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Veselyi Kut Village Territory Investigation For Heavy Metals Content In The Soil And For Water Chemical Composition

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Abstract

The study object is the negative impact of the main industry-related objects, which are located near the village of Veselyi Kut on the environment and their characteristics. The physical-geographical and climatic characteristics of the settlement were studied.

The main characteristics of sources of hazardous substances emissions occurring due to the activities of PJSC "Central Mining and Processing Plant "(CGOK), which is part of the international vertically integrated mining and metallurgical group of Metinvest companies, are described.

The territory of the village of Veseliy Kut was studied for heavy metals content in the soil, and the chemical composition of water in wells. The study has shown the presence of increased content of harmful substances.

These studies have shown the presence of hazardous situations which are potentially able to bring about concentrations of harmful emissions exceeding the maximum allowable concentrations.

Based on the results of the fulfilled work, conclusions have been developed and recommendations have been made to implement the necessary measures to improve the situation with the negative impact of the activities of PJSC "CGOK" on the environment in the village of Veselyi Kut.

Keywords: water quality, heavy metals, production activities, mining industry.

1. Introduction

The current stage of Ukrainian industry development is characterized by high volumes of industrial production. This, in turn, leads to the intensive use of natural resources in order to obtain various types of raw materials.

In this regard, the mining industry has particularly high volumes of production, it provides almost all types of resources for domestic industrial purposes. In terms of scale and intensity of production activity, the mining industry is a leader among all domestic industries [10].

High volumes of production of commodity types of raw materials, which are accompanied by a significant violation of the natural state of the subsoil, large volumes of production waste lead to a significant man-made load on the environment. This leads to irreversible negative environmental consequences.

The above directly applies to the Kryvyi Rih iron ore basin, which is currently one of the most high-output mining regions in the world. The activity of iron ore mining enterprises in the Kryvyi Rih basin, which has been going on for more than 120 years, has led to very significant violations of the state of the environment in this region, which are already on the verge of ecological catastrophe in some areas.

One of such sites is the area of the village of Veseliy Kut subordinated to the Gleyuvatka village council of the Kryvyi Rih district. The peculiarity of the location of this village is that it is located between several large nearby technogene objects that are mining enterprises. These sites are extremely dangerous due to their strong negative impact on the ecology of the area. These facilities are sources of significant amounts of hazardous emissions - dust, gases from blasting, the operation of powerful diesel mining equipment, seismic action due to blasting. At the same time, these facilities are developing dynamically, there is a constant increase in their size, as well as in the amount of waste from production activities of various kinds.

It should be noted that there has not been carried out any deep research of the area so far and studies of the consequences from production activities at technogenic works located in this area, which are significant, have not been conducted. In addition we should say that the particularity of these works operation is the fact that their negative impact is unsteady, emissions of dust, gases, hydrogeological regime are characterized by significant dependence on the mode of mining, as well as on the work concerning the storage of mining waste, ore winning, movements of atmospheric air masses, precipitations, etc [2].

All this creates significant difficulties for recording the time and duration of negative factors impacts coming from the works functioning and for the forming of a grounded evidence base concerning the negative impact on the environment in which the inhabitants of the village of Veselyi Kut live. This situation can be remedied by installing means of continuous and operational monitoring of the environment, which allow to identify and determine the degree of

danger of unsteady manifestations of technogenic facts that affect adversely the state of the environment.

Given the fact that mining facilities have the negative impact on all types of environments (air, water sources, groundwater, massif of host and sedimentary rocks), such continuous monitoring of the state of these environments (air, ground and underground) should be carried out simultaneously. The implementation of such control by identifying the degree of negative impact on the components of the environment from specific man-made factors is one of the basic elements of the management system and management decisions directed at the development of technogenic regions, the ones affected by industrial activities of large enterprises.

Accordingly, for all of the above, the purpose of this work is to determine the impact of mining facilities located in the immediate vicinity of the territory of this village on the components of the natural environment of the village of Veselyi Kut and the introduction of automated continuous monitoring of the environment.

2 General characteristics of the village of Veseliy Kut

The village of Veseliy Kut is administratively subordinated to the Gleyuvatka village council of the Kryvyi Rih district in Dnipropetrovsk region of Ukraine.

The KOATUU Code is 1221882002.

2.1 Geographical location

The village of Veseliy Kut is located to the west from the central part of the city of Kryvyi Rih at a distance of 3.20 km from the border of its territory, the global coordinates are as follows: at the northern side: the longitude is 33.387525; the latitude is 48.014255; at the south side: the longitude is 33.387791; the latitude is 48.004437.

The village is adjacent to a large number of garden plots. The territory of the village is crossed by a stream with a dam. There is a railway and the station "Prykarierna" at a distance of 1 km from the village [2].

