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ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ
Қ. И. Сәтпаев атындағы Қазақ ұлттық техникалық зерттеу университеті

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ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
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OF THE REPUBLIC OF KAZAKHSTAN
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NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы "ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы" ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

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SOIL POLLUTION WITH HEAVY METALS ON THE LAND OF THE KARASAI LANDFILL OF MUNICIPAL SOLID WASTE IN ALMATY CITY

Abstract. Soil pollution with heavy metals on the land of the Karasai landfill of municipal solid waste in Almaty city with heavy metals. The annual amount of waste accepted for disposal is more than 580.0 thousand tons. According to the recent studies, the morphostructure of MPC in Almaty consists of various components, such as: food waste – 24%, paper and cardboard - 16%, polymers (plastics) 17 %, glass 11 %, ferrous metals 2%, non-ferrous metals 1 %, textiles 3%, wood 4%, bone leather, rubber 2%, waste residues 10%, the others are 9%.The structure of 56% of municipal solid waste is suitable for reuse. And with the proper organization of separate waste collection at the source of accumulation, it is possible to increase the volume of secondary raw materials.

Currently, the Karasai landfill has accumulated more than 10 million tons of waste. In connection with this territory is characterized by land pollution not only inside the landfill, but also outside it. The purpose of the article is to analyze laboratory tests of soil samples to determine the degree of contamination of the landfill with heavy metals and compare them with the results of the previous studies.

The main material for the analysis was the results of laboratory studies of the soil which was conducted in the framework of the basic research project funded by the Ministry of education and science of the Republic of Kazakhstan. The results of laboratory analyses of soil samples show the excess of the maximum permissible concentration for some heavy metals several times. They were used to make diagrams of exceeding the maximum permissible concentration, to identify the degree of contamination of the landfill soil, to assess the pollution of heavy metals of the landfill soil, to determine the impact of the landfill on adjacent ecosystems. The paper uses field, laboratory, cartographic methods of research. The results can be used to develop recommendations for monitoring the landfill and improving the state of the ecosystem.

Keywords: landfill of solid household waste, land pollution, heavy metals, soil analysis, pollution degree, MPC, environmental protection.

Introduction. Municipal solid waste is a serious environmental problem in Kazakhstan, significant quantities of which are produced in large settlements. Thus, according to the official data, Kazakhstan has accumulated about 100 million tons of municipal solid waste, and it is increasing annually by 5-6 million tons. However, only 3-5% of it is processed, the rest of it without sorting out to the components is transported and stored in open dumps, in Kazakhstan there are 4525 of them [1]. The city of Almaty is not only a major cultural and financial center of the Republic of Kazakhstan, but it is also the producer of a large quantity of municipal solid waste - more than 500 thousand tons a year come to the landfills. Garbage removal companies following to the approved scheme of collection and disposal of municipal solid waste from the yards containers take it out to the landfill every day without prior separation of the components; the landfill is located in Karasai district of Almaty region 34 km far from Almaty, 2 km to the north off the highway Almaty - Bishkek, 1.2 km to the west off the station Aytey. Figure 1 shows a satellite picture of the object studied.

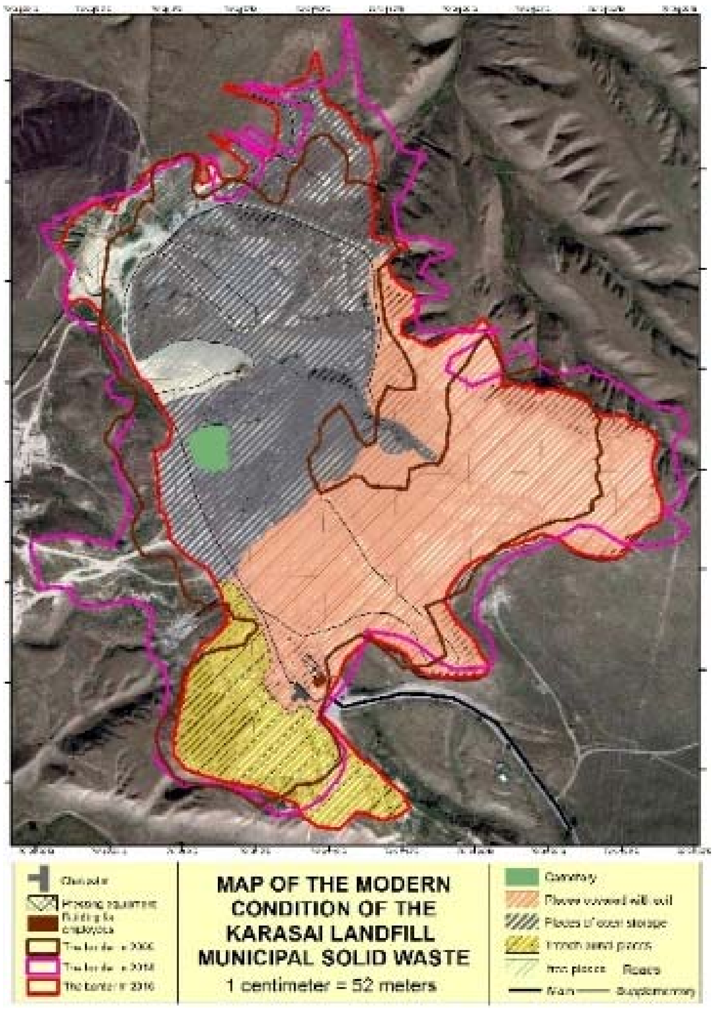

Figure 1 – Current state and dynamics of changes
in the boundaries of the Karasai municipal solid waste landfill for 2009-2016 [2]

