МИНИСТЕРСТВО НАУКИ И ВЫСШЕГО ОБРАЗОВАНИЯ
РОССИЙСКОЙ ФЕДЕРАЦИИ
Федеральное государственное автономное
образовательное учреждение высшего образования
«РОССИЙСКИЙ УНИВЕРСИТЕТ ДРУЖБЫ НАРОДОВ»

GREEN–2022

СТУДЕНЧЕСКИЕ ИССЛЕДОВАНИЯ В ОБЛАСТИ ЭКОЛОГИИ, ИНЖЕНЕРИИ И ПРИРОДЫ — 2022

СБОРНИК НАУЧНЫХ ТРУДОВ

Молодежной научно-практической конференции на иностранных языках с международным участием

Москва, 28 ноября 2022 г.

В двух частях

ЧАСТЬ 1

GREEN–2022

GRADUATE RESEARCH IN ECOLOGY, ENGINEERING AND NATURE — 2022

Proceedings of the International Youth Scientific Conference

Moscow, November 28, 2022

In Two Parts

PART 1

Москва
2022

УДК 574:62:502/504(063)
ББК 20.1+3/4
Г85

Утверждено
РИС Ученого совета
Российского университета
дружбы народов

Г85 **GREEN–2022. Студенческие исследования в области экологии, инженерии и природы = Graduate Research in Ecology, Engineering and Nature** : сборник научных трудов Молодежной научно-практической конференции. Москва, 28 ноября 2022 г.: в 2 частях. — Москва : РУДН, 2022.

ISBN 978-5-209-11676-9

Часть 1. — 482 с. : ил.
ISBN 978-5-209-11677-6

Сборник содержит материалы научных трудов Молодежной научно-практической конференции на иностранных языках с международным участием «Студенческие исследования в области экологии, инженерии и природы» (Москва, 28 ноября 2022 г.). В работе конференции принимали участие ученые, докторанты, аспиранты, магистранты и студенты российских и зарубежных вузов, сотрудники научно-исследовательских учреждений и производственных предприятий.

ISBN 978-5-209-11677-6 (ч. 1)
ISBN 978-5-209-11676-9

HUMAN ECOLOGY

ROAD AND PATH NETWORK AS ONE OF THE ECOLOGICAL AND RECREATIONAL CHARACTERISTICS OF IZMAILOVO NATURAL AND HISTORICAL PARK

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Abstract: The paper presents a model of the road and path network of Izmailovo Natural and Historical Park; five types of paths have been identified. It shows the ecological and recreational role of the path network in the life of urban population. Recommendations for improving the road and path network of Izmailovo Park to reduce the anthropogenic load on natural areas have been proposed.

Key words: Ecology, road and path network, recreation, anthropogenic load, modeling, Izmailovo Natural and Historical Park.

1. INTRODUCTION

In a modern "big" city, the role of recreation is significantly increasing. One of the most important recreational elements of parks is a road and path network, which is a complex of roads, paths, parking lots and playgrounds, interconnected for the convenience to use all functional zones of the area [1]. This paper analyzes the road and path network of such a large natural and historical park as Izmailovo Park.

Izmailovo Natural and Historical Park is considered one of the largest urban parks in Europe. It covers 1608.1 ha [2] and it includes Izmaylovsky and Terletsky urban forest, Serebryano-Vinogradny pond with an island, and Izmaylovo Park of Culture and Recreation. All these

locations, connected into a single network of roads and paths, were used as an object of research.

The purpose of the paper is to create a model of the road and path network of Izmailovo Natural and Historical Park and identify the environmental features of recreation within the park.

2. METHODOLOGY

A paper should contain the description of your study and should be structured in different sections such as: Abstract, Introduction, Methodology, Results, Conclusions, Acknowledgements (if applicable) and References. Please note that title and authors list should be coincident with the accepted abstract [TNR, 11-point, justified alignment].

The object was first studied in February 2020, and open sources of information were analyzed which turned out to be insufficient for modeling the Izmailovo Park road and path network.

Izmailovo Natural and Historical Park was studied instrumentally in the field to determine the width of paths and then to classify them. The paths were photographed and measured, and GPS trackers were used to determine their location. Figure 1 shows the types of paths in Izmailovo Natural and Historical Park.

The model of the Izmailovo Natural and Historical Park road and path network was created using Yandex Map Constructor [3].

The map was created using the Line tool (see Figure 2), which allows you to measure the length of the line drawn on the map. The values obtained are shown in Table 1.

3. RESULTS

A model of the road and path network shown in Figure 3 has become the result of the work.

Five types of paths are highlighted in different colors on the model (Figure 3).

According to the calculations (Table 1), the length of the road and path network of Izmailovo Natural and Hhistorical Park is approximately 119.03 km. This distance may vary because in warm seasons the number of paths increases, and in cold seasons, on the contrary, decreases. In fact, this is the minimum sum of the length of the paths.

Figure 1. Types of the trail: ***1.*** Asphalt paths 1.2 to 4.0 m wide; ***2.*** Paved paths 1.5 to 3.0 m wide; ***3.*** Wooden paths 1.0 to 2.0 m wide designed to accumulate water and iterate, in some places, and to protect the lawn from trampling; ***4.*** Specially designed paths with bicycle lanes 3.0 to 5.0 m wide; ***5.*** Desire paths 1 to 1.8 m wide.

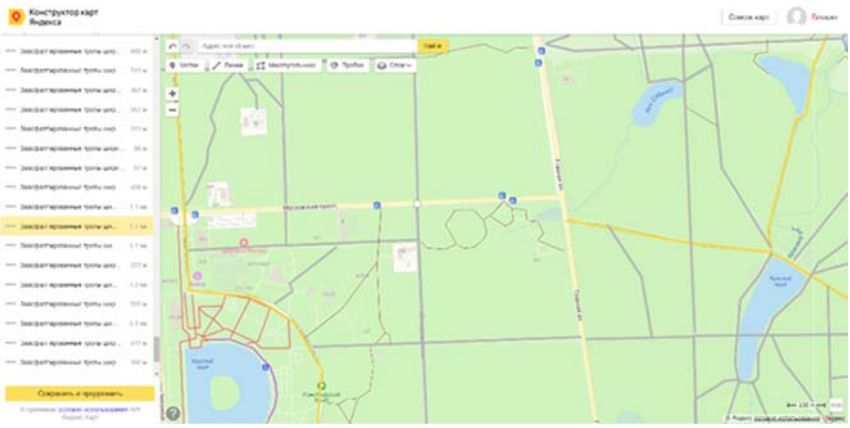

Figure 2. Construction of a road and path network map

Figure 3. The final model of the road and path network of Izmailovo Natural and Historical Park

Table 1

The length of the road and path network of Izmailovo Natural and Historical Park.

Type of a path	Length of a path (km)
1. Asphalt paths 1.2 to 4.0 m wide	75,97
2. Paved paths 1.5 to 3.0 m wide	6,59
3. Wooden paths 1.0 to 2.0 m wide	1,15
4. Specially designed paths with bicycle lanes 3.0 to 5.0 m wide	24,39
5. Desire paths 1 to 1.8 m wide	10,93
Total	119,03

4. CONCLUSIONS

So, a model of the road and path network of Izmailovo Natural and Historical Park has been created; 5 types of paths have been identified, the total length of which is 119.03 km.

The road and path network unites Izmailovo Natural and Historical Park, whose area is 1608.1 hectares, and provides city residents with accessible recreational areas; it also reduces an anthropogenic load on natural areas and risks of trampling.

The study made it possible to put forward some recommendations to improve the environmental friendliness of the road and path network:

– in order to combat soil degradation, the formation of desired paths should be reduced as much as possible;

– in Terletsky and Izmaylovsky urban forests, it is necessary to create more wooden paths, which will help reduce trampling and diversify routes.

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DETERMINATION OF THE LEVEL OF ACHIEVED RADIATION SAFETY OF PERSONNEL AT A HAZARDOUS RADIATION FACILITY

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Abstract: the paper presents the results of measurements of individual dosimetric monitoring of the personnel of a hazardous radiation facility in Moscow; average values obtained at different control points have been compared with control levels; a conclusion about the high level of radiation safety achieved for the fire department at this facility has been drawn.

Key words: radiation monitoring, individual dosimetric monitoring, radiation safety, control level, maximum permissible dose, average annual effective dose.

1. INTRODUCTION

Ensuring radiation safety at hazardous radiation facilities is a priority task not only for operating organizations, but also for the state. In order to ensure radiation safety at facilities operating in the field of nuclear energy, according to Federal Law No. 3 “On Radiation Safety of the Population”, the company must conduct regular radiation monitoring of premises and off-site area and control and record individual radiation doses of employees [1].

Any hazardous radiation facility has a fire department, whose personnel belong to group B and are engaged in constant monitoring of fire safety of premises and performs a set of fire safety measures at the facility.

During the working day, officers of the fire department go around all rooms, including potentially dangerous rooms containing sources of ionizing radiation, and assess the state of fire safety.

The purpose of this work is to determine the achieved level of radiation safety at a hazardous radiation facility in Moscow.

2. METHODOLOGY

Monitoring of average annual effective doses of external exposure of fire department personnel is carried out by the radiation safety service of the facility by an integral method in accordance with Methodological Guidelines 2.6.5.026–2016 “Dosimetric control of external occupational exposure. General requirements” [3].

The measurement and further record of individual average annual effective doses of external personnel exposure are carried out in accordance with the radiation control program at the enterprise. The fire department personnel are issued integral dosimeters DVG-01 and DVGN-01, designed to measure doses of photonic and neutron radiation, respectively, for up to 6 months, which are replaced according to the schedule or depending on the exposure. Then, the radiation safety service of a radiation-hazardous facility, as part of regular dosimetric monitoring of personnel, measures the received doses of external radiation in personnel using the AKIDK-301 complex.

3. RESULTS

This paper presents the results of measurements of individual dosimetric monitoring of personnel at a hazardous radiation facility which have been obtained by employees of the radiation safety service

of this facility over the past few years; the authors participated in this work in 2020–2021.

To determine the achieved level of radiation safety at the facility, it is necessary to compare the values of the average annual effective doses in personnel with the control levels established at the enterprise, as well as with the maximum permissible dose according to radiation safety standards [2].

3.1. Determination of the control level

To reduce personnel exposure to as low as possible, the radiation hazardous facility has developed and approved reference levels for different categories and occupations of personnel. For fire department personnel (group B), the facility's radiation safety service has developed its own reference level. The reference level for Group B personnel at the facility is 3.5 mSv/year, which is lower than the dose limit for Group B personnel (5 mSv/year) [3].

3.2. Calculation of average annual effective doses

The average annual effective dose is a normative value and is controlled by radiation safety standards. It is the sum of annual effective doses of external and internal personnel exposure. But, since the methodology specifies the determination of the average annual effective dose using individual dosimeters, only the annual effective dose of external exposure is considered in our study.

3.3. Processing of the results

In the course of the work the authors obtained the results of individual dosimetric monitoring for 2020–2021 years. For statistical analysis the data of individual dosimetric monitoring of the fire department personnel received by the radiation safety service of the facility since 2016 was provided. The results of the analysis showed that the average annual effective external exposure doses of the fire department personnel for 2016–2021 were significantly lower than the reference level of 3.5 mSv/year which indicates the proper organization of activities at the workplace.

In order to assess the achieved radiation safety level, the obtained average values in different control points were compared with the control levels; the following results were obtained under the expanded uncertainty, which is P=0.95:

– The arithmetic mean is 0.57 mSv/year;

– The maximum value is 0.79 mSv/year.

4. CONCLUSIONS

The assessment of the results of individual dosimetric monitoring of the fire department personnel ensuring fire safety at the hazardous radiation facility in Moscow shows that the values of average annual effective external radiation doses in personnel for the period from 2016 to 2021 are no more than 11% of the maximum permissible doses established by the radiation safety standards for Group B personnel, and no more than 16% of the control level established for the personnel which indicates a high level of radiation safety achieved at the facility.

ACKNOWLEDGEMENTS

The authors are grateful to the staff of the Department of Environmental and Radiation Safety at the radiation hazardous facility where this study was conducted, as well as to Gulnara Kulieva, Assistant Professor at the Department of Human Ecology and Bioelementology of the Institute of Environmental Engineering of RUDN University, for her kind assistance at all stages of the work.

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RADIATION MONITORING IN THE PREMISES OF A HAZARDOUS RADIATION FACILITY

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Abstract: The paper presents the results of radiation situation monitoring in the premises of a hazardous radiation facility in Moscow. Measurements of the ambient dose equivalent of gamma- and neutron radiation were carried out at 20 control points in the premises of the facility in operating mode using a dosimeter radiometer DKS-96. The data obtained indicate compliance with radiation safety requirements at the facility. To optimize the control of the radiation situation, the authors have put forward several recommendations.

Key words: radiation control, dose equivalent rate, gamma radiation, neutron radiation, control level.

1. INTRODUCTION

Now, there are about 1,500 hazardous radiation facilities (HRF) operating in Russia. Any activity involving the use of ionizing radiation sources should be monitored. Monitoring of the activities of such facilities to ensure the requirements of radiation safety should be carried out in accordance with Article 11 No. 3-FZ "On Radiation safety of the population" [1].

This paper presents the results of radiation situation monitoring in the premises of the HRF located within the city of Moscow. There are buildings and constructions on the territory of the HRF of the 1st category of potential hazard, where the structural subdivisions of the facility responsible for different types of work are located; there are different classes of premises with different potential radiation hazards. The Metrological Service (MS) is one of the structural subdivisions of the HRF. The MS repairs, verifies and calibrates equipment in accordance with the radiation monitoring program. The MS performs work using closed alpha-, beta-, gamma-emitting sources (CRSs) and fast neutron sources for equipment calibration in testing outfits. The MS is located in six rooms, which are classified as the facilities of the IV category of potential radiation hazard in accordance with the requirements of clause 3.1. OSPORB-99/2010 [2]; the service personnel are classified as the personnel of the A group.

The purpose of this study is to analyze the state of radiation safety at the premises where the MS works all year long.

2. METHODOLOGY

The measurements of ambient dose equivalent rate (ADER) of gamma- and neutron radiation were carried out at 20 control points (CP) in the premises of the MS at the HRF in operating mode using dosimeter radiometer DCS-96 with detector units BDMG-96 for gamma-radiation and BDMN-9 for neutron radiation.

3. RESULTS

This paper presents the results of measurements that were obtained by the MS employees for several years; the author participated in this work in 2020–2021. The facility has developed a program of radiation monitoring of the premises visited by the MS employees in accordance with the requirements of the document NP-067-16 “Basic rules for accounting and control of radioactive substances and radioactive waste in an organization” [3]. Over many years of work, the facility has accumulated a large body of data on radiation monitoring of the ADER of gamma and neutron radiation at the workplaces of MS personnel which has helped to reveal no excess of the dose limit in personnel. In accordance with clause 7.4. NRB-99/2009, control levels for the ADER of gamma and neutron radiation have been set for the personnel in these premises. For monitoring, control points (CPs) have been installed in the premises of the MS, which are linked to places with increased the ADER values relative to background values. These CPs are located near testing outfits, safe-deposits, as well as in the aisles between rooms, and next to the staff workplaces where they spend most of their time. In addition, the CPs have been installed outside the premises of the MS on the adjacent territory near the windows where the work with CRSs is carried out. The monitoring is regularly carried out in the operating mode, and the results are quarterly assessed at 20 CPs in accordance with MU 2.6.5.008–2016 “Monitoring of the radiation situation. General requirements” [4].

The analysis of the ADER of gamma- and neutron-radiation data obtained by the authors and data accumulated over several years under the radiation monitoring program and submitted for analysis by the radiation safety service shows that all rooms can be conditionally divided into 2

types depending on the ADER at workplaces: rooms for office work up to 1 μSv/h for gamma radiation and 0 μSv/h for neutron radiation; working spaces where testing outfits and CRSs are operated - no more than 5 μSv/h for gamma radiation and no more than 7 μSv/h for neutron radiation. Also, the area around the buildings where the MS works is identified of no more than 0.8 μSv/h for gamma-radiation and 0 μSv/h for neutron-radiation. Statistical processing of the data obtained for the last 6 years of the MS operation (24 quarters) showed a normal statistical law. The arithmetic mean was used for the mean trend which did not exceed the control levels. The results of the data analysis are presented in the table.

Table 1

Analysis of the ADER data for gamma- and neutron radiation in the premises of the metrological service of the hazardous radiation facility

Zones for monitoring the radiation situation in the premises	n*	ADER of gamma radiation, μSv/h				n*	ADER of neutron radiation, μSv/h			
		min	max	AM	CL		min	max	AM	CL
rooms for office work	5	0.11	0.2	0.4	1	2	0.21	0.38	0.29	1
working spaces	9	0.13	0.8	0.40	5	4	0.81	2.41	0.40	7
area around the MS	6	0.13	0.13	0.13	0,8	6	0	0	0	0
***n, pcs** — the number of CP per zone; **AM** — arithmetic mean; **CL** — control level										

The gamma- and neutron-radiation ADER values in the rooms located in the clean area in the administration building were chosen as background values.

The data analysis showed that in the territory adjacent to the MS, the ADER for gamma radiation was below the control level (CL) and was at the level of background values for gamma radiation of 0.14 mSv/h; neutron radiation was not detected. In the rooms for office work, the ADER for gamma radiation was significantly lower than the CL; in the working spaces, they exceeded the background no more than five times, but did not exceed the CL. Based on this, the following recommendations have been prepared which will contribute to optimizing the control of the radiation situation:

– it seems acceptable to reduce the number of control points in the area around the MS;

– it is proposed to revise the CLs towards their reduction in rooms for office work;

– it is recommended to introduce separate CLs for different types of premises and the territory adjacent to the MS.

4. CONCLUSION

The results of monitoring the radiation situation in the premises of the MS at the HRF and in the surrounding area showed that the control levels for the studied period were not exceeded. In the working rooms, the values of the ADER of gamma and neutron radiation exceeded the background values up to 5 times, but this was lower than the CLs. The data obtained indicate compliance with radiation safety requirements and are the basis for optimizing the volume and frequency of radiation monitoring for this facility.

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CALCULATION OF AIR POLLUTANT EMISSIONS FROM A HOT WATER BOILER NEAR THE TOWN OF VIDNOYE

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Abstract: The purpose of the work was to calculate the emissions of pollutants into the atmosphere from the projected hot water boiler near Vidnoye

with a thermal capacity of 92 MW and to predict changes in the state of the environment by the impact of the object to be placed there.

Key words: hot water boiler house, atmospheric pollution, exposure sources, hazard classes, dispersion of pollutant emissions.

1. INTRODUCTION

In the conditions of urban development, the main culprits behind air pollution are enterprises for the production and distribution of electricity, heat, steam and water, which have sources of pollutant emissions into the atmosphere. Therefore, the problems of atmospheric air pollution by heat power facilities, as well as the implementation of measures to clean it, remain relevant today.

A distinctive feature of a hot-water boiler house from other hot water boilers is the presence of a hot-water boiler, during the operation of which emissions from its chimneys will be a source of atmospheric pollution.

Nitrogen oxides are a harmful by-product of the combustion of natural gas. One of the strongest carcinogenic substances is benzopyrene, which has a harmful effect on living organisms, even at low concentrations in the air.

The maximum permissible concentrations of harmful substances in the air of the working area are established according to SanPiN 1.2.3685–21, with the working area defined as a space up to two meters above the floor level or a platform on which the places of permanent or temporary stay of employees are located.

2. METHODOLOGY

The main criteria for the quality of atmospheric air when setting the maximum permissible emissions for sources of atmospheric pollution are the maximum permissible concentrations.

Since the purpose of the facility is the heat supply of residential and public buildings, according to SanPiN 1.2.3684–21, it is not allowed to exceed hygienic standards of more than 1.0 MPC for the content of pollutants in the atmospheric air in a residential area.

The calculation of the dispersion of pollutant emissions was carried out according to the program of the UPRZA “Ecologist”.

To assess the impact of the emission sources of the production site and control the concentrations of pollutants in the atmospheric air,

control points were selected at the border of a multi-storied residential building and at the border of the facility sanitary protection zone [1, 2].

The calculation was carried out for heights of 2.0 m (human working area), at a height of 25.5 m and at a height of 45.0 m (the height of boiler chimneys) from the ground surface.

3. RESULTS

3.1. Information about the projected object and its impact on the environment

The considered section of the projected hot water boiler is located at the address: Moscow region, Leninsky district, village Bulatnikovskoye, near the village of Lopatino and has an area of 7862 m2. Lopatino is located at the southwestern border of the town of Vidnoye. The hot water boiler is planned to be in a communal area bordering the projected and existing residential development.

The boiler house has four hot-water gas boilers of the brand "Thermotechnik TT 100-02" with a capacity of 20 MW each (sources No. 0001-0004), complete with a chimney, a gas burner and one hot-water gas boiler of the brand "Thermotechnik TT 100-01" with a capacity of 12 MW (source No. 0005).

The reserve fuel is stored in three tanks with a capacity of 100 m3 each. To replenish the reserve fuel supply, a specialized drain site, a diesel fuel intake cabinet (sources No. 0006-0008), is provided.

For the purification of surface and meltwater run-off from the territory, local treatment facilities of the stormwater drain are provided (source No. 6009). Sewage treatment plants operate during the warm period for 24 hours a day.

Also, vehicles come to the territory of the facility to service the facility (source No. 6010).

According to the SanPiN, Class IV includes thermal power plants and district boiler houses with a thermal capacity of less than 200 Gcal (gigacalories) operating on solid, liquid, and gaseous fuels. A standard sanitary protection zone for the fourth-class objects is 100m.

3.2. Calculation of hot water boiler emissions

9 substances of hazard classes 1-4, with a total mass of 142.827725 tons/year, are released into the atmospheric air as a result of the hot water

boiler operation. The quantitative composition of pollutants emitted by the facility is presented in Table 1 by hazard classes.

Table 1

Quantitative composition of pollutants emitted into the atmosphere by the object, by hazard classes

Hazard class	**Total emissions of pollutants**	
	g/s	t/y
1 (code 0703)	0,0000009	0,000009
2 (code 0333)	0,0000605	0,000037
3 (code 0301, 0304, 0328, 0330)	8,8129325	55,434848
4 (code 0337, 2754)	11,271044	87,392732
ASLE — approximate safe level of exposure to the pollutant (code 2732)	0,0000611	0,000099
Total: (9 substances)	20,084099	142,827725

During the operation of a hot-water boiler house, two types of sources have an impact on atmospheric air by the nature of the release of pollutants into the atmosphere: organized sources (in the amount of 8 pcs.) and unorganized sources (in the amount of 2 pcs.), with a total of 10 sources. The quantitative composition of pollutants emitted into the atmosphere by the facility is presented in Table 2 by type of exposure sources [3].

Table 2

Quantitative composition of pollutants emitted into the atmosphere by the object, by types of exposure sources

Hazard class	**Total emissions of pollutants**	
	g/s	**t/y**
Organized sources (№ 0001–0008)	20,0830691	142,8195036
Unorganized sources (№ 6009–6010)	0,0010299	0,0082214
Total:	20,084099	142,827725

Table 3 shows an example of calculating emissions at a height of 2.0 m. It shows only those pollutants whose concentrations are more than 0.1 MPC at the calculated points [4].

Table 3

Results of the calculation of the dispersion of harmful substances in the atmosphere (the height of the calculated points is 2m)

Code	Substance	Control point/ Concentration, fractions of MPC				Back-ground
		PT1	PT2	PT3	PT4	
0301	Nitrogen dioxide (Nitrogen dioxide; nitrogen peroxide)	0,38	0,37	0,45	0,46	0,270
0304	Nitrogen (II) oxide (Nitrogen monoxide)	0,07	0,07	0,07	0,08	0,060
0337	Carbon monoxide (Carbon monoxide; carbon monoxide; carbon monoxide)	0,49	0,49	0,49	0,49	0,480

4. CONCLUSIONS

The analysis of harmful factors from the operation of hot water boilers and their impact on atmospheric air during fuel combustion was carried out in the work.

Limit concentrations of the pollutants were also determined, and information about the object and the physical and geographical conditions was systematized.

With the help of calculation methods based on the program of the UPRZA “Ecologist”, the impact of pollutants emitted in the atmospheric air by the projected hot water boiler house was estimated. This made it possible to comprehensively assess the state of the environment, in particular atmospheric air.

Analysis of the results of dispersion calculations showed that surface concentrations do not exceed 1.0 MPCm.r. for any substance on the territory of development and on the border of the normalized territory, namely on the border of the multi-storied residential building.

The change in the state of the environment is defined as maximum permissible due to its compliance with hygienic standards for atmospheric air quality, considering background atmospheric pollution.

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JUSTIFICATION OF THE BOUNDARIES OF THE SANITARY PROTECTION ZONE FOR A CONSTRUCTION INDUSTRY FACILITY ENGAGED IN THE PRODUCTION OF BRICKS

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Abstract: The purpose of the work is to determine and substantiate the boundaries of a sanitary protection zone for a construction industry facility engaged in the production of bricks by the example of LLC "LSR. Stenovye". The author conducted an inventory of the sources of atmospheric pollution, noise, and the effects of other physical factors. The study established and justified the boundaries of the projected sanitary protection zone.

Key words: production of bricks, assessment of negative impact, air pollution, noise pollution, a sanitary protection zone.

1. INTRODUCTION

Over the past century, the level of man-made impact on the environment has become much higher, as a result of the development of

various industries, including construction industry. This area of human activity also creates a negative impact on the environment and on the health of the population. One of the ways to assess this negative impact is projecting a sanitary protection zone.

The development and creation of a project for organizing a sanitary protection zone is carried out in order to prevent or reduce the negative impact of a production facility on public health, determine the technology used and the volume of production in a locality, as well as make economically and technically sound, socially and environmentally appropriate design and construction decisions [1–2].

The purpose of the work was to determine and substantiate the boundaries of the sanitary protection zone for a construction industry facility engaged in the production of bricks by the example of LLC "LSR. Stenovye".

To achieve this goal, the following tasks were set and accomplished:

1. Carrying out an inventory of the sources of pollutant emissions into the atmospheric air, noise sources and sources of exposure from other physical factors.
2. Establishing the boundaries of the approximate sanitary protection zone and the projected sanitary protection zone, considering the nearby normalized territory.
3. Calculating the dispersion of pollutants in the atmospheric air and the level of noise from the investigated enterprise.
4. Analyzing the results and justification of the established boundaries of the sanitary protection zone for the studied object of negative impact on the environment.

2. METHODOLOGY

The assessment of the acoustic impact of the object on the environment was carried out on the basis of SP sanitary rules 51.13330.2011 "Noise protection" and GOST standard 31295.2–2005 "Noise. Sound attenuation during propagation on the ground".

The normalized parameters of constant noise are sound pressure levels L, dB, in octave frequency bands with average geometric frequencies 31,5; 63; 125; 250; 500; 1000; 2000; 4000 and 8000 Hz.

Sanitary rationing was carried out according to SanPiN sanitary rules and regulations 1.2.3685-21 "Hygienic standards and requirements

for ensuring the safety and (or) harmlessness of environmental factors for humans".

Noise is considered to be within the norm when it does not exceed the established normative values both at the equivalent and at the maximum level.

The calculation of noise characteristics was carried out in accordance with the methodology given in the sanitary rules SP 51.13330.2011. Calculation of noise levels from cars NS 13–16, 18 is performed in the program "Noise from highways" (version 1.1) of the company "Integral".

Calculations of the dispersion of emissions and the maximum surface concentrations of pollutants in the surface layer of the atmosphere were carried out according to the program of the UPRZA "Ecolog" version 4.6, taking into account the development elaborated by Integral and coordinated by the Voeikov MGO (the main geophysical observatory) , implementing the Order of the Ministry of Natural Resources of the Russian Federation No. 273 dated 06.06.2017 "On approval of methods for calculating the dispersion of emissions of harmful substances in the atmospheric air".

3. RESULTS

3.1. General information about the company, atmospheric pollution, sources of noise and electromagnetic radiation, vibration at the enterprise

The company LLC "LSR. Stenovye" is located in the Moscow region in the city of Pavlovsky Posad. The main activity of the enterprise is the production of bricks.

There are 44 sources of atmospheric pollution within the industrial site (including 24 unorganized ones), which emit 21 pollutants into the atmosphere.

The standard values for pollutant emissions into the atmosphere from the enterprise sources are about 164 tons/ year and 5 g/sec. The most important pollutants to consider will be nitrogen dioxide, nitrogen oxide, carbon oxide and inorganic silicon dioxide (SiO2) dust since their concentrations in the air will be the highest.

Noise sources on the territory of the facility will be the supply and exhaust ventilation equipment of the buildings and vehicles.

On the territory of the facility there are no open 110 kw switchgears and power transmission lines (power lines) that are a source of electromagnetic fields of industrial frequency 50 Hz and higher. Other equipment at the enterprise is not a source of electromagnetic fields either.

There are no sources of intense vibration impact on the soil at the enterprise. The vibration level on the territory of the industrial site will not exceed hygienic standards since there are no sources of significant vibration at the enterprise [3–4].

3.2. Determining the boundary of the sanitary protection zone

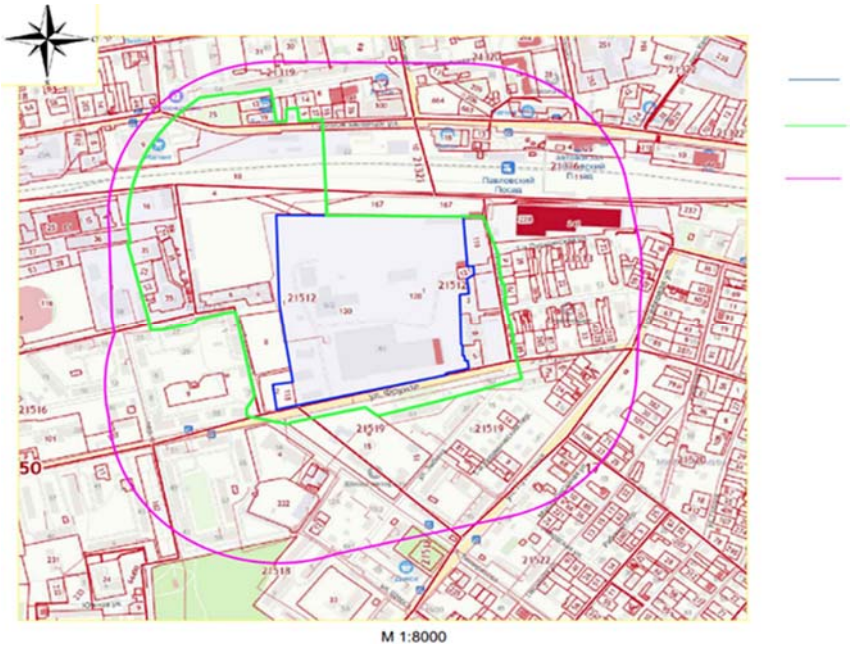

Figure 1. Situational plan of placement of LLC "LSR. Stenovye" with the boundaries of the normative and calculated SPZ (where blue — the border of the object's territory, green — the calculated SPZ, pink — the normative SPZ)

In accordance with the SanPiN sanitary rules and regulations 2.2.1/2.1.1.1200-03 "Sanitary protection zones and sanitary classification of enterprises, structures and other objects" (new edition), LLC "LSR.

Stenovye" refers to the 3rd hazard class with an approximate sanitary protection zone of 300 m.

The nearest normalized objects:

- northeast — a plot for residential development at 0 meters from the enterprise border
- east — a plot for individual residential development at 47 meters from the enterprise border
- south — a plot for a school and auxiliary buildings at 27 meters from the enterprise border.

The boundary of the sanitary protection zone for the operating enterprise engaged in the production of bricks, LLC "LSR. Stenovye" was determined and justified. Figure 1 shows a map with the initial regulatory sanitary protection zone of the company "LSR. Stenovye" and a reduced projected sanitary protection zone created and justified in the course of this work [5].

4. CONCLUSIONS

Within the framework of this work, the boundary of the sanitary protection zone for the operating enterprise engaged in the production of bricks, LLC "LSR. Stenovye" was determined and justified.

It was revealed that on the territory of the industrial site, the border of the established SPZ, there are no exceedances of the MPC for any of the emitted substances and summation groups. The calculated concentrations of pollutants at the SPZ border do not exceed 0.8 MPC.

The total calculated equivalent and maximum noise levels from vehicles do not exceed the standard values at the calculated points located on the border of the calculated SPZ during the daytime.

The total calculated equivalent noise levels from permanent noise sources do not exceed the standard values at the calculated points located on the border of the calculated SPZ during the daytime. At night, the company is not a source of noise.

Electromagnetic and vibration effects are insignificant. Electromagnetic and vibration effects were not taken into account when calculating the total SPZ.

Determining the border of the sanitary protection zone was carried out under existing conditions. There are no free territories for the placement of new industrial facilities in the area of the enterprise

location, and there are no free territories for the improvement and landscaping of the territory behind the fence of the enterprise.

No additional environmental protection measures are required.

It is necessary to carry out the following works on improving and landscaping on the territory of the enterprise and around it:

– regular sweeping away garbage and leaves

– to improve the condition of existing green spaces near and on the territory of the enterprise, it is necessary to carry out planned measures: removal of weak, dead and broken branches of trees and shrubs.

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CATEGORIZATION OF TERRITORIES IN TERMS OF POTENTIAL RADON HAZARD

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Abstract: In this work we monitored the volumetric activity of radon-222 gas in the buildings of children's educational organizations in Pyatigorsk. We

used the integral method for measurements. We surveyed 82 residential and public buildings. Dose loads on the population were calculated. We categorized the territory of the residential area and proposed to introduce 3 category of potential radon hazard.

Key words: radon, radon volumetric activity, radon monitoring, categorization by potential radon hazard

1. INTRODUCTION

The largest contribution to the total annual effective dose (AED) to the population comes from natural sources of ionizing radiation, the main one being radon gas (^{222}Rn) and its daughter decay products (DDP). ^{222}Rn enters buildings through geological faults, soils containing naturally occurring radionuclides and building materials, accumulates indoors, and humans inhale it. The lungs are a critical organ for radiation exposure [1]. According to the norms of radiation safety NRB-99/2009 equivalent equilibrium volume activity (EEVA) of radon in the premises of residential buildings must not exceed 200 Bq/m3. Preliminary studies have revealed potentially radon-hazardous territories in Russia (the Caucasus, the Transbaikal, Altai Krai, etc.). In these territories a constant monitoring of ^{222}Rn content in the air must be carried out. The town of Pyatigorsk in Stavropol Krai is one of these objects.