2.2 Physico-geographical and climatic characteristics

The work area under this agreement is located in the central part of the Kryvyi Rih district of the Dnipropetrovsk region.

The territory of the village of Veselyi Kut is located within the watershed plateau between the valleys of the rivers Ingulets and Saksagan, cut by a ravine-gulch network and represents a steppe plain gently sloping to the southwest, which is divided by the valley of the river Saksagan and its tributaries: the ravine Velyka Dubova to the east of the works area.

The territory is full of road communications, linear engineering networks (power lines, pipelines for various purposes, cable lines). The specifics of the area are determined by its location in the steppe zone. The climate belongs to the Atlantic-continental steppe type with mild winters, thaws and dry hot summers.

Середньорічна температура повітря за даними багаторічних спостережень метеостанції Кривий Ріг становить близько +8,3˚С; середня температура найбільш теплого місяця року (липня) складає +27,2°С; найбільш холодного місяця (січня) –5,0°С.The average annual air temperature according to long-term observations of the meteorological station of Kryvyi Rih is about + 8.3˚C; the average temperature of the warmest month of the year (July) is + 27.2 ° C; the one of the coldest month (January) is –5.0 ° C.

In the cold season, winds from the northeast and east prevail, and from May to September they blow from the north and northwest. The average annual wind speed is about 5.0 m / sec, with a maximum of 24 m / sec.

The maximum wind speed and the one close to it, especially in summer, are an extremely negative factor. This is due to the possibility of dust storms. The open-pit of PJSC "CGOK", the dumps of rocks with significant volumes of stored friable material around this open-pit and the rock stockpiles of other enterprises are the sources of dust, also dust that is released during the process of production activities by mining enterprises.

According to long-term observations, the average annual rainfall in the areas of the village of Veselyi Kut is 400-460 mm / year. Precipitation falls mainly in the form of heavy rains, of which about 74% are in the warm season (April-November) and about 26% are in the cold period (December-March). The average number of days with precipitation is ~ 69 per year; the average height of snow cover is 10-14 cm.

The amount of evaporation from the earth's surface reaches 400-500 mm / year, from the water surface it is 700 mm / year at a maximum value of 900-950 mm / year.

It should be noted that a powerful source of humidification in the area of the village Veselyi Kut is a bowl of tailings filled with pulp (a mixture of water and friable material). When heavy fractions settle to the bottom of the tailings pond, a water "lake" with an area exceeding 14 km^2 is formed on the surface. Evaporation of water from this lake in the summer provides very large amounts of moisture into the air, which is a positive factor and as high humidity conrtibutes to the adsorption of dust by water and promotes its faster settling and removal from the air.

Along with this, it should be noted that the rapid evaporation of water from the surface of the tailings lake leads to the exposure of material accumulated in it (the formation of so-called "Beaches") at certain areas, at high wind speeds it leads to intense dust uprising which is an extremely negative factor.

Both of these processes taking place in the tailing pond are extremely unsteady, their parameters significantly

depend on specific weather conditions and are virtually uncontrollable, the negative consequences usually outweigh the positive processes.

The largest number of inversions in the atmosphere in the village of Veselyi Kut is observed at night in the warm season (April to October). During the day, inversions are rare, averaging 6% of all cases.

Indicators of average annual inversions at a wind speed of 11.2 m / s are as follows:

- the surface ones: the speed is 0.34 km at night, 0.24 km during the day; the intensity is 3.1˚C at night, 0.5˚C during the day;
- the rising ones: the speed is 0.39 km at night, 0.35 km during the day; the intensity is 2.5 ° C at night, 1.7 ° C during the day.

3. The main environmentally hazardous industrial facilities located near the village of Veselyi Kut

The peculiarity of the location of the village of Veselyi Kut is that it is in the immediate vicinity, and almost surrounded, by a number of technogenic works, which have an extremely negative impact on its territory, land and underground space, as well as air and water basins.

The mutual location of these works and the distance from them to the boundaries of the village of Veselyi Kut can be seen on the map (Fig. 1).

Fig. 1 Location of the village of Veselyi Kut

This figure shows the works and the factors of their negative impact on the environment:

1. The tailing pond of PJSC "Central Mining and Processing Plant "(CGOK) (total area 14.0 km2) provides dust emissions and drainage of contaminated water into the terrestrial and underground environment.
2. The Beneficiation Plant of PJSC " CGOK " provides emissions of harmful gases, dust.
3. The collapse zone of Gvardeyska Mine of PJSC "Krybaszalizrudkom" provides emissions of dust, explosive gases, seismic action of explosions.
4. The collapse zone of PJSC "Sukha Balka" provides emissions of dust, explosive gases, seismic action of explosions.
5. The old zone of collapse of the mine "Yuvileyna" of PJSC "Sukha Balka" has dumps of waste rocks, provides dust emissions.
6. The open-pit №2 hollow, which is used for storage of waste rocks removed from the open-pit №1 of PJSC "CGOK" (Gleyuvatka) provides dust emissions.