The problems of land, soil, air and water pollution in the areas of the Karasai landfill have been investigated by the scientists of the Kazakh National Technical University named after K. I. Satpayev. Thus, a number of papers study such issues as:

- processes of formation of biogas, the evaluation of the factors affecting the efficiency of the gas collection systems at the municipal solid waste landfill;
- Temporal dynamics of the Karasai landfill methanotrophs in Almaty;
- technologies to reduce methane emissions at PTBO;
- Mathematical modeling of processes of formation of biogas at the Karasai landfill.

These studies were based on experiments and observations under the guidance of Professor S.S. Nurkeev [3-11].

The purpose of the article is to analyze the laboratory studies of soil samples, and to compare them with the results of previous ones to determine the degree of pollution of the landfill with heavy metals.

In accordance with the purpose of the study, the following tasks were set as follows:

-analysis of the previous years' results, laboratory data and drawing up the charts for exceeding the maximum permissible concentrations;
- identifying the degree of pollution of the soil of the landfill by heavy metals;
- assessing the pollution indicators of the landfill soil with heavy metals;
- determining the degree of impact of the landfill on the ecosystem of the region.

The characteristic of soil pollution with heavy metals is determined by the fact that, coming on food chains from the soil into plants and then into animals and humans, they cause the decrease in the number of plants and livestock products, the increase in the population morbidity, and the decrease in life expectancy. The soil, unlike other components of the natural environment, not only geochemically accumulates pollution components, but also acts as a natural buffer that controls the transfer of chemical elements and compounds to the atmosphere, hydrosphere and living matter [12-15].

Since the landfills in Kazakhstan, built without a set of measures that reduce their negative impact on the environment, are significant sources of its pollution [2]. Placed waste undergoes complex physico-chemical and biochemical changes under the influence of atmospheric phenomena, specific conditions forming in the stratum of waste, and also as a result of interaction with each other. This leads to the formation of various compounds, including toxic ones, which, moving into the environment, adversely affect its components.

Heavy metals with excessive exposure to environmental objects behave like toxicants and Eco toxicants. In this case, toxicants include elements and compounds that have a harmful effect on a single organism or a group of organisms, while Eco toxicants are elements or compounds that negatively affect not only individual organisms, but also the ecosystem as a whole. Environmental specialists have identified a priority group among toxic metals. It includes cadmium, copper, arsenic, nickel, mercury, lead, zinc and chromium as the most dangerous to human and animal health. Of these, mercury, lead and cadmium are the most toxic [16].

According to the World Health Organization's (WHO) definition, lead, mercury, and cadmium are the most dangerous heavy metals, representing the "terrible trinity" in the natural environment [17]. Hazardous wastes contain in their composition substances having a hazardous property or their combination (toxicity, infection, explosion hazard, fire hazard, high reactivity or other similar properties), and toxic chemical elements are divided into hygienic hazard classes:

The first hazard class includes extremely dangerous (arsenic (As), beryllium (Be), mercury (Hg), selenium (Sn), cadmium (Cd), lead (Pb), zinc (Zn), fluorine (F), benzopyrene). The recovery period is missing.

The second hazard class includes highly hazardous ((Cr), cobalt (Co), boron (B), molybdenum (Mb), nickel (Ni), copper (Cu), antimony (Sb)). The recovery period is at least 30 years.

The third hazard class includes moderately hazardous (barium (Ba), vanadium (V), tungsten (W), manganese (Mn), strontium (Sr), acetophenone). The recovery period is at least 10 years.

The fourth hazard class includes low-hazard substances (aluminum, kerosene, iron compounds, ammonia, methane). The recovery period is at least 3 years.

The fifth hazard class is almost not dangerous. The impact on the environment is practically absent [18].

Elements of hazardous wastes should not be treated in the same way as normal household wastes, their impact on the environment and its components grows every year, Kazakhstan has amended the Environmental Code on Waste Management, as well as expanded obligations of producers, under which since 2016 dumping mercury-containing lamps and appliances, scrap metal, waste oils and liquids, batteries, electronic waste at landfills is prohibited. The dumping of plastics, waste paper, cardboard and paper waste, glass is prohibited by law since 01/01/2019, then, since 01/01/2021, the ban on the dumping of construction and food waste comes into force [19].

Since toxic wastes are a significant risk to the environment, including human health, their disposal should be carried out in strict accordance with existing rules and standards. For example, at MSW landfills, toxic wastes of only III and IV hazard classes are accepted, and certain groups and types of waste are taken to landfills in limited quantities and stored under special conditions. The list of industrial wastes permitted for disposal at MSW landfills is governed by regulatory documents [19].