The purpose of this work is to categorize the territory inhabited by the population of Pyatigorsk by potential radon hazard.

2. METHODOLOGY

The integral method was used to monitor the volumetric activity of radon (VA_{Rn}). The essence of the method consists in the registration of alpha-particles ^{222}Rn and its DDP using solid-state track detectors of LR 115–2 type. Alpha-particles, hitting the detector material, leave traces (tracks) on it. To detect the tracks, the detectors were subjected to chemical etching, and an automatic spark track counter AIST-4 was used to count tracks. For air sampling, the detectors were placed in sampling chambers (exposition chambers) REI-4 and set in the buildings of Pyatigorsk. Sampling was carried out passively for two months for each period.

3. RESULTS

We measured VA_{Rn} and calculated the average annual EEVA in 82 residential and public buildings, with a total of 2854 integral measurements.

We found that there were few basements in the surveyed area (56% of the total number of buildings), and few measurements were made in them (12% of the total number of measurements). Besides, in buildings with basements, the values of EEVA exceeding the established limit were concentrated on the 1st floor (22% of the total number of measurements) [2]. We calculated doses of radiation exposure of people living on the 1st floor. This made it possible to categorize the territory by potential hazard depending on EEVA on the 1st floor.

In order to categorize the territory, we calculated the AED of the population exposure to ^{222}Rn in Pyatigorsk. The calculation was made according to methodical instructions of MU 2.6.1.1088-02. In accordance with the criteria established by SanPiN 2.6.1.2800-10 the degree of radiation safety depending on the AED is defined as

– less than 5 mSv/year — acceptable level of population exposure to natural sources of ionizing radiation;

– over 5 to 10 mSv/year — increased population exposure;

– over 10 mSv/year — high population exposure.

When calculating the AED of internal radiation exposure of population to ^{222}Rn, it was revealed that the values of AED depended on the average annual EEVA, as presented in Table 1.

Table 1

Criteria for population exposure

EEVA of 222Rn, Bq/m3	AED, mSv/year
less than 80	less than 5
80–160	5–10

We proposed to introduce 3 categories of potential radon hazard according to the values of the average annual EEVA on the 1st floors, which are presented in Table 2.

Table 2

Categories of potential radon hazard according to the values of the average annual EEVA

EEVA of ^{222}Rn, Bq/m^3	Potential radon hazard category
less than 80	I
80-160	II
over 160	III

We performed statistical processing of the data obtained from the results of EEVA measurements on the 1st floors. The results are presented in Table 3.

Table 3

Statistical results of EEVA measurements on the 1st floors

N	AA	GA	CO	The median and its confidence interval edges*	MIN	MAX	Over 160, Bq/m3	80–160, Bq/m3	Less than 80, Bq/m3
1834	100	54	135	56(50–62)	<10	2408	18	19	63
Note: **N** — measurement quantity **AA** — arithmetic average; **GA** — geometric average; **SD** — standard deviation; **(*)** — if p=0,95; interval: left edge — right edge.									

As can be seen from Table 3, the values of AA, GA and median did not exceed the established limit of 200 Bq/m3. Rooms with EEVA values greater than 160 Bq/m3 accounted for 18% of the total number, with values from 80 to 160 Bq/m3 — 19%, and less than 80 Bq/m3 — 63%.

4. CONCLUSIONS

We measured VA_{Rn} in the premises of residential and public buildings in Pyatigorsk and proposed to introduce III category of potential radon hazard of the territory. Pyatigorsk showed that 18% of the studied area was classified as category III of potential radon hazard, 19% — category II, 63% — category I. The study showed that the situation in Pyatigorsk was generally stable, but there were several buildings in need of rehabilitation.

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EFFECT OF POLYMERS ON SANITARY AND CHEMICAL PARAMETERS AND ORGANOLEPTIC PROPERTIES OF WATER

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Abstract: This paper is devoted to the problem of water quality. It studies polymeric materials used in water supply and production of bottled containers and assesses the impact of these materials on bottled water quality.

Key words: polymeric materials, plastic containers, polypropylene, bottled water, water quality.

1. INTRODUCTION

The quality of water directly affects the livelihood of the population, the socio-economic well-being of states and maintains the ecological balance of the territories. Poor quality water cannot be considered a consumable resource. Water that does not meet standards can be considered as a lack of this resource, because such water cannot be used for various purposes.

Today, from an economic point of view, it is beneficial to use polymeric materials both in water supply systems and in bottled products made from these materials. From an environmental standpoint, we can also say that, due to their properties, polymeric materials fit perfectly into water supply systems, which does not apply to plastic containers. Currently, there is insufficient data on the effect of polymeric materials on water quality. This fact makes this work relevant [1–2].

The purpose of the work was to study the effect of polymeric materials on water quality in water supply systems and bottled containers.

The tasks were the following:

1. To study polymeric materials used in water supply and production of bottled containers
2. Assess the impact of polymeric materials on water quality
3. Analyze the attitude of the population to water packaged in containers.

2. METHODOLOGY

In our work, we used various research methods and literature analysis:

1. МУ 2.1.4.2898-11 “Sanitary and epidemiological studies (tests) of materials, reagents and equipment used for water purification and (water) treatment. Methodical instructions”.
2. ПНД Ф 14.1:2:3:4.121-97 – technique for measuring the pH of water samples by the potentiometric method.
3. GOST R 57164-2016 5.8.1 – 5.8.2 – Methods for determining water odour, taste, and turbidity.
4. GOST 31954-2012 (method A) – a method for determining water hardness based on the formation of complex compounds of Trilon B with ions of alkaline earth elements (complexometric method).
5. МУ 2.1.4.2898-11 “Sanitary and epidemiological studies (tests) of materials, reagents and equipment used for water purification and (water) treatment. Methodical instructions”.
6. ПНД Ф 14.1:2:3:4.121-97 — technique for measuring the pH of water samples by the potentiometric method.
7. GOST R 57164-2016 5.8.1 – 5.8.2 — Methods for determining water odour, taste, and turbidity.
8. GOST 31954-2012 (method A) — a method for determining water hardness based on the formation of complex compounds of Trilon B with ions of alkaline earth elements (complexometric method).

3. RESULTS

3.1. Results of studying the effect of polypropylene on sanitary and chemical parameters and organoleptic properties of water

Odour: on the day of control when testing a prototype test water with a temperature of 20° C, the score ranged from 0 to 1, at a temperature. of 60° C. At all control points, test samples were assigned 1 point for the parameter under study.

Taste: at all points of control, the control sample had a taste at 60°C, but at a temperature of 20°C, there was no taste either on the 15th or on the 30th day.

Turbidity: at all control points, the prototype showed a result less than one, but on the 30th day the result was 1.8 ± 0.4 FTU (Formazine Turbidity Unit).

Table 1

Results obtained for the 1st and 5th days of the study

Parametrs of control	Control points			
	1st day		5th day	
	C	P	C	P
pH	7,6 ± 02 pH	7,7 ± 0, 2 pH	7,88 ± 0,2 pH	7,56 ± 0,2 pH
Odour	0/0	0-1/0-1	0/0	0-1/1
Taste	0/1	1/1	0/1	1/1
Water hardness	4,42 ±0,66 dH	4,45 ±0,67 dH	4,22 ±0,63 dH	4,32 ±0,65 dH
Permanganate oxidation	2,8 ± 0,3 mgO/dm3	5,4 ± 0,5 mgO/dm3	2,2 ± 0,2 mgO/dm3	7,8 ± 0,8 mgO/dm3
Turbidity	< 1 FTU	< 1 FTU	< 1 FTU	< 1 FTU
Presence of sediment	–	–	–	–
Foaming	–	Fine bubble foam at the walls 1mm	–	Fine bubble foam at the walls 2mm

Table 2

Results obtained for the 15th and 30th days of the study

Parametrs of control	Control points			
	15th day		30th day	
	C	P	C	P
pH	7,95 ±0,2 pH	8,29 ±0,2 pH	8,22±0,2 pH	8,13±0,2 pH
Odour	0/0	1/1	0/0	0/0-1
Taste	0/0	0/1	0/0	0/1
Water hardness	4,32 ±0,64 dH	4,42 ±0,6 dH	4,15±0,62 dH	4,3±0,6 dH
Permanganate oxidation	2,06 ± 0,2 mgO/dm3	2,2 ± 0,2 mgO/dm3	2,3±0,2 mgO/dm3	3,6±0,4 mgO/dm3
Turbidity	< 1 FTU	< 1 FTU	< 1 FTU	1,8 ± 0,4 FTU
Presence of sediment	–	–	–	–
Foaming	–	Fine bubble foam at the walls 2mm	–	Fine bubble foam at the walls 2mm

Presence of sediment: the results of both samples at all stages of the control showed the absence of sediment, so, the water was suitable for drinking.

Foaming: on the day of control, each time the prototype formed fine-bubble foam of 2 mm at the walls. Normally, fine-bubble foam near the walls should not exceed 1 mm, in our case the foam is 2 mm, which indicates that, according to this parameter, the water is not suitable for drinking.

It was found that in the experimental sample of the water under study, the minimum pH value was on the 5th, the maximum pH value was on the 15th day. In the control sample of the water studied — dechlorinated tap water, the maximum and minimum values occurred on the 30th and 1st days, respectively.

Studying the overall water hardness — dH, it was recorded that the maximum value in the control sample was on the 1st day, and the minimum — on the 30th day. A similar situation was observed in the control sample.

According to the results of permanganate oxidizability, in the experimental sample, the maximum value was registered on the 5th day, and the minimum registered on the 15th day. The results for the control sample are as follows — the maximum value was recorded on the first day, and the minimum — on the 15th day.

3.2. Results of the survey

When processing the results of the survey, it was revealed that when buying bottled water, most respondents, namely 63.6%, are guided by taste, smell, and color, but the remaining 36.4% of the respondents consider only taste. So, we can say that it is taste that plays a major role when choosing bottled water.

90.9% of the respondents gave a positive answer to the question “Do you use filters for water purification?” The rest of them chose the option “no”. The next question was “Do you drink tap water?” to which the majority — 81.8% answered “no”. The remaining part divided into two equal groups and chose either “yes” or “sometimes” (by 9.1%).

The results obtained indicate that, despite the fact that most of the respondents use water filters, they do not use tap water at the same time. From this, it can be concluded that the respondents do not trust the quality of tap water [3–4].

4. CONCLUSIONS

When studying polymeric substances, materials used in water supply system and in the manufacture of containers for bottled water were considered. Currently, there is a small number of works studying the effect of polymeric materials on the quality of consumed water, which indicates the need to continue research in this field [5].

During the study, water in contact with polypropylene pipes was examined for 8 indicators for 30 days; control measurements were carried out on the 1st, 5th, 15th and 30th days. As a result, we can say that in general polypropylene pipes affect water quality. Of the eight parameters studied, 6 were normal (hydrogen index, odour, hardness, taste, turbidity, sediment) and only 2 did not fit into the established norms — permanganate oxidation and foaming.

From the results of permanganate oxidizability, it was established that: the maximum of the experimental sample falls on the 5th day and is equal to ± 7.8 mgO/dm3, the minimum was registered on the 15th day — ±2.2 mgO/dm3. According to SanPiN 2.1.3684-21, drinking water in terms of permanganate oxidizability should be in the range from 5 to 7 mgO/dm3 so the test sample is not suitable for drinking. When analyzing foaming, no foam appeared in the control sample during the control. The test sample showed the opposite result. In the studies that took place on the day of control, each time fine bubble foam of ± 2 mm formed at the walls. Normally, small-bubble foam near the walls should not exceed 1 mm. In the study, ± 2 mm foam was recorded, which indicates that, according to this parameter, the water is not suitable for drinking.

The survey found that 90.9% of the respondents use water filters but do not drink tap water. When buying water, the majority of respondents (63.6 %) prefer to focus on taste, smell and color. At the same time, the remaining 36% only pay attention to taste, from which we can conclude that the main quality for the respondents when buying water is taste.

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HEALTH RISK IMPOSED BY ATMOSPHERIC POLLUTION WITH CHEMICALS FROM A BOILER HOUSE OPERATING ON FUEL OIL

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Abstract: Within the framework of this work, an assessment of carcinogenic and non-carcinogenic risk to the public health of the locals was carried out when the following chemicals were inhaled from atmospheric air due to boiler house pollution: nitrogen dioxide, nitrogen (II) oxide, carbon (soot), sulfur dioxide, carbon oxide, benz/a/pyrene, fuel oil ash of thermal power plants.

Keywords: atmospheric air, inhalation, risks, hazard index, boiler house, fuel oil.

1. INTRODUCTION

Human activity is impossible without contact with such a key environmental object as atmospheric air. Due to the constant contact of human organism and air, the state of the air environment directly affects the health of the population. It is because of this that the task of preserving air quality is the primary task of mankind. Despite the large number of factors negatively affecting the quality of atmospheric air, emissions associated with the combustion of fuel resources are the leading factors of atmospheric pollution.

At a certain level of anthropogenic impact, acceptable air pollution is provided by nature itself through self-purification processes. Pollutants are removed from it under the influence of gravitational forces (only aerosols), washed out by precipitation and destroyed in the process of photochemical reactions. [12].

Nowadays, the growth of anthropogenic loads is so high that it exceeds the limits of the ability of the atmosphere to the natural process of self-purification. This leads to the accumulation of harmful impurities and an increase in the level of pollutants, which significantly worsens the quality of atmospheric air and the health of the population.

Modern scientists are seriously turning their attention to the problem of the carbon footprint. And despite the academic promotion of alternative energy sources, which are quite successfully used in Europe and the United States, in Russia such a practice is still impossible due to the territorial and economic characteristics of the country. Today in the Russian Federation, the practice of using traditional fuels is very common. Boilers based on traditional fuels are no exception and are used for both personal and industrial purposes: heat and electricity production, water heating.

A large amount of fuel resources is burned in boiler rooms. One of the most popular types of fuels for boilers in the Russian Federation today is fuel oil. During the combustion of fuel oil, many pollutants are released, some of which, in addition to toxic, have carcinogenic properties, which in turn leads to the risk of environmentally caused diseases.

2. METHODOLOGY

Within the framework of this work, 5 boilers were examined. Among them there are boilers of both hot water and steam type. Fuel for

these boilers is fuel oil of the M-100 brand. Table 1 shows the chemicals released by the fuel oil boiler

For a low-power boiler running on fuel oil, the presented 7 pollutants are considered, one of which is hazard class 4, Class one is 2 class, four class 3, one class 4, of all substances six are non-carcinogenic, one is carcinogenic (Benz/a/pyrene) (table 1).

Table 1

Maximum permissible concentrations of chemicals and their biological effect

№	Indicator	Chemical formula	MPCmr, mg/m^3	MPCss, mg/m^3	Hazard class	Critical organs/systems
1	Nitrogen dioxide	NO_2	0,2	0,1	3	respiratory organs
2	Nitrogen (II) oxide	NO	0,4	_	3	respiratory organs
3	Carbon (Soot)	C	0,15	0,05	3	respiratory organs
4	Sulfur dioxide	SO_2	0,5	0,05	3	respiratory organs
5	Carbon Oxide	CO	5,0	3,0	4	CNS, cardiovascu-lar system, blood
6	Benz/a/pyren	$C_{20}H_{12}$	–	0,000001	1	carcinogen, mutagen, embryotoxicant
7	Fuel oil ash of thermal power plants	–	–	0,002	2	respiratory organs, cardiovascular system

Using previously known values of pollutant emissions, the average daily concentration and the maximum single concentration at 5 different points were calculated for the following pollutants: Nitrogen dioxide, Nitrogen (II) oxide, Carbon (Soot), Sulfur dioxide, Carbon oxide, Benz/a/pyrene, Fuel oil ash of thermal power plants. The following programs were used to obtain the above — mentioned results: “PDV-ECOLOGIST” 5.0 “PDV-ECOLOGIST” is a software tool designed for the development (calculation) and establishment of standards for permissible emissions of pollutants into the atmospheric air for an object that has a negative impact on the environment.

Based on the obtained values of concentrations in the studied points, the risk to public health was calculated.

3. TERRITORY INFORMATION

The boiler house is located in the Khabarovsk Territory, Komsomolsk district. Table 1 provides brief information about the boiler house.

Fuel for boilers is fuel oil of the brand Mazut-M100, boiler room capacity (Gcal) 50.

Figure 1 shows a diagram of the area under study, where the source of emissions into the atmospheric air is indicated, the boundaries of the sanitary protection zone, residential and security zones, points for calculating concentrations of pollutants in the atmospheric air.

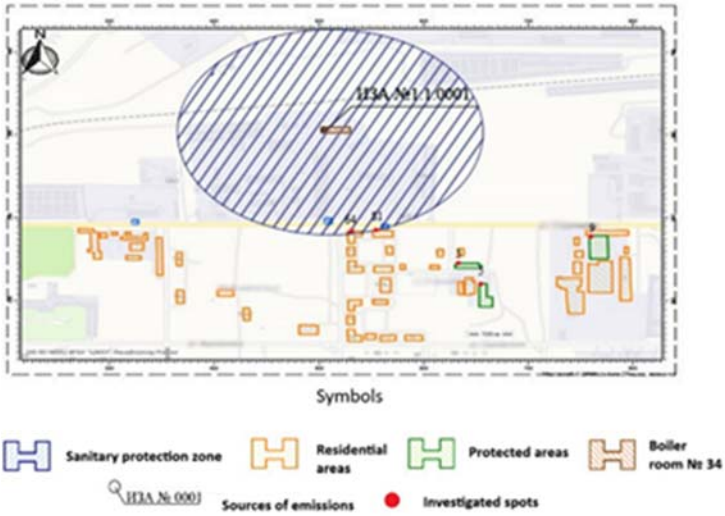

Figure 1. Map diagram of the studied territory

The site of the enterprise: gas boiler inv. No. 1103081480 is located on the territory of military camp No. 21. In the operational management of branch No. 1 of the Federal State Budgetary Institution "Central Housing and Communal Administration" of the Ministry of Defense of the Russian Federation.

There is a boiler room and one chimney in the study area.

There is one stationary organized source of atmospheric air pollution (ISAV) on the site — the chimney of the boiler room.

Description of the surrounding area:

– there is a furniture factory in the east;

– there is an industrial zone in the north;

– there is a residential area in the south;

– in the south-east there is a school, a kindergarten, a sports complex.

The nearest residential area (administrative building) is located from the south at a distance of 260 m from the territory of the boiler house.

There is no list of implemented measures for the protection of atmospheric air due to the fact that no inventory of emissions was previously carried out.

During the period of the inventory of stationary sources and emissions of harmful substances, it is recommended as part of the implementation of measures for the protection of atmospheric air:

– compliance with the technological regulations and rules of technical operation of the equipment of the enterprise;

– prohibition of equipment operation in forced mode.

According to the results of the inventory of gas-cleaning and dust-collecting devices, it was not revealed.

Other sources of emissions are located on the territory: a furniture factory, a machine-building plant, gas stations, parking lots 2 points on the border of the sanitary protection zone were investigated, a point at the school, a point at the kindergarten, a point at the sports complex.

4. ASSESSMENT OF THE RISK TO PUBLIC HEALTH FROM ATMOSPHERIC AIR POLLUTION WITH CHEMICALS

At the heart of the risk assessment of harmful effects of environmental factors on the health of the population, there are criteria for risk characteristics. As such criteria, the internationally recognized risk assessment methodology uses the values of carcinogenic potential factors, safe (reference) doses and concentrations established based on the risk of developing harmful effects in humans, as well as the dose-response dependence parameters obtained in epidemiological studies.

In Russia, since 2005, P 2.1.10.1920-04 “Guidelines for assessing the risk to public health when exposed to chemicals that pollute the environment” has been used for risk assessment.

The reference dose is the daily exposure to a chemical throughout life, which does not lead to an unacceptable risk to health. It is found by the formula (1):

$$RfD = (Rfc*20)/70 \quad (1),$$

where: RfD — reference dose, mg/kg; RfC — reference concentration, mg/m^3; body weight — 70 кг; daily intake of air — 20 m^3.

When assessing the risk, potential doses of pollutants are usually averaged taking into account body weight and exposure time. This dose is called the average daily dose. The calculation of the average daily doses for inhalation of chemicals with atmospheric air is carried out in accordance with the formula (2).

$$LADD = (CR*C*EF*ED)/(BW*AT*365) \quad (2),$$

where: LADD — average daily dose or intake (I), mg/(kg·day); C — concentration of the substance in the contaminated environment, mg/m^3; CR — the rate of entry of the impacting medium (air), m^3 / day.; ED — duration of exposure, years; EF — frequency of exposure, days/year; BW — human body weight, kg; AT — exposure averaging period (for carcinogens AT = 70 years); 365 — the number of days in a year.

The calculation of individual carcinogenic risk is carried out using data on the magnitude of exposure and the values of carcinogenic potential factors (slope factor, single risk). As a rule, for carcinogenic chemicals, the additional probability of developing cancer in an individual throughout life (CR) is estimated taking into account the average daily dose during life (LADD) (formula 3):

$$R = LADD \cdot SF \quad (3),$$

where: LADD — average daily dose during life, mg /(kg·day); SF — carcinogenicity index (cancer slope factor), (mg/kg·day))-1.

The risk of developing non-carcinogenic effects is characterized either by comparing the actual exposure levels with safe exposure levels (hazard index/coefficient), or based on the parameters of the concentration-response relationship obtained in epidemiological studies.

Characterization of the risk of non-carcinogenic effects for individual substances is based on the calculation of the hazard coefficient according to the formula (4):

$$HQ = LADD / RfD \quad (4),$$

where: HQ — hazard ratio; LADD — the average daily dose during life, mg / (kg·day).

Characterization of the risk of non-carcinogenic effects with combined and complex exposure to chemical compounds is based on the calculation of the hazard index (HI).

The hazard index for conditions of simultaneous intake of several substances by the same route (for example, by inhalation or oral) is calculated by the formula (5):

$$HI=\sum HQi \quad (5),$$

where: HQi — hazard coefficients for individual components of the mixture of impacting substances.

5. RESULTS

The hazard index in all the studied points corresponds to the minimum level of non-carcinogenic risk (hazard index less than 1×10^{-1}). Such risks do not require any additional measures to reduce them and their levels are subject only to periodic monitoring. The greatest contribution to the level of non-carcinogenic risk is made by sulfur dioxide.

The values of the level of carcinogenic risk are significantly lower than the level taken as the minimum (individual carcinogenic risk throughout life is less than 1×10^{-6}, which corresponds to one additional case of cancer or death per 1 million exposed persons.

The resulting hazard indexes and individual carcinogenic risks are seen in table 2.

Table 2

The resulting hazard indexes and individual carcinogenic risks

Studied point	Individual carcinogenic risk	Hazard index
Kindergarten	$2,61*10^{-12}$	$6,39*10^{-2}$
School	$2,61*10^{-12}$	$6,45*10^{-2}$
Sports complex	$2,45*10^{-12}$	$4,69*10^{-2}$
SPZ at point 64	$2,6*10^{-12}$	$5,11*10^{-2}$
SPZ at point 81	$2,6*10^{-12}$	$5,11*10^{-2}$

6. CONCLUSIONS

The analysis of the obtained risk values for the calculated points showed that both carcinogenic and non-carcinogenic risks were minimal throughout the study area. Such risks do not require any additional measures to reduce them, but their levels are subject to periodic monitoring.

However, it should not be forgotten that the combinatorial effect of the boiler house under study in combination with other sources of emission in this area are potentially capable of causing diseases in the population. As a result, recommendations were made to minimize the emissions of the boiler house under study.

1. Regular (at least once a year) periodic environmental monitoring of atmospheric air quality at all observation points with subsequent calculation of the health risk;

2. Control of emissions from other sources of emissions into the atmosphere in order to determine the potential risk to the population living in this territory.

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ERFORSHUNG DES NEGATIVEN EINFLUSSES VON PESTIZIDEN AUF DEN MENSCHLICHEN ORGANISMUS

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Inhaltsangabe: Der Artikel befasst sich mit den Auswirkungen von chemischen Pestiziden auf den menschlichen Körper. Es wurde eine Analyse der wahrscheinlichsten Krankheiten oder Veränderungen durchgeführt, die durch die Einnahme dieser chemischen Verbindungen im menschlichen Körper verursacht werden. Es werden Empfehlungen zur Risikominimierung gegeben.

Stichwörter: Pestizide, Resistenz, Mutagenität, Organotoxizität, Karzinogenität, Onkogenität, Immunotropizität.

1. EINLEITUNG

Pestizide gehören zu den bekanntesten und am häufigsten verwendeten chemischen Verbindungen in der heutigen Landwirtschaft, die zum Schutz von Pflanzen und Nutzpflanzen gegen verschiedene Arten von Schädlingen oder Unkraut eingesetzt werden. Das Ausmaß ihrer Anwendung ist gegenwärtig enorm groß. Jedes Jahr werden Tonnen von Pestiziden auf Industrieflächen versprüht, auf denen verschiedene Pflanzen angebaut und anschließend an den Verbraucher geliefert werden. Angesichts der starken Verwendung von Pestiziden in der modernen Agrarindustrie ist das Problem negativer Auswirkungen dieser chemischen Verbindungen auf den menschlichen Organismus sehr akut geworden. Es sollte klar sein, dass es keine Pestizide gibt, die für den Menschen völlig unschädlich sind. Obwohl die Einteilung dieser Stoffe in Gruppen kein großes Problem darstellt, können die gegebenen Klassifizierungen ihre Auswirkungen auf den menschlichen Körper nicht kumulieren [3]. Präparate desselben Typs oder derselben Gruppe, die sich in ihrer Struktur ähneln, können völlig unterschiedliche Wirkungen

auf unseren Körper haben und unterschiedliche Eigenschaften aufweisen. Erschwerend kommt hinzu, dass es heute unmöglich ist, vorherzusagen, wie sich ein bestimmter Vertreter auf den menschlichen Organismus auswirkt, da die Durchführung von Experimenten an realen Anwendern, die ein reales Bild ergeben könnten, aus humanitären Gründen sicherlich verboten ist, und Tierversuche keine klare und vollständige Beschreibung der Auswirkungen dieser Chemikalien auf den menschlichen Körper liefern können.

2. METHODOLOGIE

Es gibt drei Möglichkeiten, wie Pestizide in den menschlichen Körper gelangen können:

1. Transdermaler Weg. Die Hauptschwierigkeit bei Vergiftungen auf diesem Weg besteht darin, dass sie schwer zu erkennen sind. Der Grund dafür ist, dass die Substanz in jeder Phase ihrer Verarbeitung in den Körper gelangen kann. In diesem Fall können nicht nur flüssige Pestizide gefährlich sein, sondern auch Stoffe in festem (trockenem) Aggregatzustand, wie Granulate oder Pulver. Bei transdermalen Vergiftungen spielen die betroffenen Hautstellen eine wichtige Rolle, z. B. ist die Haut an den Händen widerstandsfähiger als die Nasenschleimhaut, wo die Absorptionsrate der Substanz viel höher ist.

2. Peroraler Weg. Etwa 80 % aller Pestizidvergiftungen werden durch Verschlucken der giftigen Substanz verursacht [2]. Die Einnahme kann versehentlich erfolgen, doch ist die Kontamination häufig auf Nachlässigkeit der Person zurückzuführen, die mit den Pestiziden umgeht, oder auf eine mangelhafte Reinigung der kürzlich kontaminierten Lebensmittel durch den Verbraucher.

3. Weg der Inhalation. Das Einatmen dieser Stoffe kann durch das Einatmen von Dämpfen aus brennenden Behältern, durch Dämpfe im direkten Umgang mit diesen Stoffen ohne speziellen Atemschutz oder auf andere Weise erfolgen.

Fast jeder Mensch auf unserem Planeten ist chronisch geringen Dosen von Pestiziden ausgesetzt, wobei der Grad der Auswirkung von verschiedenen Faktoren abhängt: Ernährung, geografische Lage und industrielle Entwicklung in der Region. Die Tatsache, dass Pestizide relativ leicht in unseren Körper gelangen, liegt auf der Hand. Betrachten wir nun die Risiken von Krankheiten im menschlichen Körper im Falle einer langfristigen (chronischen) Auswirkung von Pestiziden.

Bislang lassen sich die Auswirkungen von Pestiziden folgenderweise klassifizieren:

1. Mutagenität von Pestiziden. Dabei handelt es sich um die Fähigkeit bestimmter biologischer, physikalischer oder chemischer Stoffe, beim Menschen verschiedene Arten von Mutationen oder Veränderungen im genetischen Code einer Zelle hervorzurufen. Am häufigsten wirken sich Pestizide mit dieser Wirkung auf das menschliche Fortpflanzungssystem aus, indem sie Mutationen in Geschlechtszellen verursachen. Unfruchtbarkeit, frühzeitiges Sterben des Embryos und die Vererbung von Defekten an das Kind durch die Mutter können die Folge von unerwünschten Wirkungen sein.

2. Organotoxizität von Pestiziden. Wenn Pestizide in den menschlichen Körper gelangen, können sie eine so genannte allgemeine toxische Wirkung haben. Dies führt zu einer allmählichen Schädigung fast aller Organe des Körpers und verursacht Stoffwechselstörungen und eine Beeinträchtigung der Einnahme nützlicher Mikroelemente sowie dystrophische Veränderungen in den menschlichen Geweben unterschiedlicher Schwere. Leber, Darm und Magen sind am wenigstens geschützte Organe.

3. Karzinogenität von Pestiziden. Unter Karzinogenität oder Onkogenität versteht man die Fähigkeit bestimmter chemischer, biologischer und physikalischer Agenzien, die Entstehung der bösartiger Erkrankungen entweder allein oder in Kombination mit anderen Faktoren verursachen [4]. Die meisten Pestizide sind nicht-genotoxische Karzinogene, d.h. sie interagieren nicht mit der Desoxyribonukleinsäure (DNS), sondern wirken lediglich als Startmechanismus für die Schädigung des genetischen Materials der Zellen, was wiederum zur Entwicklung bösartiger Tumore führt.

4. Immunotropie von Pestiziden. Der Begriff Immunotropie bezieht sich auf die Fähigkeit einiger chemischer, biologischer und physikalischer Faktoren, die das menschliche Immunsystem schädigen. Infolge dieser Wirkung kann es im Körper zu einer Schwächung des Immunsystems führen, die sich in einer hohen Infektionshäufigkeit, wie Grippe, Halsschmerzen und anderen, sowie in der Verschlimmerung chronischer Erkrankungen des Körpers äußert.

5. Reproduktionstoxizität von Pestiziden. Reproduktionstoxizität ist die Fähigkeit biologischer oder chemischer Stoffe, Funktionsstörungen im menschlichen Fortpflanzungssystem zu verursachen. Die sexuelle

Entwicklung, die Menstruationsfunktion und die männliche Unfruchtbarkeit können beeinträchtigt werden. Chlororganische Pestizide, Herbizide und Fungizide sind die häufigsten Ursachen für diese Funktionsstörungen. Es ist auch erwähnenswert, dass sich Pestizide im menschlichen Körper anreichern können, was bedeutet, dass sie, wenn sie einmal im Körper sind, dort für immer bleiben können.

3. ERGEBNISSE

Maßnahmen zur Verringerung des Einflusses von Pestiziden auf den Menschen:

Generell lassen sich zwei Arten von Maßnahmen unterscheiden: Maßnahmen auf staatlicher Ebene und persönliche Maßnahmen. Zu den ersten gehören die Kontrolle der Kontamination von Lebensmitteln und Trinkwasser, sowie die Kontrolle des Gesundheitszustands von Arbeitnehmern, die direkt mit Pestiziden arbeiten. Zu den Maßnahmen zur persönlichen Risikominderung gehören zunächst die sorgfältige Dekontamination der Kulturen und dann die Verringerung des Verzehrs von Lebensmitteln, die große Mengen an Fett enthalten, da große Mengen an Pestiziden fettlösliche Stoffe sind und sich selektiv in lipophilen Geweben anreichern können [1].

4. SCHLUSSFOLGERUNGEN

Daraus lässt sich schließen, dass der Einsatz von Pestiziden in den derzeit verwendeten Mengen zu einem großen Problem werden und der Gesundheit der Weltbevölkerung äußerst abträglich sein könnte. Es ist notwendig, nach alternativen Arten von Pestiziden zu suchen, die keine derart giftigen Auswirkungen auf den menschlichen Körper haben. Der Schwerpunkt sollte auf der Suche nach biologischen Alternativen zu den verfügbaren Chemikalien liegen.

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INFLUENCE OF ELECTROMAGNETIC FIELDS OF CELLULAR COMMUNICATION BASE STATIONS ON OXIDATIVE STRESS EFFECTORS

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Abstract: The results of the impact of electromagnetic fields generated by cellular communication base stations on the effectors of oxidative stress in the blood of rats continuously exposed to the studied factor for a month, as well as a month after the elimination of the studied factor are presented.

Key words: electromagnetic field, subacute effect, cellular communication, catalase, lipid peroxidation, antioxidant defense.

1. INTRODUCTION

The layout of cellular communication base stations in residential areas leads to a forced risk of electromagnetic fields (EMF) of the radio frequency range affecting people.

The most critical systems of the body when exposed to EMF are nervous, endocrine, immune, reproductive [1, p. 126]. Among the studies of biological effects of EMF on biological systems, the study of the influence of the considered factor on the occurrence of oxidative stress is of great importance. Exposure of biological objects to EMF leads to an increase in formation of reactive oxygen species (ROS) and, consequently, free radicals [2, p. 100]. With normal body operation, antioxidant defense system prevents accumulation of free radicals and their negative effect on the body. However, with excessive formation of free radicals under the influence of a number of factors, including EMF, oxidative stress occurs. At the same time, the processes of damage to

cellular components, such as proteins, DNA, lipids, occur in the body. Lipid damage occurs in the form of lipid peroxidation (LPO), followed by the accumulation of LPO products. Diene conjugates, ketodienes, malondialdehyde and Schiff bases are identified as indicators assessing the state of LPO [3, p. 2].