7. The ground waste rock dump of the open-pit №1 PJSC " CGOK " provides dust emissions.

8. The open-pit №1 hollow of PJSC " CGOK " (total area of 500 hectares) provides emissions of dust, gases, seismic action of mass explosions.

9. . The waste rock dump of quarry №1 PJSC " CGOK " provides dust emissions.

The total area of technogenic facilities that are located around the village of Veselyi Kut exceeds 25.0 km^2.

The following photos show some of the most dangerous works located near the village of Veselyi Kut.

3.1 General characteristics of PJSC "CGOK"

PJSC "Central Mining and Processing Plant"(CGOK) is a mining enterprise that specializes in the extraction, processing and production of raw materials for the metallurgical industry in the form of iron ore concentrate and pellets.

The plant includes three open-pits and a mine named after Ordzhonikidze with a total actual capacity of 14.2 million tons of raw ore per year, a crushing plant, a beneficiation plant with an actual capacity of more than 5 million tons of iron ore concentrate per year, a pelletizing plant with an actual capacity of more than 2.2 million tons of pellets per year, auxiliary shops. The company employs 8.5 thousand people (Fig. 2).

Fig. 2 PJSC "CGOK"

3.2 Characteristics of sources of polluting emissions

PJSC "CGOK" is a powerful mining enterprise that conducts large-scale production operations and, accordingly, the specificificity of this activity is associated with significant man-made disturbance of the subsoil and the use of powerful technical means to perform technological processes and mechanization of production.

All these aspects of the production activity of PJSC "CGOK" and its structural technological elements lead to a significant man-made load on the environment due to significant emissions of harmful gases, dust, acoustic waves, etc.

The following is a description of the main factors in the work of PJSC "CGOK", which lead to the classification of its production activities as environmentally hazardous ones.

PJSC "CGOK" operates 221 sources of pollutants, among them: - organized with refuse treatment - 43; - organized without refuse treatment - 135; - unorganized - 43.

As a result of the operations, the emissions from stationary sources (Beneficiation Plant) of the industrial site №1, 12 pollutants enter the atmosphere and have the following volumes [1]:

- substances in the form of suspended solid particles - 966,917 t / year;
- carbon monoxide - 472,626 t / year;
- nitrogen oxides (in terms of nitrogen dioxide) - 180,552 t / year;
- reticulate anhydride - 106,903 t / year;
- sulfuric acid - 0,004 t / year;
- lead and its compounds - 0.002 t / year;
- barium chloride - 0.002 t / year;
- sodium carbonate - 0.0003 t / year;
- silicon dioxide - 0,007 t / year,
- phosphoric acid - 0.005 t / year;
- synthetic detergent - 0.0007 t / year;
- formaldehyde - 0.002 t / year.

There are also emissions of 22 types of pollutants, namely:
- manganese and its compounds - 0.0520 t / year;
- highly soluble fluorides - 0.025 t / year;
- poorly soluble fluorides - 0.014 t / year;
- nickel and its compounds - 0.0002 t / year;
- mercury and its compounds - 0.0002 t / year;
- chromium and its compounds - 0.001 t / year;
- zinc and its compounds - 0.0001 t / year;
- tin oxide - 0.0001 t / year;
- acrylic acid -0.0001 t / year;
- acetic acid - 0.002 t / year;
- chloroprene - 0.00004 t / year;
- hydrogen chloride - 0.006 t / year;

There are emissions of 16 types of pollutants belonging to other categories:
- sodium hydroxide - 0.0002 t / year;
- emulsion - 0.005 t / year;
- methane - 1,887 t / year;
- ammonia - 0.062 t / year;
- non-methane light organic compounds - 1,132 t / year.

The total amount of pollutants emitted at the Plant is 114060,934 t / year.

The pollutants enter the atmospheric air from stationary sources of the industrial site №2, the total amount of them is 1154,662 t / year, they are as follows:

Pollutants in the form of suspended solids make up 25,449 t / year:- carbon monoxide - 22,010 t / year;- nitrogen oxides (with reference to nitrogen dioxide) - 10,882 t / year;- sulfur dioxide - 0.147 t / year;- sulphatic acid - 0,001 t / year; - lead and its compounds - 0.00002 t / year; - silicon dioxide -0.008 t / year.