The main hygienic criterion for assessing the risk of soil pollution by chemicals is MPC - the maximum permissible amount of this substance (in mg / kg of arable layer is absolutely dry soil). According to which the environmental protection includes monitoring the soil and plant pollution to control the content of exogenous chemicals (ECS), which should not exceed the MAC in the soil and, accordingly, do not exceed the residual amounts of harmful ECS in the environment above permissible limits. The amount of the determined ECS and the frequency of control are determined in the landfill monitoring project (that is, in the production control program) and agreed with specially authorized environmental protection authorities [20].

Heavy metals are dangerous in that they have the ability to accumulate in living organisms, enter into the metabolic cycle, form highly toxic organometallic compounds (for example, methyl mercury, alkyl lead), change the form while the transition from one natural environment to another, without being biodegradable. Heavy metals cause serious physiological disorders, toxicosis, allergies, cancer, adversely affect the embryo and genetic heredity in human beings [16].

There are heavy metals in the remains of the chemical, ceramic, textile and match industry, cosmetology, test equipment, lighting lamps, dental fillings and amalgam, photo products, plastic products with cadmium dyes, the production of construction materials.

There are heavy metals in consumer goods, including children's toys, and, in concentrations that significantly exceed the permissible norms. Thus, in 2012, six organizations participating in the International Network for the Elimination of IPEN, working in the field of health and environmental protection in more than 100 countries of the world, examined for toxicity 569 children's products bought at random in markets and stores in Armenia and Belarus, Kazakhstan, Kyrgyzstan, Russia and Ukraine. The products were tested for antimony, arsenic, cadmium, chromium, lead and mercury. As a result, it turned out that in 164 of them at least one toxic element out of six is contained in dangerous concentrations. In 75 samples there was more than one. Lead was found in 104 samples, antimony in 75, arsenic in 45, mercury in 18. Among the dangerous items were stuffed animals and plastic toys, cosmetics, mugs, jewelry [21].

Materials and methods of research. The experimental part of the work is consisted of several stages: selection, preparation, analysis of samples and processing of the obtained results. The research route took place on the territory of the Karasai MSW landfill, which is a natural V-shaped broad gully with steep sides. The width and depth of the broad gully are reduced to the north from 350-340 m to 150-140 m and from 95-90 m to 40-35 m, respectively. The relief of the site is heavily rough; the surface is a combination of broad gullies, hills and ridges with flat tops sloping to the north. Adjacent area is a steppe. The climate of the region under consideration is moderate continental with dry air and a large number of sunny days. Annual precipitation is 509 mm; average annual evaporation is 452.2 mm. The average multi-year air temperature of the coldest month (January) is minus 9.9 ° C, the average multi-year air temperature of the hottest month (July) is plus 29.5 ° C [22].

The landfill is divided into sites, some of them are full, the site 5 and the site 7 and are out of use at the moment. The main sites in use are the sites 9, 10, 11. The site 9 is in the natural ditch. As it can be seen at figure 4 the garbage removal trucks are going down and unloading MSW. We can see that the people are engaged in different activities. So, they primarily carry out sorting on plastic bottles, glass bottles, cardboard, and then crush and compact the remains with the tractors. In the winter, this site does not work because the ground is icy and it is impossible to get there, and they use the sites 10 and 11 that are located at the top of the ditch. This picture was taken at the site 11.

Figure 2 – View of the site 9 on the landfill [23]

There is a cattle cemetery on the territory of the landfill. It is surrounded by a concrete fence. The household buildings for the staff of the landfill are located at the checkpoint. There are a shower room, a kitchen and a recreation room. On entering and leaving the landfill the weight of the garbage removal trucks is determined on an electronic balance at the checkpoint. Besides MSW construction debris is taken here too. There is also press equipment for PET bottles.

During the period of cameral preparation, we compiled a map of soil sampling (figure 3). The16 test sites were chosen trying to cover not only the territory inside the landfill, but also outside it, in order to identify the zone of impact of the landfill on the environment and assess its impact. Soil samples were taken from a layer of 0-10 cm using the "envelope" method, and their transportation and storage were carried out in accordance with the generally accepted method of sampling for soil monitoring [24].