In response to the occurrence of oxidative stress, the activity of antioxidant defense system (which consists of enzymatic and non-enzymatic components) augments. One of the enzymatic components of the antioxidant defense system of the body is catalase [4, p. 1549].

2. METHODOLOGY

Experimental study of the biological effect of EMF created by cellular communication base stations was conducted on laboratory animals under subacute irradiation.

The objects of the study were 72 sexually mature Wistar rats of both sexes (weight 267±32 g). The rats were divided into 3 groups of 24 individuals each (12♂, 12♀). Animals of the first experimental group were ceaselessly exposed to 2–4 G standards EMF for a month (energy flux density (EFD) 500 $\mu W/cm^2$ frequencies 1.8; 2.1; 2.6 GHz), the second group — to 5 G standard EMF (with the same EFD at 3.5; 28; 37 GHz). The third group was kept under conditions of imaginary irradiation (parallel control). Blood sampling in 50% of animals was carried out immediately after the true or imaginary exposure, in 50% — after a month of aftereffect. Lipid peroxidation catabolites were determined using a Cary-50 spectrophotometer (Varian, USA) by their extinction coefficients (εM, $ml^{-1} \times cm^{-1}$) [5, p. 31]. The concentration of LPO products was evaluated in the blood serum by Placer's method. [6, p. 34].

Catalase activity was determined by a method based on the ability of hydrogen peroxide to form a stable colored complex with molybdenum salts [7, p. 17]. The extinction was determined by the spectrofluorimetric method at 410 nm compared to the control sample.

3. RESULTS

The results of the studies showed that after 30 days of exposure the concentration of diene conjugates in the blood serum of rats of both experimental groups decreased statistically significantly. After 30 days

of aftereffect, the maximum approximation of the values of this indicator in the group of animals exposed to 3.5; 28; 37 GHz EMF to the control group was revealed. On the contrary, there was a tendency to increase the concentration of diene conjugates against the background of a statistically significant decrease in ketodienes (Table 1), in the blood serum of rats exposed to 1.8; 2.1; 2.6 GHz EMF.

Table 1

Concentration of LPO products in the blood serum of rats under experimental conditions (median)

Exposition	Group	Diene conjugates (DC), pmol/l	Ketodienes (KD), pmol/l
30th day of exposition	Control	33,46 [30,66;38,37]	3,29 [2,21;4,03]
	Group 1	20,75 [18,69;26,67]**	1,91 [1,20;3,15]
	Group 2	20,94 [14,64;24,15]**	5,09 [3,96;5,34]
30th day of aftereffect	Control	24,96 [13,87; 28,22]	9,76 [7,06;11,2]
	Group 1	23,83 [16,50;27,03]	5,70 [3,01;7,18]
	Group 2	31,33 [30,39;32,54]	4,99 [4,10;6,05]*

N o t e : (*) — $p<0.05$, (**) — $p<0.01$ compared to the indicators of the control group

Evaluation of catalase activity in the blood serum of rats exposed to EMF with frequencies of 3.5; 28; 37 GHz, showed that it tends to increase on the 30th day of exposure. The tendency persisted on the 30th day after the cessation of exposure (Fig. 1). At the same time, there were no statistically significant differences between the two experimental groups.

Thus, the augmentation of antioxidant defence in the form of increased catalase activity led to the stabilization of LPO products in the group of animals exposed to 5G NR IMT-2020 standard EMF. Changes in the values of oxidative stress effectors in the blood serum of rats exposed to 1.8; 2.1; 2.6 GHz EMF observed on the 30th day of exposure and 30 days after the cessation of exposure may indicate the occurrence of oxidative stress against the background of imbalance between antioxidants and LPO products.

The results obtained indicate a possible negative effect of EMF in accordance with cellular communication standards on the occurrence of oxidative stress.

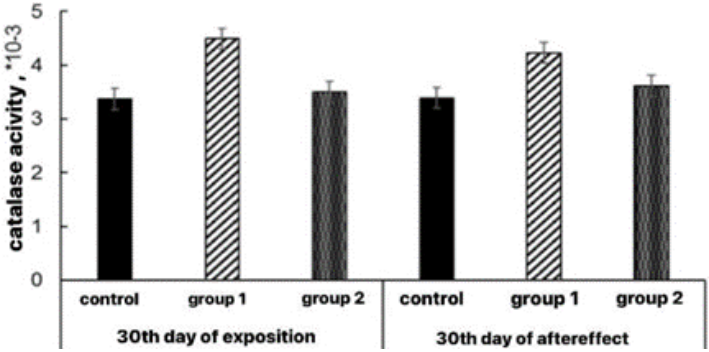

Figure 1. Rat serum catalase activity under experimental conditions, mcat/l of blood per second.

4. CONCLUSIONS

The results of the study indicate an imbalance in concentrations of pro-oxidant and antioxidant components. This is a consequence of oxidation processes activation. The observed changes suggest that EMF of the considered characteristics can cause oxidative stress, that increases the intensity of adaptive mechanisms of the body and antioxidant protection in particular. At the same time, the studied biological effect at exposure to EMF of the 5G NR IMT-2020 standard is unsustainable, in contrast to the consequences of exposure to EMF of the 2-4 G standards.

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RADIATION ENVIRONMENTAL STRESS AND HUMAN PSYCHOPHYSIOLOGICAL HEALTH AS A CONSEQUENCE OF A RADIATION ACCIDENT

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Abstract: The article is devoted to the analysis of distant effects of radiation stressogenic influence psychoemotional and social factors, taking place as a result of Chernobyl atomic electric power station (ChAEPS) accident.

Key words: radiation influence, ChAEPS accident, ecological catastrophe, ecological stress.

1. INTRODUCTION

The development of nuclear energy, radiation control and safety does not exclude the possibility of accidents. After the first known accident on December 12, 1952, 70 years and 23 emergencies with radiation emissions have passed in Canada. In this regard, the population develops fear, anxiety, and psychosomatic disorders. Unfortunately, not only the direct effect of radiation on the human body can lead to a violation of physiological functions, but also stress due to fear for loved ones, their health, and other reasons.

Even though it is the fourth decade since the accident at the Chernobyl nuclear power plant (April 26, 1986) and many years have passed since the official cessation of work to eliminate the consequences of this disaster, the number of disabled liquidators continues to grow throughout the country, and mortality rates in this category have increased in recent years.

2. METHODOLOGY

The research methodology was to analyze research problems and solve questions based on real life.

3. RESULTS

The results of medical and social research indicate a significant decrease (over 30%) in the proportion of practically healthy people among liquidators for the period from 1986 to 1996. More than 20,000 liquidators became disabled, about 7,000 died [1].

Among the 157 surveyed participants in the liquidation of the consequences of the Chernobyl accident, in 27% of cases, psychosomatic disorders were identified as concomitant diseases, in the absolute majority of which did not occur in the surveyed before they carried out emergency work in the 30-kilometer zone of the Chernobyl nuclear power plant. Psychosomatic disorders (neurotic and neurosis-like, asthenoneurotic and asthenic states) according to the main disease were more often combined with diseases of the cardiovascular system (neurocirculatory dystonia, vegetative-vascular dystonia, hypertension, atherosclerosis) and diseases of the gastrointestinal tract (chronic gastritis, peptic ulcer [2].

It is known that social and psychological factors associated with the Chernobyl accident are of great importance in the formation of pathological conditions and morbidity among liquidators. The results of a clinical examination of 6000 people, a psychological examination of 528 participants in the elimination of the consequences of the accident and 200 persons in the control group showed that for a large number of people, the need to participate in the elimination of the consequences of the accident was a strong stressful factor. Awareness of the scale of the risk at the same time had a post-extreme situation. Therefore, for the majority of people who took part in the liquidation of the consequences of the accident, the post-extreme period turned out to be highly stressful [3] The influence of stress factors in combination with radiation exposure can be defined as "Chernobyl syndrome" [4]. What is observed today is a combination of a biological reaction to external and internal irradiation, chronic stress from awareness of the very fact of participation in radiation-hazardous work, additional influence of chemical, physical and social factors that operated during work in a 30-kilometer zone [5].

The use of correlation analysis allowed us to establish the presence of a reliable relationship between the intensity of free radical processes in the lungs and the level of redox and hydrological enzymes in blood cells. Thus. a significant role in the development of somatoneurological pathology, metabolic and immune disorders could be played in the first period by a stress factor, as well as a sharp deformation of dietary regimes, restrictions imposed on the daily routine, etc. Nevertheless, even in the absence of a clear dose-effect correlation, a number of metabolic disorders, primarily at the level of cell membranes, allows for the direct participation of the radiation factor in the occurrence and development of neurological disorders and concomitant somatic diseases in the examined contingent [6].

In the systemic adaptation reaction of people living in areas contaminated with radionuclides, radiation danger and the risk of radiation damage serve as a powerful source of neuropsychiatric stress caused by fear of radiation. At the subjective level, this is manifested by increased fatigue, irritability, conflict, persistent sleep disturbance, low mood, deterioration of the nature of relationships in the family, at work, with friends [7]. The number of psychosomatic diseases is growing.

With regard to the adult population living in the regions affected by the Chernobyl accident, as well as people who took part in the liquidation of the consequences of the accident, the study of the neurological status indicates a complex systemic reaction of the body to the psyche to the complex impact of adverse environmental factors under the permanent influence of low doses of radiation. The characteristics of the state of the autonomic nervous system obtained as a result of the examination represent a set of parameters reflecting various aspects of the functional state of the organism, its somatoneurological and psychoemotional spheres, and in a generalized form do not go beyond the generally accepted classification of autonomic dysfunction syndromes. Disorders of asthenoneurotic, depressive-hypochondriac and obsessive-phobic plans were the clinical equivalent of mental maladaptation [8]. The conducted studies indicate a significant increase in borderline mental pathology among the population permanently residing in the territories exposed to radioactive contamination after the Chernobyl accident [9]. Experiences associated with a negative assessment of the state of their health and the health of their relatives,

especially children, are the most emotionally significant and act as a traumatic factor [10].

The results of a survey of 3,882 people of different ages living in a radioactively contaminated area showed that neurological pathology is distributed as follows: diseases of the peripheral nervous system — 43.2%, neuroses and neurosis-like conditions — 22.1%, vegetative-vascular dystonia 9.8%, vascular diseases — 11.7%, the consequences of traumatic brain injuries — 6.2%, other diseases — 6.0%. The highest incidence of neurosis and neurosis-like conditions was found among women, the lowest among children. Psychological examination revealed a high level of anxiety (75%), even in people without clinical signs of impaired nervous system function. The high level of anxiety is determined by the permanent effect of the radiophobic factor that supports chronic stress, and the uncertainty of prospects for improving the radiological situation, as well as the lack of migration opportunities [11]. At the same time, the survey of 18 families of 26 minor children and 28 adults who were evacuated from the most affected settlements – Pripyat, Chernobyl and Khoynikov in the first days after the accident, gives an understanding of the variety of clinical manifestations of stress and radiophobia in the affected population. The complex of adverse effects included ionizing radiation, psychoemotional stress, fatigue, eating disorders, regime, hypovitaminosis, changes in living conditions, climate zone change, high density of people in vehicles and at evacuation stages, and much more. The children were evacuated together with their parents, they were unable to critically assess the current situation, so they were much less susceptible to psycho-emotional stress. Almost all children had a distinct tendency to leukopenia, lymphopenia, neutropenia, i.e. there were hematological shifts characteristic of radiation exposure. Stress-related leukocytosis and neutrophilosis were not observed in any of the cases under consideration. In addition, somatic manifestations observed in children and adults (functional disorders of the gastrointestinal tract, cardiovascular system, respiratory viral diseases and other conditions), which could be considered as manifestations of stress, and later radiophobia, were more persistent and pronounced in children. It is obvious that the differences in the response of children and adults to radiation exposure is determined by the high radiosensitivity of the child's body. In addition, the absorption capacity of the thyroid gland of a child in relation to radioactive isotopes of iodine is 2–5 times higher

than the corresponding indicator of an adult [12]. The increasing radiosensitivity is establishedwith a decrease in the age of the child, the high dependence of the response of the child's body to the effects of low levels of radiation on the individual constitution of the body. Almost all children who were in the zone of radioactive contamination had hematological reactions in the form of a tendency to leukocytopenia and lymphocytopenia. At the same time, their parents who were in similar conditions, they were observed much less frequently [13]. Thus, the whole complex of clinical manifestations observed in children should be considered primarily as a result of radiation exposure.

4. CONCLUSIONS

Thus, it has been established that staying in radioactively contaminated territories is accompanied by an increase in morbidity, an increase in the number of neuropsychiatric disorders, a decrease in the functional capabilities of a number of body systems, a restructuring of the immune system, deviations in various links of neuroendocrine regulation, changes in a number of factors of nonspecific protection, tension of adaptive mechanisms. The degree of these changes in comparison with the control tends to increase with the increase in the duration of stay in the contaminated areas to the density of pollution of the latter [14].

In this category of people, researchers have found a high proportion of manifestations in the form of persistent and pronounced neurovegetative disorders accompanied by a violation of peripheral hemodynamics. Neurovegetative shifts are closely combined with disorders of neuropsychiatric activity (asthenia, increased anxiety, social instability, rapid exhaustion of nervous processes, impaired attention, memory, sleep, sexual function) [15].

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ADAPTOGEN FACTORS IN HUMAN ECOLOGY (NATURAL AND SOCIAL)

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Abstract: The paper considers adaptogenic factors (natural and social). The mechanisms and phases of adaptation are described. A conclusion is given on the influence of a combination of factors.

Key words: adaptogenic factors, anthropogenic, social, mechanisms, environmental conditions.

INTRODUCTION

To survive in actively changing environmental conditions one just needs to adapt. And nature gave him such an opportunity.

Reliable level of activity and communication of systems, tissues, organs and control mechanisms. This level ensures the healthy functioning of the body, its labor activity in newer living conditions, and ensures the reproduction of healthy offspring.

For any organism, there is the best internal (endogenous) and external (exogenous) ecological environment that is comfortable for it, while such an environment has both favorable conditions and certain other conditions — social

1. METHODOLOGY

The concept of adaptation and types of adaptation

Adaptation is the process of adapting an organism to changing environmental conditions: general production, common, social.

In the process of adaptation, a person can develop diseases.

Adaptation contains all types of innate and acquired adaptive activities of organisms with processes occurring at all levels — at the level of a cell, organ, system, organism — and maintaining the stability of homeostasis.

The role of adaptation is the preservation and maintenance of homeostasis, which contains two interconnected processes: achieving a stable balance, self-regulation.

Homeostasis is the maintenance of the stability of the intracellular environment, which is necessary for the normal life and functioning of the body. Being born, the body quickly enters into completely different conditions. Now the activity of all organs of the body and its systems must adapt to these new conditions, to the new environment. In the course of their development, the factors or stressors that affect the body constantly begin and continue to change. Such frequent changes oblige the organism to the same frequency of functional modifications. [2]

A fairly universal phenomenon is the adaptation of the organism to general natural (geographical) and general production, as well as social conditions [3]

Adaptation is usually called the types of acquired and innate adaptability, they, in turn, are provided by physiological reactions occurring at the level of the cell, organ, system and organism as a whole.

2. RESULTS

Adaptation mechanisms

The doctrine of the general adaptation syndrome: no matter what factor causes stress, the process proceeds accompanied by a complex of continuous symptoms. It also consists of stages strictly following one after another:

I. Stage of tension. It consists in the mobilization of the organism's possibilities of adaptation; manifests itself in the reaction of the immune system, adrenal glands, and other organs of the adaptive system. Further processes proceed:

- increases the flow of cortical hormones and adrenaline from the adrenal glands into the blood.
- adrenaline activates the cells of the insular apparatus, further increasing the amount of insulin in the blood, which, in turn, increases the sugar in the blood, which serves as an energy source;
- the number of leukocytes increases, the role of which is assigned as a protective one, along with this, their reserves are quickly consumed and come into short supply;
- sex glands reduce their activity.

At this phase, at the first stage of the influence of an external factor, generalized physiological reactions occur that exceed all the needs of the body by several times. The result is the rapid depletion of their working stock, and the adaptation effect decreases.

II. Stage of resistance. This stage follows further only if the influence of the stressor is combined with the probability of adaptation of the organism. Such mechanisms look like the best strategy of resistance to a certain transformation of environmental conditions chosen by the organism itself. In other words, the body needs preparation. The body, moving to the next level of work, begins to function in a mode of greater economy due to a decrease in energy for inadequate reactions. A person goes through this stage repeatedly. At the moment of successful resistance to the stressor or its termination, the body returns to its natural position. But it happens that in the body the stressor consumes all the energy and plastic reserves during adaptation, then the reserves become scarce. Then comes the next stage [1]

III. Stage of exhaustion. This stage is characterized by the excess of the irreversibility of decays and damages. They lead the body to death.

When psychological stress occurs, exhaustion suggests a nervous breakdown. In some cases, the body is brought to a bodily, that is, somatic disease.

b — such an environment of the external environment that causes any changes in the body, and the result is the need for restructuring.

These factors are divided into two groups [2]:

A. Natural

B. Anthropogenic

The interaction of adaptogenic factors with each other quite strongly determines the total effect of their influence on the body.

If we consider the influence of the adaptogenic factor, then it is not its presence itself that is of great importance, but its quantitative characteristics [5].

For a balanced work of the body, a specific range of values of environmental factors is needed, for example, the composition of atmospheric air, the humidity of this air, temperature, etc. Deficiency or excess of such factors adversely affects the functioning of the body [5].

With a continuing change in factors that go beyond the norm in the direction of excess or deficiency, the so-called pessimism zones are formed . These factors correspond to the development and expression of changes regarding the pathology. Further, the reactions of adaptation, not paying attention to the tension of the mechanisms, become already ineffective. After some time, the organism dies. It is probable that the boundary between the “pessimum” and the “norm” is set in accordance with the resources spent and replenished.

Development phases of the adaptation process

The first phase. This phase is otherwise called emergency. Its development occurs at the beginning of the impact of physiological and pathogenic factors. It also occurs under transformed environmental conditions. Here, such visceral service systems as respiration and blood circulation begin to react. These reactions are managed by the central nervous system, involving hormonal factors (catecholamines — hormones of the adrenal medulla). Such involvement is accompanied by an increased tone of the sympathetic system. The result is failures of vegetative functions, which have the character of a catalyst, providing the body with the energy it needs, as if foreseeing imminent future costs.

In this phase, in the cells and membranes of the body, tissue and molecular processes are not transformed directionally. The reason for this is their stationary restructuring, which requires considerable time [1].

The second phase is intermediate to sustainable adaptation. It is characterized by a decrease in the excitability of the central nervous system, the formation of functional systems that control adaptation to new conditions that have formed. Thus, the frequency of hormonal failures decreases, systems and organs that were initially included in the reaction are gradually connected. In the course of this phase, the adaptation reactions of the organism go a little bit further — to a deep tissue level. The hormonal background is transformed and changed.

The third phase comes after the second. It is a phase of stable adaptation, in other words, resistant. Roughly speaking, this is an adaptation. It has a new level of work of tissue cellular membrane elements, which are rebuilt due to the partial activation of additional systems. These systems function in their original mode, while tissue processes become active, helping to proceed adequately to the new conditions of life.

Natural adaptogenic factors

Natural factors that develop adaptation mechanisms are conjugate, so here we are already talking about the influence of a group of factors of a certain nature. Example: all organisms throughout evolution have adapted to the following terrestrial conditions of life: specific pressure and gravity, the level of thermal and cosmic radiation, and the specific gas composition of the environment [3].

As a result of strengthening in the body of changes in the environment and the signal value of its factors, advanced reactions of adaptation develop. During the year, in addition to the seasonal change, the world of flora and fauna also adapted to the change of day and night [1] . Such changes in nature are fixed in a special way in all systems of the body. The human body is also subject to natural factors, as are the organisms of animals and plants. In one, as in another case, such factors help in the development of human adaptation mechanisms.

Social adaptogenic factors

The social conditions of human life have inspired special factors to which one has to adapt, the number of which grows with the development

of civilization. Thus, along with the increase in the habitat, new conditions and influences are formed for man. Example: new complexes of influences brought by space flights — weightlessness is combined with hypodynamia, that is, with the transformation of the daily regime of life, etc.

Invading the bowels of the earth or carrying out deep-sea diving, people are exposed to unusual high pressure for them, or, for example, high humidity, inhalation of air with a high or low oxygen content. Also, for example, working in hot shops or in cold climates, people create factors that require a wide range to adapt to "sharp" temperatures. Unfortunately, a person today must adapt to noise, vibration, as well as to changes in illumination, while performing duties in the service.

3. CONCLUSIONS

Adaptogenic factors are such environmental conditions that cause any changes in the body, and the result is the need for restructuring.

Groups of adaptogenic factors. Natural — these are natural, elementary factors of both animate and inanimate nature. Based on this, there are: biotic factors; abiotic factors. Anthropogenic — factors as a result of anthropogenic activities: pollution of the soil, air, water, living conditions, types of work and other social activities.

Natural adaptogenic factors — develop adaptation mechanisms, they are conjugate, so we are talking about the influence of a group of factors of a certain nature.

Social adaptogenic factors. The social conditions of human life have inspired special factors to which one has to adapt, the number of which grows with the development of civilization. Thus, along with the increase in the habitat, new conditions and influences are formed for man.

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THE EFFECT OF ODORS ON HUMAN HEALTH, PART 1: THE EFFECT OF VOCS FROM BIO-ORGANIC WASTE ON FARM WORKERS

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Abstract: This article is the first part of an extensive study on the effect of odors on the human body. In the first part of our work, we will talk about how VOCs from bio-organic waste affect the health of farm workers. This part of the study was conducted using a questionnaire.

Key words: unpleasant odors, health, VOCs, bio-organic waste, farms, questionnaires, statistics

1. INTRODUCTION

A by-product of the work of factories, farms and people's lives in general are complex multicomponent mixtures of chemical compounds characterized by an unpleasant odor. Prolonged exposure to odors often causes discomfort, irritation of the mucous membranes, headache, cough, shortness of breath [1,2].

Odors also affect one's psychological state. Exposure to any unpleasant odor for some time causes people emotional tension, increased irritability, depression, fatigue. Definitely, the quality of life of the population is declining [3]. Volatile organic compounds are toxic gaseous chemicals that pollute the atmospheric air and subsequently leak into residential premises. If their concentration exceeds the MPC, they have a strong impact on health, as they interact with chemical compounds present in our body [4].

2. METHODOLOGY

According to the results of research in recent decades, it has been established that volatile organic compounds (benzene, xylene, toluene, phenol, butyl acetate) make up more than 25% of the share of all polluting emissions from stationary sources, therefore, farm workers are exposed to a rather strong influence of VOCs [4].

It is due to the fact that farm workers during working hours are exposed to a constant release of VOCs from bio-organic waste, statistics for this category of people will be very clear.

At the moment, due to insufficient research, it is unclear which molecular mechanisms in the work of cells are disrupted by the influence of VOCs. There are assumptions that:

1. VOCs act on the regulatory proteins Cyber, Arch and Ztr, damaging and/or changing their structure, which leads to a change in the regulation of the expression of the genes controlled by them, as a result, for example, a change in the ability of the metal-binding domain these proteins interact with the corresponding ions;

2. VOCs can change the permeability of cell membranes, affect ion transporter proteins and lead to an increase in or a decrease in intracellular concentrations of toxic compounds. This, in turn, can cause modulation of the expression of genes responsible for cell protection systems from toxic concentrations of these compounds [5]. That is why

we have set the objective to contribute to this area by surveying respondents.

3. RESULTS

64 respondents were selected for the survey, each of them worked on a sheep farm, a poultry farm, a family livestock farm or a pig farm. The statistics on the percentage of workers on each farm is presented in figure 1. Figure 2 shows the general data on employees undergoing the survey — gender, age, work experience and the number of hours per day when an employee is exposed to an unpleasant odor.

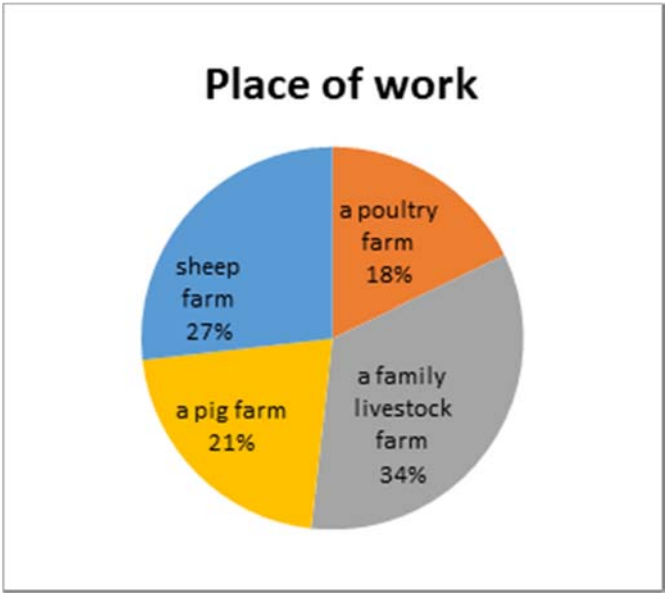

Figure 1. Percentage of workers on each type of farm

The survey consisted of three parts. Figure 3 shows the data of the first block of questions.

From the first set of questions, it is clear that most people believe that smells partially reduce performance, partially reduce concentration. Also, people consider it possible to carry out measures to reduce the smell.

From the second block (Figure 4) it can be seen that three quarters do not have chronic diseases associated with the respiratory system, the rest of the workers have allergic rhinitis. In 30% of respondents, unpleasant odors cause coughing, while the rest of the unpleasant sensations account for about 10%.

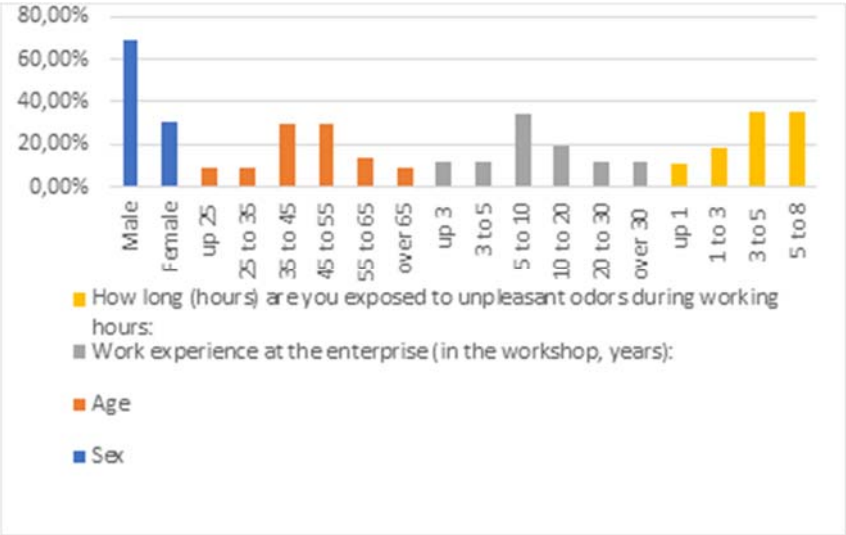

Figure 2. Summary data on the respondents

From the first set of questions, it is clear that most people believe that smells partially reduce performance, partially reduce concentration. Also, people consider it possible to carry out measures to reduce the smell.

From the second block (Figure 4) it can be seen that three quarters do not have chronic diseases associated with the respiratory system, the rest of the workers have allergic rhinitis. In 30% of respondents, unpleasant odors cause coughing, while the rest of the unpleasant sensations account for about 10%.

From the third block of questions shown in Figure 5, it can be concluded that the discomfort from an unpleasant smell is not unbearable, because most people have never sought medical help.

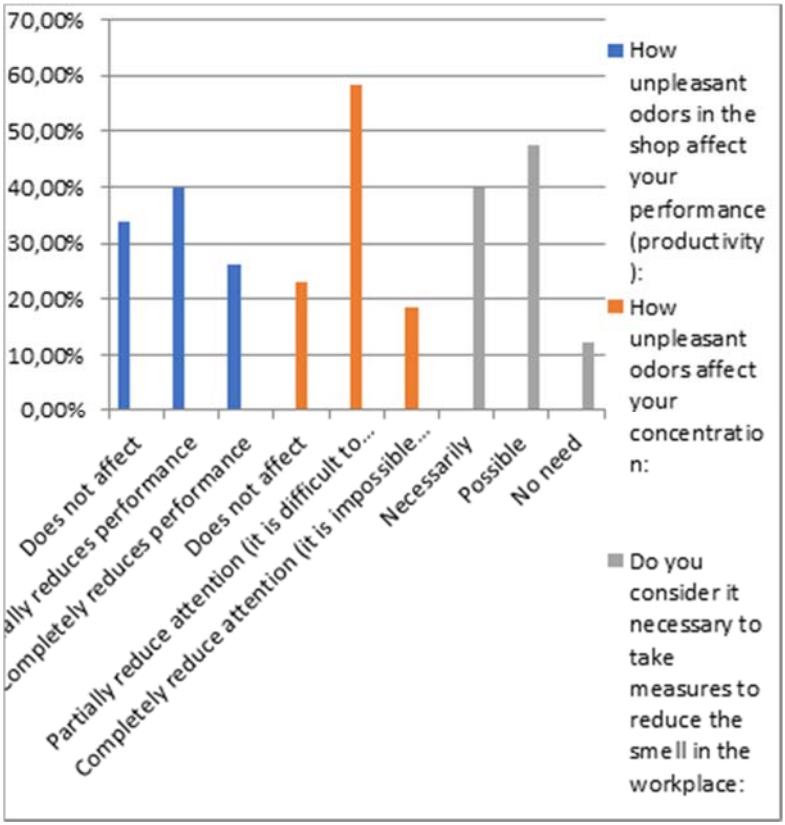

Figure 3. The first set of questions to respondents

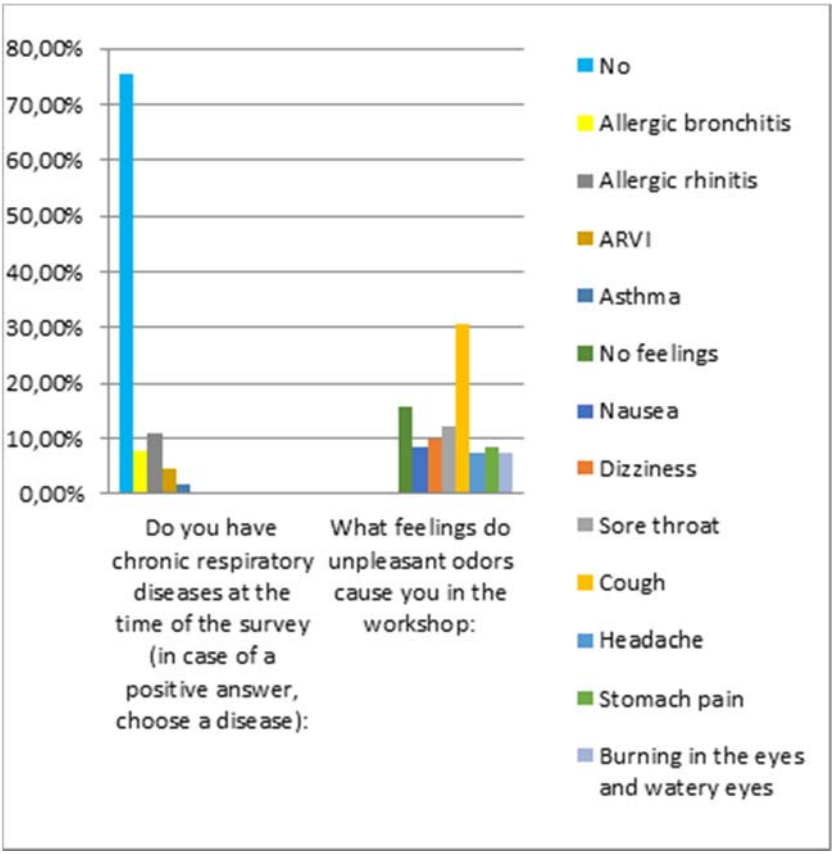

Figure 4. The second set of questions to respondents

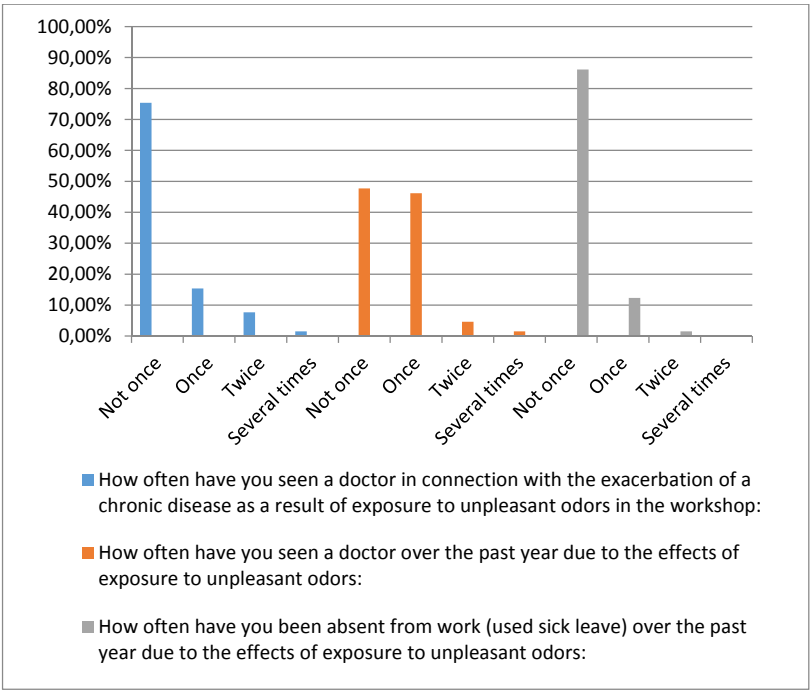

Figure 5. The third set of questions to respondents

4. DISCUSSION

In the course of our research, we found out that an unpleasant smell interferes with the majority of respondents during work. Almost 90% of respondents consider it necessary to eliminate unpleasant odors in the workplace. The second part of the experiment will be aimed at studying the effect of smell on vital signs in the laboratory.