Dangerous pollutants are:- manganese and its compounds - 0.016 t / year; - highly soluble fluorides - 0.026 t / year; - poorly soluble fluorides 0.027 t / year; - fluorine hydride- 0.012 t / year; - iron and its compounds - 0.222 t / year; - arsenic and its compounds - 0.00001 t / year; - vanadium and its compounds - 0.000001 t / year; - nickel and its compounds - 0.0001 t / year; - mercury and its compounds - 0.000001 t / year; - chromium and its compounds - 0.0003 t / year; - zinc and its compounds - 0.0001 t / year; - tin oxide - 0.00001 t / year; - ethylene oxide and propylene oxide - 0.000003 t / year; - styrene - 0.00001 t / year; - chloroprene - 0.00001 t / year; - hydrogen chloride- 0.0003 t / year; - acrylonitrile - 0.00002 t / year [1, 12].

The pollutants belonging to other categories are: - methane - 0.009 t / year; - divinyl - 0.00002 t / year; - isoprene oligomers - 0.00001 t / year; - butylene - 0.0001 7 years; - non-methane light organic compounds - 2,258 t / year.

Pollutants for which no MAC is set for the air in populated areas (carbon dioxide and nitrous oxide), are, respectively, in quantities of 537,593 t / year and 0.001 t / year.

The total amount of pollutants is 1154,662 t / year.

The pollutants entering the atmospheric air from stationary sources of the industrial site №3:

The most common pollutants are:- substances in the form of suspended solid particles - 292,281 t / year; - carbon monoxide - 0.0654 t / year; - nitrogen oxides (with reference to nitrogen dioxide) - 0.0479 t / year; - silicon dioxide - 0.0000438 t / year;

Five varieties of harmful pollutants: - manganese and its compounds - 0,0033 t / year, - highly soluble fluorides - 0,002102 t / year; - poorly soluble fluorides - 0.001183 t / year; - hydrogen fluoride - 0.000552 t / year; - iron and its compounds - 0.0941 t / year;

The pollutants belonging to other categories are: - mineral oil - 0.0000003 t / year; - allowable hydrocarbons C_{12}-C_{19} - 0.000003 t / year.

The total amount of pollutants is 292,469 tons / year [1, 12].

The most common pollutants entering the atmospheric air from stationary sources of the industrial site №4:

- substances in the form of suspended solid particles - 32,781 t / year; - carbon monoxide - 12,706 t / year; - nitrogen oxides - 3,444 t / year; - silicon dioxide - 0.000256 t / year.

The total amount of pollutants is 48,956 t / year [1, 12].

3.3 Prospects for production development at PJSC "CGOK"

PJSC "Central Mining and Processing Plant"(CGOK) (Kryvyi Rih) is an integrated industrial and technological

complex specializing in the extraction, processing and production of raw materials for the ferrous metallurgical industry (pellets and iron ore concentrate). The main raw material for the manufacture of iron ore products are magnetite quartzites.

The analysis of operational activity of PJSC " CGOK " for 2012-2016 showed that in the studied period the production of iron ore decreased, respectively, the production of concentrate and pellets decreased as well. The highest rates of production were observed in 2013, and the lowest ones were in 2016 (a decrease of 10% relative to nominal productivity).

Along with this, it should be noted that production volumes still remain high (more than 6.0 million tons of iron ore products per year). In addition, this company has a significant raw material base. The total volume of geological reserves of iron ore for this enterprise reaches 1.0 billion tons, and at the open-pit №1 (Gleyuvatka) balance reserves amount about 50.0 million tons. Most of the company's products (concentrate) are exported, while pellets are mainly sold on the domestic market.

All tailings obtained at PJSC "CGOK" are stored in one tailings pond, which is refilled every year by almost 2.0 million m^3 of this waste.

The management of PJSC "CGOK" pays attention to perspective development. This company has developed a program in order to use the innovation potential. Given that the program of extensive development is not economically feasible, the plans to improve product quality in terms of metal content (already implemented a project to modernize the process of ore beneficiation) and to deepen the mining operations were considered and adopted for implementation.

An analysis of existing traditional methods for managing the production capacity of iron ore open-pits has shown that they are designed as stages with relatively stable parameters of the working area of the open-pits, and they do not take into account the trend of constant deepening of mining operations. The achieved rate of deepening mining operations in the open-pits of this enterprise is 5-8 m / year with a constant productivity of the mining and transport complex with increasing the height of the working area at stripping rocks.

Currently, the creation and constant refill of internal dumps in the open-pit №2, where hematite quartzites were extracted and processed from Gleyuvatka deposit in the 1970s and 1980s, is taking place. In the 1970s, the veins of the tiger's eye and a little later the falcon's eye were discovered on the west side of this open-pit. The veins of these minerals have a lenticular shape, in different years there were from 3 to 5 vein zones along the strike of the western side of the open-pit. Their reserves refer to the contact of the seventh schistose horizon with the sixth ferruginous horizon. These reserves are of industrial importance for the prospect of mining resumption in this open-pit.

Fig. 3 Open pits №1 and №2

Dumping is carried out in the open-pit №2 on the north side without affecting the working area. The possible development of mining in the future will be aimed at merging open-pits №1 and №2 to increase the investment resource component of the enterprise (Fig. 3).