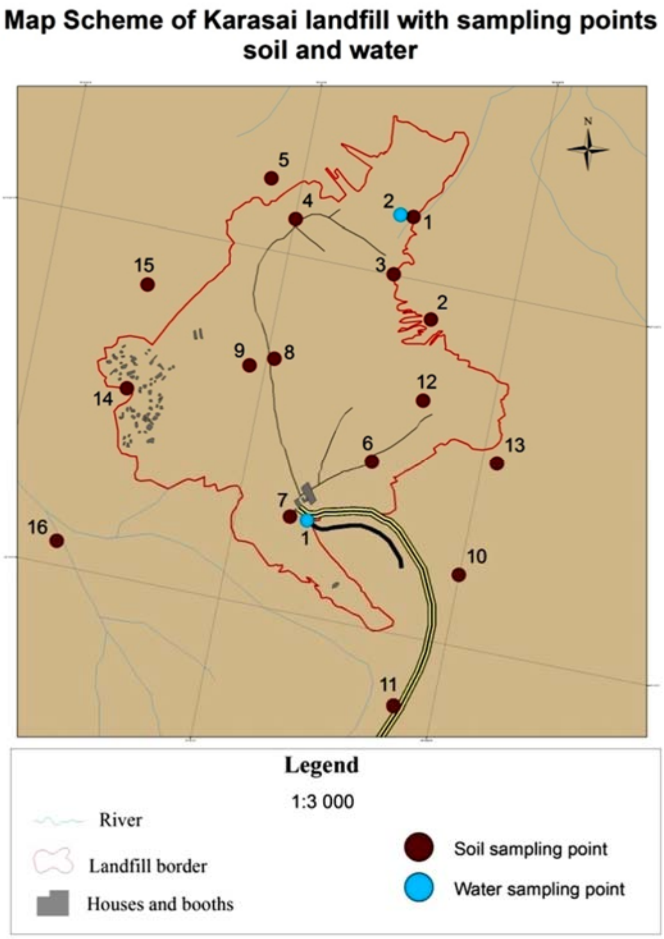

Figure 3 – Sampling points in the Karasai landfill [23]

The study of the environmental impact of land pollution of the MSW landfill was investigated by many scientists. Depending on the criteria and indicators used, different methods were applied, for example, landfill area, geodetic index (Igeo), enrichment factor (EF), pollution index (PI) and combined pollution index (IPI). We examined the studies performed by using optical emission and microwave plasma-atomic emission spectrometry [25-28].

Our research and processing of the results of laboratory analyzes of soil samples for the content of heavy metals was carried out on an analytical equipment of X-ray fluorescence spectrometer Spectroscan Max-G. On the whole, the field, laboratory, statistical, cartographic methods of research were applied, and a review of the literature related to the Karasai landfill was also conducted. As a result of the analysis of laboratory study, the assessment of soil pollution of the MSW landfill with heavy metals was made [23].

Results and discussion. Physical and chemical changes in the composition and content of heavy metals in the soils of the Karasai landfill for municipal solid waste were studied by G. A. Dzhamalova, the results were used for a comparative analysis of changes in the MPC norms. A comparative analysis of the results of exceeding the MPC for heavy metals, studied by G. A. Dzhamalova, was performed, i.e. the analysis of the physico-chemical changes in the composition of the soil grounds of municipal solid waste landfills. Where the physical characteristics of the soil, the determination of the degree of soil pollution by heavy metals on the territory of the landfill, the sanitary protection zone (SPZ), outside the SPZ and control points of the nearest residential area of the Karasai landfill were studied. As a result of the study made by Dzhamalova G. A., in the soil of the Karasai solid waste landfill compared with the 1999 data, there is an increase in the maximum permissible concentration of heavy metals of the first class of hazard - lead by 1.8-4.2 times, zinc - by 1.1-8.8 times, by arsenic - by 2,3 times, cadmium - 3.1 times and mercury 1.7-6.4 times; the second class of hazard is 1.4-214 times for copper, 4.5 times for chromium [29].

At the end of the field survey of soil samples, heavy metals were measured in soil on analytical equipment using an X-ray Spectroscan X-ray fluorescence spectrometer. The analysis of the protocols obtained showed the accumulation of heavy metals in soil samples, and in the results table 1, there are heavy metals: lead, zinc, chromium, arsenic, mercury and cadmium at 16 sampling points and their maximum permissible concentration (MPC) in mg/kg.

Table 1 – Research results of heavy metals in the soil of MSW landfill

Soil Sampling Points	Metals					
	zinc	chrome	lead	arsenic	mercury	cadmium
	MPC value mg / kg					
	20-23	20-23	20-32	2.0	2.1	2.0
1	85,64	45,92	–	10,95	–	–
2	–	33,24	2,10	10,52	–	1,35
3	15,53	51,65	–	8,78	–	2,87
4	30,34	43,02	14,52	11,47	–	3,54
5	6,86	19,49	–	10,10	–	5,38
6	32,37	31,71	–	4,07	–	4,12
7	44,40	35,66	–	7,25	–	8,65
8	112,9	32,7	–	8,28	–	0,93
9	14,4	26,36	–	6,63	–	14,85
10	49,71	47,68	–	5,43	–	12,39
11	20,64	26,34	6,13	10,26	–	15,39
12	5,29	17,4	6,13	9,09	–	2,35
13	2,64	24,2	–	7,06	–	2,35
14	160,9	23,34	7,07	9,46	–	0,85
15	–	44,59	–	6,61	–	0,83
16	9,6	17,08	2,1	6,61	–	18,03

The data obtained by using the spectral analysis of the soil revealed some patterns in the content of heavy metals in the soil, to assess the degree of pollution of the area.

The sanitary and hygienic criterion of environmental quality is the maximum permissible concentration (MPC) of chemicals in the environmental objects. MPC corresponds to the maximum content of a chemical in natural objects that does not cause a negative (direct or indirect) effect on human health (including long-term effects on the human resources) [30-33]. Using the data of the laboratory studies, we made the table, where the excess of MPC for polluting elements are shown. Then we combined them into three groups according to the norms of MPC. The first group is lead with MPC of 20–32 mg / kg, the second group includes zinc and chrome (with MPC of 20–23 mg / kg), and the third group includes cadmium (with MPC of 2 mg / kg). Mercury pollution on the territory of the landfill by the study protocols was not detected.