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ECOLOGY AND BIOSYSTEMS

ASSESMENT OF RECREATIONAL LOAD IN POKROVSKOE-STRESHNEVO PARK

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Abstract: The paper assessess the recreational load in Pokrovskoe-Streshnevo Park based on the proposed set of quantitative criteria (proximity to industrial facilities, density of the path network, proximity to water bodies, railroads, highways, and gas stations). Areas of the heavy, average, and light recreational load were identified which is relevant for the development of a system of measures to ensure its subsequent reduction.

Key words: ecosystem, recreational load, anthropogenic load, anthropogenic changes

1. INTRODUCTION

Pokrovskoye-Streshnevo Natural and Historical Park is a natural and cultural-historical complex with great environmental, historical, cultural, educational, and recreational significance [1].

Deterioration of urban and suburban landscape complexes, reducing their functionality, is a steady trend. This problem cannot be solved without mitigation of anthropogenic (including recreational) impacts based on regulatory actions. The development of norms and regulations of recreational load is aimed at establishing the maximum permissible values and regulations for the use of an area under the condition of sustainable functioning of landscape complexes. However, there is no unified methodology of recreational activities regulation

considering the full range of factors determining it and thereby corresponding to real-world settings.

The Pokrovsky-Streshnevo natural complex is under the constant influence of both natural and man-made processes. Natural components are affected by such anthropogenic factors as road laying, housing development, changes in the chemical regime of soils, and household pollution of ponds. Unorganized recreation contributes to the disturbance of vegetation cover. Experiencing constant stress, ecosystems are gradually undergoing changes. Not always reacting adaptively to environmental effects, they change their states in time and space up to the destruction of landscape complexes [2].

2. METHODOLOGY

Literary sources containing information on the physical and geographical position of the district were studied, and the recreational load was assessed in the park according to the quantitative criteria of the degree of anthropogenic and recreational load.

3. RESULTS

Pokrovskoe-Streshnevo Natural and Historical Park is one of the popular recreation places of Moscow residents. The location of the park and many visitors affect its recreational and anthropogenic load [2,3].

With reference to our own field studies, we developed a table of quantitative criteria (Table 1).

Table 1

Criteria for determining the degree of anthropogenic load (AL) and recreational load (RL)

Degree of anthropogenic and recreational load	Heavy	Average	Light
Proximity to industrial facilities (AL)	0–200 m	200–400 m	400 + m
The density of the path network (RL)	3–5 paths per 100 sq. m.	2 paths per 100 sq. m.	1 path per 100 sq. m.
Proximity to water bodies (RL)	0–200 m	200–400 m	400 + m
Proximity to the railways (AL)	0–200 m	200–400 m	400 + m
Proximity to motorway and petrol stations (AL)	0–200 m	200–400 m	400 + m

Figure 1 shows a map of the boundaries of Pokrovskoye-Streshnevo Park and the boundaries of its water bodies. The southern border runs along the railway and part of the Volokolamsk highway. The western border runs along the road to the north, where it touches part of the Leningrad highway. Further, it bypasses residential multi-storey buildings, and in the north, it borders the boat station. Closer to the north-west, the border covers the Khimka River, bypassing the football field. To the south, the border repeats the border of the forest, reaching residential buildings and bypassing them to the Volokolamsk highway.

Figure 1. Map of the boundaries of Pokrovskoye-Streshnevo Park and its water bodies

Figure 2 shows a load map depending on the density of the path network in the park. The map shows that the heavy load is observed in the southeast near the ponds and in the western part of the park. The average load is typical for the central, northern and north-eastern parts. The light load is observed in the southern, western, and western-northern parts of the park.

Figure 3 shows a map that reflects the load in the park according to the criterion “proximity to industrial facilities”. As you can see, it consists of two colors (mostly green, but also orange), this is because

Figure 2. Map of the path network in Pokrovskoe-Streshnevo Park

Figure 3. Map of the proximity to industrial facilities

industrial facilities are located farther than 200 meters. The average load is observed on the eastern and southern parts of the park, all the rest is the light load with the proximity to objects of more than 400 meters.

It is worth noting that this area is characterized by westerly and southerly winds, which also minimizes the impact of production on the ecosystem of the park [4].

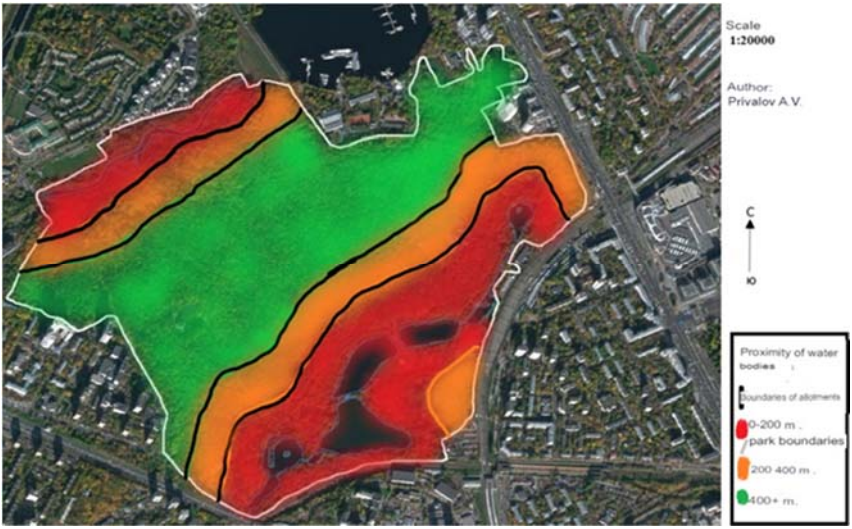

Figure 4. Map of the proximity to water bodies in Pokrovskoe-Streshnevo Park

Figure 4 highlights the areas of influence of the proximity to water bodies in the park. The load in the central part of the park is light, as the distance from water bodies exceeds 400 meters. Closer to the Khimka River to the north-west and to the south-east to the ponds, the average recreational load begins. Around the water bodies, the recreational load is heavy since water bodies attract many visitors to the park.

Figure 5 shows the influence of the proximity to highways and gas stations. The entire south-eastern border of the park is subject to the heavy load, as highways and gas stations are located closer than 200 meters to the park. The central and all western parts are the least affected by this criterion.

Figure 5. Map of the proximity to petrol stations and highways

Figure 6. Map of the proximity to the railway

The railway runs along the eastern and southern boundaries of the park. The border is less than 200 metres away. Most of the park is not subject to the heavy and average load according to this criterion, which is reflected in Figure 6.

Figure 7. Anthropogenic facilities near Pokrovskoye-Streshnevo Park and within its boundaries

Figure 7 shows the anthropogenic facilities that are located inside the park itself and near its territory. All sources of the anthropogenic load can be conditionally divided into the following types [5]:

1) Internal. Internal sources refer to anthropogenic influence directly on the park's area, for example, residential and park administration buildings, a football field and the building of the medical and rehabilitation center, and a manor [5, 6].

2) External. External sources refer to the influence of settlements, enterprises, and roads on the park's borders, for example, a boat station, a gas station, Leningrad and Volokolamsk highways, a railway, production enterprises [5, 6].

Figure 8 shows 3 degrees of the anthropogenic load on the area: heavy, average, and light (Table 1).

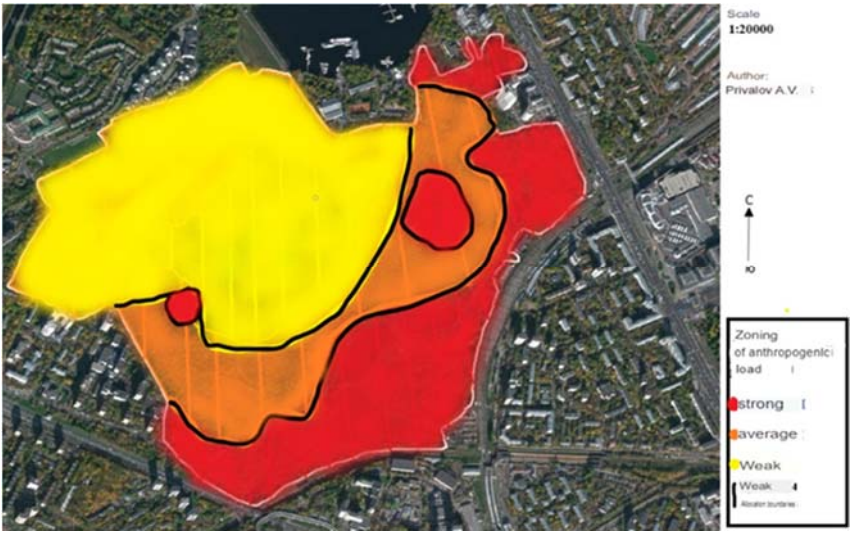

Figure 8. Zoning of anthropogenic load in Pokrovskoye-Streshnevo Park

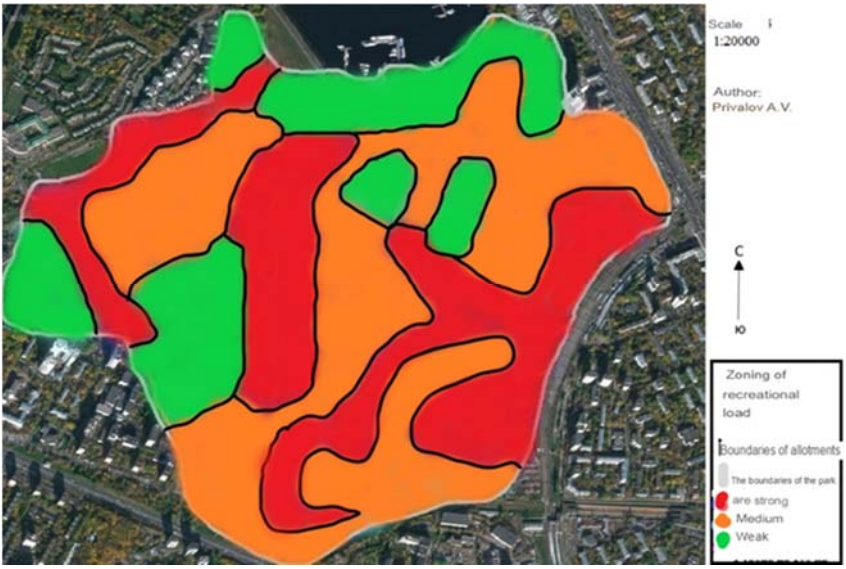

Figure 9. Zoning of recreational load in Pokrovskoe-Streshnevo Park

The heavy anthropogenic load is observed throughout the south-eastern border which is due to the influence of the sources presented in the table. The proximity to highways and railways causes severe noise pollution and pollution from vehicle emissions.

The eastern part of the park is also characterized by the heavy anthropogenic load associated with the location of the residential buildings.

In the western, western-southern, and northern, north-eastern parts around the residential buildings there is the light anthropogenic load, since the distance from the park to highways, railways, and production enterprises exceeds 400 meters.

The situation in the central part can be described as favorable.

Analyzing Figure 9, we can conclude that most of the park is subject to the heavy and average recreational loads. Mainly the western and eastern borders, as well as the central part, are subject to the heavy load. The northern and southwestern borders have the light load. The rest of the park is characterized by an average level of the recreational load.

4. CONCLUSIONS

So, we can conclude that the heaviest recreational load is characteristic of the southern, central, eastern parts of the park and around ponds; the light recreational load is characteristic of the northern and southwestern parts; the average recreational load is characteristic of the part from the borders of the park to the center. The heaviest anthropogenic load is characteristic of the southeastern border of the park; the average anthropogenic load is found west of the southeast and the light anthropogenic load is characteristic of the entire central and western parts of the park. The approximate ratio of the anthropogenic load in % is the following: light amounts to 45%, average to 20%, and heavy to 35%. The ratio of the recreational load in % is the following: average amounts to 40%, heavy to 30%, and light to 30% Thus, as shown in Figures 8 and 9, the anthropogenic and recreational load in the park is intense.

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BIOINDICATIVE ENVIRONMENTAL ASSESSMENT OF TIMIRYAZEVSKY DISTRICT OF MOSCOW BASED ON THE ANALYSIS OF FLUCTUATING ASYMMETRY OF SILVER BIRCH LEAF BLADES

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Abstract: a selection of birch leaf blades was made to determine the magnitude of fluctuating asymmetry, integrated indicators of development stability were calculated

Key words: bioindication, silver birch, environmental assessment

INTRODUCTION

Timiryazevsky district is located in the north of Moscow and is considered to be the greenest in Northern Administrative Okrug. Forest and park zones occupy more than 50% of the area. The basis of the ecological framework of the district is made up of two green areas:

Timiryazevsky Park and Dubki culture and recreation park. These green areas play an important role in the ecological optimization and stabilization of the urban environment. Forests emit oxygen, absorb carbon dioxide, deposit dust and enrich the atmospheric air with phytoncides with high antimicrobial activity. In addition, green spaces perform the functions of thermoregulation, wind speed reduction and moisture redistribution. Soil is an important reservoir of pollutants.

The purpose of the work is to make a bioindicative environmental assessment of Timiryazevsky district of Moscow based on the analysis of fluctuating asymmetry of silver birch leaf blades.

1. METHODOLOGY

The object of the study is silver birch. The subject of the study is the value of fluctuating asymmetry of silver birch leaves, as an indicator of the quality of the environment.

The quality of the environment within the study areas was determined by the bioindication method by fluctuating asymmetry of silver birch leaves in accordance with the methodological recommendations of the Ministry of Natural Resources of the Russian Federation dated October 16, 2003 № 460-p, which made it possible to carry out an express environmental assessment of the study area and identify areas with different disturbances. The method is based on morphogenetic changes degree determination in leaves of silver birch, which normally have bilateral symmetry. At each site, 100 birch leaves of comparable size were collected. Each leaf was measured by five traits on the left and right sides of the central vein, and on the basis of the obtained data, integral indicators of developmental stability were calculated. To assess the quality of the environment in the regions, according to the obtained values of asymmetry, a five-point scale for assessing deviations from the conditional norm was used (Andreeva, Morev, Taller, Vasenev, 2021).

2. RESULTS

The results of calculations of the integral indicator of the stability of silver birch leaf plates development allow us to conclude that the highest level of deviation from the norm is observed near the northern

part of Dmitrov highway (point 4) (0.056), the average level of deviation is in points No. 1 (territory of the Russian State Agrarian University) (0.047), No. 2 (Dmitrov highway, south) and No. 5 (the southern part of the district) (0.046), the lowest level of deviation is at point No. 3 (a grove on the shore of the Big Garden Pond) (0.036).

Table 1

Scoring scale for assessing the quality of the environment according to the value of the integral indicator of the sustainability of the development of silver birch (*Betula pendula Roth*) (Zaharov, 2000)

Rank	Environmental quality	FA
I	Conditionally normal	< 0,040
II	Initial (minor) deviations from the norm	0,040-0,044
III	Average level of deviation from the norm	0,045-0,049
IV	Significant (significant) deviations from the norm	0,050-0,054
V	Critical condition	> 0,054

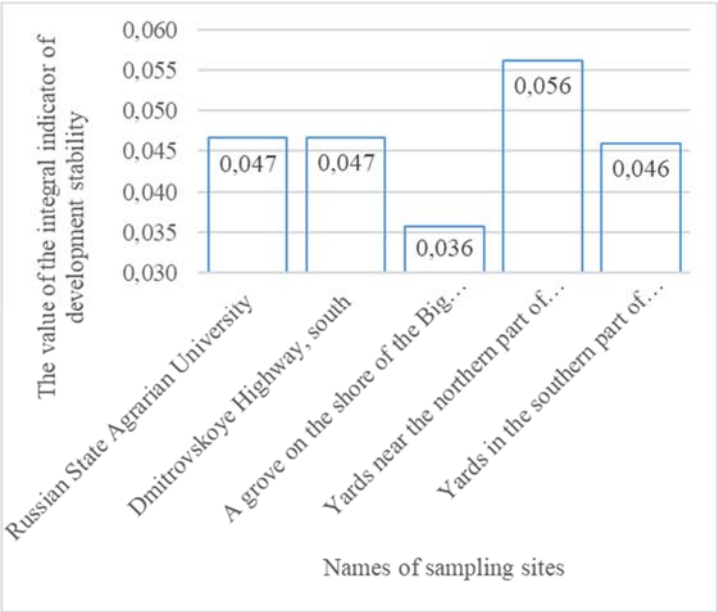

Fig. 1. Distribution histogram of integral indicator of development sustainability in the sampling area

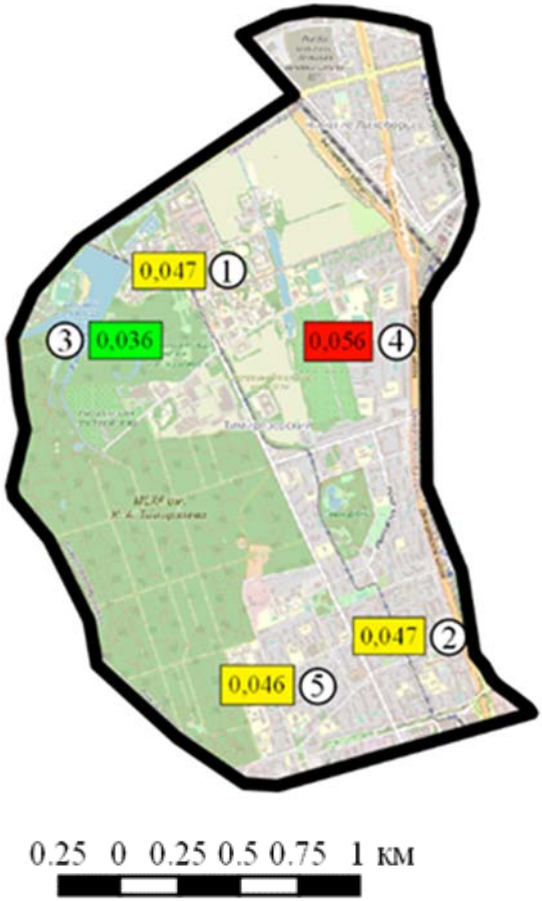

Fig. 2. Scheme of sampling points in Timiryazevsky district of Moscow

3. CONCLUSIONS

Thus, as a result of the study, the following goal was achieved: a bioindicative environmental assessment of Timiryazevsky district of Moscow was carried out based on the analysis of the fluctuating asymmetry of silver birch leaf blades. In the study area, areas with

varying degrees of this parameter were identified. The plots with the highest degree of deviation from the norm were found near the northern part of Dmitrov highway.

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ECOLOGY OF THE POND FROG (PELOPHYLAX LESSONAE CAMERANO, 1882) IN THE SMOLENSKOYE POOZERYE NATIONAL PARK

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Abstract: The purpose of the work was to study the ecology of the pond frog in the Smolenskoye Poozerye Park because it makes a significant contribution to the ecosystem. Particular attention was paid to the sex and age structure of the species, its abundance, activity, the dynamics of morphometric changes and the features of the color coloration of the species.

Key words: national park, red book fauna, the pond frog, age structure, abundance, activity, morphometrics, colour.

1. INTRODUCTION

Smolenskoye Poozerye Park is rich in diverse soils, red book flora and fauna, and includes 35 lakes of glacial origin, such as Sapsho, Chistik and Mutnoye lakes.

The main results of the study: many aspects of the national park have been studied, from the geological structure to the flora and fauna; the morphology of the species, its feeding habits, nutrition, reproduction, distribution, biotope confinement and enemies have been studied. Particular attention is paid to the sex and age structure of the species, its abundance, activity, the dynamics of morphometric changes and the features of the color coloration of the species.

The relevance of this topic lies in the fact that the national park is in urgent need of new research on the pond frog because it makes a significant contribution to the ecosystem.

The object of the research is the pond frog, the subject of the research is the ecology of the species. The purpose of the work is to study the ecology of the pond frog in the park.

2. METHODOLOGY

The basic research methods were trapping, morphometry, sex determination, age determination, tagging, accounting on the sites, route accounting, accounting using traps.

The studies were conducted from 2.06.2021 to 06.19.2021. All the material was collected on the territory of the Smolenskoye Poozerye National Park.

During the study, 59 pond frog individuals were caught and measured — 6 fingerlings, 33 males and 20 females.

The main research was carried out at 3 sites — the Dug Pond, the Small Pond, the Pond of the Przewalski Museum. In addition to these reservoirs, accounting was carried out on ecological trails and with the help of traps. With the help of such research methods, not a single individual of the species was caught.

3. RESULTS

3.1. Size and age groups of males and females

In the course of the work, the size and age groups of males and females of the pond frog were compiled. The data obtained can be divided into three age groups:

- **Age group I** — 6 individuals, larger in size than those known in literature. The sex of the fingerlings is not determined.
- **Age group II** has 36 individuals, the largest group; males make up 61.1% of the sample, and females — 38.9%.
- **Age group III** includes mature frogs, has 17 individuals with a length of 60 to 90 mm. Males make up 64.7% of the sample, and females — 35.3%.

No tadpoles were found during the study.

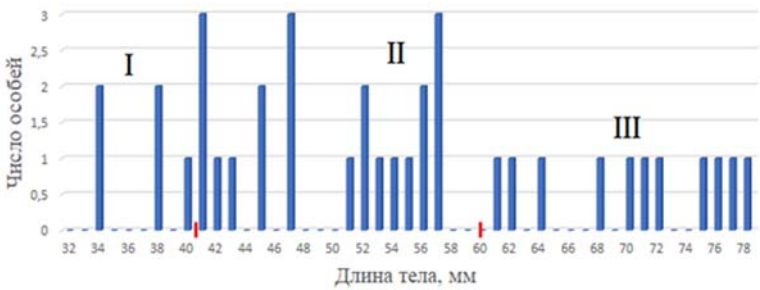

Figure 1. Size and age groups of male pond frogs in the Smolenskoe Poozerye National Park

3.2. Changes in linear parameters

With age, frogs have some changes in linear parameters. The increase in indicators occurs in the 2nd–3d years due to the length of the body, and the limbs increase due to the lower leg.

3.3. Dependence of activity on the main climatic factors

During the hot summer period, the daily activity of frogs occurred in the morning from 6 to 11 o'clock, in the evening from 9 pm to one o'clock am. From 11 o'clock in the morning to 9 o'clock in the evening, their activity decreases sharply.

During the study, daytime air temperature ranged from 22°C to 31°C, night air temperature — from 14°C to 20 °C. The average air temperature was 27°C. Daytime water temperature ranged from 18°C to 28°C. The average water temperature was 25°C.

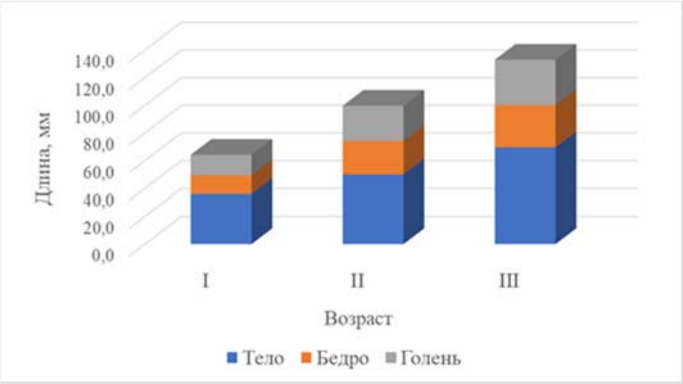

Figure 2. Change of linear parameters depending on the age of the pond frog

In the morning, at a warm temperature and high humidity, the frog is active. At high temperature and low humidity, the frog hides in a pond. In the evening, with a decrease in temperature and an increase in humidity, the frog is active again.

The dependence of the daily activity of the species on the water temperature has an inverse relationship. In the morning the water is cold — the frog is active. The water warms up during the day — the species returns to the reservoir. In the evening, as in the morning, the water cools down — the frog is active.

Frogs are active on the dug pond from 6 to 8 in the morning and from 21 to midnight. The maximum number of active frogs on the site is 24 individuals. The water temperature is 28°C.

Frogs are active on the small pond from 6 to 11 am. Evening rush from 21 to one o'clock in the morning. The maximum number of active frogs on the site is 14 individuals. The water temperature is 23°C.

The pond of the Przhevalsky Museum is the least favorable. Frogs are inactive even during peak hours, and the maximum water temperature is extremely low — 20°C. The maximum number of active frogs on the site is 8 individuals.

The color of the species differs on different ponds — it depends on the surrounding factors. Frogs can disguise themselves under the background color. So, on the Dug Pond frogs are dark green, on the Small Pond — light green, and on the pond of the museum — gray-green.

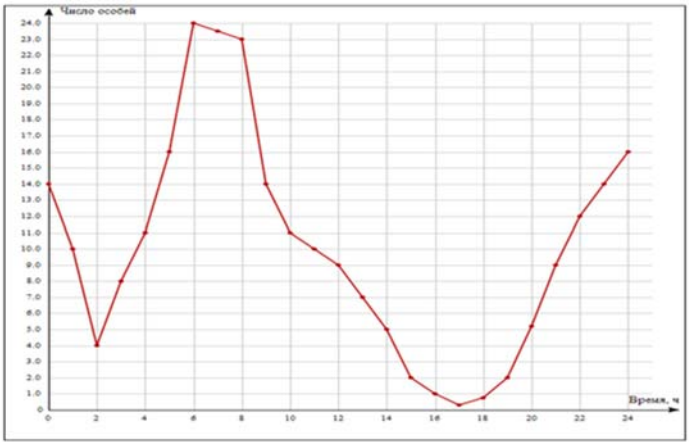

Figure 3. Dependence of activity on the main climatic factors

4. CONCLUSIONS

1. There are 3 age groups of the pond frog in the national park: 6 individuals in Group I, 36 in Group II and 17 in Group III.
2. Group II is the largest group of individuals. They make up 61% of the population.
3. The gender of Group I is not determined. Age Group II counts 61,1% of males and 38.9% of females in the sample. Age Group III counts 64,7% of males and 35,3% of females in the sample.
4. The increase in linear parameters with age occurs primarily due to the length of the body. The limb increases mainly due to the growth of the lower leg.
5. The daily activity of the pond frog in July had a two-vertex character. The main peak of activity occurred in the morning hours from about 6:00 to 11:00. The evening peak of activity began around 21:00 and lasted until one o'clock in the morning. The activity time was slightly different depending on the environmental conditions of different ponds.
6. The activity was inversely proportional to the water temperature.
7. The coloring of the three settlements of different ponds had significant differences. Dark green in a dug pond, light green in a small pond and gray-green in a museum pond.

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STUDY OF PHYTOPLANKTON PHOTOSYNTHESIS BY FLUORESCENT METHODS IN RESERVOIRS OF THE MOSCOW REGION

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Abstract: Using chlorophyll fluorescence, the photosynthetic activity of summer phytoplankton in reservoirs of the Moscow region (MSU ZBS) was

studied. In the course of the study, a connection was established between the physiological state of phytoplankton and light conditions in water bodies.

Key words: phytoplankton, chlorophyll fluorescence, photosynthesis, bioindication, ecology, biophysics.

1. INTRODUCTION

Phytoplankton is the primary link in the trophic chain and determines the state and productivity of aquatic ecosystems. During the exposure of various environmental factors, first of all, such characteristics as the abundance and photosynthetic activity of algae are changed. Changes at the primary trophic level lead to changes in other parts of the aquatic ecosystem. Therefore, registration of phytoplankton characteristics is one of the ways to assess the state of the aquatic environment.

The primary production of phytoplankton is determined by the functioning of a complex photosynthesis system, including reaction centers with an electron transport system, in which the primary conversion of solar energy takes place [1]. Previously, the fluorescence parameter FV/FM was used in hydrobiology. The measurement of the ratio of fluorescence intensity under photosynthetic saturating light (FM) and under conditions that do not cause changes in the state of the photosynthetic apparatus (FO) (low light intensity) makes it possible to determine the maximum efficiency of the processes of photosystem 2 (FS2), which is equal to (FM-FO) / FM = FV/FM. The FV/FM parameter is a dimensionless energy characteristic of photosynthesis, similar to the efficiency coefficient and independent from the species specificity of the organism [1–3].

Recent years, methods of rapid measurement of the kinetics of light induction are actively developing while working with algae cultures, characterizing electronic transport within FS2 and between FS2 and FS I [1, 2]. Fluorescent methods make it possible to quickly, reliably and with high sensitivity register the characteristics of phytoplankton directly in its habitat in situ in real time [3].

2. METHODOLOGY

The studies were carried out in Sterlyazhiy, Pozharny and Kostin ponds, as well as in the upper sphagnum swamp “Sima Quarry” (s. Sima)

of the MSU ZBS in July 2022. The temperature, illumination and hydrochemical parameters of the water were measured. The quantum flux density in the headlight region was determined using a quantum meter (Walz, Germany). Chlorophyll concentration was determined by direct spectrophotometric method in acetone extracts on a spectrophotometer based on a USB 2000 portable spectrometer (Ocean Optics, Inc., USA).

The ratio of phytoplankton of different classes was determined using a Phyto-PAM fluorimeter (Walz, Effelrich, Germany) with excitation of fluorescence in different spectral ranges. The parameters of the fluorescence induction curves were recorded on a FluorPen FP100 pulsed fluorimeter (Photon System Instruments, Czech Republic) after switching on the red light (λ = 650 nm). The JIP test [2] was used and the following parameters were determined: FO is a parameter correlating with the abundance of phytoplankton; $F_V/F_M = (F_M–F_O)/F_M$ is the maximum quantum yield of the primary photochemical reaction in the reaction centers of FS2; $\varphi E_0 = (1-V_J)/(F_V/F_M)$;– quantum output of electronic transport; PI_{ABS} — performance index — an indicator of functional activity of FS2 related to absorbed energy.

3. RESULTS

Studies in 2022 showed that Kostin and Pozharny ponds, according to fluorescence measurements (F_O indicator) have an extremely low concentration of summer phytoplankton (less than 0.3 micrograms/l in chlorophyll a concentration). The low concentration of phytoplankton in these reservoirs can be explained by extremely unfavorable conditions — its eating by zooplankton and a high degree of shading caused by trees adjacent to the ponds and macrophytes completely covering the water surface [4]. The greatest contribution of dissolved organic matter (DOM) was recorded in these ponds, confirming the absence of phytoplankton.

A high concentration of phytoplankton was observed by the value of F_0 in the s. Sima. A significant concentration of chlorophyll a (15 micrograms/l) and the smallest contribution of DOM were also recorded in this reservoir. The contribution of dominant diatoms was determined using the Phyto-Pam instrument. High photosynthetic

activity was observed under shaded conditions, recorded by F_V/F_M — the maximum quantum yield of the primary photochemical reaction in the reaction centers of FS2 in the s. Sima. The F_V/F_M value averaged 0.7–0.65.

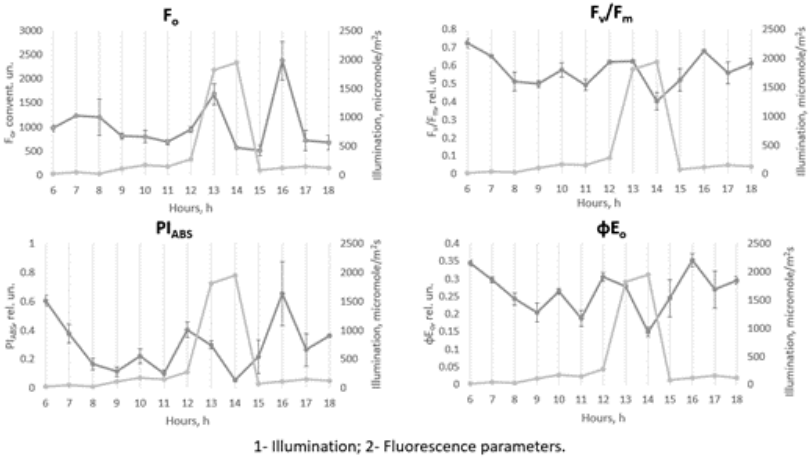

Figure 1. Diurnal changes in illumination (1) and parameters of the induction curve of phytoplankton fluorescence (2) in the Sterlyazhiy pond of ZBS MSU in the surface water layer on July 15, 2022. Partly cloudy

In Sterlet Pond in 2022, the concentration of mainly green (Volvox sp., Oocystis sp.), as well as diatom and euglen (Trachelomonas sp., Euglena sp.) microalgae prevailed. The concentration of chlorophyll was 6 micrograms/l. The F_V/F_M value averaged 0.6. However, this value varied throughout the day depending on light conditions. The high functionality of FS2 is recorded in the morning, during the period of low solar activity, when the reaction centers are not yet closed. During the midday depression at 14:00 hours, the highest temperature was recorded, as well as the highest illumination. At this moment, the lowest functional activity of FS2 (F_V/F_M) and the quantum efficiency of electronic transport (φE_0) were observed. Also during this period, a

reduced concentration of phytoplankton was recorded, which can be associated with vertical migration due to high illumination. Thus, the phytoplankton moved to more favorable conditions for it. The suppression of phytoplankton activity is a consequence of the midday depression of photosynthesis to protect against an excess of active photosynthetic products that can lead to the burnout of the algal cell. The data showed that the shutdown occurs at the FS2 level, which is manifested by the parameters F_V/F_M, electronic transport φE_0 and PI_{ABS}. A decrease in illumination leads to the resumption of the functioning of the most primary reactions of photosynthesis at the level of the reaction centers of FS2. This effect is observed in conditions of variable clouds (Fig. 1). The fluorescence parameters used (F_V/F_M, φE_0 and PI_{ABS}) allow us to track key photosynthetic reactions in phytoplankton when environmental conditions change.

CONCLUSIONS

Phytoplankton is the primary link in the trophic chain and determines the state and productivity of aquatic ecosystems. That is why it is so important to study it and find favorable natural environments for it. And here's why, in the course of the study, a connection was established between the physiological state of phytoplankton and light conditions in water bodies.

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DETERMINATION OF ANTHRAQUINONE DERIVATIVES IN EXTRACTS FROM THE ROOTS AND RHIZOMES OF RUBIA TINCTORUM BY ^{1}H NMR SPECTROSCOPY

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Abstract: This research aimed to identify target anthraquinone derivatives using proton signals in the 12.62 to 13.40 ppm area in the ^{1}H NMR spectrum of an extract of roots and rhizomes of Rubia tinctorum in DMSO-d_6 with the addition of 2,2,2-trifluoroacetic acid.