As a result, this prospect will lead to an increase in the height and volume of the dumps, as well as to an increase in the volume of tailings (increasing the impact on the hydrological regime of the area) [5].

Also, the work is underway to increase the capacity of the existing tailings pond.

The constant change of the macrolandscape, accompanied by a change in the hydrological regime will have consequences for the availability and quality of well water, the amount of precipitation (which will have a gusty nature) and an increase in the negative impact on air quality.

The assessment of the risk to public health from air pollution may show that the expansion of these prospects may lead to increased emissions of hazardous substances at PJSC "CGOK", especially of the volatile ones, which can have a chronic inhalation effect (which falls under Article 40 of the Law of Ukraine "On ensuring the sanitary and

epidemiological well-being of the population" and the order of the Ministry of Health № 184 of 13.04.2007) and causes creating conditions with increased environmental burden on the inhabitants of the village of Veselyi Kut.

4 Experimental studies of the territory of the village of Veselyi Kut for heavy metals content in the soil and water chemical composition

It is known that the largest volumes of waste in the Dnipropetrovsk region are generated at the enterprises dealing with extraction and beneficiation of iron, manganese and polymetallic ores. Only within the Kryvyi Rih iron ore basin there are 8 tailings ponds, the total area of land occupied by them is 9,155 thousand hectares. 234 million tons of waste are generated annually while processing iron ore. In total, over 125 years of development of local iron ore deposits, more than 13 billion tons of overburden and substandard ores have been accumulated in dumps, and more than 4 billion tons of beneficiation plants waste have been accumulated in tailings ponds. Long-term storage of large-tonnage waste of the iron mining industry in the immediate vicinity of the residential areas of Kryvyi Rih district leads to progressive degradation of the environment, growth of areas of excessive pollution, spread of harmful substances outside sanitary protection zones of industrial enterprises, worsening of ecological situation in adjacent villages.

The crisis situation is also exacerbated by non-compliance with the environmental requirements of newly established enterprises for the processing of secondary raw materials, scrap metal, industrial waste and consumption residue. Thus, the environmental component in forming the population health of local residents becomes more important (according to the WHO, it can reach 20-25 (%) in regions with unfavorable environmental conditions), and this may lead to an increase in the number of cases of environmental diseases, especially for the children and the elderly, for people with chronic pathologies.

Thus, the identification of priority pollution and vulnerable objects in the areas of influence of the iron extraction industry is necessary for further creation of a system of automated environmental monitoring and minimizing environmental risks for local population health [13-15].

The work was performed under the contract № 05-01 / 2019 dated May 2, 2019. Laboratory tests were carried out on the basis of the "Dnieper Regional Center for Ecological, Hygienic and Medical-Biological Assessment of Industrial Waste" of the State Institution "Dnipropetrovsk Medical Academy of the Ministry of Health of Ukraine" (Accreditation Certificate of the Ministry of Health of Ukraine №142 dated 29.06.2016, Certificate of the State Enterprise “Dniprostandartmetrologiia” on technical competence № PC 06-2 / 99-2018 dated 14.02.2018).

The aim of the research was to determine the content of heavy metals, as well as physical-chemical and organoleptic parameters of certain layers underground and surface soil in the village of Veseliy Kut of Kryvyi Rih district in Dnipropetrovsk region.

4.1 Sampling procedure and laboratory testing methods

Sampling of environmental items was carried out in the village of Veseliy Kut within the settlement zone of the village from the homesteads along the central Sadova Street (Table 1). The soil samples were taken from the surface (tilth-top soil) layer to a depth of 20-30 cm in a "checkerboard pattern" according to the method defined in [11]. Heavy metal content in the samples was determined applying the method of atomic absorption flame spectrophotometry using a spectrophotometer ICE-3300 (USA) and atomic emission spectrometry with inductively coupled plasma using a spectrometer iCAP7000 (USA) according to the methods described in [6-9, 11] and further processing of the results on a PC. The study of the mobility of heavy metals was carried out in accordance with Appendix №6 of the Guidelines [14].

Water samples having volume of 1.0-1.5 dm^3 were taken from existing wellpoint system, flooded basements, cellars, observation wells, surface water bodies in accordance with [29-34]. A total of five samples were examined (see Tables 1, 2). Elements determining in water samples was fulfilled according to the instructions [3, 4], organoleptic properties were studied according to the source.

Analysis of underground and surface water pollution, of soil was fulfilled according to regulations [3].