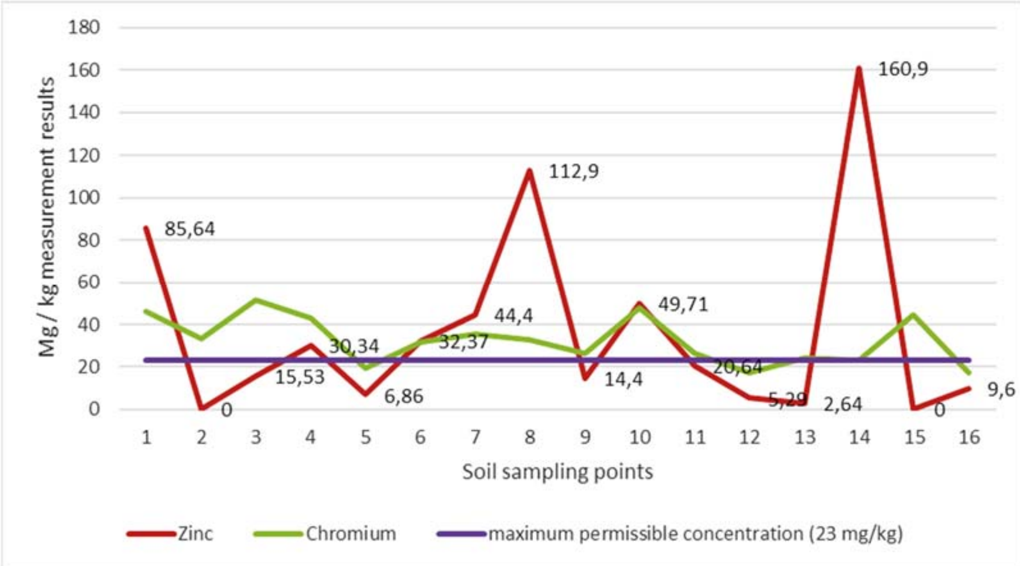

Figure 4 – Results of soil pollution indicators measurement of solid waste landfill with heavy metals (Zn, Cr)

As it can be seen in figure 4, zinc pollution at points is1–85.64 mg / kg, at 4–30.34 85.64 mg / kg, at 6–32.37 85.64 mg / kg, at 7–44, 40 85, 64 mg / kg, at 8 - 112.9 85.64 mg / kg, at 10 - 49.71 85.64 mg / kg, at 14 - 160.9 85.64 mg / kg. There is an excess of the MPC of zinc at points 8, 14 and 2, the highest excess of 160.9 mg / kg was at 14 sampling point.

The results of measurements of soil pollution with chromium show the MPC standards for only 3 points, for the remaining 13 points they exceed the level of 23 mg / kg within the limits of 24.2 to 51.65 mg / kg, the highest excess of 51.65 mg / kg is at the third sampling point.

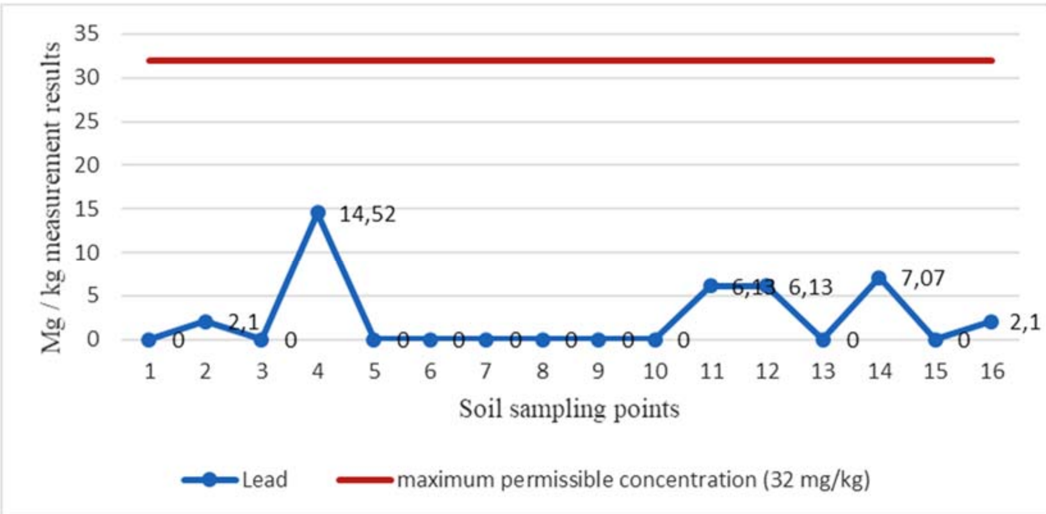

Figure 5 – Results of soil pollution indicators measurement of solid waste landfill with lead

Maximum permissible concentration of lead is set in the range of 20-32 mg / kg, compared to other metals, lead is found only at 6 points in the normal range, and at the other points lead pollution is not observed. The lead content in the studied soils varied from 2.1 to 14.52 mg / kg and in all cases did not exceed the MPC; the highest amount of 14.52 mg / kg in the soils was at sampling point 4.

