A STUDY OF SURFACE AND GROUNDWATER CONDITIONS IN THE AREA OF THE UNAUTHORIZED LANDFILL SITE (TRANSLATION OF THE ORIGINAL PUBLICATION IN ENGLISH)

Research article

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Abstract

Translation of the original publication Kesheva L.A. Issledovanie sostojanija poverhnostnyh i podzemnyh vod v rajone razmeshhenija nesankcionirovannoj svalki [Investigation of the state of surface and groundwater in the area of unauthorized landfill] / Kesheva L.A., Teunova N.V. // Mezhdunarodnyj nauchno-issledovatel'skij zhurnal [International Research Journal]. — 2023. — №8 (134). — DOI: 10.23670/IRJ.2023.134.147.

The article examines the condition of surface and ground waters in the area of an unauthorized landfill site in the town of Karabulak, Republic of Ingushetia. For the study, 6 samples of surface and underground natural, surface and underground anthropogenic water were taken and analysed according to 36 different indicators.

Surveys showed increased magnesium and lithium content in surface and groundwater samples, and ammonium ion in the groundwater sample from the operating well. In all samples, exceedance of the maximum allowable concentration of hydrocarbonates and biological oxygen demand was observed.

When analysing technogenic water (filtrate), excesses for chlorides, iron, manganese, arsenic, chromium, lithium, magnesium, phenol and oil products are observed. Concentrations of pollutants in technogenic water samples taken from under the body of the landfill are several times higher than in samples taken at the foot of the landfill. High values of dry residue, chemical oxygen demand, biological oxygen demand and hydrocarbonates were also determined.

Keywords: waste, filtration water, surface water, groundwater, landfill, sample analysis.

ИССЛЕДОВАНИЕ СОСТОЯНИЯ ПОВЕРХНОСТНЫХ И ПОДЗЕМНЫХ ВОД В РАЙОНЕ РАЗМЕЩЕНИЯ НЕСАНКЦИОНИРОВАННОЙ СВАЛКИ (ПЕРЕВОД ОРИГИНАЛЬНОЙ ПУБЛИКАЦИИ НА АНГЛИЙСКИЙ ЯЗЫК)

Научная статья

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Аннотация

Перевод оригинальной публикации Кешева Л.А. Исследование состояния поверхностных и подземных вод в районе размещения несанкционированной свалки / Л.А. Кешева, Н.В. Теунова // Международный научно-исследовательский журнал. — 2023. — №8 (134). — DOI: 10.23670/IRJ.2023.134.147.

В статье рассматривается состояние поверхностных и грунтовых вод в районе размещения несанкционированной свалки в г. Карабулак, Республики Ингушетия. Для проведения исследования были отобраны 6 проб поверхностной и подземной природной, поверхностной и подземной техногенной воды и проанализированы по 36 различным показателям.

Исследования показали повышенное содержание магния и лития в пробах поверхностной и грунтовой воды и ион аммония в пробе грунтовой воды из действующей скважины. Во всех пробах наблюдается превышение предельно-допустимой концентрации по гидрокарбонатам и биологическому потреблению кислорода.

При анализе техногенной воды (фильтрата), наблюдаются превышения по хлоридам, железу, марганцу, мышьяку, хрому, литию, магнию, фенолу и нефтепродуктам. Концентрации загрязняющих веществ в пробах техногенной воды, взятых из-под тела свалки в несколько раз выше, чем в пробах, взятых у подножья свалки. Также определены высокие показатели по сухому остатку, химическому потреблению кислорода, биологическому потреблению кислорода и гидрокарбонатам.

Ключевые слова: отходы, фильтрационные воды, поверхностные воды, грунтовые воды, свалка, анализ проб.

Introduction

Unauthorized landfills are one of the significant pollution factors that have a negative impact on all natural components: atmosphere, soil, water. Landfills are one of the major social problems of urbanized areas and objects of high environmental risk of environmental pollution of natural environment. The main factor determining the negative impact of solid waste disposal sites household waste is infiltration within the waste storage area. Atmospheric heavy metals and other substances that seep into the soil are washed out by sediments from the landfill body, accumulate and poison surface and groundwater.

Research of surface and groundwater in areas where authorized and unauthorized landfills are located in various regions of the Russian Federation many works are devoted [1], [2], [3], [4].

This paper examines the pollution of surface, ground and filtration waters in the territory of an unauthorized landfill for the disposal and storage of household waste, located in the south-western outskirts of Karabulak, Republic of Ingushetia.

Ingushetia is considered the republic with the highest population density in the Russian Federation. The population of the republic, according to Rosstat, is 488 043 people (2018). Population density – 134.52 people/km^2 (2018). The rapid rate of population growth leads to large amounts of solid waste, which are stored in places not intended for waste storage [6].