Key words: Rubia tinctorum, anthraquinone derivatives, spectroscopy NMR.

INTRODUCTION

A potentially interesting area for the observation of chemical shifts of protons of various polyphenolic compounds is the area of the ^{1}H NMR spectrum from 11 ppm, since no other signals appear in this area of the spectrum than the signals of organic acid protons and signals of hydroxyl group protons bound by intramolecular hydrogen bonding. To detect such signals, it is necessary to use aprotonic solvents, such as dimethyl sulfoxide, because it reduces the proton exchange rate, and the signals of hydroxyl group protons are narrowed.

METHODOLOGY

An extract of the roots and rhizomes of Rubia tinctorum contains anthraquinone derivatives whose position 1 contains a hydroxyl group in which the proton forms an intramolecular hydrogen bond with the

oxygen of a nearby carbonyl group. To establish the value of the chemical shifts of the protons of the hydroxyl groups in position 1 of the anthraquinone derivatives, the ^{1}H NMR spectra of the standard samples of ruberythric acid, lucidin-3-primeveroside, alizarin, lucidin and purpurin in DMSO-d_6 were researched as shown in Fig. 1.

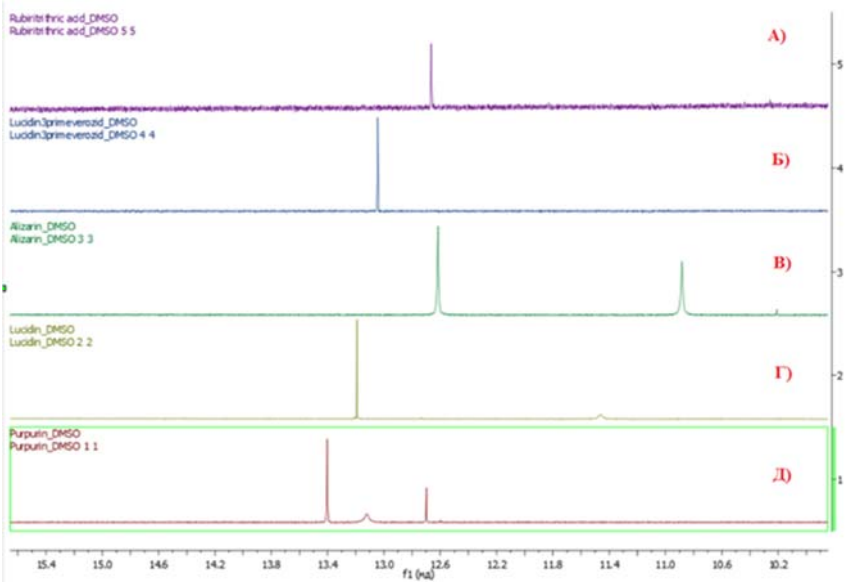

Figure 1. Stack of ^{1}H NMR spectra *a)* ruberythric acid; *b)* lucidin-3-primeveroside; *c)* alizarin; *d)* lucidin; *e)* purpurin.

However, in the ^{1}H NMR spectrum of the extract of roots and rhizomes of Rubia tinctorum in DMSO-d_6 in the area from 12.62 to 13.40 ppm, there are no narrow signals, but rather very broadened signals. This means that proton exchange occurs even in DMSO-d_6. The rate of proton exchange and narrowing of the signals can be reduced by adding 2,2,2-trifluoroacetic acid, as shown in [2], which is a strong organic acid. Fig. 2 demonstrates that 2,2,2-trifluoroacetic acid effectively narrows the signal width of the hydroxyl group protons at position 1.

This research attempted to identify the target anthraquinone derivatives using proton signals in the 12.62 to 13.40 ppm area shown

in Fig. 3 in the ^{1}H NMR spectrum of an extract of roots and rhizomes of Rubia tinctorum in DMSO-d6 with the addition of 2,2,2-trifluoroacetic acid. For this purpose, ^{1}H NMR spectra of standard samples of ruberythric acid, lucidin-3-primeveroside, alizarin, lucidin and purpurin in DMSO-d_6 with addition of 2,2,2-trifluoroacetic acid were registered, the volume ratio of which to the analyte in all registered samples, as well as in the extract of roots and rhizomes of Rubia tinctorum was 8.33×10^{-3}.

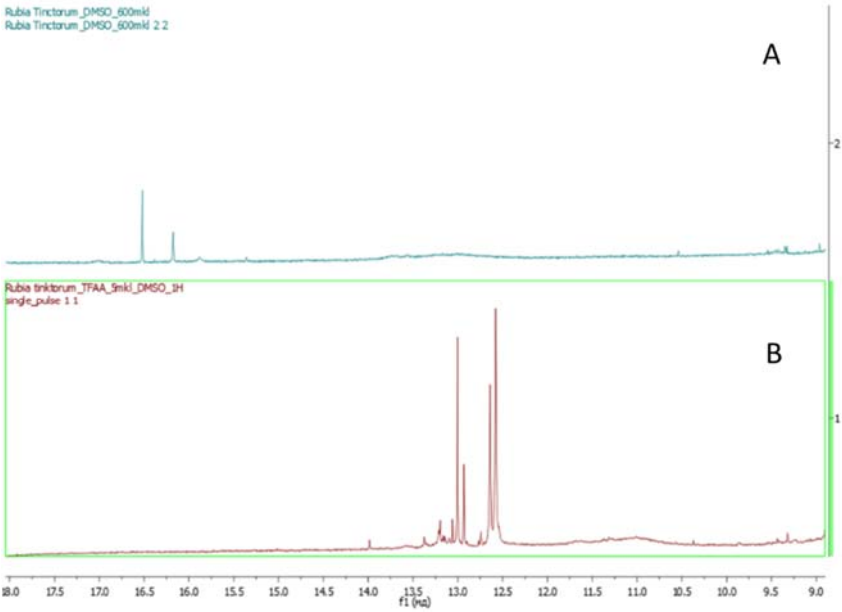

Figure 2. Stack of ^{1}H NMR spectra of an extract of roots and rhizomes of Rubia tinctorum in DMSO-d6:
a) without addition of 2,2,2-trifluoroacetic acid;
b) with addition of 2,2,2-trifluoroacetic acid.

RESULTS

In the ^{1}H NMR spectrum of the extract of roots and rhizomes of Rubia tinctorum in 12.40–13.60 ppm signals of ruberythric acid, lucidin-3-primeveroside, alizarin, lucidin and purpurin are observed. The signal

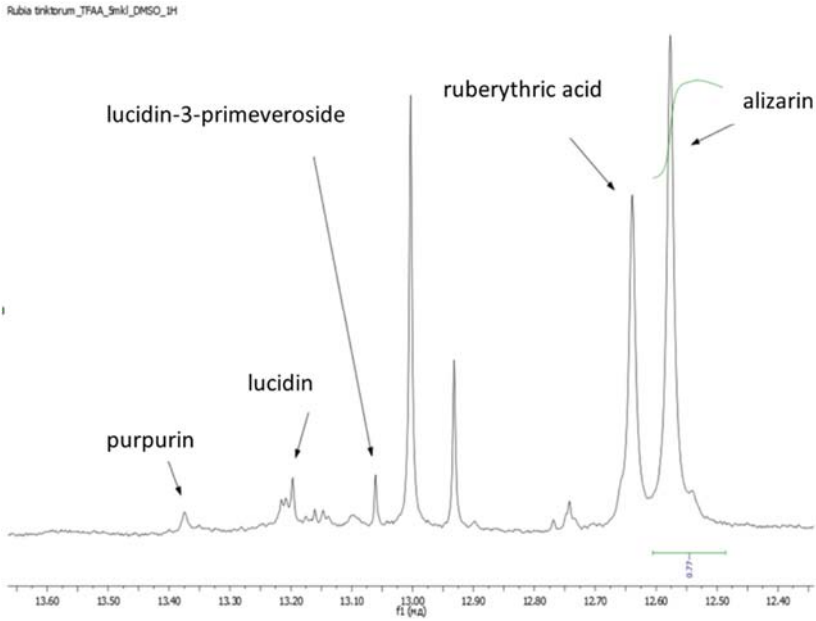

Figure 3. Selected area (12.40–13.60 ppm) of the ^{1}H NMR spectra of extract of Rubia tinctorum with addition of 2,2,2-trifluoroacetic acid

intensities of the ruberythric acid are lower than those of alizarin. Potentially, the addition of 2,2,2-trifluoroacetic acid leads to an acidic hydrolysis of ruberythric acid to alizarin. The same is observed with lucidin-3-primeveroside. Apparently, in this case, acid hydrolysis leads to the formation of another lucidin derivative, so the signal intensities of lucidin and lucidin-3-primeveroside are comparable. To prove our assumptions about the chemical transformation of ruberythric acid and lucidin-3-primeveroside, it is necessary to extract our proposed anthraquinone derivatives by preparative chromatography, followed by structure determination by NMR spectroscopy and mass spectrometry. We plan to carry out this research further in the study of the roots and rhizomes of Rubia tinctorum.

However, in the ^{1}H NMR spectrum of the extract of roots and rhizomes of Rubia tinctorum in DMSO-d6 without adding 2,2,2-trifluoroacetic acid, signals in an even weaker area, as observed in Fig. 4.

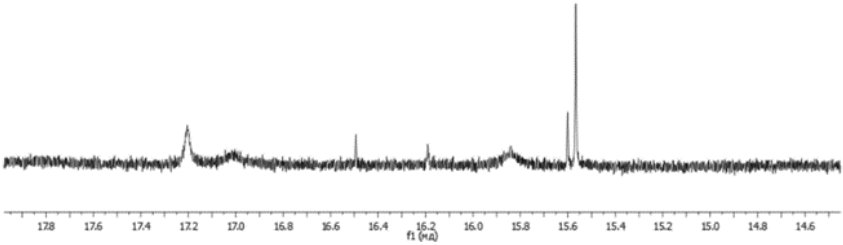

Figure 4. Increased fragment (14.60–17.80 ppm) of the ^{1}H NMR spectrum of an extract of roots and rhizomes of Rubia tinctorum in DMSO-d_6 without adding 2,2,2-trifluoroacetic acid.

Signals of protons of strongly deshielding hydroxyl groups can appear in 14.60–17.80 ppm. A search in the scientific literature for similar anthraquinone derivatives was carried out. The works [1, 3] describe the content of pseudopurpurpurine in the roots and rhizomes of Rubia tinctorum, the structural formula of which is presented in Fig. 5. Also in [3] its ^{1}H and ^{13}C NMR spectrum in DMSO-d6 and chemical shifts of hydroxyl groups protons at 15.88, 16.18 and 16.49 ppm are shown.

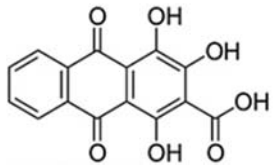

Figure 5. Structural formula of pseudopurpurine.

In pseudopurpurine, the proton of the hydroxyl group is strongly deshielded due to the location of carbonyl groups between the two oxygenates. Apparently, the extract of roots and rhizomes of Rubia tinctorum contains not only pseudopurpurine but also its derivatives, because more than 3 signals are observed in the 14.60–17.80 ppm area of the ^{1}H NMR spectrum.

CONCLUSIONS

In this research we investigated the possibility of using the hydroxyl group proton signals at position 1 of the anthraquinone ring in

the 12.40 - 13.60 ppm area of ^{1}H NMR spectra to identify ruberythric acid, lucidin-3-primeveroside, alizarin, lucidin, and purpurin.

ACKNOWLEDGEMENTS

This paper has been supported by the RUDN University Strategic Academic Leadership Program.

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THE CONTRIBUTION OF MICROPLASTIC PARTICLE CONSUMPTION TO THE DEVELOPMENT OF INFLAMMATORY BOWEL DISEASES

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Abstract: This article talks about the effect of micro plastic particles on the development of inflammatory bowel diseases in mice. The authors consider its prevalence in the environment, the effect on the intestines of rats and mice,

as well as the difference in the effect of microplastic particles on healthy individuals and individuals with induced colitis.

Key words: microplastic, colitis, microplastic effect

1. INTRODUCTION

Plastic is one of the cheapest materials with a wide range of applications, which is why its use has increased dramatically over the past 20 years. Every year, 300 million tons of plastic are produced in the world, some of which are microplastics used for cosmetic and household purposes. [1, 2, 3, 4].

In addition to the artificial creation of microplastics, it can be formed during the destruction of large plastic products as a result of such processes as: biodegradation, which occurs as a result of the activity of organisms, especially microbes; photodegradation, caused by solar activity; hydrolysis as a result of reaction with an aqueous medium, as well as thermal oxidation due to the influence of temperatures [5].

Getting into the water, microplastics can be absorbed by marine organisms, using them for food, a person exposes his health, in particular intestinal health, to danger. However, at the moment, the potential harm of microplastics is poorly understood.

2. METHODOLOGY

To study the topic, a search of scientific literature was conducted for the queries “microplastic”, “mouse microplastic”, “microplastic colitis” in the National Library of Medicine, Scopus systems, Elibrary.ru, Cyberleninka and Elsevier.

3. RESULTS

3.1. The concept of microplastics

There is still no approved classification of plastic sizes. Different authors mean different size ranges by microplastics. For example, M. Gregory and A. Andari took particles of synthetic polymers with a size of 67–500 microns as microplastics, and some scientists call microplastics particles less than 5 mm [6, 7, 8]. However, after analyzing various scientific papers, it can be noted that most scientists consider microplastic particles of synthetic polymers whose diameter lies within 0.0001–5.0 mm [9, 10, 11].

3.2. The spread of microplastics

Microplastics migrate uncontrollably, accumulating not only in the abiotic environment, but also in living organisms, posing a threat to their health. For example, microplastic gets into the ocean from sewage and rivers, where it is consumed by plankton and necton, which in turn is used in human food. Microplastics are absorbed not only by wild marine organisms living in the ocean, but also artificially grown. So in 2014, researchers from Belgium studied seafood on German farms and in supermarkets in France and obtained data that the average portion of oysters contains 50 microparticles of plastic, and the average portion of mussels contains 90 microparticles [12].

3.3. The effect of microplastics on humans

There is very little data on the effect of microplastics on terrestrial mammals. Currently, there are about 40 papers in the PubMed and Scopus databases in which the effects of microplastic particles on laboratory mice and rats have been studied. The articles show that microplastics in mice and rats can cause biochemical changes, structural damage and dysfunction of the intestines, liver, kidneys, reproductive system, etc. Perhaps microplastics can pose the same danger to human health. However, due to the small number of studies and significant variation in the types of plastic, particle sizes, dose, route and mode of administration by methods, the data obtained are fragmentary and contradictory, which is why it is impossible to say about the exact effect of microplastics on humans.

3.4. Inflammatory bowel diseases

There is an assumption that microplastics can contribute to the development of various groups of diseases, one of which is the group of inflammatory bowel diseases (IBD) [13, 14]. IBD includes two diseases — ulcerative colitis and Crohn's disease, which are chronic recurrent diseases, the etiology of which is not clear and which, with a long course, lead to the development of many complications, carcinogenesis and disability of patients [15].

3.5. The effect of microplastics on colon of rats and mice

The results of some studies have shown that when taking MPs orally in mice, intestinal motility is disrupted, the composition of the

intestinal microbiota changes, mucin secretion decreases and the number of inflammatory cytokines in the intestine increases [16, 17, 18].

Other studies have shown that the microbiome has not changed significantly in mice, but a disorder in the large intestine was detected, which caused the activation of congenital lymphoid cells and, as a consequence, led to the appearance of mild inflammation of the large intestine [19].

3.6. A model of inducing colitis with sodium dextran sulfate

It is assumed that microplastics can aggravate the course of already existing inflammatory bowel diseases. Mouse models of IBD are used to prove or disprove this theory.

The most common model of colitis indexing is the use of sodium dextran sulfate. During the experiment, water in mice and rats of the experimental group is replaced with a solution of DSN. After a few days, the animals show signs of intestinal inflammation [20].

3.7. Microplastic and experimental colitis

In part of the studies comparing the effect of microplastics on healthy mice and on mice with induced colitis in the results, it is stated that exposure to PS MP increased acute colitis and caused a violation of lipid metabolism, a decrease in mucin secretion and a more pronounced reduction in the length of the colon, while microplastics had minimal effect on healthy individuals [21, 22].

In other studies, the adverse effect of PS on the intestine and the development of colitis was not revealed [23].

4. CONCLUSIONS

Every year, the environment is polluted by tons of microplastics. It migrates uncontrollably, accumulating not only in the abiotic environment, but also in living organisms, posing a threat to their health and human health.

Currently, inflammatory bowel diseases are common diseases, the etiology of which is unknown, but a number of studies indicate the role of microplastics as one of the important factors in the etiology and pathogenesis of IBD. Data on the contribution of MP to the development of IBD are fragmentary and contradictory. More thorough studies of the

role of MP in IBD will allow the development of new approaches to the prevention and treatment of these diseases.

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WHY ARE CORAL REEFS DYING?

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Abstract: Coral reefs are under the influence of continuous stress due to a variety of global and local problems, including climate change, deterioration of water quality, overfishing, pollution and unsustainable development of coastal areas.

Key words: corals, coral reefs, ecology, environment, UNEP.

1. INTRODUCTION

The purpose of the article: to study the problem of coral reefs, to understand why reefs are dying, to conduct a study among students of non-core faculties, analysis of the contribution and significance of the UNEP coral reef conservation program.

Objectives:

- to study the literature sources on the topic;
- conduct testing among students, analyze the results and draw conclusions.

An extensive network of dynamic skeletal invertebrates lives under the surface of the ocean waters, which contains at least 25 percent of all known marine species [4]. Both hard and soft corals serve as the basis for the functioning of coral reefs, which represent one of the most biologically diverse and valuable ecosystems on the planet. Coral reefs are a source of important cultural, economic, recreational and social benefits for hundreds of millions of people. They protect the coastline from storm damage and serve as a source of medicines. And they die [3].

"Coral reefs are one of the most sensitive ecosystems in the world to the destructive effects of human activity", says Gabriel Grimsditch, Marine Ecosystems Specialist at the United Nations Environment Programme (UNEP) [1]. "They are particularly vulnerable to climate change and rising ocean temperatures, and the frequency and intensity of mass coral bleaching and death are projected to increase as temperatures continue to rise".

2. METHODOLOGY

Both theoretical and practical methods of information analysis were used for the study. First of all, I studied the literature on this environmental problem. Further, I also used a survey of students from other institutes (to understand the relevance and quality of young people's knowledge about current environmental problems).

3. RESULTS

Coral reefs are found in the Pacific, Indian and Atlantic Oceans in the waters of more than 100 countries. Most are located in the belt between the tropics of Cancer and Capricorn, but they are also in regions

more remote from the equator, where warm tropical currents lead. For example, off the coast of Japan or the US state of Florida. Now coral reefs in the world occupy 284.3 thousand square kilometers (almost like two Vologda regions, or one Italy) [2].

1. The state of coral reefs at the moment.

According to the findings of the report "The State of Coral Reefs in the World, 2020" (a quantitative analysis of world data for 1978–2019, prepared by UNEP together with the International Coral Reef Initiative (ICRI), the Global Coral Reef Monitoring Network (GCRMN) and various international partners), 14 percent of the world's corals were lost from 2009 to 2018 [2].

2. What you need to do to avoid the death of reefs

To ensure the survival of coral reefs, policymakers need to take urgent action against climate change. Firstly, the inclusion of coral reefs as a priority ecosystem in the UN Convention on Biological Diversity for the period after 2020 will place the responsibility for their conservation on governments, enterprises and other stakeholders. After the UN Climate Change Conference in Glasgow, politicians must go beyond the goals of the Paris Agreement and secure the future of coral reefs [1].

Meanwhile, reducing anthropogenic pressure on the ground through legislation, education and other means will contribute to the sustainability of reefs [5]. "Combating climate change and reducing local threats must go hand in hand if we want coral reefs to survive so that future generations can enjoy and benefit from them", says Grimsditch [1].

3. UNEP solves the problem of the state of coral reefs

UNEP sets the environmental agenda and acts as an authoritative advocate for the world's environment. She examines the state of coral reefs through the prism of science, management, policy and financing.

Together with its partners, UNEP prepares important reports on the state of coral reefs, concerning their restoration, bleaching forecasts, international policy, economic value, etc., in order to provide policy makers and the public with reliable information and recommendations.

4. Test results

According to the test results, it was revealed that most of the students do not know about the problems of coral reefs. I think it is necessary to attach great importance to environmental education and highlight current issues.

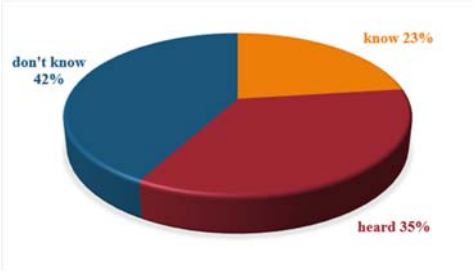

Chart 1. Percentage ratio

4. CONCLUSIONS

Unless drastic measures are taken to limit global warming to 1.5°C, the number of living corals on reefs may decrease by 70–90 percent by 2050. Even with a rapid reduction in greenhouse gas emissions, it may take decades to stabilize the temperature of the world's oceans [1].

Reef restoration is a long process, the first results of which become noticeable years later. But this is the price of preserving marine biodiversity. It is likely that before the end of the century, only those coral reefs that are cared for by underwater animal technicians will remain on the planet.

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IMPACTS OF CLIMATE CHANGE IN PAKISTAN: A CASE STUDY OF IMPACT OF CLIMATE CHANGE IN GENERAL AND IN THE GILGIT BALTISTAN REGION OF PAKISTAN

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Abstract: The objective of this study is to analyze climate change and its adverse impact in Pakistan and the changes that have been occurred in the past years, such as its impact on vulnerable areas; agriculture, infrastructure, biodiversity, water resource, natural ecosystem, economy and human health. Furthermore, to overview the current consequences of climate change in all over Pakistan and to predict the challenges that could be expected in the future and how to mitigate and face those challenges. Analysis of the past depicts that; Global climate is altering the succession of both natural and anthropogenic activities and it is imposing direct consequences on human endurance. In order to overcome greenhouse gases emission, it will be necessary to understand the climate changes impacts in Pakistan, it's main causes, mitigation processes, adaptation and future strategies. Pakistan is an agriculture country which ranks 5th in the world in terms of one of the most vulnerable country affected by climate change but ranks 135th in the world in terms of Greenhouse gases emission. Climate change had seriously harmed Pakistan with the history's worst drought that the country experienced in 1998-2001 and the history's worst flood hit in 2010. The impacts of climate change were felt this year again in all dimensions of sustainable development, economic, social as well as environmental. Problems are most likely to arise in overall the country, where it will exert adverse stress on the resources and economy, because the resources are already under stress. The work also highlights the adaptation and mitigation measures and identifies the central elements that will be necessary in the climate change action change of Pakistan and stresses their mainstreaming into the national development policies and plans.

Key words: climate change, biodiversity, mitigation, agriculture, karakoram mountains, vulnerability

1. INTRODUCTION

Climate change is a profound and serious Global environmental issue, that is exerting a diverse effect on our planet, Earth in a way that

is unpredictable. It is caused by natural and anthropogenic sources like heatwaves, volcanic eruption, burning of fossil fuel, deforestation, soil erosion, mining, different pollution. The impact would be particularly severe in tropical areas, which mainly consists of developing countries, including Pakistan. According to IPCC (2007), developing and the least developed countries are expected to suffer more due to climate change as compared to the developed countries. Pakistan is located in South Asia, having a long latitude extent stretching from the Arabian sea in the south to the Himalayan mountains and Karakorum ranges in the North. It is located in sub-tropics and partially in temperate region. 59% of the annual rainfall is due to monsoon rains, a dominant hydro-meteorological resource for Pakistan, and the Himalayan region above 35 N receives winter precipitation mostly in the form of snow and ice. The snow melt contribution keeps the rivers perennial throughout the year.

Pakistan is highly vulnerable to the adverse impacts of climate change. With a population of 220 million people and most of the population lives in Hamid and arid areas, with significant spatial and temporal variability in climatic parameters. The country's economy is dependent on agriculture and fisheries, which has been spoiled this year because of flood drought and monsoon rain caused by climate change in different regions of Pakistan, especially the southern region (Sindh), Balochistan region, Punjab, Khyber Pakhtunkhwa and Northern Areas of Pakistan.

Climate change has harmed Pakistan, with its tremendous social, environmental and economic impacts this year and is already experiencing a shortage in freshwater resources and economical problems.

2. LITERATURE REVIEW

According to the IPCC, there has been a significant increase in public awareness of energy usage and its effects on climate change, as well as a great deal of interest in learning more about energy use and its connections to the current weather [5,6]. Building energy demand and climate change have been demonstrated to be related in previous research [3,16,79,33]. Building energy demand has been impacted by climate change, according to a review by Andric et al. [3].

By 2025, urbanization would account for 50% of the population. Above all, the country's economy has already suffered economic losses

of 14 billion US dollars as a result of the unfavorable weather, and as a developing nation, it is unable to bear these losses (ADB 2017; Hussain et al. 2020). The environmental impact of Pakistan's per-capita carbon dioxide emissions, which will rise with stable economic activity. As the oceans and seas warm, there will likely be more precipitation in South Asia, which will increase the frequency of weather-related occurrences that are influenced by the Indian Ocean Dipole around the world [64]. As a result, it is anticipated that episodes would become more intense and frequent. They contend that competition and conflict between different interest groups over the management of relief and development aid increased. Pakistan likewise saw a similar scenario of the effects of climate change, where the entire ecosystem was altered as a result of those effects (Hussain et al., 2019)

3. SOME FACTS ABOUT CLIMATE CHANGE

Global warming basically is a term used for the increase in temperature of our planet Earth. This claim is not hypothetical rather it is fact driven from the meteorological measurements all around the Globe covering both sea and land surfaces. These measurements follow uniform method using globally accepted standard instruments under the supervision of the United Nation's world meteorological organization (WMO) since 1935. When a change in global climate were felt back in 1980's, the working group of nation's decided to establish a forum of political decision makers for devising strategies to mitigate the effects of climate change. Global leaders appreciated this initiative of WMO and United Nations Environment Programme (UNEP) and an international forum now known as Inter-Governmental Panel on climate change (IPCC) was established. The aim of IPCC includes reduction of greenhouse gases (GHG) to certain level in developing countries, generate resources for adaptation, incentives to mitigation efforts and to publish climate change assessment report for the globe on 6-years term. IPCC released its fourth assessment report in 2007 which includes plausible facts on changing climate in different parts of the world. Not only the past changes in climate of different parts of the world but also the consideration of future climate projections and impacts. In this paper I will try to explain the Global warming and climate change impacts in different regions of Pakistan and how it's affecting the economy.

The number of situation is of damaged houses in 2022 by district is shown in fig. 1.

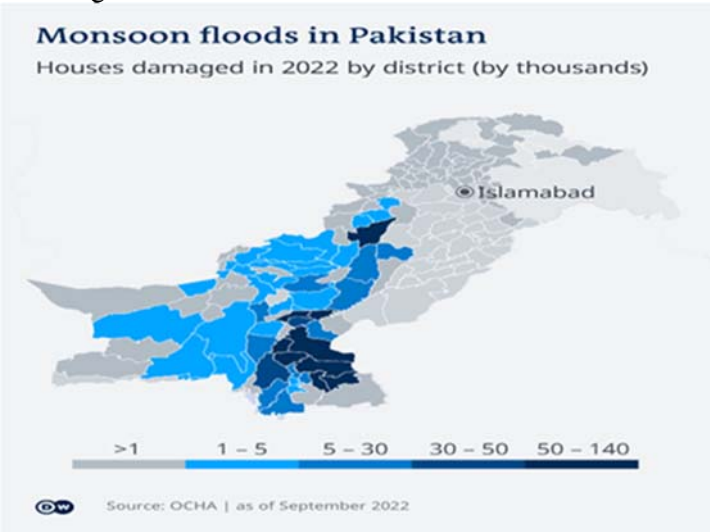

Figure 1. Overall damaged houses in Pakistan as per district

3.1. Causes of Cliamte Change in Pkaistan

Climate change is product of weather which always experience variations over space and time. The two main cause of climate change are natural and anthropogenic reasons.

3.1.1. Natural Reason: Natural reasons result in climate variability over different time scales but they are least responsible for a significant change in climate. Example of natural climatic change are solar, volcanic activities, land, ocean and atmosphere interactions which are the main cause of climatic variations in weather conditions over the globe

3.1.2. Anthropogenic Activities: Anthropogenic activities are the human impact on the earth's climate and the main reason of global warming and climate change. Anthropogenic include activities like urbanization, land use, aerosols, and greenhouse gases. Anthropogenic reasons are controllable but they been dominating now over the natural, due to which balance of the atmospheric heat budget has been disturbed and more amount of heat has been trapped in the biosphere than usually required to regulate the life processes.

4. CLIMATE SITUTAION IN GILGIT BALTISTAN REGION OF PAKISTAN

Gilgit Baltistan is located in the North of Pakistan, which covers an area of 72,496km2. It represents a portion of Asia's three highest mountain ranges, the Himalayas, karakoram and Hindukush. It's border cross those of China, Afghanistan and India and is home to more than 20 peaks over 6,100 meters (20,000ft) including K-2 the second highest mountain on Earth, Nanga Parbat, Gasherbrum I, II, Broad Peak so on, which draws thousands of tourists each year. It is well known for its biodiversity especially including many endangered species, snowcapped peaks, lofty mountains, lush green meadows, and biodiversity especially including large number of streams feed the Indus river which receive abundance of water each year from melting glaciers, snow and ice in the region. This water is used for energy generation, irrigation, drinking and for filling storage reservoir.

The main reason of flood this year in Pakistan was heavy monsoon rain and melting of glaciers.

Climate change has adversely affected this region with more rains and glacier outburst, on august 2022, most villages in Ghizer district and Hunza were severely affected by the ongoing flooding and displacing many people. The flood also damaged the karakoram highway, 4 persons were missing and 23 people were dead and the karakoram highway was damaged by floodwater.

The worst impacted districts were Ghizer, Nagar, Diamer, Astore and Ghanche. Due to the flood and landslide 420 homes were completely destroyed and 740 were damaged. Strategic highways also suffered erosion due to high water flow in the Indus river. The Ishkoman river flooded, cutting off the ishkhoman valley road at Gutkash and a bridge at Chhorbat was also inundated. Nagar district valley roads and two bridges were destroyed by floodwaters. In the Diamer district there have also been reports of damage in Khanar and Bonar. Most of Ghizer valley had been devasted by the flood as of august 26, Buber valley, Ghakuch and Gulmuti are few of these. Residents in the flood affected areas were ordered to leave.

RECOMMENDATIONS/SRATEGIES

Climate change refer to a long-term change in the climate that take over decades, centuries or longer. It is caused by the use of fossil fuels,

Figure 2. Affected districts of Gilgit Baltistan

greenhouse gases, which are rapidly accumulating in the earths atmosphere and are the main cause of climate change. Pakistan has often been listed as one of the countries most impacted by climate change. Climate change is currently having a significant negative impact on people in many different parts of the country, including increased heatwaves, food shortages, flash floods caused by glacier melt, water scarcity, rising sea levels and, population displacement. The most horrifying aspect of these effects are simply going to cause further deterioration of our land. It is mandatory that we act to stop climate change in such a circumstance. The government should take urgent reforestation and afforestation programmes on mountain slopes. As Northern areas have suffered severe deforestation due to lack of access to natural gas and electricity. We should start a campaign to engage the community in plantation. The government should build dams to store rainwater. Devise and implement a waste management for mountainous areas. Since mountain communities have nowhere to dispose their waste, they end up either troughing it in the rivers or burning the waste in open air, which contributes to the black carbon deposition on glaciers and accelerate there melting. Instead of diesel and gas we should try to use renewable energy sources and electric vehicles. We have a massive potential for solar energy in Thar Sindh and

hydropower in the North, which can produce clean, cost-effective and uninterrupted energy. Pakistan is facing a diverse climate challenges in different geographical and cultural context. Therefore, there is a need ideate solutions keeping in mind the context and diversity. We should make climate change a priority in the development and political agenda. Climate change will influence every area of human and economic development and needs to be taken in account at every level. The developing countries of Asia like Pakistan, the place influeneces of local weatheralterante are likely to be felt most severely because of resource and infrastructure constarints need to develop and implement incremental adaptation strategies and policies to take advantage of noregret.

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ENVIRONMENTAL FACTORS OF RED BOOK PLANTS SURVIVAL IN CENTRAL CHERNOZEM NATURE RESERVE

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Abstract: The paper considers environmental factors of Red Book plants survival in the conditions of climatic changes; it analyzes the data of phenological observations of red book plants from 1960 to 2019; it also reveals a shift in phenophases timing of red book plants due to changes in climatic parameters such as temperature and precipitation. The author concludes that changes in climatic parameters do not significantly affect the life cycle of red

book plants and their survival; human agricultural activities continue to pose a threat to plant survival. The study proposes a set of measures to protect red book plants from anthropogenic impact.

Key words: phenological observations, red book plants, climatic changes, biosphere reserve.

1. INTRODUCTION

The study of environmental factors of Red Book plants survival is especially important in a context of climate change.

The purpose of this study is to investigate environmental factors of Red Book plants survival in the Central Chernozem Natural State Biosphere Reserve, which provides protection of natural habitats of fourteen species of vascular plants from the Red Book of the Russian Federation. This amounts to 70% of Red Book plant species reliably known at present in the Kursk region [1].

The tasks of the study are as follows:

• to assess natural conditions of the Central Chernozem State Nature Biosphere Reserve.

• to identify and analyze environmental factors of Red Book plants growth in conditions of climate change;

• to develop recommendations for Red Book plant species conservation.

The Central Chernozem Natural State Biosphere Reserve was founded in 1935 by professor V.V. Alyokhin. It is located in the Kursk region and consists of 6 remote areas at a distance of 120 km from each other [1].

According to the data for the entire observation period, 1359 species of hybrids, vascular plants, including nonnative herbaceous plants and arboreal introduced species were recorded in the Central Chernozem Reserve from 1945 to the end of 2014. These species belong to 128 families and 550 genera.