As it can be seen in Figure 6, arsenic pollution is observed at all 16 points, at the 6th sampling point, the smallest contamination was 4.07 mg / kg, and the highest MPC of 11.47 mg / kg was noted at point 4.

As it can be seen in Figure 6, cadmium pollution is noted at the norm and does not exceed MPC at 8, 14 and 15 points. According to the study protocols, heavy metal pollution with cadmium was not detected at point1. At sampling point15, the lowest indicator was 0.83.

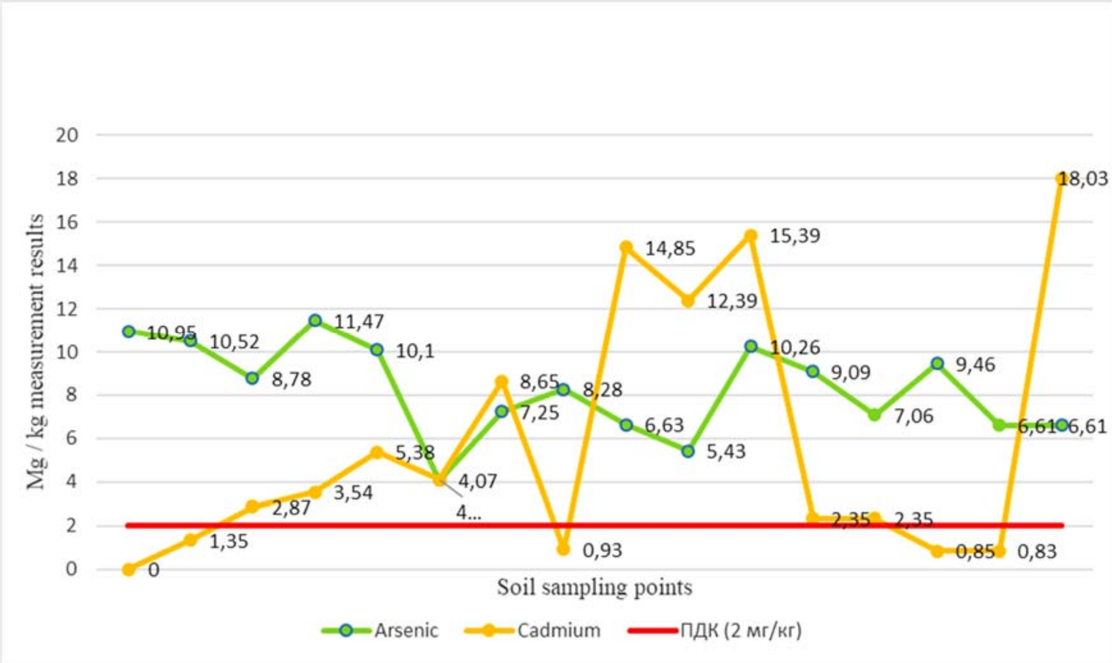

Figure 6 – Results of soil pollution indicators measurement of solid waste landfill with heavy metals (Ar, Cd)

Mercury was not identified at all 16 sampling points, though the tests carried out by the Ltd "Scientific Analytical Center" in 2009 showed the mercury of 0.07 mg /kg at the MPC of 2.1 mg/kg [23].

The results obtained show a strong pollution of the landfill soil with heavy metals like zinc, arsenic, and cadmium.

In the case of complex soil pollution with heavy metals, it is necessary to use an appropriate criterion to assess the potential hazard of contamination. Most literary data show that the most sensitive indicator of the state of pollutants is the content of mobile forms of their compounds in the soil, since these forms are the most dangerous, getting primarily into plants and the human body [34].

Taking into account the important role of soil cover in the component composition of the environment, we made an assessment of the state of the area, which is shown in table 2.

Table 2 – Indicators of soil pollution with heavy metals

Elements	Hazard class	MPC value, mg / kg	Maximum concentration, mg / kg, 2012	Maximum concentration, mg / kg, 2015	Excess of MPC, times	Type of environmental situation
Lead	I	20-23	134,4	14,52	Lessthan	Satisfactory
Zinc	I	20-23	202,4	160,9	6,9	Crisis
Chromium	II	20-23	642,3	51,65	2,2	Pre-Crisis
Arsenic	I	2,0	4,6	11,47	5,7	Crisis
Mercury	I	2,1	13,49	–	–	
Cadmium	I	2,0	9,4	18,03	9	Crisis

The study of the laboratory data of the soil samples taken in the studied area of the solid waste landfill showed that the average content of toxic chemical elements in soil samples in the storage area of solid household waste is significantly higher compared to the maximum permissible concentration: zinc is 6.9 times, chromium is 2.2 times, for arsenic - 5.7 times, for cadmium - 9 times (table 2). Pollution of the soil grounds of the landfill with heavy metals can be explained by its long-term operation, which over time can lead to different changes in the ecosystem regardless of the point of pollution.