The landfill in question is located on the right bank of the river Sunzha, 11 kilometers north of Magas and has area 31.2642 hectares. The landfill is a former quarry, partially forested and filled with garbage. This territory has been used for disposal of household waste for a long time (since 2002) and landfill masses periodically move to the bottom of the quarry as they accumulate in its upper part. Currently, the thickness of landfill soil reaches 23.0 meters (Fig. 1).

Figure 1 - Landfill territory

The surface of the site is technogenically altered; various diggings and heaps of soil and debris are observed here.

Groundwater at the site is represented by a Quaternary alluvial aquifer, which lies at depths of more than 5.0 m in a thick layer of pebbles. The aquifer is fed by infiltration atmospheric precipitation, is discharged into the underlying aquifer and into the local hydrographic network.

The composition of the leachate depends on the type and age of the waste, the prevailing physicochemical conditions (aerobic or anaerobic), microbiological and water balance of the landfill.

Research methods and principles

For a comprehensive assessment of the state of surface and underground natural, surface and underground technogenic water samples were taken for chemical, microbiological, parasitological laboratory analysis.

As a result of the inspection of the territory of the unauthorized waste, the following sampling sites were identified:

6 water samples:

– 1 sample of surface natural water (NW1) from a flooded quarry;

– 2 samples of technogenic water (TW), of which sample TW2 is from the body of the landfill and sample TW1 is taken from the accumulation of filtrate under the landfill body;

– 3 samples of underground natural water (UNW): sample UNW1 was taken from an active well to the south of the survey site, the UNW2 sample was taken at the spring outlet, the UNW3 sample was taken from a geological well.

To determine the water quality at the location of the unauthorized waste, physical-chemical tests were carried out [7].

Sampling was carried out in accordance with regulatory documents [8], [9].

Sampling equipment and sample storage containers were free of contamination and were not altered in sample composition. The volume of the sample taken was determined by the relevant regulatory document (RD) for the method determining a specific indicator, taking into account the number of indicators being determined.

Shelf life of selected surface water samples, the need for their preservation, storage methods and transportation, as well as the volume required for the analysis, complied with regulatory requirements documents and requirements of analytical laboratories, in accordance with those used for analysis methods [8], [9].

Researching of the selected samples were carried out with using certified equipment at Testing Center «Nortest», Moscow.

Main results

Laboratory studies of samples of natural surface, ground and technogenic (filtrate) water were carried out according to 36 indicators. Excess of maximum permissible concentrations (MPC) was observed for 18 indicators (Table 1). MPC value is given in accordance with sanitary rules and regulations (SRR) 1.2.3685-21 [10].

Table 1 - Results of analysis of natural surface samples, ground and technogenic (filtrate) water, in which MPC was exceeded

№	Place of selection	Surface natural	Underground natural water	Technogenic water	MPC

			water						
	Index	Unit change	Flooded Quarry	An active well to the south of the survey site	Spring outlet	Geological well	Accumulations of leachate under the body of the landfill	From the body of the landfill	
1	Dry residue	mg/dm^3	1214	338	1376	10920	14956	>35000	1000
2	Chemical oxygen demand	mg/dm^3	42	30	20	48	>30 000	>30 000	30
3	Biological oxygen demand	mgO_2/dm^3	6.30	7.50	5.00	7.20	>1000	>1000	4
4	Chlorides	mg/dm^3	21.5	53.7	29.6	17.8	2012	5393	350
5	Sulfates	mg/dm^3	537.0	61.8	504.0	486	164	26.8	500
6	Ammonium ion	mg/dm^3	<0.05	>150.0	<0.05	0.40	0.72	>150.0	1.5
7	Hydrocarbonates	mg/dm^3	384	21	592	680	980	2200	10
8	Iron	mg/dm^3	0.15	0.058	<0.04	0.097	4.24	18.8	0.3
9	Manganese	mg/dm^3	0.0012	0.0059	<0.001	0.0058	0.17	0.53	0.1
10	Cadmium	mg/dm^3	<0.0001	<0.0001	<0.0001	<0.0001	0.00011	0.0017	0.001
11	Arsenic	mg/dm^3	<0.005	<0.005	<0.005	<0.005	0.12	0.36	0.01
12	Chromium	mg/dm^3	0.0027	<0.002	0.0032	0.0044	0.43	0.70	0.05
13	Lithium	mg/dm^3	0.047	0.042	0.066	<0.015	>2	>2	0.03
14	Magnesium	mg/dm^3	63.8	1.19	62.1	61.2	154	378.0	50
15	Petroleum products	mg/dm^3	<0.05	0.013	<0.005	<0.005	>50	>50	0.3
16	Phenols	mg/dm^3	<0.0005	0.0007	<0.0005	<0.0005	2.02	3.28	0.001
17	Cyanide	mg/dm^3	<0.01	<0.01	<0.01	<0.01	>0.4	>0.4	0.3
18	Thermotolerant coliform bacteria	CFU/ 100 ml	30	4	7	-	$1.8*10^2$	-	not >100