№	Sample №	Sampling location	Sampling point	Quantity, g	Sampling depth, cm	Sample kind (point sample, integrated sample)
1	166	64, Sadova Street	front garden	500	20-30	integrated
2	167	61, Sadova Street	front garden	500	20-30	integrated
3	168	54, Sadova Street	front garden	500	20-30	integrated
4	169	53, Sadova Street	front garden	500	20-30	integrated
5	170	48, Sadova Street	front garden	500	20-30	integrated
6	171	39, Sadova Street	front garden	500	20-30	integrated
7	172	36, Sadova Street	front garden	500	20-30	integrated
8	173	27, Sadova Street	front garden	500	20-30	integrated
9	174	20, Sadova Street	front garden	500	20-30	integrated
10	176	9, Sadova Street	front garden	500	20-30	integrated
11	177	1 (6) , Sadova Street	Sanitary Protection Zone limit	500	20-30	integrated

FigTalbe 1. Soil sampling sites in the village of Veseliy Kut

№ з/п	Sample №	Sampling location	Sampling point	Quantity, dm^3	Sampling depth, cm	Sample kind (point sample, integrated sample)
1	178	46, Sadova Street	Mine well	1,5	200	point
2	179	46, Sadova Street	cellar	2,0	200	point
3	180	46, Sadova Street	Point well	1,5	800	point
4	181	Sadova Street (500 m from waste dump at Sanitary Protection Zone limit)	observation wells № 1417	1,5	120	point
5	182	9, Sadova Street	Mine well	1,5	150	point
6	183	Dump Sanitary Protection Zone	lake	1,5	20	point

FigTalbe 2.Places of water sampling on the territory of the village of Veseliy Kut

4.2 The results of sanitary and chemical research

The studied material is shown in the following tables (tab. 3 -6)

Form of presence	Concentration, mg / kg (X), substance toxicity class									
	As (1)	Cd (1)	Cu (2)	Mn(2)	Ni (2)	Pb (1)	Zn (1)	Fe**	V(3)	pH
	Sample № 166, x*									
Gross	3,06	0,092	84,02	338,75	14,73	40,16	55,71	14,85	25,84	7,99
Mobile: - at t=25°C	0,93	0,028	57,99	181,68	3,59	30,56	24,19	4,35	5,01	
Sample № 167, x*										
Gross	2,09	<0,05	11,79	273,73	15,41	8,24	51,10	19,56	21,29	6,73
Mobile: - at t=25°C	0,72	<0,05	6,20	211,81	5,14	5,22	24,97	4,78	5,84	
Sample № 168, x*										
Gross	1,70	<0,05	43,36	285,12	9,91	31,64	45,65	11,83	17,64	7,51
Mobile: - at t=25°C	1,04	<0,05	12,37	217,28	3,81	30,45	23,27	1,26	6,17	
Sample № 169, x*										
Gross	0,35	<0,05	11,93	541,86	10,41	14,23	40,02	17,91	15,33	6,30
Mobile: - at t=25°C	0,32	<0,05	7,77	307,43	3,31	12,12	20,75	1,30	2,94	
Sample № 170, x*										
Gross	0,87	<0,05	22,17	299,86	6,09	6,94	34,61	13,09	12,79	7,05
Mobile: - at t=25°C	0,26	<0,05	6,70	167,89	1,74	5,77	19,38	6,86	2,19	
Sample № 171, x*										
Gross	1,69	<0,05	13,38	289,96	11,37	8,81	38,95	9,83	22,67	7,16
Mobile: - at t=25°C	0,35	<0,05	5,88	167,89	4,17	6,13	17,01	0.24	5,01	
Sample № 172, x*										
Gross	2,04	0,11	10,85	245,05	9,60	7,32	*35,34*	*8,65*	18,65	8,58
Mobile: - at t=25°C	0,66	<0,05	4,65	146,13	2,79	5,44	15,68	0,31	4,73	
Sample № 173, x*										
Gross	1,47	<0,05	7,14	185,31	7,51	5,11	22,89	6,35	16,58	7,59
Mobile: - at t=25°C	0,43	<0,05	3,51	145,45	2,43	4,38	7,22	0,20	4,14	
Sample № 174, x*										
Gross	3,26	<0,05	18,46	330,21	14,57	10,69	45,50	13,26	32,54	8,38
Mobile: - at t=25°C	0,75	<0,05	6,21	172,15	3,27	9,77	12,56	0,44	5,88	
Sample № 176, x*										
Gross	1,39	0,12	14,59	283,39	11,13	13,32	50,28	14,91	17,23	

Form of presence	Concentration, mg / kg (X), substance toxicity class									
	As (1)	Cd (1)	Cu (2)	Mn(2)	Ni (2)	Pb (1)	Zn (1)	Fe**	V(3)	pH
Mobile: - at t=25°C	0,42	<0,05	4,50	190,57	4,31	6,95	8,07	0,20	5,98	6,74
Sample № 177, x*										
Gross	3,02	<0,05	18,44	538,52	24,42	7,36	47,56	-	-	7,29
Mobile: - at t=25°C	0,63	<0,05	4,19	320,92	9,11	4,84	6,72			
Background [40,41] concentr. in soils, (mg / kg)	1,3	1,2	10,8	570,0	4,9	12,0	33,0	21,25	57,0	-
LOC in soil, (mg / kg): - Gross form	2,0	1,5	-	1500,0	-	32,0	-	-	150,0	-
- mobile form	-	-	3,0	100,0	4,0	6,0	23,0	-	-	-