2. METHODOLOGY

The study was conducted during the vegetation period of 2021 using the descriptive method of phenological observations [2]. 10 Red Book plants growing in the protected area were examined: *Adonis vernalis, Anemone sylvestris, Carex humilis, Echium maculatum, Iris aphylla, Linum perenne, Scorzonera purpurea, Stipa pennata, Stipa tirsa, Valeriana rossica.*

3. RESULTS

The main meteorological factors affecting plant development and ripening are air temperature, precipitation, and solar radiation [3].

The reserve is located in a moderately cold climate zone with an average annual air temperature of + 5.7°C. The sun shines for an average of 1800 hours during the year [1].

Duration of vegetation period is 185 days on average. The thermal regime is generally stable. The long-term annual average precipitation is 570 mm.

The analysis of data from 1960 to 2019 showed that the average temperature was steadily rising. The warmest year was 2019 and its average temperature was 9.3°C; the coldest year was 1987 and its average temperature was 4°C. It can be predicted that the average air temperature after 2019 will be gradually increasing over the next years.

As for the amount of precipitation, this parameter slightly changed compared to temperature changes. The driest year was 2010 with 245.1 mm of precipitation, and the most abundant in precipitation was 1991 when 728.7 mm of precipitation fell.

It can be predicted that the amount of precipitation after 2019 will be gradually decreasing over the next years.

Analyzing the phenological graphs, we can say that in such species as *Carex humilis*, *Adonis vernalis, Echium maculatum*, *Iris aphylla*, the beginning of vegetation, budding, and flowering are shifted to earlier dates, and fruiting and the end of vegetation are shifted to later dates. The differences range from 10 days to 3 months, i.e., the vegetation period is extended by several months.

For other species (*Anemone sylvestris, Stipa tirsa*, *Valeriana rossica, Linum perenne*), the following pattern can be observed: due to changes in climatic parameters, the timing of phenophases changes in the following sequence: vegetation begins earlier as well as budding, the beginning of flowering, and dying-off. Other processes (the end of flowering and fruiting) are shifted to later dates, about 2 weeks. Thus, the whole vegetation process starts and ends earlier although the dates of different phenophases are shifted.

In such plants as *Scorzonera purpurea* and *Stipa pennata*, the beginning of vegetation shifts towards later dates, as well as other processes: budding, flowering and fruiting, except the end of the vegetation, which comes earlier. Thus, the vegetation period is shortened, and all other processes are shifted to later dates.

Also, after analyzing the data of the phenological tables, it is possible to note the cyclicity associated with the ontogeny of individuals.

So, we can conclude that changes in climatic parameters have not yet significantly affected the life cycle of Red Book plant species and their survival as compared to the anthropogenic factor.

4. CONCLUSIONS

The study conducted allowed us to draw the following conclusions:

1) there was an increase in the average annual temperature during the studied period (from 1960 to 2019), which coincides with the global trend; there was an increase in average winter, summer and autumn temperatures. There was an extension of vegetation period due to later winters and earlier springs;

2) an increase in winter temperatures leads to thawing weather which can negatively affect rare and protected plants;

3) following the increase in the average annual air temperature, there was also an increase in the average annual temperature of the soil surface;

4) there was a decrease in precipitation; it can have a harmful effect on plants, especially in springs and autumns;

5) the red book plant species studied respond to climate change, but at the same time the survival of these species has not yet been affected by global climate change;

7) the main reason for listing plants in the Red Book is human agricultural activity (mowing, grazing, etc.).

To preserve the Red Book plants, it is proposed to reduce the plowing of steppe areas, limit anthropogenic loads in places where endangered species grow, and create protected areas. It is necessary to monitor the state of local species populations and prohibit uncontrolled collection for herbal medicine.

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ESSENTIAL ENVIRONMENTAL PROBLEMS IN THE REGIONS OF RUSSIA AND IN THE WORLD

TROUT FARMS WASTE DISPOSAL BY AEROBIC COMPOSTING IN HARSH CLIMATIC CONDITIONS OF KARELIA: PECULIARITIES AND METHODOLOGY

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Abstract: The Russian Federation is located in most climatic zones of the planet. The climatic conditions in the north of the country are the most severe; the implementation of any economic and industrial activity is associated with the introduction of the latest hardware design, as well as waste disposal technologies that can make a minimal negative impact on the environment, while increasing production capacity and strengthening positions in domestic and global markets.

Key words: trout farms, biological waste disposal, aerobic composting, harsh climatic conditions

1. INTRODUCTION

According to Rosstat data, the annual consumption of fish and fish products has been growing. Owing to import substitution the demand for domestic aquaculture products is rising [1,2]. The increase in manufacturing is inevitably associated with necessity of reusing and recycling waste. The main reason of this problem is the harsh natural and climatic conditions of Karelia [3].

The study was conducted within the project implemented on request LLC “Viktan”. LLC “Viktan” is a trout farm located in the Muezersky district on Lake Tikshozero of the Republic of Karelia [4]. It is planned to develop and implement a technology for the disposal and processing of waste in harsh natural and climatic conditions and taking into account the legal regulation of Karelia, as well as reducing the intensity of unpleasant odor.

2. METHODOLOGY

To conduct a laboratory experiment, an author's original method was developed for modeling the process of composting fish waste into various sorbents — peat, pine sawdust, sphagnum moss and vermiculite. Sorbents were selected from natural materials, except the vermiculite, that was chosen for ability to absorb water and chemical inertness [5]. The substrate and filler-sorbent were taken in a ratio of 3:1 under real composting conditions, assumed layer-by-layer arrangement of the substrate and filler. After that you will see the experiment course on the composting of trout farm waste and explanations for its implementation.

The experiment was carried out for 2 weeks. The mass consisted of 2,1 kg of trout and 0.6 kg of sapropel was defined into 10 plastic containers: 5 — control samples, without biological product and 5 — experimental samples with «Liquidator-2» biological product, used for reducing unpleasant odor and composting process speed-up. Experiment indicators were pH of the substrate, pH of the air above the substrate, temperature in the substrate and odor intensity. According to the obtained results tables were compiled, graphs were drawn and conclusions about the effect of the biological product and the natural filler were made.

3. RESULTS

During laboratory research the temperature increased in the studied samples. The usage of a biological product in combination with natural fillers accelerates the process of compost maturation. The most optimal is a combination of a biological product and sphagnum or peat.

The addition of a biological product makes a significant effect on pH in substrate changing. It can be said that biological product in combination with peat and vermiculite proceed more dynamically and closer to the composting scheme.

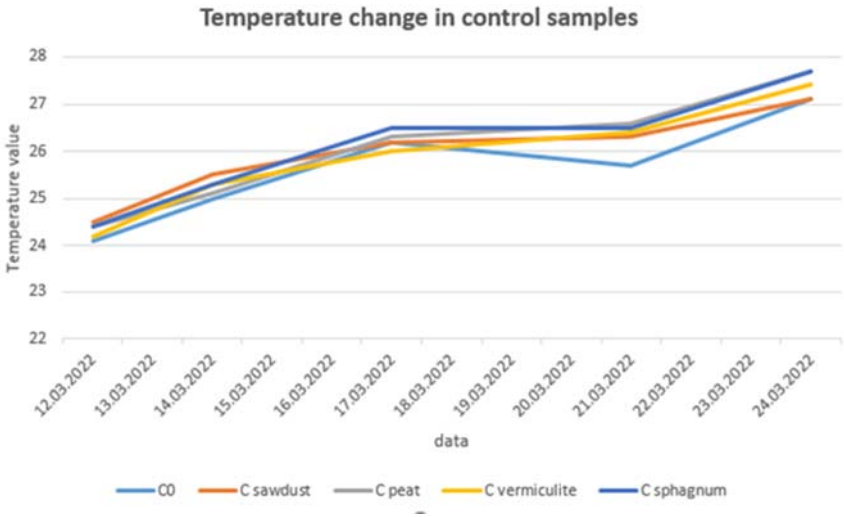

Figure 1. Temperature values changes in control samples

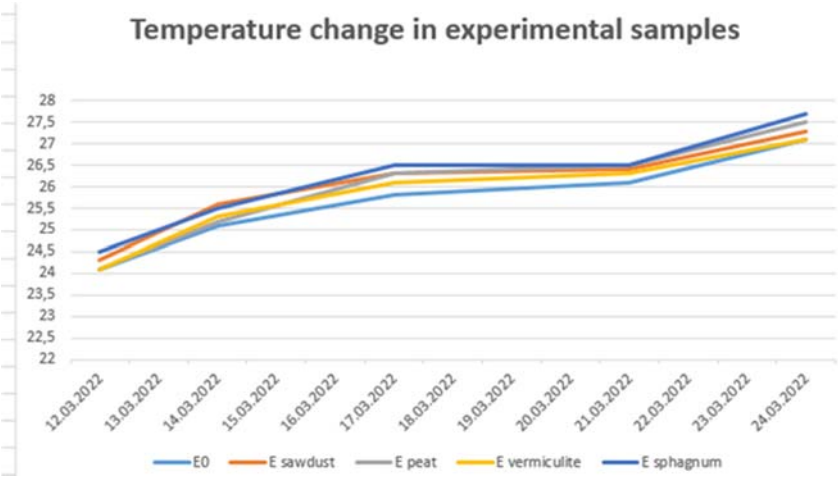

Figure 2. Temperature values changes experimental samples

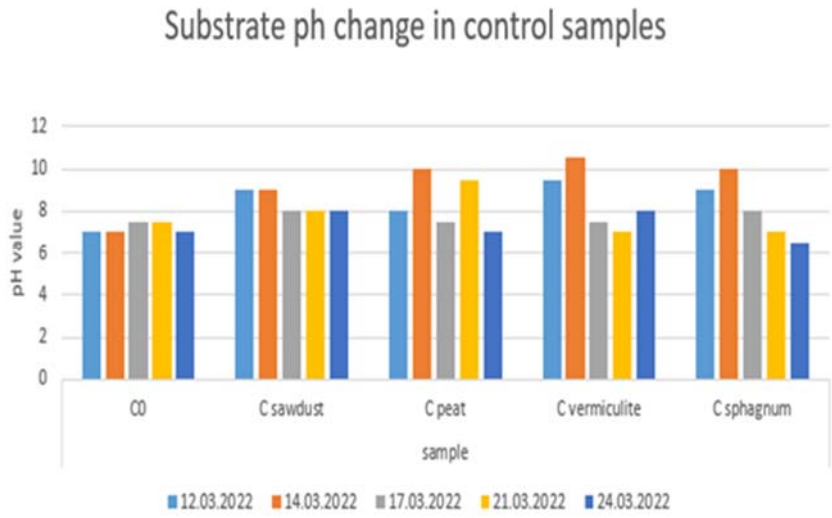

Figure 3. Changes in pH values of the substrate in control samples

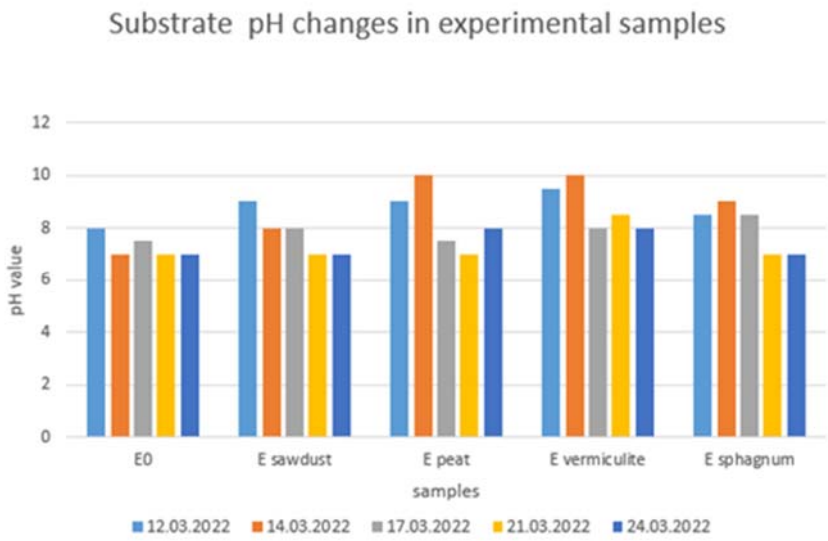

Figure 4. Changes in pH values of the substrate experimental samples

Owing to biological product usage odor intensity has been significantly decreased. The combination of a biological product and sawdust or peat is the most optimal. The pH above the substrate was neutral or alkaline; a strong odor of ammonia indicates the ongoing ammonification processes in substrate.

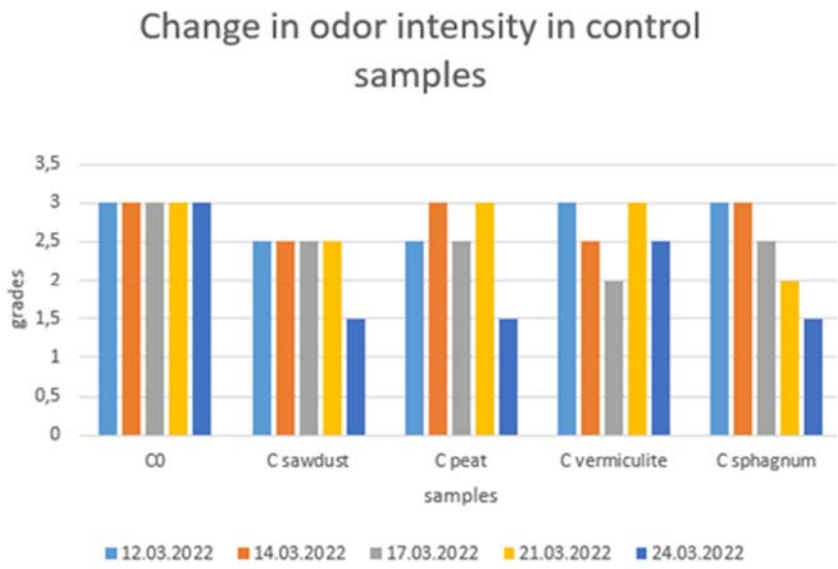

Figure 5. Changes in odor intensity (*1* — the smell is practically not felt; *2* — the smell is felt; *3* — the smell is difficult to tolerate) in control samples

4. CONCLUSIONS

The results of the experiment showed the potential of biological product and its greatest effectiveness in conjunction with peat and saws.

The technology of composting in lagoons was adopted for harsh conditions of Karelia. The generated waste volume, moisture and composition were taken into account, as well as the necessity to add natural sorbents to accelerate the maturation of the compost and reduce the unpleasant odor.

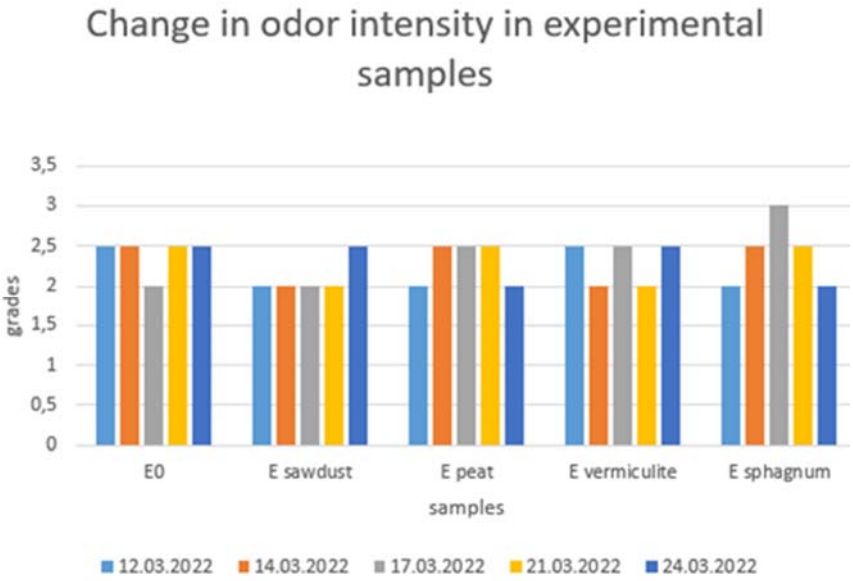

Figure 6. Changes in odor intensity
(*1* — the smell is practically not felt; *2* — the smell is felt;
3 — the smell is difficult to tolerate) in experimental samples

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ESTABLISHING METHODOLOGICAL GROUNDS FOR CONSIDERING THE RESULTS OF AIR POLLUTION MONITORING WHILE UPDATING THE SUMMARY CALCULATIONS OF ATMOSPHERIC POLLUTION

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Abstract: The article describes a new methodological approach developed to integrate air pollution monitoring data into the results of summary calculations of air pollution in order to improve the accuracy of calculations and to minimize the probability of detection the discrepancies between the calculated and instrumental data.

Key words: atmospheric air pollution, emission quota system, emission quotas, experiment on emission quotas, priority pollutants, summary calculations of atmospheric pollution

1. INTRODUCTION

Currently there is conducted the air pollutant emissions quota experiment in 12 pilot cities of Russian Federation, which are — Bratsk, Krasnoyarsk, Lipetsk, Magnitogorsk, Mednogorsk, Nizhny Tagil, Novokuznetsk, Norilsk, Omsk, Chita, Chelyabinsk, Cherepovets. The aim of the current quota experiment is to create a new accessible and generally understandable tool for urban air quality management in order to reduce the level of air pollution.

The calculation and analytical basis of the experiment are the summary calculations of atmospheric pollution based on the modelling of the ground-level concentrations of emissions from 3 types of emission sources: stationary industrial sources, transport and autonomous heating sources. In order to obtain more accurate results of summary calculations of atmospheric pollution it is necessary to consider information obtained by air pollution monitoring stations.

Due to inventory of emissions the summary calculations of atmospheric pollution need to be updated annually. The objective of this research is to develop a single algorithm for all regions of the experiment for considering the results of air pollution monitoring while updating the summary calculations of atmospheric pollution.

2. METHODOLOGY

The calculation and analytical algorithm for comparing concentrations used to establish methodological grounds is based on the current rules for conducting summary calculations approved by the order of the Ministry of Natural Resources of Russia from 29.11.2019 № 813, namely section VIII, which implies considering the results of air pollution monitoring by calculating a constant «low-priority additive» when conducting/updating the summary calculations [1–4].

The input data for the methodological recommendations are the values of the annual average and maximum single concentrations of air pollutants obtained by monitoring at the stations of Russian meteorological service located in each Russian city, and concentrations obtained by providing summary calculations.

Algorithm for calculating emissions concentrations of harmful (polluting) substances (excluding radioactive substances) is determined by methods of calculation of dispersion of emissions of harmful (polluting) substances in the air, approved by the order of the Ministry of Natural Resources of Russia from 06.06.2017 №273 [1–4].

3. DISCUSSION

The developed methodical algorithm is based on the comparison of values of average annual and maximum single concentrations of pollutants. The comparison of values is carried out in accordance with section VIII of the rules of conducting the summary calculations and the constant « low-priority additive» is considered.

Then it is necessary to adjust the summary calculations results by considering the new value and to determine new zones of excess of the maximum permissible concentration (MPC), as their location in the territory of the pilot city may change. Accordingly, there is a possibility that new objects may enter this zone of excess of MPC, which affects the number and coordinates of control points where the concentration of pollutants is determined during conducting summary calculations of atmospheric pollution.

4. RESULTS

As a result of using the methodology, no discrepancies between the calculated and instrumental data on pollutant concentrations would be

found. The availability of methodology will ensure a unique and systematic response to detected concentrations in the pilot cities of experiment.

5. CONCLUSIONS

It is the first time when experiment on emission quotas is conducted in Russian Federation. Its goal is to achieve the target values set by the President of Russian Federation, namely, to reduce the amount of pollutant emissions by 20% by 2024, and 50% by 2030. Therefore, there is an urgent need to develop new systematic approaches to change the system of air quality monitoring and management.

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INTEGRATED WATER QUALITY MANAGEMENT IN THE WATER SUPPLY WATER CONSUMPTION SYSTEM IN THE CANTON OF PEDRO VICENTE MALDONADO (ECUADOR)

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Abstract: This work is concerned with the drinking water issue in Latin America. Based on the laboratory analysis of drinking water samples, an

integrated assessment of surface water contamination by hydrochemical indicators was carried out for one of the territorial-administrative units of the Republic of Ecuador — canton Pedro Vicente Maldonado.

Key words: integrated assessment, surface water contamination combinatorial index, drinking water, water quality, hydrochemical indicators, Republic of Ecuador

1. INTRODUCTION

According to the World Health Organization, safe drinking water and sanitation is vital for the well-being and health of all people. It is indicated in the Sustainable Development Goals, that humanity has to unite in order to find the solutions to global problems, one of which is the drinking water and sanitation issue [1, 2].

Indeed, water is a universal value, which is not defined by countries or nations. Thus, international study on water quality has importance in overall context of solving the global water problem [1].

Water quality research is particularly relevant to the Republic of Ecuador as a developing country.

The research objective is to assess the chemical and ecological state of the water supply and water consumption systems in the municipality of Pedro Vicente Maldonado.

2. METHODOLOGY

The methodology of the study includes the following method: integrated assessment of surface water contamination by hydrochemical indicators [3].

The study object is raw water from the surface water source of the canton of Pedro Vicente Maldonado.

In total, 24 samples of raw and treated water were selected during 2017 and 2018. The sampling was carried out in accordance with the recommendations of the Ecuadorian standard INEN 2176:982 [4].

Laboratory analysis was conducted according to the methods established by standard INEN 2169:983 [5, 6].

Integrated assessment of surface water contamination by hydrochemical indicators is divided into three parts: the assessment of the complexity of the water pollution, the calculation of a Specific Combinatorial Water Pollution Index, assigning to the water object a class and a category according to the level of water pollution [3].

3. RESULTS

The water pollution complexity coefficient was 43%, which gave the basis for further calculation.

The Specific Combinatorial Water Pollution Index was calculated for dry and wet seasons, as the amount of precipitation may affect the water body regime, but the resulting values are in the same interval. The results are presented in the Table 1.

Table 1

Specific Combinatorial Water Pollution Index for the Talala River of the canton of Pedro Vicente Maldonado estimated for the seasons of 2017 and 2018

Period	Specific Combinatorial Water Pollution Index, S'_i
2017 (wet season)	3,62
2017 (dry season)	3,85
2018 (wet season)	3,75
2018 (dry season)	3,46

4. CONCLUSIONS

Based on the results of an integrated assessment of surface water contamination by hydrochemical indicators, a high complexity of water pollution of the Talala River (43%) was determined.

The obtained values of the Specific Combinatorial Water Pollution Index correspond to class 3 and category «b» of water pollution classification, which defines water of the Talala river as «highly polluted».

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RADIATION MONITORING OF THE DOSE OF EXTERNAL EXPOSURE ON THE TERRITORY IN THE AREA OF PLACEMENT OF RADIATIONLY HAZARDOUS FACILITIES

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Abstract: This article presents the results of measuring the dose of external radiation in the area near a radiation-hazardous object. The paper compares potential AEDR due to external exposure, obtained during monitoring of the RHF territory by different methods. Recommendations for optimizing radiation monitoring are given.

Key words: radiation monitoring, dose of external exposure, effective dose, thermoluminescent method

1. INTRODUCTION

The main criterion for evaluating the fulfillment of radiation safety requirements during the operation of the ROO is the average annual effective dose of radiation (AEDR), which is the sum of the dose of external and internal exposure. The assessment of AEDR exposure is based on the results of radiation monitoring of personnel and radiation monitoring of exposure doses to the population living in the area where radiation hazardous facilities (RHF) are located, which is carried out in accordance with the requirements of the main regulatory documents of the nuclear industry. Depending on the objectives of the study, different

methods are used for assessing the AEDR of external exposure: instantaneous, based on the results of measuring the ambient dose equivalent rate of gamma radiation (ADER), and integral, in particular, thermoluminescent. In this paper, we conduct a comparative analysis of different methods for assessing the AEDR of external exposure.

2. METHODOLOGY

The radiation survey of the territory was carried out by the instantaneous-one-time method — measurement of ADER. The measurement was carried out in accordance with [1] by the method of continuous walking gamma survey using portable spectrometric installations MKS-01A "Multirad-M" and MKS-AT6101S. Calculation of the AEDR of external exposure for the population and personnel was carried out on the basis of the document [2]. To measure the integral dose of external irradiation, TLD dosimeters with detectors based on LiF of the DTG-4 type were used. Dosimeters were installed for one year.

3. RESULTS

The analysis and interpretation of the data was carried out using the methods of mathematical statistics. Statistical data processing was carried out using the STATISTICA 10 software, the parameters of the distribution of ADER values and integral annual doses of external exposure were determined on the territory of the industrial site and in open areas in the observation zone (OS) and in the background territory. We revealed the median distribution of values in the territory of the RHF and the normal distribution in the OS and in the background territory, the results of statistical processing are shown in the table.

4. CONCLUSIONS

In general, the AEDR due to external irradiation, obtained by different methods, are comparable, the readings are within each other's confidence intervals. The difference is largely due to the annual fluctuation of the natural radiation background due to differences in natural conditions during the year: the presence of snow cover, changes in weather conditions, the absence or presence of vegetation cover, etc. The integrated method for estimating AEDR, in particular the method of

thermoluminescent dosimetry, is able to take into account and level out annual fluctuations in the radiation background, since dosimeters are installed for a long time. Because of it we get more objective results. The AEDR data differ significantly in the area near the surface of the Territory 1, which is due to the specifics of the facility, which is designed for the storage of radioactive waste.

Table

Comparison of potential AEDR of external irradiation obtained by different methods

Territory	AEDR, mSv			
	D*	CI at P=0,95	Integral	CI at P=0,95
Territory of the industrial site				
SPZ	0.74	0.49-1.04	1.3	0.51–2.3
Industrial site	1.66	0.98–2.5	1.4	0.64–3.3
Near Territory 1	4.7	3.1–6.8		
Territory 1**	28	8–117	14	5.8–23.0
Territory 2	1.04	0.67–1.72	2.2	0.55–5.5
Observation zone				
Living sector	0.43	0.31–0.55	0.89	0.75–1.00
OS	0.55	0.43–0.74	0.94	0.82–1.04
Background territory				
Background territory	0.61	0.37–0.74	0.73	0.53–1.27

D* — Potential annual effective dose of external exposure, calculated according to ADER GI, measured by the instantaneous method;
** — measurement was carried out on the storage surface.

The TLD method has a number of advantages over the instantaneous one: TLD dosimeters are installed for 1 year, and they do not require maintenance for the entire exposure period, only a measurement after the end of the exposure period, which is not labor-intensive, can be performed by 1 person; the cost of maintaining this method is determined only by the cost of the necessary equipment for measurement.

To carry out radiation monitoring by the instantaneous one-time method, according to the program, it is necessary to conduct a survey of the territory in all seasons and several times according to the schedule, and this is a costly event, it takes time and personnel. The data obtained are the basis for substantiating control points by the integral method, and

will allow dosimeters to be positioned in such a way as to fully control dose loads at these points. Territories with elevated ADER values need to be investigated in more detail using a larger number of TLD dosimeters. Such a technique will allow optimizing the scope of radiation monitoring in the area where the RHF is located.

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MITIGATION AND PREVENTION OF CLIMATE CHANGE AS A RESULT OF THE IMPLEMENTATION OF CLIMATE STRATEGIES OF RUSSIAN AND FOREIGN BANKS

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Abstract: This article is devoted to comparing the best practices of Russian and foreign banks aimed at combating climate change. It is the banking

sector that in recent years has been increasing its potential in matters of reducing emissions, both directly and indirectly through green financing instruments. For the Russian Federation (RF), this topic has become relevant relatively recently, but there are already banks that have shown their worth and are at the forefront in contributing to the fight against climate change.

Key words: banks, climate change, green financing, ESG practices, green taxonomy, non-financial reporting.

1. INTRODUCTION

Today, the problem of climate change is considered one of the main challenges of humanity, which covers absolutely all spheres of human activity. According to the researchers, climate change will increase the frequency of banking crises (from 26 percent to 248 percent), while the rescue of insolvent banks will lead to an additional financial burden of about 5 to 15 percent of gross domestic product (GDP) per year and an increase in public debt relative to GDP by half in 2100 [1]. However, the transition to sustainable development based on low carbon emissions can provide a direct economic benefit of $26 trillion by 2030 compared to the traditional development path [2].

Already in September 2019, at the UN Climate Summit, key areas were identified that can make the greatest contribution to solving the problems of preventing climate change, including financing of measures to combat climate change. With regard to this point, it is the banking sector that is increasing its potential to reduce emissions, both directly and indirectly through green finance instruments [3].

A new special report by the IEA states: in order to put the world on the path to achieving net zero emissions by 2050, it is necessary to increase investments in clean energy from less than 150 billion US dollars to more than 1 trillion US dollars by 2030 [4].

Thus, for a variety of reasons, banks find themselves in a situation of taking serious action on low-carbon development. The transition to a low-carbon development model opens up huge opportunities for the banking sector.

2.METHODOLOGY

In order to better understand the disclosure of the problem of climate change in the non-financial reporting of companies in the banking sector and the success in implementing the concept of low-

carbon development, a benchmark analysis of 20 foreign and 20 Russian banks in the field of combating climate change and adapting to its consequences was carried out as part of the work.

The choice of benchmarking as a research method is conditioned by the need to compare the performance of companies, in particular Russian ones, with the best market practices in order to choose the best directions for the development of companies and areas for improving efficiency. Benchmarking involves the collection and comparison of quantitative and qualitative data, in this case key performance indicators in achieving decarbonization goals.

The selection of 20 foreign leading companies in the banking sector is based on their ESG rating, including climate indicators. Analyzed banks are among the best companies in the sector in terms of ESG in their countries and are among the top companies according to the S&P Global rating [5]. 20 Russian companies represent the largest banks in terms of revenue and profit according to the RBC 500 rating[6].

3. RESULTS

To begin with, consider the situation in foreign banks.

All the considered leaders had separate pages on the websites where the issues of sustainability and ESG are raised. However, at the time of the analysis, only slightly more than half of the banks (60%) had developed a climate policy or statement on climate change.

Climate reports were prepared by 9 banks. These reports, as well as sections in the reports of 10 companies, were built with the adaptation of TCFD recommendations.

The analysis also found that 80% of banks have some quantified climate change targets. In addition, 11 companies have already declared their readiness to achieve carbon neutrality.

As for the disclosure of information on greenhouse gas emissions, 85% of banks prepared and published calculations for Scope 1 and 2, 65% — for Scope 3.

Nearly all of the banks on the list have been given CDP climate ratings ranging from D- to A, while two Chinese banks have an F rating, indicating insufficient data.

Now consider how things are with Russian banks.

Thus, according to the analysis, 60% of companies have created separate pages and sections on the site dedicated to sustainable

development and ESG. The mention of the problem of climate change is present only in Alfa Bank, Sovcombank and Rosbank.

The study also revealed that only 65% of Russian companies publish non-financial reports, compared to 100% of foreign companies. For five banks from the list, the issues of business participation in the climate agenda are highlighted in a separate part of their reporting.

Currently, only a quarter of banks publicly disclose their emissions across the various scopes, with the focus often being on Scope 1 and 2 disclosures.

It is also worth noting that 6 companies in the sector have identified quantitative goals and objectives in the field of climate change, of which 4 have set themselves the goal of achieving carbon neutrality.

Despite the fact that no bank publishes a stand-alone climate report, work in this direction has already begun. For example, in 2021 Sovcombank became the first Russian bank to support TCFD recommendations.

Unfortunately, many Russian companies have not yet received a CDP assessment in the field of climate, and so far only Sberbank has an assessment.

Among all the considered foreign banks, ING Group bank from the Netherlands can be singled out as a leader, and among Russian ones — Sberbank. Interestingly, both banks are in the last stages of developing the company's climate strategy as a separate document and a fundamental vector for low-carbon development.

Also, having studied the reports of 40 companies, it was possible to form a typology of the main activities that banks carry out to reduce the carbon footprint of their activities and their portfolio (Table 1).

Table 1

Typology of the main activities of banks on mitigation and prevention of climate change

Setting goals to reduce the carbon footprint of the portfolio	Customer and partner support	Modernization of methodologies, application of internal approaches and practices
Reduced funding for carbon-intensive industries	Use of green finance tools	Joining international initiatives

3.1. Recommendations for the formation and development of climate strategies for Russian banks. In connection with all of the above, recommendations were made regarding the most important elements that Russian banks should pay attention to when developing a climate strategy:

- The strategy must be holistic and coherent, with a clear purpose and vision.
- Banks need to consider significant climate risks at the company-wide level and clearly define responsibilities for managing them.
- The active introduction of green finance tools shows that banks are responding positively to the changing demands of stakeholders.
- Identification, classification and minimization of risks, as well as the preparation of appropriate reporting are important components that should be built into the framework for the preparation of a climate strategy.
- A detailed assessment of greenhouse gas emissions in Scope 1, 2 and 3 is required.
- It is important to prioritize the most effective levers for climate change action.

4. CONCLUSIONS

The banking sector has a dual responsibility. On the one hand, it needs to prepare for the negative effects of climate change on the business of the banks themselves and clients. On the other hand, it can greatly help reduce economic risks and enter a low-carbon economy by providing related products and services.

The main task of banks is to determine the long-term ESG priorities that are the most significant for the business model of a particular bank.

The green finance market that is emerging in Russia has a huge growth potential, taking into account the accumulated environmental problems and the challenges to solve them.

Only the concerted efforts of banks, companies and the state can give the necessary effect for the successful implementation of climate policy, where banks, being the business life support system, play one of the leading roles.

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KARADAG NATURE RESERVE: LONG-TERM DYNAMICS OF AIR TEMPERATURE

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Abstract: The article considers the long-term temperature dynamics in the Karadag Nature Reserve. The average monthly temperatures for the periods 1846–1871 and 2006–2021 are considered. During the period 2006–2019, the temperature regime in the reserve was considered in detail, namely, average annual surface temperatures, absolute maxima and minima of temperatures, and intra-day temperature amplitudes. According to the available data, tables and graphs were built. As a result of the study in the Karadag Nature Reserve, an increase in temperatures by ~ 1–2 ° C has been revealed for all months of the year, which corresponds to the global trends of increasing surface temperatures.

Key words: climate change, temperature regime, Karadag Nature Reserve, seasonal fluctuations.