In samples of surface natural water from the quarry, an excess of the maximum permissible concentrations is observed for dry residue, chemical oxygen demand, biological oxygen demand, sulfates, hydrocarbonates, lithium and magnesium. The concentration of hydrocarbonates is one of the greatest importance and is 38.4 MPC. Concentration hydrocarbonates determines water hardness, the value of which is critical for many industrial waters.

An increased content of chemical oxygen demand (1.4 MPC) and biological oxygen demand (1.6 MPC) indicates a high percentage of organic matter in the surface natural water of a flooded quarry.

The concentration of lithium in surface water is 1.56 MPC, and magnesium – 1.28 MPC.

According to the results of the study, excesses of the following elements are observed in groundwater samples:

– concentration of ammonium ion in a sample from an active well located south of the research site (UNW 1) is more than 100 MPC;

– the lithium concentration in the sample from well UNW 1 is 1.4 MPC and in the sample from the spring (UNW 2) – 2.2 MPC;

– magnesium concentration in the sample from the spring (GV2) and in the sample from well No. 5 (UNW 3) – 1.2 MPC.

In groundwater samples the amount of dry residue was also exceeded: it was 1.4 MPC in a sample from a spring, and it was 10.9 MPC in the sample from well No. 5 (UNW 3). All samples show high biological oxygen demand values, which range from 1.3 MPC in water from the spring to 1.9 MPC in water from well No. 5 and hydrocarbonates from 2 MPC in water from operating well up to 68 MPC in samples from well No. 5.

All samples of technogenic water (filtrate) excess of 15 MPC in dry residue, in the sample, taken at the site of filtrate accumulation, at the foot of the landfill in the southern part of the site, up to 35 MPC from well No. 25 from under landfill bodies. There is an increased content of chemical oxygen demand, more than 1000 MPC and biological oxygen demand, more than 250 MPC in both samples.

The content of hydrocarbonates ranges from 98 MPC to 220 MPC.

According to the results of laboratory tests, excesses are observed for: chlorides from 5.7 MPC at the foot of the landfill to 15.4 MPC in samples taken from under the landfill body; iron from 14.1 MPC to 62.6 MPC; manganese from 1.7 MPC to 5.3 MPC; arsenic from 12.0 MPC to 36.0 MPC; chromium from 8.6 MPC to 14.0 MPC; lithium more than 66.6 MPC; magnesium from 3.1 MPC to 7.56 MPC; petroleum products more than 166.6 MPC; phenol from 2020 MPC to 3280 MPC.

In well No. 25 (TW 2) there are excesses of ammonium ion (more than 100 MPC), cadmium (1.7 MPC), benz(a)pyrene (1.2 MPC).

In the accumulation of leachate under the body of the landfill, a focus of thermotolerant coliform bacteria is observed, the number of which exceeds the maximum permissible concentration by almost 2 times, which indicates contamination of technogenic waters with products human life and poses a microbiological hazard.

Conclusion

Studies conducted in the area where the unauthorized dump is located point to chemical pollution of surface and ground waters.

There is an excess of the maximum permissible concentration for lithium and magnesium, and values are 1.56 MPC and 1.28 MPC, respectively, in surface natural water from the quarry. The concentration of hydrocarbonates is 38.4 MPC and is observed increased content of chemical oxygen demand and biological oxygen demand, which indicates a high percentage of organic matter.

The content of ammonium ions in groundwater exceeds the maximum permissible concentration by more than 100 once. The concentration of lithium and magnesium is also higher than the maximum permissible concentration, by 2.2 and 1.2 times, respectively. There is an increased content of dry residue and hydrocarbonates. These changes in the composition of groundwater point to the technogenic impact of the landfill on the groundwater quality.

Analysis of technogenic water (filtrate) showed exceeding the maximum permissible concentration for chlorides, iron, manganese, arsenic, chromium, lithium, magnesium, phenol, as well as petroleum products. Concentrations of pollutants taken from under the landfill body in 1.6-4.4 times higher than in samples taken at the foot of the landfill.

The filtrate, passing through the thickness of the waste, is enriched with toxic substances and penetrates through the soil into groundwater leads to its contamination, which may have a negative impact on the characteristics of drinking water spring water, which is used by residents.

Arsenic, cyanides and phenols belong to hazard class 2 substances; they are toxic substances and if they enter the human body with water, they can cause serious poisoning of the body.

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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