetry [8].

When conducting studies, the concentrations of heavy metals in all samples were compared with the values of their maximum permissible concentrations (MPC) [9].

Soil samples for research were selected in accordance with the methods of [10], [11].

According to the methods, at each test site, soil samples were taken from the upper humus layer, from a depth of 0.0 to 0.2 m, and the lower layer, from a depth of 0.2-1.0 m, at three points equidistant from each other. Then, having thoroughly mixed each layer, average samples were taken using the envelope method, which were subjected to further operations. In this form, the soils were ready for elemental analysis.

The classification division of heavy metals into 3 hazard classes is given on the basis of Interstate standard 17.4.1.02-83 [12].

Main results

When conducting studies of soil samples taken on the territory of the ASTRC “Veduchi“, the presence of seven heavy metals was revealed: arsenic, mercury, lead, cadmium and zinc are especially toxic and belong to the first class. Nickel and copper are toxic and belong to the second hazard class. No low-toxic heavy metals of the third class were detected.

The results of determining the concentration of heavy metals obtained from soil analyzes are shown in Table 1.

Table 1 - Concentration of heavy metals, arsenic in soil samples

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№/№	Sampling depth (m)	Element						
		Mercury, mg/kg	Lead, mg/kg	Arsenic, mg/kg	Cadmium, mg/kg	Zinc, mg/kg	Nickel, mg/kg	Copper, mg/kg
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.	< 0.5	0.136±0.	0.117±0.	<1.0	0.577±0.	<1.0

		064		054	047		26	
	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

The condition of the soil cover was assessed by comparing the results obtained with the value of the maximum permissible concentrations of heavy metals (pollutants) in the soil cover (Table 2).

Table 2 - Values of maximum permissible concentrations of heavy metals and arsenic in soil and soil samples

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№ п/п	Determined indicators	Hygienic standard

1	Mercury, mg/kg	2.1
2	Lead, 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	Copper, mg/kg	3.0

According to the data obtained (Table 1), the concentrations of all tested substances in all sixteen samples do not exceed the maximum permissible concentrations in the upper twenty-centimetre layer, as well as in the layer from 0.2 to 1 m.

Soil pollution was also assessed using another approach, based on the total pollution indicator (Z_c). When using the formula $Z_c = K_{ci} + \ldots + K_{cn} - (n - 1)$, where n is the number of chemical elements taken into account; K_{ci} is the concentration coefficient of the i-th component of pollution, exceeding one, proposed by the famous Soviet scientist Yuli Efimovich Sayet, the values of the total indicator of chemical soil contamination were obtained for seven heavy metals found on the territory of the tourist recreational complex (Table 3). The critical values characterizing the total pollution Z_c by degree of hazard are as follows: when the total indicator of chemical pollution Z_c <16, the level of soil pollution is considered acceptable; at 16 < Z_c < 32 – pollution is considered moderately dangerous; at 32 < Z_c <128 – highly dangerous; at Z_c > 128 – extremely dangerous [12], [13].

Table 3 - Total indicator of chemical contamination of soils

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№№	Sampling depth (m)		Element						
			mercury	lead	arsenic	cadmium	zinc	nickel	copper
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						

As can be seen from Table 3, the total indicator of chemical contamination of soil Z_c in all studied samples, both from the surface twenty-centimeter layer and from a depth of 0.2-1.0 m, is less than 16. The results obtained showed that the values of the total indicator of chemical contamination in all samples taken from depth 0.2-1.0 m is lower than in the top layer of soil. Consequently, soil contamination in the study area of the tourist recreational complex can be considered “acceptable.”

Conclusion

When conducting studies of the soil cover on the territory of the ASTRC “Veduchi“, it was established that the concentrations of chemical pollution with heavy metals in all samples taken from the upper twenty-centimeter layer and the layer from a depth of 0.2-1.0 m in the survey area do not exceed the maximum permissible concentration. The total indicator of the concentration coefficients of heavy metals in all samples is $Z_c < 16$; accordingly, the level of chemical pollution in all studied samples belongs to the “acceptable” category of pollution and will not have a negative impact on its border ecosystems, as well as human health.

Конфликт интересов

Не указан.

Рецензия

Все статьи проходят рецензирование. Но рецензент или автор статьи предпочли не публиковать рецензию к этой статье в открытом доступе. Рецензия может быть предоставлена компетентным органам по запросу.

Conflict of Interest

None declared.

Review

All articles are peer-reviewed. But the reviewer or the author of the article chose not to publish a review of this article in the public domain. The review can be provided to the competent authorities upon request.

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