1. INTRODUCTION

The trends of climate change that have been observed in recent years cause serious concerns among scientists. As of the end of 2021, the last eighteen years of the XXI century were among the twenty hottest years in the history of meteorological observations [1]. 2018, along with

2014, has been recognized as the hottest year in Europe since the beginning of instrumental weather observations [2]. The rate of increase in global surface temperature is higher than predicted. In 2021, the average global temperature (based on data from January to September) was about 1.09 °C above the average for the years 1850–1900 [1].

The World Meteorological Organization noted in 2015 that "one of the most effective means for adaptation to the effects of climate change is the strengthening of early warning systems for disasters and climate services" [3, 4]. That is why the study of transformations of meteorological indicators based on long-term observations in specially protected natural areas is relevant to study. Such studies will help complement the holistic picture of current climate change.

The object of the study was the Karadag Nature Reserve located on the southeastern coast of the Crimean Peninsula. The total area of the reserve is 2874.2 hectares [5]. The climate of the reserve can be defined as transitional from the sub-Mediterranean characteristic of the western part of the Southern Coast of Crimea, to the moderately continental (moderately hot and dry) characteristic of the steppe part of the peninsula. The factor complicating the climatic features of this area is the orography of the southeastern coasts of the Crimea which has a direct impact on the climatic conditions of the area [5].

2. METHODOLOGY

The information base of the work was made up of the materials of the Karadag Scientific Station named after T.I. Vyazemsky — Nature Reserve of the Russian Academy of Sciences.

Data from long-term meteorological observations of the temperature regime for the periods from 1846 to 1871 and from 2006 to 2021 was used to determine the dynamics of climatic changes within the reference area.

Generally accepted statistical methods were used to process, analyze, and evaluate the material.

3. RESULTS

In accordance with the purpose of the study, the following areas of work were identified:

1. Systematization of meteorological data provided by the meteorological station of the Karadag Nature Reserve.

Table 1

Monthly and long-term average temperatures in the Karadag nature reserve for the periods of 1846–1871 and 2006–2021

year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.	per year
1846	0.7	-0.3	5.0	9.9	13.2	15.0	20.8	21.3	17.1	12.9	1.0	7.4	10.3
1847	-2.5	1.9	2.9	10.3	15.9	17.3	20.7	20.6	18.1	10.5	5.2	-1.2	10.0
1848	-0.9	2.6	4.4	13.0	13.5	21.3	22.0	22.8	15.6	13.2	6.4	-1.9	11.0
1849	-2.5	-1.3	2.2	9.7	13.6	18.7	19.4	21.3	14.1	12.9	10.0	2.2	10.0
1850	-2.5	-0.6	-0.4	7.6	13.2	20.2	21.0	23.1	15.5	13.2	7.1	0.5	9.8
1851	-0.9	-1.2	5.3	9.1	18.8	17.4	19.3	21.9	18.4	12.6	12.8	0.6	11.2
1852	0.9	0.9	1.8	6.8	13.0	17.2	18.4	18.5	16.1	12.3	8.5	3.1	9.8
1853	2.2	4.8	6.5	7.8	15.3	17.3	21.4	23.3	16.8	16.6	6.2	2.2	11.7
1854	1.1	0.0	-0.6	5.0	16.4	18.2	21.8	20.7	15.2	14.2	9.5	5.9	10.6
1855	-1.2	3.1	8.8	10.1	16.6	21.9	20.5	22.4	13.7	15.0	8.3	-0.2	11.6
1856	3.1	0.7	-2.0	4.9	14.2	19.3	19.4	20.6	16.9	9.4	5.4	6.0	9.8
1857	4.5	-2.8	3.5	11.3	14.2	17.5	18.2	17.1	12.9	12.0	6.2	-0.1	9.5
1858	-4.1	-2.4	3.6	8.4	15.3	16.6	21.9	20.7	17.3	15.9	6.9	4.5	10.4
1859	-1.6	1.8	3.4	11.2	17.6	16.9	19.9	22.9	18.4	12.5	5.1	8.2	11.4
1860	2.4	0.8	3.1	11.4	14.0	20.4	21.6	21.6	19.4	11.7	6.0	3.6	11.3
1861	-4.2	0.6	6.4	5.9	9.8	17.7	21.0	19.2	14.9	9.1	9.8	-1.6	9.1
1862	-0.6	-1.9	8.7	9.5	14.6	19.5	20.7	19.7	14.9	8.0	3.0	-2.1	9.5
1863	0.7	0.0	6.9	6.1	15.7	17.0	20.4	19.9	19.2	11.9	5.8	0.8	10.4
1864	-7.0	2.4	8.6	7.9	11.6	19.1	17.1	19.7	16.4	9.8	6.8	0.9	9.4
1865	6.0	3.6	6.2	6.1	13.1	14.2	20.2	19.4	12.2	13.1	7.0	-2.2	9.9
1866	-0.3	0.2	7.8	8.3	12.1	17.6	20.3	19.5	17.6	7.9	4.8	0.5	9.7
1867	5.4	0.3	0.2	9.9	14.3	14.8	20.0	17.8	15.0	11.6	3.1	3.2	9.6
1868	1.6	-2.9	3.0	7.1	11.6	18.7	18.4	20.7	17.1	14.2	4.6	3.3	9.8
1869	-4.7	2.7	7.1	8.0	15.0	17.7	16.6	21.7	14.5	13.4	6.3	4.0	10.2
1870	2.9	-1.7	4.9	5.2	15.7	15.8	18.8	18.1	13.8	8.8	11.4	3.5	9.8
1871	0.4	0.0	3.7	8.3	11.0	16.3	20.8	21.5	13.2	8.6	9.9	1.0	9.6
year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.	per year
2006	-2.6	0.5	6.2	10.5	14.7	20.4	22.8	25.9	19.7	14.9	8.7	5.4	12.3
2007	6.5	2.8	6.5	10.0	18.1	23.6	25.9	26.8	20.3	16.1	7.1	4.0	14.0
2008	-0.3	2.4	7.6	11.4	15.2	21.1	24.1	26.2	19.8	14.9	9.8	3.8	13.0
2009	3.7	4.8	6.4	10.5	15.4	22.6	25.5	22.9	20.3	16.2	10.9	7.2	13.9
2010	2.7	5.2	5.7	11.0	16.6	23.4	26.1	27.6	20.8	12.0	13.3	7.5	14.3
2011	2.4	0.3	4.3	10.1	15.8	21.3	25.0	23.9	20.3	12.5	4.2	7.0	12.3
2012	2.4	-2.9	4.0	12.2	18.7	23.6	26.7	24.9	20.8	17.7	10.2	4.2	13.5
2013	4.8	5.5	6.1	12.0	19.6	22.8	25.0	26.2	17.6	11.5	10.3	3.7	13.8
2014	3.4	4.0	8.3	11.9	17.6	21.4	25.4	26.2	19.8	12.2	7.2	6.6	13.7
2015	4.4	3.8	6.8	10.0	16.4	21.5	24.2	26.0	23.7	12.5	10.0	4.8	13.7
2016	2.1	7.2	8.0	13.4	16.0	22.8	25.2	26.6	20.0	12.2	7.3	1.5	13.5
2017	1.4	2.9	8.9	10.3	15.9	21.8	24.6	26.6	21.6	13.4	7.8	8.3	13.6
2018	3.4	4.2	6.6	14.1	19.4	23.3	25.4	27.4	20.8	15.9	6.7	4.5	14.3
2019	4.6	4.3	7.2	10.9	17.2	25.5	23.7	25.1	20.3	15.3	10.1	7.7	14.3
2020	4.5	5.3	8.4	10.4	15.1	22.1	25.8	24.8	22.7	18.6	9.0	5.7	14.4
2021	5.7	3.4	5.3	9.9	16.4	20.5	26.9	25.7	18.4	12.8	10.4	6.7	13.5

2. Analysis of the long-term dynamics of air temperature in the Karadag Nature Reserve using the tools of the statistical analysis package of the Microsoft Office Excel program.

3. Identification of trends in the average annual and seasonal values of the temperature regime for the period under review in comparison with the regional averages.

Table 1 shows data for two time periods from 1846 to 1871 and from 2006 to 2021. The difference between the compared periods is 135 years. The analysis of the presented data shows a change in the average climatic parameters.

The table shows that in recent years maximum temperatures have been observed in July and August, and they range from 25–26°C, whereas in the period 1846–1871 the maximum temperatures reached 23°C, but the fluctuations from year to year were in the range of 18–23°C. Thus, the maximum summer temperatures have increased by 3–4°C.

The same trend was observed with the temperatures of the winter months. The period 2006–2021 was characterized by positive winter average monthly temperatures, only three years of this period were characterized by above-zero average temperatures in January and February. Whereas in the period 1846–1871 negative average monthly temperatures were not only observed during all winter months, but three years of this period were characterized by low average temperatures in March. In the period 1846–1871, the minimum average temperature was -7°C. In the period 2006–2021, the minimum average temperature increased to -2.9°C.

The increase in average temperatures can also be traced by the example of average annual values. The maximum annual average temperatures increased from 11.7°C to 14.4°C.

A comparison of two time periods with a difference of more than a hundred years shows the scale of climate change, namely, an increase in average temperatures by 2–3°C.

Then the temperature regime of the Karadag Reserve for the period 2006–2019 was considered. The analysis shows that the average annual air temperature in the Karadag Nature Reserve varies from year to year but remains in the range of 11–13°C. Based on the data under consideration, the line graph shown in Figure 1 was plotted. This graph shows a tendency for average annual temperatures to exceed long-term averages since 2012.

It is worth noting that 2019 stands out with the warmest temperatures of all years studied. The average annual value of the surface temperature was 13.58°C, which is more than the same value in 2006 (11.8°C). The coldest year was 2011 (the average annual temperature was 11.3°C).

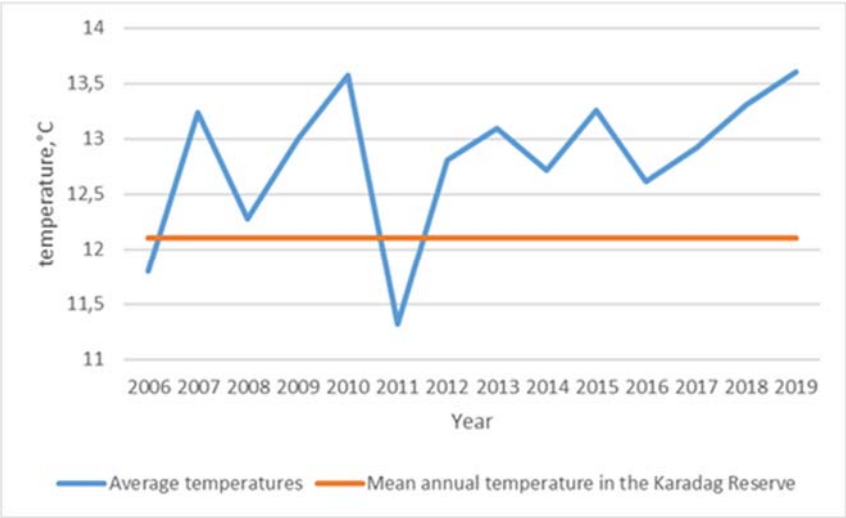

Figure 1. Average temperature values in the Karadag Nature Reserve according to the meteorological station data for 2006–2019 [6, 7]

The maximum temperature values were observed in the Karadag Nature Reserve in the summer months — in July and August. The average monthly values were 24.35°C and 25.23°C, respectively (for the period of 2006–2019). Distribution of surface temperatures relative to summer months was symmetrical. But autumn temperatures were slightly higher than spring temperatures. The minimum temperature values were observed in the winter months — in January and February.

Figure 2 shows a line graph that reflects the dynamics of changes in the absolute maximum and minimum temperatures. There is a clear increase in the absolute minimum. It changed from -24ºC in 2006 to -6.8ºC in 2019.

The analysis of average temperatures in the Karadag Nature Reserve showed that average temperatures in summer practically did not change over fourteen years and varied between 23°C–25°C. The change

in the absolute maximum cannot be characterized by a pattern, and the temperature ranged from 34°C to 37°C. There was a slight increase in intraday temperature amplitudes in the summer period. The winter period was characterized by a decrease in the intraday amplitude.

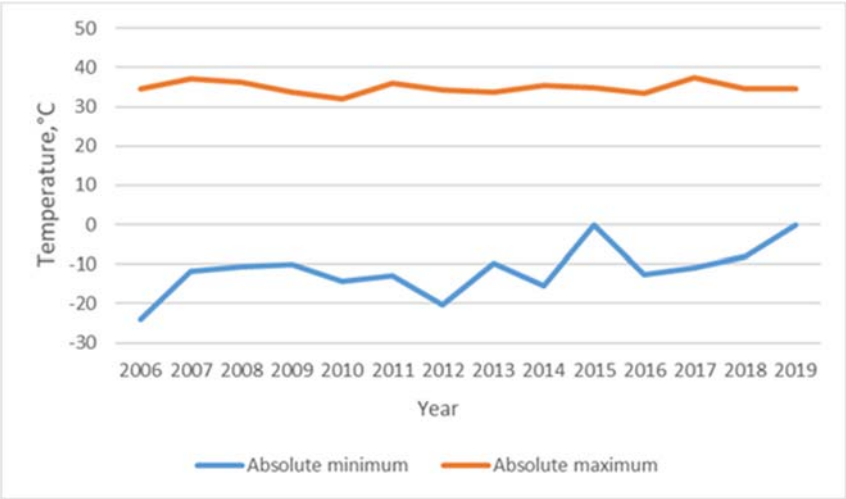

Figure 2. Absolute minimum and maximum values in the Karadag Nature Reserve according to the meteorological station data for 2006–2019 [6, 7]

Even though the record temperature value over fourteen years studied was recorded in 2017, this year considering the average annual temperature values cannot be called extraordinary, unlike 2018. This is due to the fact that in 2018, high average daily air temperatures persisted for a long time. The number of days with an average daily temperature of more than 25°C in 2018 was the largest. The number of days with negative average daily temperatures decreased during the study period.

The features revealed in the dynamics of air temperature indicators in the Karadag Nature Reserve over a long period of time suggest that the existing trends will persist, which correlate with the general global processes of climate change.

4. CONCLUSIONS

Based on the conducted study of the dynamics of the average annual air temperature and precipitation, the following can be concluded:

1. When comparing meteorological conditions for 2006–2019, according to the Karadag weather station with the average long-term climatic indicators for the Karadag Nature Reserve, an increase in temperatures by ~ 1–2°C was revealed for all months of the year, except November, which corresponds to the global trends of increasing surface temperatures.

2. There is a general trend towards warming in the study area, which may be one of the consequences of global processes of the Earth's climate transformation.

3. The trend of maximum temperatures in the summer months allows us to talk about the risks associated with fire danger in the region and risks of droughts in the reserve.

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ANALYSIS OF KRASNOYARSK WEATHER DATA FOR THE LAST 100 YEARS

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Abstract: The article considers the changes in annual averages of air temperature and precipitation for the period from 1922 to 2021 and identifies patterns of these changes. Based on the graphs plotted, it shows that over the past 100 years there has been a tendency to increase the air temperature, especially in the cold season. The author calculated the climate continentality indices according to the formulas proposed by Khromov and Shvert. It has been found that the values obtained indicate an increase in the degree of climate continentality which is due to an increase in air temperature and precipitation.

Key words: climatic conditions of Krasnoyarsk, air temperature, amount of precipitation, climate continentality, global warming, climate change.

1. INTRODUCTION

Global climate change and its consequences are one of the most urgent issues nowadays. The twentieth and twenty-first centuries have seen notable changes in climate, both globally and regionally. Thus, the International Panel on Climate Change (IPCC) found that the average air temperature in the last century increased by 0.6°C [1]. Significant changes in climatic parameters have a negative effect on people. For example, a negative effect of climate on mortality in areas with a continental type of climate was revealed as a case of Krasnoyarsk, where heat waves were found as risk factors for the population in cities with this type of climate, which led to a greater number of additional deaths [2]. Thus, one of the most important tasks is to collect climatic data in various physical and geographical conditions for the purpose of further analysis to identify their patterns and establish the effects on various ecosystem components.

The purpose of this study is to analyze the meteorological data of Krasnoyarsk for the last 100 years.

2. METHODOLOGY

In the study, data from a meteorological station of Krasnoyarsk located at an altitude of 276 m above sea level and having the following

coordinates: 56°1'48" north latitude; 92°45'0" east longitude [3; 4] was used. Based on the data, graphs of the average annual air temperature and annual precipitation values from 1922 to 2021 were plotted.

Also, to assess the change in the degree of climate continentality of Krasnoyarsk, the continentality index using the Khromov formula was calculated:

$$K = \frac{A - 5{,}4 \cdot \sin\varphi}{A}$$

where A is the annual temperature amplitude; is the sine of the latitude angle of the area.

The value of the presented continentality index is a two-digit number that increases with the degree of continentality [5].

Also, to determine the climate continentality, the Schwer continentality coefficient was used [5]:

$$K = \frac{\sum X_{3-8}}{\sum X_{9-2}}$$

where $\sum X_{3-8}$ is the sum of precipitation for March-August; $\sum X_{9-1}$ – the amount of precipitation for September-February.

According to this coefficient, the following types of climates are distinguished:

Table 1

Climate types according to the Schwer continentality coefficient [5]

№	Type name	K values
1	non-continental	K <1
2	semi-continental	1 <K <1,75
3	continental	1,75 <K <3,5
4	heavy continental	K> 3,5

3. RESULTS

Based on the available data [3;4], a graph of average annual temperature indicators (°C) was plotted for the period from 1922 to 2021 (Fig. 1).

This graph shows there is a trend towards an increase in the average annual air temperature for the period under review. Moreover, there is

also a tendency for the average monthly temperatures to increase in all months of this period. It should be noted that the increase in the average annual air temperature is primarily due to the increase in the average temperatures of the winter months. The average value of the average annual air temperature for this period was +1.04°C. The maximum value for this indicator was in 2020 (+4.2°C), and the minimum was in 1947 (-1.3°C).

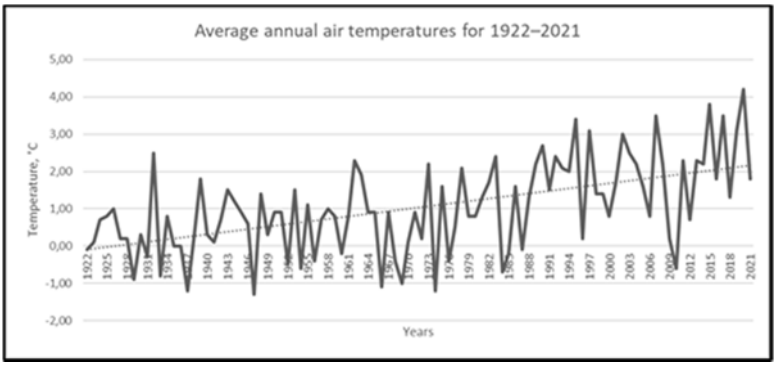

Figure 1. Average annual air temperatures for 1922–2021

The maximum values of average monthly temperatures were recorded in Krasnoyarsk in July; the largest in January-February. The highest value for this indicator was recorded in July 1969 (+22.4°C); the lowest in January 1942 (-28.7°C).

Then a graph of the dynamics of annual precipitation (mm) for the period from 1922 to 2021 was plotted (Fig. 2).

The graph shows a trend towards an increase in annual precipitation over the period under review. This is primarily due to the increase in precipitation during the winter months. It is also worth noting that in July there was an opposite trend (a decrease in the amount of precipitation), unlike other months. The highest value for this indicator was recorded in 2020 (749 mm), the lowest in 1945 (285 mm). The greatest amount of precipitation fell in summer (about 60–80 mm of precipitation per month on average), and the least amount of precipitation occurred in winter (about 10–25 mm of precipitation per month).

Further, based on the calculated continentality indices according to Khromov, the following graphs were plotted (Fig. 3; Fig. 4).

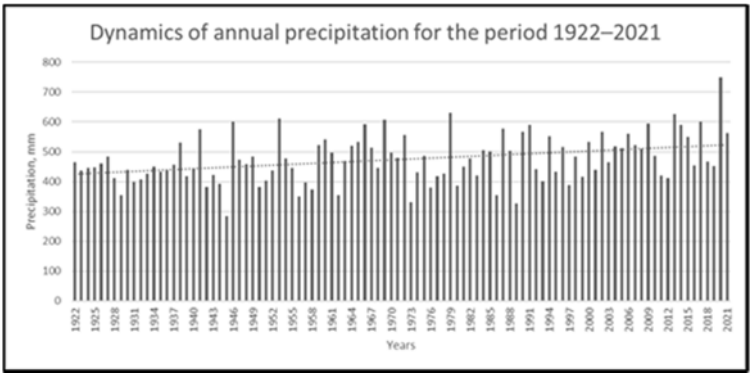

Figure 2. Dynamics of annual precipitation for the period 1922–2021

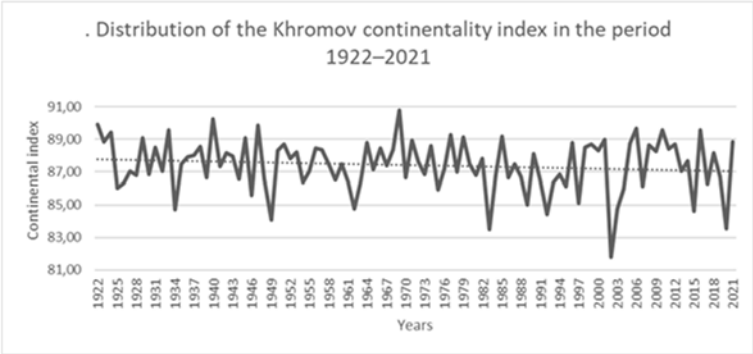

Figure 3. Distribution of the Khromov continentality index in the period 1922–2021

The graph (Fig. 3) shows there has been a trend towards a decrease in the climate continentality in Krasnoyarsk over the past 100 years. This regularity is explained by the tendency for the average annual temperatures to increase in winter. The highest value of the continentality index was recorded in 1969 (continentality index of 90.8%), the lowest in 2002 (continentality index of 81.1%). The average indicator for the Khromov continentality index was also calculated; it amounted to 87.4%.

Below is a graph of changes in the degree of continentality according to the Schwer index for the period from 1922 to 2021 (Fig. 4):

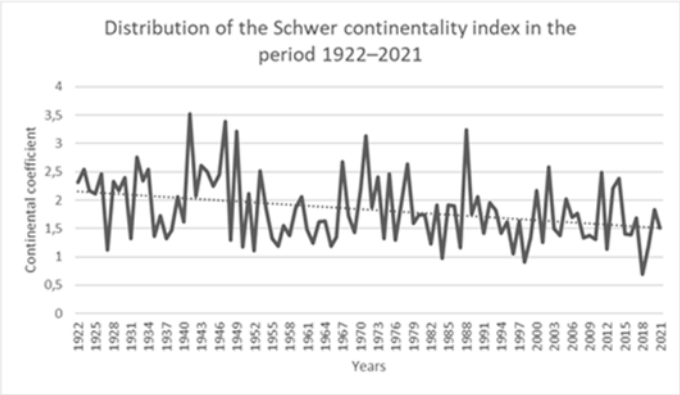

Figure 4. Distribution of the Schwer continentality index in the period 1922–2021

The graph shows there is also a decrease in the degree of continentality according to the Schwer index. This pattern is explained by an increase in precipitation especially in winter. The highest value of the continentality index according to Schwer was recorded in 1941 (continentality coefficient of 3.5 which corresponds to a heavy continental climate), the lowest in 2018 (continentality coefficient of 0.7 which corresponds to a non-continental climate). The average indicator for this coefficient was 1.8, that is a continental climate.

4. CONCLUSIONS

So, the following conclusions can be drawn:

1) in the period under consideration (1922–2021), there was a tendency of increasing the average annual temperatures and average monthly temperatures, first of all, the average monthly temperatures of the cold season;

2) there was an increase in annual precipitation which was due to an increase in precipitation in winter while in July the opposite trend was observed;

3) according to the Khromov index, over the past 100 years, there has been a tendency towards a decrease in the climate continentality in Krasnoyarsk which is mainly due to the trend towards an increase in average annual temperatures in winter;

4) according to the coefficient proposed by Schwer, there was also a decrease in the degree of continentality which was due to an increase in the amount of precipitation, primarily in winter.

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MOTOR TRANSPORT WASTE: PROBLEMS AND SOLUTIONS

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Abstract: The article deals with the problem of waste from road transport, as well as ways to solve this situation. Much attention is paid to the consideration of the possibility of recycling specific components of the car: worn tires, car body and spent batteries. As a result, options for processing each of the listed types of automotive waste are considered separately.

Key words: waste, motor transport, vehicle recycling, worn tires, vehicle body, batteries.

INTRODUCTION

To date, one of the most significant elements of the socio-economic development of society is transport. Among all types of transport, it is the automobile that is most actively used. The increase in the number of passenger cars is due to the complexity of the functions of the production sector, as well as the elementary desire of a person to have freedom of movement.

The term “motorization” is now included in the country's development indicators from an economic point of view. It implies not only a car, but also a road.

Despite all the advantages of using transport, there is no denying the negative impact on the environment and human health. Of all the numerous modes of transport, the automobile causes the greatest damage, polluting the atmospheric air with toxic substances.

Relevance. At the moment, in more than 150 cities of Russia, it is motor transport that causes a significant share of pollution. At the same time, the issue of recycling motor vehicle waste remains open. Despite this fact, the state's costs for solving the problem of waste disposal of motor vehicles are several times less than, for example, in developed Western countries.

METHODOLOGY

When studying the problem of vehicle waste, the methods of theoretical analysis were mainly used. Now, the topic of automotive waste is relevant, which is the reason for the large number of studies and literature on this issue.

The work included a general literature review of specific types of automotive waste, and then a detailed study of technical documentation on the possible processing of each of the types.

RESULTS

Approximately, there are about 5 cars per 1 km² of the territory, while in large cities of developed countries the density is hundreds of times higher. The process of urbanization is relevant not only for Russia, but also for many other countries of the world. Accordingly, with an increase in the number of cars, the urgency of the issue of recycling and recycling of transport is growing [7].

Table 1

Types of waste during the operation and maintenance of road transport in a large city [2]

Types of waste	Quantity, tons
Battery electrolyte	647,3
Battery lead scrap	999,9
Worn tires	4816,9
Scrap of ferrous metals during repair	6665,2
Scrap of non-ferrous metals during repair	174,9
Waste of plastic materials	276,1

Vehicle recycling

Before considering the recycling of the components of a car, it is worth familiarizing yourself with the general scheme for the recycling of motor vehicles.

So, the recycling scheme includes 5 stages [4]:

1) *Dismantling the vehicle.* Already at this stage, some of the components of the car (engine, gearbox, etc.) can be reused — installed on other vehicles.

This fact is extremely important, because reuse is one of the factors to reduce the negative impact on the environment, as well as reduce energy costs.

2) *Sorting parts according to materials.* If the parts are unsuitable for repair, they are sent for processing, which consists in the following activities: pressing (typical for the body), cutting and crushing, remelting.

3) *Pyrolysis of organic compounds.* The process of pyrolysis of compounds can be used as an energy resource, but most often it is inefficient.

4) *Burning of the remaining materials in the form of tires, etc.* Most often, it is this stage that causes most of the damage to the environment, since a large amount of slag and exhaust gases are released during the direct combustion process.

5) *Waste disposal.* Waste disposal should only be considered as a temporary method.

Tire recycling

According to today, only about 20% of car tires are recycled, the remaining 80% are accumulated. It is interesting to note that a worn tire

weighs about 1 kg less than a new one. It is likely that the lost mass has been converted to the dust mentioned earlier [3].

In some countries, used tires are used as fuel (burning). At the same time, as well as processing into rubber crumb, this method is ineffective, since the costs will not be replenished.

At the same time, in the process of burning tires, a number of toxic substances (carbon dioxide and other hydrocarbons) are released into the atmosphere. This fact cannot but affect the state of the environment, and in particular, the aggravation of the greenhouse effect.

At the moment, the secondary use of tires is the main way to solve this problem.

The result of tire recycling can be used as a material for the rubber industry, roofing and sports surfaces, as well as for the manufacture of road surfaces.

One of the promising directions in tire recycling is recycling based on steam-thermal destruction in a superheated steam environment.

Vehicle body

The car body is a black scrap. Scrap metal, which is used in smelting, can save public costs in the national economy due to the fact that the rational use of its resources is the most important condition for achieving high productivity of public labor [6].

The problem is that not all metal resources are disposed of on time. Often, they are not extracted and are lost. It should not be forgotten that the metal is also susceptible to corrosion and abrasion, which increases losses.

Significant savings in production can be achieved due to complete collection, proper sorting, as well as safety from mixing during transportation.

Consider the car body recycling scheme (Fig.1) [6].

First of all, large parts and elements (1) are removed from the car: wheels, bumper, etc. Then the body is packaged using press scissors (2), and then crushed using a crusher (3). Using a magnetic separator suspended above the plate conveyor (5) (4), the crushed product is extracted ferrous metals. Further, the residual material passes through a pneumatic separator, where non-ferrous metals and non-metallic materials are isolated. Non-ferrous metals pass through radiometric separation, where they are separated according to the type of alloy [6].

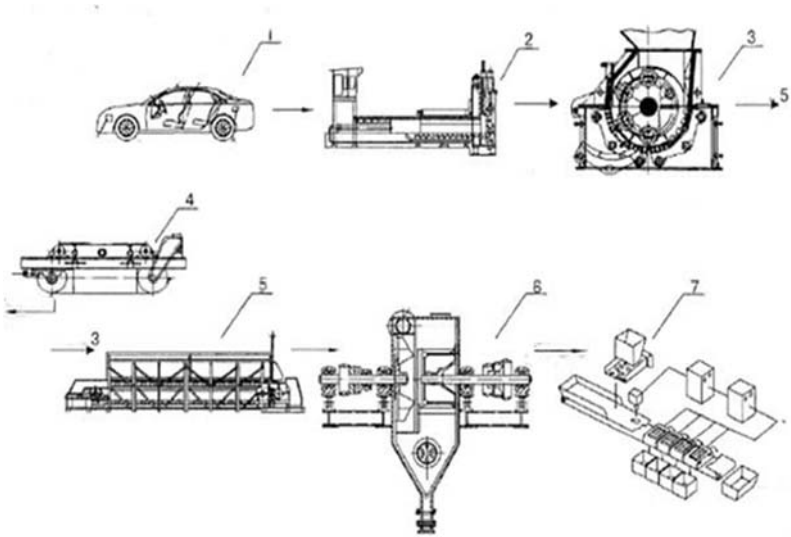

Figure. 1. Car body recycling scheme [8]
1 – car, *2* – press scissors; *3* – hammer crusher;
4 – suspended magnetic separator; *5* – plate conveyor;
6 – pneumatic separator; *7* – radiometric separation unit.

It can be said that body recycling is understood as a technical process through which scrap metal is pressed, crushed and sorted to transition to a state suitable for secondary use in foundries.

Batteries

The development of measures for the disposal and recycling of batteries, as well as the further use of processed products, directly depend on the type of battery.

At the moment, only 11% of all waste generated is recycled in the form of batteries, although there are obvious economic benefits.

Thanks to the use of materials extracted from spent batteries, it is possible to reduce the consumption of non-renewable natural resources. In addition, it is possible to avoid negative impacts during the extraction and processing of ores, if the material can be recycled. In any case, the negative consequences in the process of recycling and recycling are significantly less than in the manufacture of the primary product [1].

In general, recycling helps to avoid waste treatment costs. Spent batteries are most often classified as hazardous waste (hazard class I-III), respectively, the costs of transportation and processing of such waste are much higher. First of all, it is worth noting that each of the types of batteries has features in the process of recycling and disposal. Many of them can be easy to process, while others have a number of dangerous characteristics that require special technical solutions.

Consider the process of recycling a lead-acid battery. The battery case is opened. The electrolyte from sulfuric acid is drained. The components in the form of plates and connectors are removed from the housing. At this stage, familiar manipulations in the form of grinding and separation can occur. As the final product of processing, the blue will be sent for remelting, plastic — for the formation of new buildings. Sulfuric acid is either neutralized or processed into sulfide salts [1].

The main advantage of processing lead-acid batteries is the use by all manufacturers of the same raw materials (sulfuric acid, lead and lead oxide). In addition to the same raw materials, lead-acid batteries have an identical design, which allows you to speed up the processing process using automated equipment. The advantage is also recycled lead, which practically does not differ in quality from the primary [5].

The problem may arise due to the rapid obsolescence of battery recycling technology due to constantly changing production technologies.

The quality of processing can be improved by using convenient labeling for proper distribution by species. The new rules will contribute to the development of safe transportation and handling. The recycling process will be much simplified if all batteries are designed with subsequent recycling in mind, avoiding the use of materials without the possibility of reuse [5].

CONCLUSIONS

Having studied and analyzed the main problems of recycling and disposal of motor vehicle waste and possible solutions, it can be concluded that the problem of disposal of motor vehicle waste will remain relevant for quite a long period. Despite the authorities' concern about this issue, measures for the rational disposal of transport waste are being taken in insufficient quantities.

To date, the disposal of motor vehicle waste is an indispensable measure in the fight for the preservation of not only the environment, but also human health.

Thanks to the recycling of motor transport waste, it will be possible to reduce the consumption of non-renewable natural resources.

It should be noted that the active development of the utilization of transport contributes to progress in the automotive industry, which has a positive effect on the economy of the country as a whole.

It is necessary to solve the problem of lack of financing in the field of waste recycling of motor transport. Also regulate the system of sale of secondary materials and products made from them.

Summing up, we can say that the solution of the problem of recycling of motor transport waste at the legal state level lags behind the active development of the automotive industry. The creation of an integrated system of recycling and disposal of motor vehicle waste will not only improve the environmental situation in the country but will also encourage many enterprises to switch to resource-saving technologies.

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EXPERIENCE OF IMPLEMENTING HE EXTENDED PRODUCER RESPONSIBILITY SYSTEM

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Abstract: This article examines the concept of Extended Producer Responsibility (EPR), an effective resource management tool by which manufacturers take responsibility for end-of-life management of used products. The benefits and environmental motivations for the introduction of the EPR system were studied. The legislative basis for the development of the EPR of the European Union and the Russian Federation is considered. In fact, the Russian EPR system reproduces a foreign analogue, but has many shortcomings, which leads to inefficiencies in its functioning. In general, the EPR system is one of the most effective economic mechanisms for reducing the negative impact of industrial activity on the environment.