FigTalbe 3. The content of chemicals in the soil at the studied areas

Notes*: * - *arithmetic mean according to the results of the analysis of three point samples;*

*** - iron concentrations are given in g / kg.*

The coefficients of concentration of chemicals for certain metals, the content of which in the soil exceeds the background, were calculated according to the formula:

$$Zc = \Sigma_i K_c - (n-1) \qquad (1)$$

where Zc is the total pollution index;
K_c - concentration coefficients (K_c / K_f) of individual substances;
n is the number of substances taken into account.

The total indicator Zc of soil contamination for the studied areas (for individual samples) was:

Sample №	*166*	*167*	*168*	*169*	*170*	*171*	*172*	*173*	*174*	*176*	*177*
Zc	15,1	<10,0	<10,0	<10,0	<10,0	<10,0	<10,0	<10,0	<10,0	<10,0	<10,0

FigTalbe 4. The value of the total indicators of soil contamination at the studied areas

Concentration, mg / kg (X), substance toxicity class								
Dry residue	As (1)	Cd (1)	Cu (3)	Ni (2)	Pb (1)	Zn (3)	Fe (3)	pH
Sample № 178								
8200,0	<0,005	<0,0005	<0,05	<0,01	0,005	<0,05	<0,15	7,32
Sample № 179								
9320,0	<0,005	<0,0005	<0,05	<0,01	0,005	<0,05	<0,15	7,05
Sample № 180								
9640,0	<0,005	<0,0005	<0,05	<0,01	0,005	<0,05	<0,15	7,56
Sample № 181								
9440,0	<0,005	<0,0005	<0,05	<0,01	0,005	<0,05	<0,15	7,24
Sample № 182								
6880,0	<0,005	<0,0005	<0,05	<0,01	0,005	<0,05	<0,15	7,77
Sample № 183								
2380,0	0,03	<0,0005	0,85	<0,01	0,05	0,59	1,20	7,80
MAC in water, (mg / dm^3)*								
1000,0/1500,0	0,05/0,01	0,001/ 0,001	1,0/1,0	0,1/0,02	0,03/0,01	1,0/1,0	0,3/1,0	6,5-8,5

FigTalbe 5 The results of studies of water physicochemical properties

Note: * - in the numerator for Sanitary Rules and Regulations (SanPiN) 4630-88 [3], in the denominator - for State Sanitary Rules and Regulations (DSanPiN) 2.2.4-171-10 [4].

Indicator			
Scent (t=30°C/60 °C), number	Color, degrees	Turbidity	Taste and aftertaste, number
Sample № 178			
2 (unspecified)/ 3 (soil)	35	2,9	4 (saltish)
Sample № 179			
2 (unspecified)/ 3 (soil)	35	3,3	4 (saltish)
Sample № 180			
0 2 (soil)	20	2,1	4 (saltish)
Sample № 181			
2 (unspecified)/ 4 (swamp)	40	3,9	4 (saltish)
Sample № 182			
2 (unspecified)/ 3 (soil)	35	3,7	4 (saltish)
Sample № 183			
3 (organic)/ 4 (organic)	60	6,9	3 (salty-bitter)
Normalized value in drinking water / reservoirs, (mg / dm^3)*			
-/≤3	≤30	≤3,5	≤3

FigTalb 6 Results of research of water organoleptic properties

Note: * - in the numerator for SanPiN 4630-88, in the denominator - for DSanPiN 2.2.4-171-10

4.2 Analysis of the obtained results

Sanitary and chemical studies of the soil at all the studied areas testify to the "spotted" nature of the pollution, which is typical for urban ecotopes adjacent to the industrial sites of mining enterprises. Concentrations of heavy metals, that are indicator substances, in some tested samples exceed the maximum allowable content for arsenic, copper, lead. Iron being a priority substance depending on the location of iron ore open-pit dumps, is present in quantities comparable to its background concentrations in the relevant types of uncontaminated soils (typical low-humus chernozems, medium-destroyed non-loess).

Calculated indicators of total surface pollution for up to 30 cm layer of natural soil (Zc) within all homesteads of private households on the Sadova Street show the "permissible" degree of pollution. The highest concentrations of the studied metals were found in the soil of the homestead located at the address: 64, Sadova Street, where the level of pollution is on the border of the "moderately dangerous"category. Should similar researches continue on the territory of the village of Veselyi Kut, attention must be payed to the study of the soil in the radius corresponding to the location of this household, because it is situated at the distance where we can predict the highest surface concentrations of suspended solids carried by wind from the dominant surface of the dump.