Compared with the results carried out by Dzhamalova G. A. we observe a comparative decrease in the content of heavy metals in the soil, the excess of the maximum permissible concentration limit is observed in zinc, chromium, arsenic and chromium. Traces of residual mercury pollution are completely absent compared to 13.49 mg / kg previously. The increased concentration of cadmium 18.03 mg / kg at the sampling point 16 and its widespread distribution, we associate with the close location of a functioning brick plant. The increased concentration of arsenic at point4 is 11.47 mg / kg we associate with trucks transporting solid waste, since there is a widespread of arsenic pollution along the road inside the landfill.

Analyzing these tables, we observe the predominance of the pre-crisis and crisis types of the ecological situation, which negatively affects the ecosystem, the soil cover not only accumulates pollution components, but also acts as a natural buffer, which significantly reduces the toxic effects of heavy metals and regulates the flow of chemical elements into plants and the body of animals and humans. Unlike the atmosphere and hydrosphere, where processes of periodic self-cleaning from heavy metals are observed, the soil has practically no such ability. Metals that accumulate in soils are removed from it extremely slowly only by leaching, plant consumption, erosion and deflation. In this connection, it is necessary to reduce the storage of sources accumulating heavy metals compounds[19].

At present, due to an insufficiently thought-out environmental management strategy, the extensive development of industry, ignoring the need and possibilities for scientific regulation of anthropogenic loads, the ever more threatening degradation of the natural environment of Kazakhstan continues [35-38].

Ultimately, the degradation of natural ecosystems, along with social tensions, leads to public health disorder, changes in the genetic fund. Therefore, the study of the ecological situation, as well as the cause-effect relationships of its change, is becoming increasingly necessary at the present time.

Conclusion. We know that the environment and nature are invaluable resources, which, unfortunately, are not unlimited. It should be noted that human activity over the past 60 years has accelerated at an unprecedented pace and has become a serious problem for them. The realization that the very existence of humanity and our desire for growth, prosperity and pleasure can cause irreversible damage and extremely deplete these essential resources entailed the consolidation of efforts to protect the environment and the tightening of measures to protect public health.

In our country, in accordance with Article 305 of the Environmental Code: "Control and monitoring during the operation of the landfill is ensured by the operating organization of this landfill". In addition, they must also annually submit an environmental monitoring report to the authorized body and then coordinate with it “the nature and timing of corrective measures that they will take to reduce the adverse environmental impact”. Unfortunately, it was not possible to get acquainted with the annual reporting. As a result of our research and relying on the results of a study conducted earlier on this polygon, we observe a comparative decrease in pollution of the soil of the landfill with heavy metals as lead, zinc and chromium and the absence of traces of mercury contamination. Conducted research of the state of the solid household waste landfill soil found out the presence of heavy metals in soils with an excess of MPC from 2.2 to 9 times (cadmium), which creates a crisis type of environmental situation.

Based on the analysis of the laboratory studies of soil samples determining the degree of the landfill pollution with heavy metals, we can draw the following conclusions:

- analysis of the exceedances of MPC for heavy metals shows the presence of heavy metals and the uneven distribution of the heavy metals in the soils of the landfill;
- assessment of landfill soil pollution with heavy metals showed the existing anthropogenic stress exerted on the landfill site.

As a result, it is noted that, for today, the ecosystem of the landfill is experiencing a critical environmental load within the landfill and beyond its boundary. The increased concentration of cadmium and arsenic requires additional measures in order to prevent the natural state from deteriorating to an unsatisfactory level. During this time, the landfill is actively affecting the environment. Therefore, it is necessary to tifhten control and monitoring measures at the storage sites for solid household waste on the territory of the Republic of Kazakhstan.

In order to self-regulate the polygon ecosystem, it is necessary to reduce the anthropogenic impact that needs to be started today. In accordance with Article 301 of the Environmental Code, from January 1, 2019, the following types of waste should not be accepted for disposal at the landfills of the country: plastic, polyethylene and polyethylene terephthalate packaging, waste paper, cardboard and paper, as well as glass breakage. This is a serious step forward, but at the same time, the procedure for implementing this ban has not been thought through to the end. The ban has been adopted, and how it will be observed in practice is not fully understood, since the citizens of Almaty do not sort them at the source of waste by type, but collect it in one package and carry it into a common trashcan, which is taken away by one garbage collection machine. As well as the extended producer, responsibility introduced today does not have a large-scale component development and geographical coverage. In the developed metropolis of Almaty, there are not enough collection points for waste paper, glass containers, plastics, metals, textiles, hazardous waste (mercury lamps, mercury devices), electronic waste (computers, electronic scrap, office equipment, household appliances), medical waste of the population, and more. Until we can organize the proper organization of sorting and collection of solid waste at the source of accumulation, then all our efforts to improve and protect the environment will be one-sided.