Arsenic, copper and lead should be considered as priority elements for the control of the upper soil layers. Concentrations of gross and mobile forms of these elements in separate integrated soil samples exceed the values of MAC / background (respectively, the multiplicity factor is): As - 1,10-1,63 / 1,20-2,50; Cu - 3.52-20.00 / 1.32-8.40; Pb - 1.52-5.10 / 1.10-3.42.

Research of physical and chemical, and organoleptic properties of water from underground horizons (at a depth of 1.5-8.0 m) on the territory of homesteads in the village of Vesely Kut testifies to its non-compliance with current regulations, in particular SanPiN 4630-88 and DSanPiN 2.2.4-171-10. In all samples, with no exception, significant exceedances of the dry salt content were determined: 4.6-5.5 times the MAC for drinking water from mine wells and 6.9-9.6 times the MAC for groundwater sources. Organoleptic qualities of water samples also do not meet the requirements of regulatory documents in terms of taste (aftertaste), turbidity and color. This quality water is unsuitable for food use due to organoleptic, technological and toxicological properties.

Significant concentrations of dry residue salts (2.38 MAC) and unsatisfactory organoleptic qualities were determined in a sample of water taken from a surface reservoir (lake) located close to the slope of the waste dump. In particular, the water has a significant amount of suspended solids visible to the naked eye, a pronounced organic odor and taste, which is not typical of natural unpolluted ponds and lakes. The concentrations of lead in the water of the reservoir are equal to 1.7 MAC. This may indicate that the water quality in the appeared lake is formed, among other things, under the influence of chemicals leached from the body and the surface of the adjacent dump of the iron open-pit.

5. Conclusion

Based on the results of the whole set of studies, we can draw the following conclusions and provide the following recommendations:

1. The village of Veselyi Kut, which is subordinated to the Gleiuvatka village council, is in a difficult situation with regard to an extremely negative impact on its environment. This situation is determined by the large number of large-scale man-made facilities which are components of production and technological systems of a number of high-output enterprises of the mining industry.

The largest negative impact on the environment of the studied area is carried out by PJSC "CGOK", large production facilities of which are located in close proximity to the territory of this village, namely: open-pit №1 (Gleyuvatka) at a distance of 1.5 km; tailings of this enterprise - 500 m; open-pit №2, which currently does not carry out ore mining, but which is used for storage of overburden from the open-pit №1.

2. The gases from blasting operations, as well as dust generated during blasting operations, the formation of waste dumps and storage of iron ore beneficiation waste are the biggest factors contributing to the environmental pollution coming from these production facilities.

3. Investigation of the content of heavy metals and the chemical composition of water in wells and ponds can lead to the following conclusions. Sanitary and chemical studies of the soil at all the studied areas testify to the "spotted" nature of the pollution, which is typical for urban ecotopes adjacent to the industrial sites of mining enterprises. Concentrations of heavy metals, that are indicator substances, in some tested samples exceed the maximum allowable content for arsenic, copper, lead. Iron being a priority substance depending on the location of iron ore open-pit dumps, is present in quantities comparable to its background concentrations in the relevant types of uncontaminated soils (typical low-humus chernozems, medium-destroyed loess).

The highest concentrations of the studied metals were found in the soil of the homestead located at the address: 64, Sadova Street, where the level of pollution is on the border of the "moderately dangerous"category. Should similar researches continue on the territory of the village of Veseliy Kut, attention must be payed to the study of the soil in the radius corresponding to the location of this household, because it is situated at the distance where we can predict the highest surface concentrations of suspended solids carried by wind from the dominant surface of the dump.

Arsenic, copper and lead should be considered as priority elements for the control of the upper soil layers. Concentrations of gross and mobile forms of these elements in separate combined soil samples exceed the values of MAC / background (respectively, the multiplicity factor is): As - 1,10-1,63 / 1,20-2,50; Cu - 3.52-20.00 / 1.32-8.40; Pb - 1.52-5.10 / 1.10-3.42.

4. Research of physical and chemical, and organoleptic properties of water from underground horizons (at a depth of 1.5-8.0 m) on the territory of homesteads in the village of Veselyi Kut testifies to its non-compliance with current regulations, in particular SanPiN 4630-88 and DSanPiN 2.2.4-171-10.

In all samples, with no exception, significant exceedances of the dry salt content were determined: 4.6-5.5 times the MAC for drinking water from mine wells and 6.9-9.6 times the MAC for groundwater sources.

Organoleptic qualities of water samples also do not meet the requirements of regulatory documents in terms of taste (aftertaste), turbidity and color. This quality water is unsuitable for food purposes because of organoleptic, technological and toxicological properties.

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