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АЛМАТЫ ҚАЛАСЫ ҚАРАСАЙ ҚАТТЫ ТҰРМЫСТЫҚ ҚАЛДЫҚТАР ПОЛИГОНЫ ЖЕРЛЕРІ ТОПЫРАҒЫНЫҢ АУЫР МЕТАЛДАРМЕН ЛАСТАНУЫ

Аннотация. Мақала Алматы қаласының Қарасай қатты тұрмыстық қалдықтар полигоны жерлерінің ауыр металдармен ластау мәселелеріне арналған. Полигонда көмуге қабылданатын қалдықтардың жылсайынғы көлемі 580,0 мың тоннаны құрайды. Соңғы зерттеулерге сәйкес Алматы қаласының ҚТҚ-ры морфоқұрылымы әртүрлі компоненттерден тұрады, олар: тағам қалдықтары – 24%, қағаз және картон - 16%, полимерлер (пластик, пластмасса) - 17 %, шыны - 11 %, қара металдар - 2%, түсті металдар - 1%, тоқыма - 3%, ағаш - 4%, сүйектер, тері, резеңке - 2%, қоқыс қалдықтары - 10%, басқа қалдықтар - 9% құрайды. Құрылымы бойынша қатты тұрмыстық қалдықтардың 56% қайта пайдалануға жарамды. Пайда болу көздерінде қалдықтарды сұрыптауды дұрыс ұйымдастыру жүзеге асырылса, қайта пайдалануға жарамды шикізат көлемін ұлғайтуға мүмкін болады.

Қазіргі уақытта Қарасай полигонында 10 млн тоннадан астам қалдықтар жинақталған. Осыған байланысты, аталған территория үшін полигон ішінде ғана емес, шекаралас жерлерде де топырақтың ластануы орын алуда. Мақаланың мақсаты полигон топырағының ауыр металдармен ластану дәрежесін анықтау үшін топырақ сынамаларының зертханалық зерттеулерін талдау және оларды бұрын жүргізілген зерттеу нәтижелерімен салыстыру болып табылады. Қазақстан Республикасы Білім және Ғылым Министрлігі қаржыландыратын іргелі зерттеулер жобасы шеңберінде жүргізілген топырақты зертханалық зерттеу нәтижелері талдау үшін негізгі материал болды. Топырақ сынамаларын зертханалық талдау нәтижелері кейбір ауыр металдар бойынша шекті жол берілетін шоғырланудың бірнеше есе артқанын көрсетеді. Олар бойынша шекті рұқсат етілген концентрациялардан асып кету диаграммалары жасалды, полигон топырағының ластану дәрежесі анықталды, полигон топырағының ауыр металдармен ластануын бағалау орындалды, полигонның шектес экожүйелерге әсері анықталды. Жұмыста далалық, зертханалық, картографиялық зерттеу әдістері қолданылды. Алынған нәтижелер полигон мониторингін жүргізу және осы экожүйенің жайкүйін жақсарту жөніндегі ұсыныстарды әзірлеу үшін пайдаланылуы мүмкін.

Түйін сөздер: қатты тұрмыстық қалдықтар полигоны, жердің ластануы, ауыр металдар, топырақты талдау, ластану деңгейі, ШРК, қоршаған ортаны қорғау.

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ЗАГРЯЗНЕНИЕ ПОЧВЫ ЗЕМЕЛЬ КАРАСАЙСКОГО ПОЛИГОНА ТЯЖЕЛЫМИ МЕТАЛЛАМИ ТВЕРДЫХ БЫТОВЫХ ОТХОДОВ Г. АЛМАТЫ

Статья посвящена вопросам загрязнения земель Карасайского полигона твердых бытовых отходов города Алматы тяжелыми металлами. Ежегодный объем принимаемых для захоронения отходов составляет более 580,0 тыс. тонн. Согласно последним исследованиям морфоструктура ТБО г. Алматы состоит из различных компонентов, таких как: пищевые отходы 24%, бумага и картон 16%, полимеры (пластик, пластмассы) 17 %, стекло 11 %, черные металлы 2%, цветные металлы 1 %, текстиль 3%, дерево 4%, кости кожа, резина 2%, остатки отходов 10%, другое составляет 9%. По структуре 56% отходов твердых бытовых отходов пригодны для повторного использования. А при правильной организации раздельного сбора отходов у источника накопления возможно увеличение объемов вторичного сырья.

В настоящее время на Карасайском полигоне накопилось более 10 млн тонн отходов. В связи с этим, для данной территории характерно загрязнение земель не только внутри полигона, но и за ее пределами. Целью статьи является анализ лабораторных исследований проб почвы для определения степени загрязненности полигона тяжелыми металлами и сопоставление их с результатами проведенных ранее исследований.

Основным материалом для анализа послужили результаты лабораторных исследований почвы проведенных в рамках проекта фундаментальных исследований, финансируемого Министерством образования и науки Республики Казахстан. Результаты лабораторных анализов проб почв показывают превышение предельно допустимых концентрации по некоторым тяжелым металлам в несколько раз. По ним составлены диаграммы превышения предельно-допустимых концентрации, выявлена степень загрязнения почвы полигона, выполнена оценка загрязнения тяжелыми металлами почвы полигона, определено воздействие полигона на сопредельные экосистемы. В работе использованы полевые, лабораторные, картографические методы исследовании. Полученные результаты могут быть использованы для выработки рекомендации по ведению мониторинга полигона и улучшению состояния данной экосистемы.

Ключевые слова: полигон твердых бытовых отходов, загрязнение земель, тяжелые металлы, анализ почв, степень загрязнения, ПДК, охрана окружающей среды.

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