Keywords: extended producer responsibility, EPR, resource management, producer's responsibility, recycling

INTRODUCTION

Every year, the demand and consumption of various goods increases, which contributes to the negative impact on the environment associated with the loss of consumer properties of such goods. A large number of worn out or end-of-life products. This has created a need for proper management of the waste generated.

Since the 1990s, countries of the Organization for Economic Cooperation and Development began to develop new policies aimed at redirecting waste to recycling and reuse [1]. Since then, EPR has contributed to a significant increase in recycling rates and savings in government waste management costs and has helped to decouple waste management from economic growth [2].

Recycling has several advantages over other waste management options. It reduces the cost of production, the need for waste disposal facilities, saves energy and natural resources, and creates employment opportunities [3]. Over the past two decades, legislation and policies aimed at reducing the environmental impact of products have increased in various countries [1]. Most of them are based on the principle of "extended producer responsibility" (EPR).

EPR is a policy approach in which the producer's responsibility for the product extends to the stage of the product life cycle after the consumer [4]. This may include collecting, sorting, and processing for their recycling and recovery. Its main feature is that the participants in the packaging value chain (manufacturers, importers and retailers) take a significant degree of responsibility for the environmental impact of their products throughout the entire life cycle [2].

The goal of EPR policy is to shift physical and/or financial responsibility to the manufacturer earlier in the product life cycle [4].

The motivations for practicing extended producer responsibility include a combination of economic, environmental, and social factors. Extended producer responsibility shifts the economic burden of disposal costs from the government to the product manufacturer [5].

In an environmental context, products must be designed with recyclability in mind, and extended producer responsibility encourages design with recyclability in mind while discouraging the use of toxic components in products. Finally, extended producer responsibility meets the growing consumer demand for environmentally friendly products that can be easily recycled or produced using recycled materials [5].

Environmental motivations for extended producer responsibility include increasing product recyclability, reducing the use of toxic components in products, and reducing the amount of material that is sent to landfill or incinerator rather than being reused or recycled. Product recycling can reduce the amount of energy required to produce the product and the associated air and water pollution compared to producing the product from virgin raw materials [5].

1. METHODOLOGY

Four key benefits of EPR that drive the political approach to end-of-life packaging management:

– EPR requires manufacturers to change packaging to make it recyclable;

– EPR offers additional funds for recycling programs, thereby increasing recycling rates;

– EPR increases recycling efficiency, thereby reducing costs;

– EPR promotes a fairer waste management system — individual producers/importers pay the cost of their environmental impact [6].

Rather than regulating product disposal through traditional end-of-production management and control methods, extended producer responsibility is a preventative measure that uses a cradle-to-grave life cycle or perspective. Extended producer responsibility policies attempt to change the way a product is produced — the "cradle" — to affect how the product can be disposed of — the "grave" [5].

EPR is an individual commitment because companies that put products on the market are responsible for their proper end-of-life management. In practice, however, producers often work collectively to realize this responsibility by creating producer responsibility organizations [2].

The legislative framework for the development of EPR at the European Union level consists of both general waste legislation and specific directives governing the recovery and recycling of specific waste streams. The Waste Framework Directive (2008/98/EC) establishes a general framework for waste management in the EU. It allows member states to create EPR circuits. In addition, the EU has issued directives on specific waste streams.

2. RESULTS

EPR systems for different waste streams differ in developed and developing economies. Over the past two decades, there has been a significant increase in the use of EPR in OECD and developing countries [1].

In the Russian Federation, the EPR mechanism was introduced in 2015 by Federal Law No. 458-FZ of December 29, 2014 "On Amendments to the Federal Law 'On Production and Consumption Waste', Certain Legislative Acts of the Russian Federation and the Annulment of Certain Legislative Acts (Provisions of Legislative Acts) of the Russian Federation".

The main changes related to the EPR in Russia:

– provision of EPR funds to organizations that dispose of waste and are on the register of disposers;

– annual increase in recycling rates;

– creation of personal accounts in the Unified Federal State Information System for recording waste from the use of goods to confirm compliance with recycling standards and interaction with the supervisory authority;

– the obligation to dispose of arises from the sale of the goods and packaging.

In fact, the Russian EPR system reproduces a foreign analogue, but has many deficiencies in the Russian version, which leads to inefficiencies in operation [7].

In the Russian Federation, the EPR system is not legally enshrined, as in most EU countries, which makes it impossible to clearly imagine the purpose of its introduction [7].

Also, the EU EPR system, unlike the RF EPR, has a clear and legislated framework: from the conditions of participation of subjects, waste collection, logistics to the methods of processing of different fractions and financing [7].

In Europe, the average recycling rate is more than 60%; in Russia, on average, it does not reach 7% [8].

3. CONCLUSIONS

All The EPR system is one of the most effective economic mechanisms to reduce the negative impact of industrial activity on the environment, because when producers and importers of goods comply with the principles of EPR:

– reduction in the volume of waste sent to landfills. As a consequence, a reduction in greenhouse gas emissions from landfills;

– reduction of production costs through the use of secondary material resources;

– increasing the environmental image of the company and, as a consequence, a competitive advantage.

In the Russian Federation, the structure of the EPR is not ideal, and individual links in the system are not interconnected and do not have control over their functioning. That is why a conceptual change is necessary.

It is worth implementing a fair and clear principle — “the polluter pays”. If a producer/importer makes a profit by affecting nature, he must reduce this harm and eliminate the consequences.

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ЭКОЛОГИЧЕСКАЯ И ЭСТЕТИЧЕСКАЯ ОЦЕНКА ПАРКОВЫХ ТЕРРИТОРИЙ ГОРОДА КЛИНЦЫ БРЯНСКОЙ ОБЛАСТИ

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ECOLOGICAL AND AESTHETIC ASSESSMENT OF THE PARK TERRITORIES OF THE CITY OF KLINTSY, BRYANSK REGION

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Аннотация: в работе дан анализ видовому разнообразию зелёных насаждений городских парков и скверов г. Клинцы с учётом санитарно-

гигиенического и эстетического состояния растений. Проведена приборная оценка распространения загрязнителей на территории рекреационных насаждений: углекислого и угарного газов, летучих органических соединений и формальдегида. С помощью метода анкетирования изучено эмоциональное впечатление, производимого ландшафтом рекреационного назначения и зелёными насаждениями на отдыхающих в зоне парка или сквера. Рассмотрена общая рекреационная привлекательность мест отдыха.

Ключевые слова: парки, скверы, санитарно-гигиеническая оценка, эстетическая оценка, оценка эмоционального впечатления, видовой состав зеленых зон, качество воздуха, уровень шумового загрязнения, экотуризм.

Городская среда представляет собой комплекс природных, природно-антропогенных и социально экономических факторов, оказывающих большое и разнообразное действие на жителей городов. В условиях увеличения техногенных нагрузок санитарно-гигиеническая роль городской растительности становится мощным средством нейтрализации вредных последствий техногенного загрязнения [2].

Ведущее звено системы озеленения городов – городские парки, проектируемые как озелененные открытые территории, предназначенные для отдыха. Без парков система озеленения городов считается неполноценной, так как именно парк создаёт условия для организации практически всех видов отдыха.

Благоприятное состояние экземпляров растений, опрятные улицы дают не только свое экологическое воздействие, но и украшают город, создавая приятное эмоциональное впечатление, как для жителей города, так и для туристов [1].

Город Клинцы Брянской области — самый крупный населённый пункт в области богат разнообразными формами насаждений, экомониторинг которых необходимо продолжать для поддержания их сохранности и функций. Рассматривая экологическую и эстетическую оценку парковых территорий города Клинцы обследовали: парк им. Н.А. Щорса, сквер 169-й дивизии, Центральный сквер, Ленинский парк, Городской парк им. В.В. Воровского.

Методом учета общего числа видов деревьев и кустарников был изучен видовой состав растительности парковых зон города, с учетом преобладания того или иного вида.

Используя методы санитарно-гигиенической оценки (Нестеров Б.Г., 1989 г.) и эстетической оценки (Агальцова В.А., 1980 г.)

зеленых насаждений был определен класс жизненной устойчивости деревьев и кустарников, а также их декоративность.

Кроме того, используя тестер для определения качества воздуха (марка JD — 3002) измеряли содержание углекислого и угарного газа, летучих органических соединений и формальдегида, а также температуру и влажность воздуха в трех локациях: за территорией — области непосредственного влияния главных источников загрязнения, на периферии и в центральной части парка.

Оценивали также и шумовое загрязнение с помощью шумомера интегрирующего (ШИ — 01) в трех локациях.

Все замеры проходили в условиях сухой и безветренной погоды. Время проведения измерений устанавливали в периоды максимальной интенсивности движения транспортных потоков, в среднем оно составляло — 3–4 минуты. Все результаты заносились в полевой журнал измерений. С целью исключения возможных ошибок было проведено несколько контрольных замеров с определением среднего значения.

Оценивая эстетическую привлекательность, а также эмоциональное впечатление производимого ландшафтом рекреационного назначения и зелеными насаждениями на жителей города, отдыхающих на территории парка или сквера, нами был выполнен анкетный опрос. Анкета включала в себя три блока вопросов: первый — включал ряд общий вопросов, второй — давал оценку эколого-эстетическим свойствам пейзажа зеленой зоны, а третий — оценку впечатления, производимого природными компонентами ландшафта на отдыхающих.

Также проводили оценку состояния и общей вписанности рекреационных объектов и сооружений, встреченных на территории зеленой зоны, с учетом дорожно-тропиночной сети, малых архитектурных форм и объектов санитарного назначения.

В ходе исследования было установлено, что в настоящее время на территории муниципального образования город Клинцы зеленые насаждения общего пользования представлены городскими парками и многочисленными скверами. Основная часть зеленых насаждений общего пользования сконцентрирована в центральной части муниципального образования.

В озеленении парков и скверов г. Клинцы из деревьев преобладают: липа мелколистная *(tilia cordata),* липа крупнолистная *(tilia*

platyphyllos), каштан конский *(aesculus hippocastanum),* клен остролистный *(acer platanoides)*, ясень обыкновенный *(fraxinus excelsior*), клен шаровидный *(acer globosum)*, ель колючая *(picea pungens)*, ель обыкновенная *(picea abies)*, береза бородавчатая *(betula pendula)*, туя западная Брабант *(thuja occidentalis Brabant)*, рябина обыкновенная *(sorbus aucuparia)*, ива вавилонская *(salix babylonica)*, робиния лжеакация *(robinia pseudoacacia)*.

Липа мелколистная и крупнолистная широко распространены в возрасте от 15 до 40 и более лет. Как правило, большинство экземпляров деревьев соответствуют второму классу устойчивости — деревья с несколько замедленным приростом по высоте, с единичными сухими сучьями в кроне и незначительными (по 20–15 см) наружными повреждениями ствола, без образования гнилей. Это, очевидно, связано с тем, что липа очень требовательна к почве, предпочитает плодородные увлажненные почвы и очень чувствительна к выхлопным газам.

Каштан конский обыкновенный встречается в возрасте от 10–15 до 25 лет, состояние хорошее, декоративные качества высокие. Растение очень красивое в одиночных и аллейных посадках. Каштан конский следует высаживать на расстоянии 6–8 и даже 10 м друг от друга, тогда под деревьями будет хорошо расти газон. В настоящее время кроны деревьев создают сильное затенение. Не помогает и удаление нижних ветвей, что, несомненно, ведет к угнетению травяного покрова.

Клен остролистный встречается в возрасте от 10–12 до 20–40 лет. Как правило встречается одиночно или небольшими группами. Состояние хорошее, соответствует второму классу устойчивости и декоративности.

Ясень обыкновенный встречается в возрасте 20–45 лет. Общее санитарное состояние хорошее, однако, некоторые экземпляры имеют средний балл декоративности, требуя небольшие работы по лечению ран, обрезке сухих ветвей и сучьев с последующей заделкой и декорированием мест повреждения.

Клен шаровидный встречается в возрасте 12–15 лет. Состояние отличное. Как и каштан конский имеет высокие декоративные качества. Особую популярность в озеленении получил за счет плотной, шаровидной формы кроны, сохраняющейся без формирующей обрезки.

Ель колючая в небольшом количестве отмечены во всех парках. Растение очень декоративное и устойчивое в городских условиях. Крупные экземпляры растут в сквере им. 169 Дивизии и Центральном парке. Возраст более 50 лет, состояние хорошее. Молодые посадки также в хорошем состоянии.

Ель обыкновенная встречается реже, приживается хуже ели колючей. В парке им. В.В. Воровского имеются хорошие экземпляры, но чаще растения встречены в удовлетворительном состоянии.

Береза бородавчатая распространена в основном в возрасте 20–30 лет, состояние хорошее. Высота нередко достигает 20 м. Хороша во всех видах посадок. Очень красива в молодых (10–20 лет), а с возрастом становится очень высокой и затеняет окна, нередко теряя свои декоративные качества.

Туя западная (форма Брабант) очень популярное растение в озеленении парков и скверов. Все, прижившиеся растения в хорошем состоянии, возраст, в основном, в пределах 15–20 лет. Деревья имеют высокие декоративные качества, проведения санитарных мероприятий практически не требуется.

Рябина обыкновенная используется в посадках в парках, скверах, в жилых районах. В большом количестве рябина высажена в Ленинском парке. Возраст от 10 до 20 и более лет. Состояние отличное. Растение оригинальной формы, но с возрастом теряет декоративность, поскольку оголенные и толстые, искривленные стволы производят впечатление уродливых растений, у некоторых стоят подпорки.

Ива вавилонская встречается в возрасте от 3–5 до 20 лет. Особенно обильные посадки молодых экземпляров растений высажены в парке им. В.В. Воровского. Состояние хорошее, но ежегодно однолетние побеги подмерзают, в суровые бесснежные зимы растение может вымерзать, теряя свою декоративность.

Робиния лжеакация или белая акация также широко распространена в озеленении. Посадки, в основном, в возрасте 20–40 лет, состояние хорошее, декоративные качества высокие, особенно в период цветения.

Из кустарников наиболее широко представлены: пузыреплодник калинолистный *(physocarpus opulifolius)*, кизильник блестящий *(cotoneaster lucidus)*, сирень обыкновенная *(syringa vulgaris),* барбарис Тунберга *(berberis thunbergii).*

Пузыреплодник калинолистный встречается очень часто и составляет до 50% живых изгородей парков г. Клинцы. Очень практичный кустарник в озеленении, поскольку сохраняет свои декоративные качества по поздней осени.

Кизильник блестящий представлен в виде сформированных полушаровидных групп. Состояние хорошее. Кустарник декоративен, хорошо формируется и заслуживает широкого использования в озеленении при создании живых изгородей, а также в свободно растущем виде.

Сирень обыкновенная наиболее представлена в единичных экземплярах в Центральном парке, изредка в живых изгородях. Возраст различный от 3–5 до 30 и более лет, состояние, в основном, везде хорошее, однако декоративные качества оставляют желать лучшего.

Барбарис Тунберга особенно хорошо смотреться в живой изгороди у входа в сквер им. Н.А. Щорса. Состояние хорошее, возрасте более 20 лет, декоративные качества высокие.

Определив качество воздуха и уровень шумового загрязнения было установлено, что по всем рассмотренным нами показателям наиболее благоприятная экологическая обстановка наблюдается в самом центре зеленой зоны. Здесь выявлен наименьший уровень вредных веществ, а также уровень проникновения городского шума.

Экологическая ситуация ухудшается по мере продвижения от центра зеленой зоны к периферии, поскольку отмечено возрастание уровня загрязнения углекислым газом, летучими органическими соединениями и формальдегидом. Наивысший уровень загрязнения воздуха отмечен за территорией зеленой зоны, поскольку рядом с обследованными нами парками и скверами пролегали автотранспортные пути — главные источники загрязнения. В то же время загрязнения парковых территорий угарным газом ни в одной из изученных нами локациях не обнаружено (таб.1).

Рассматривая температуру и влажность в формировании микроклимата зеленной зоны следует отметить, что насаждения парка благоприятно влияют на параметры микроклимата, изменяя их в сторону более комфортных.

Изучив эстетическую привлекательность парков, а также эмоциональное впечатление отдыхающий на территории зеленых зон с

помощью метода анкетирования, отмечено, что по первому блоку вопросов, дающих оценку экотуризму, большее число отдыхающих предпочитают посещают городские парки и скверы не реже одного раза в месяц, как правило с семьей в целях отдыха, общения с природой; реже отдыхающие проходят попутно через парк с целью посещение досугового объекта. По мнению опрошенных, нахождение на территории зеленой зоны особенно приятно в летнее и осеннее время года.

Таблица 1

Средние значения экологических показателей загрязненности воздуха и уровня шума на территории парков г. Клинцы с учетом их локации

	CO_2 (ppm)	ЛОС (мг/м^3)	НСНО (мг/м^3)	СО (мг/м^3)	Уровень шума (дБ)	t (C^0)	φ (%)
Центр зеленой зоны	402,3	0,022	0,0033	0	51,2	26,4	54,4
Периферия зеленой зоны	417,1	0,035	0,0054	0	56,8	26,1	55,7
За зеленой зоны	485,6	0,091	0,0153	0	61,7	26,2	55,8

Оценивая эколого-эстетические свойства пейзажа городских парков г. Клинцы, отдыхающие дали, хорошую оценку, находя его весьма разнообразным, красивым и, в то же время, гармоничным. Однако, многие отметили, что не помешало бы добавить объекты зеленого строительства, в частности цветущие формы и, в целом, улучшить визуальные качества пейзажа.

Оценка впечатления, производимого природными компонентами ландшафта и эмоциональная оценка пейзажа позволяют говорить о том, что больше всего на территории парков отдыхающих привлекает: воздух, растительность и объекты водных сооружений. Все опрошенные отмечают чувство радости, душевного подъема, умиротворения, а иногда и восторга, пребывая в парках и скверах.

Нами также отмечено, что все рассмотренные парки, в целом, имеют весьма хорошую рекреационную привлекательность. Зеленые зоны расположение в шаговой доступности. Дорожно-тропиночная сеть и объекты малых архитектурных форм находятся в хорошем состоянии. В достаточном количестве имеются объекты

санитарного назначения. Нужно отметить, что в разных парках по-своему, уникально подобрано стилистическое благоустройство парка элементами искусства, будь то архаичные деревянные фигурки, арки, стелы, памятники. Все они хорошо вписываются в общую композицию пейзажа парка или сквера.

Итак, выяснено, что на сегодняшний день зеленные зоны города Клинцы имеют весьма хорошую эколого-эстетическую оценку. Весьма богат и разнообразен видовой состав растений искусственного озеленения. Большинство растений отличаются весьма высокой декоративностью. Однако, следует отметить, что во всех парках были встречены экземпляры растений, которые нуждающиеся в проведении некоторых санитарных мероприятий.

Исследования в области распространения вредных веществ и шума по территории парка позволяют говорить о снижении уровня углекислого газа, летучих органических соединений и формальдегида, проникающего сквозь зеленую массу вглубь зеленой зоны, создавая наиболее чистую зону отдыха в центре парка или сквера.

По мнению отдыхающих, во всех парках и скверах г. Клинцы необходимо увеличение общего числа зеленых насаждений, как деревьев, так и кустарников. Особенно жители города хотели бы видеть большее количество цветущих растений, оказывающих особо высокое положительное воздействие на эмоциональное впечатление, что, возможно, в будущем станет одной из причин увеличения экотуризма.

В целом же рекреационная привлекательность парков и скверов г. Клинцы заслуживает хорошей оценки.

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WATER RESOURCES AND ECOLOGY: MONITORING, POLLUTION AND RESTORATION

ECOLOGICAL MONITORING OF WATER BODIES IN THE NORTH OF THE GYDA PENINSULA UNDER CONDITIONS OF INTENSIVE DEVELOPMENT

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Abstract: the article presents the results of water bodies monitoring in the north-east of the Gyda Peninsula in 2018–2020 for such sources of pollution of natural waters as heavy metals, cations and anions of various salts and residues of petroleum products. It also presents the calculations of maximum permissible concentrations (MPC) in relation to regional, commercial fishing, and household standards, as well as the results of calculating the Specific Combinatorial Index of Water Pollution (SCIWP). Conclusions are made about the quality of surface waters in the studied areas.

Keywords: north-east of the Gyda Peninsula, water monitoring, the Kureika River,the Khaltsnayakha River, the Nyan-Yakha River, Yabtarmato Lake, MPC, SCIWP.

1. INTRODUCTION

The Gyda peninsula includes huge water spaces and is unique.

In recent years, it has been subject to intensive oil and gas developments.

This work is relevant because the water resources of the Gyda Peninsula and the factors affecting their pollution are still insufficiently studied.

The purpose of the work is to assess the changes in the chemical composition of natural waters of the Gyda Peninsula under conditions of anthropogenic impact for three years.

The geochemical features of natural waters of Western Siberia are insufficiently covered in the literature.

There are data on the composition of the Yuribey and Gyda Rivers [1], the Messoyakha and the Monga-Yuribey [2, 3], The Khalmyer Bay [4], rivers, streams, and lakes near Lake Parisento [5].

2. METHODS

The study area is in the northeast of the Gyda Peninsula in the Arctic latitudes of 70°N and 74° E.

Water sampling was carried out taking into account the recommendations of GOST 31861–2012: in 1. the Lareyakha River, 2. the Nyan-Yakha Rver, 3. Yabtarmato Island, 4. A tributary of the Khaltsei-nayahi River and 5. a stream w/n.

In the laboratory, the pH value, BOD5 and the concentration of ammonium ions, nitrate ion, phosphate ion, sulfate ion, chloride ion, surfactants, oil products and metals were determined.

The assessment of surface water quality was carried out on the basis of the results of quantitative chemical analysis by comparing them with the standard concentrations of pollutants.

Specific Combinatorial Index of Water Pollution (SCIWP) was calculated according to the guidelines of ROSHYDROMET, RD 52.24.643–2002.

3. RESULTS

Water sampling was carried out during the low-water season (at the end of July and at the beginning of August) and high-water season (at the beginning of June and at the end of July).

The results of chemical analysis and calculations of MPC excess for samples from the Nyan-Yakha River and Yabtarmato Lake are presented in Tables 1–4.

The data obtained showed: 1) an excess of the maximum permissible concentration of ammonium ions in 2018 during the low-water season in

Table 1

Content of main ions in surface waters, mg/l.

Name of the point	Year	NH_4^+		PO_4^{3-}		Cl^-		SO_4^{2-}		NO_3^-	
		low water	high water	low water	high water	low water	high water	low water	high water	low water	high water
River Nyan-Yakha	2018	0,06	0,58	0,02	0,05	25	93	27	<25	0,6	1,1
	2019	0,025	0,03	<0,01	0,04	23	42	23	19	1,4	0,6
	2020	<0,02	<0,02	<0,01	<0,01	73	73	19	20	0,8	0,36
Lake Yabtarmato	2018	0,21	0,02	0,39	0,48	<10	<10	<25	<25	0,5	1,8
	2019	0,07	0,09	0,22	0,26	<10	<10	<10	<10	0,21	0,4
	2020	<0,02	<0,02	<0,01	<0,01	28	32	<10	<10	0,54	0,33

Table 2

Heavy metals content in surface waters, mg/l.

Name of the point	Year	Cu		Ni		Pb		Cr_6^+		Zn		$Fe_{ofm.}$		Mn	
		low water	high water	low water	high water	low water	high water	low water	high water	low water	high water	low water	high water	low water	high water
River Nyan-Yakha	2018	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	0,001	<0,005	<0,005	0,49	<0,05	0,0018	<0,001
	2019	<0,001	<0,001	<0,001	<0,001	<0,001	0,004	<0,025	<0,025	<0,005	<0,005	0,5	0,43	0,0016	0,0014
	2020	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,005	<0,005	<0,05	0,12	0,21	0,11
Lake Yabtarmato	2018	0,0011	0,001	0,0051	0,0053	0,0015	0,0011	0,007	0,007	0,0063	0,0072	6,6	7,2	0,037	0,029
	2019	0,008	0,011	0,011	0,009	0,001	0,0027	<0,025	<0,025	0,019	0,021	8,8	9,3	0,04	0,047
	2020	0,001	<0,001	<0,001	<0,001	<0,001	<0,005	<0,001	<0,001	<0,005	<0,005	0,15	0,2	0,004	0,009

Table 3

The ratio of the ions concentration to their MPC

Name of the point	Ions	2018						2019						2020					
		high water			low water			high water			low water			high water			low water		
		Reg. b	MPC brown held fdb	MPC of fish farms	Reg. b	MPC brown held fdb	MPC of fish farms	Reg. b	MPC brown held fdb	MPC of fish farms	Reg. b	MPC brown held fdb	MPC of fish farms	Reg. b	MPC brown held fdb	MPC of fish farms	Reg. b	MPC brown held fdb	MPC of fish farms
Lake Yabtarmato	NH_4^+	-26	-75	-25	-2,4	-7,1	-2,4	-5,8	-16,6	-5,6	-7,4	-21,4	-7,1	-26	-75	-25	-26	-75	-25
	PO_4^{3-}	12,6	-7,3	2,4	10,2	-9	2	6,8	-13,5	1,3	5,8	-15,9	1,1	-3,8	-350	-20	-38	-350	-20
	Cl^-	-1,3	-35	-30	-1,3	-35	-30	-1,3	-35	-30	-1,3	-35	-30	4,2	-11	-9,4	3,6	-12,5	-10,7
	SO_4^{2-}	12,6	-20	-4	12,6	-20	-4	5,1	-50	-10	5,1	-50	-10	5,1	-50	-10	5,1	-50	-10
	NO_3^-	3,5	-25	-22,2	-1,04	-90	-80	-1,3	-113	-100	-2,5	-214	-190	-1,6	-136	-121	1,0	-83,3	-74,1
A stream without a name	NH_4^+	-6,5	-18,8	-6,3	7,3	2,5	7,6	-25	-75	-25	-2,1	-6	-2	-	-	-	-	-	-
	PO_4^{3-}	-3,8	-350	-20	22,1	-4,2	4,2	-3,8	-350	-20	-3,8	-350	-20	-	-	-	-	-	-
	Cl^-	7,3	-6,3	-5,4	103,4	2,3	2,6	2,7	-16,7	-14,3	4,5	-10,3	-8,8	-	-	-	-	-	-
	SO_4^{2-}	-12,6	-20	-4	50,5	-5	1	-5	-50	-10	-5	-50	-10	-	-	-	-	-	-
	NO_3^-	2,7	-32,1	-28,6	2,9	-30	-26,7	-3,7	-321,4	-285,7	-1,3	-109,8	-97,6	-	-	-	-	-	-

Table 4

The ratio of the metals concentration to their MPC.

Name of the point	Metals	2018						2019						2020					
		high water			low water			high water			low water			high water			low water		
		Reg. b	MPC brown held fdb	MPC of fish farms	Reg. b	MPC brown held fdb	MPC of fish farms	Reg. b	MPC brown held fdb	MPC of fish farms	Reg. b	MPC brown held fdb	MPC of fish farms	Reg. b	MPC brown held fdb	MPC of fish farms	Reg. b	MPC brown held fdb	MPC of fish farms
River Nyan-Yakha	Cu	1	-1000	1	1	-1000	1	1	-1000	1	1	-1000	1	1	-1000	1	1	-1000	1
	Ni	-2,9	-20	-10	-2,9	-20	-10	-2,9	-20	-10	-2,9	-20	-10	-2,9	-20	-10	-2,9	-20	-10
	Pb	-1,7	-10	-6	-1,7	-10	-6	2,4	-2,5	-1,5	-1,7	-10	-6	-1,7	-10	-6	-1,7	-10	-6
	Cr_6^+	-7	-50	-7	-7	-50	-7	3,6	-2	3,6	3,6	-2	3,6	-7	-50	-7	-7	-50	-7
	Zn	-1,9	-200	-2	-1,9	-200	-2	-1,9	-200	-2	-1,9	-200	-2	-1,9	-200	-2	-1,9	-200	-2
	$Fe_{ofm.}$	-12,6	-6	-2	-1,3	1,6	4,9	-1,5	1,4	4,3	-1,2	1,6	5	-13,2	-2,5	1,2	-12,6	-6	-2
	Mn	-41	-100	-10	-22,7	-55,6	-5,6	-2,9	-74,4	-7,1	-25,6	-62,5	-6,3	2,7	1,1	11	5,1	2,1	21
Lake Yabtarmato	Cu	1	-1000	1	1	-1000	1	8,5	-91	11	6,2	-125	8	1	-1000	1	1	-1000	1
	Ni	1,8	-3,8	-1,8	1,76	-4	-2	3,1	-2,2	-1,1	3,8	-1,8	-1,1	-2,9	-20	-10	-2,9	-20	-10
	Pb	-1,5	-9,1	-5,4	1,1	-6,6	-4	1,2	-5	-3	-1,7	-10	-6	2,9	-2	-1,2	-1,7	-10	-6
	Cr^{6+}	1	-7,1	1	1	-7,1	1	3,6	-2	3,6	3,6	-2	3,6	-7	-50	-7	-7	-50	-7
	Zn	-1,3	-139	-1,4	-1,5	-158,7	-1,6	2,2	-47,6	2,1	2	-52,6	1,9	-1,9	-200	-2	-1,9	-200	-2
	$Fe_{ofm.}$	11,4	24	72	10,5	22	66	14,8	31	93	14	29,3	88	-3,2	-1,5	2	-4,2	-2	1,5
	Mn	-1,4	-3,4	2,9	-1,1	-2,7	3,7	1,1	-2,1	4,7	1	-2,5	4	-4,5	-11,1	-1,1	-10,2	-25	-2,5

the sampling point of the stream w/n was 7,5 of r.MPC; 2,5 of household MPC; 7,6 of commercial fishing MPC, and in 2019 during the high-water season of the Lareyakha River amounted to 4,8 r.MPC, 1,7 household MPC and 5 commercial fishing MPC; 2) an increase in the concentration of iron in 2018–2019 in the Lareyakha River and Yabtarmato Island and a sharp decrease of its content in 2020, which may be due to the transition of $Fe^{3+}$from organic complexes to insoluble $(FeOH)_3$ which migrated to the bottom sediments [6].

An excess of manganese concentration by 5,1 MPC and 21 commercial fishing MPC was observed in the Nyan-Aha River only in 2020. In the Island of Yabtarmato, the Mn content was at the same level (3,7 MPC) during 2018 and 2019, and in 2020 its concentration did not exceed MPC (Fig.4).

The concentration of Cr^{6+} ions at all sampling points was constantly 1,4 MPC in 2018, and in 2019 it was 3,6 MPC in the high water and low water seasons. In 2020, the concentration of Cr^{6+} did not exceed r.MPC.

An excess of copper content of 11 commercial fishing MPC in the high-water season and 8 commercial fishing MPC in the low-water season in Lake Yabtarmato in 2019 was a sign of anthropogenic pollution.

SCIWP conditionally estimates the share of the polluted effect caused by the simultaneous presence of a number of pollutants.

In this work, the SCIWP was calculated taking into account 15 pollutants (dissolved in water O_2, BOC_5,XOC, phenols, petroleum products, NO_2^- , NO_3^-, NH^+_4, common iron, Cu^{2+}, Zn^{2+}, Ni^{2+}, Mn^{2+}, Cl^-, SO^{2-}_4) by the formula:

$$S_j' = \frac{S_j}{k}$$

where, S_j is the combinatorial index of water pollution, k is the reserve coefficient.

The results of the calculations are shown in Table 5.

In 2018, the surface waters of the Lareyakha and Nyan-Yakha Rivers, and the tributary of the Khaltsnayakha River were assessed as polluted, and in 2019 as slightly polluted.

The water of Yabtarmato Island in 2018–2019 was assessed as dirty, and in 2020 as polluted. The water in the stream w/n in 2018 was dirty, and in 2019 it was slightly polluted.

Table 5

Assessment of water quality according to the SCIWP indicator

Sampling location	Specific Combinatorial index of water pollution			Water quality class		
	2018	2019	2020	2018	2019	2020
Lareeyakha River	3a	2	-	Polluted	Slightly polluted	-
Nyanyaha River	3a	2	3a	Polluted	Slightly polluted	Polluted
Lake Yabtarmato	4б	4a	3a	Dirty	Dirty	Polluted
Stream, tributary of the Khaltsanayakhi river	3a	2	-	Polluted	Slightly polluted	-
A stream without a name	4б	2	-	Dirty	Slightly polluted	-

1. CONCLUSIONS

The presence of iron ions, manganese, organic substances in high concentrations is a natural feature of natural waters of the Gyda peninsula and is not considered as pollution.

Excess copper content in natural waters of Lake Yabtarmato in 2019 is considered as anthropogenic pollution associated with the oil and gas development. According to the results of SCIWP, the greatest pollution of water bodies was in 2018.

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ANTHROPOGENIC IMPACT ON THE ICHTHYOFAUNA OF THE PRONYA RIVER

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Abstract: The paper presents the results of the study of the Pronya River which is the right tributary of the Oka River (the Volga basin) and its fish resources; it analyses the anthropogenic load on this water body. Substances polluting the river have been identified and their danger to ichthyofauna of the reservoir have been assessed.

Key words: the Pronya River, anthropogenic load, ichthyofauna, recreation, poaching.

1. INTRODUCTION

While small and medium rivers have less self-purification ability than large rivers, the anthropogenic load on them is comparable with the load on large rivers, which negatively affects the water quality of small and medium rivers their ichthyofauna. This explains the relevance of the study. The Pronya River was the object of study.

The purpose of the study is to assess the anthropogenic impact on the ichthyofauna in the Pronya River. To achieve the purpose, it necessary to solve the following tasks:

1. To make a brief description of the Pronya River;

2. To analyze the anthropogenic load on this water body;

3. To assess the anthropogenic impact on the hydrobionts of the river.

2. METHODOLOGY

During the study, the following methods were used: the method of collecting information, the analysis of sources, the method of hydrochemical research

3. RESULTS

Fig. 1. The Pronya River on the map of the Ryazan region

The Pronya is a river in the European part of Russia, in the Ryazan and Tula regions; it is the right tributary of the Oka (the Volga basin) (Fig.1). The Pronya originates on the northeastern slopes of the Central Russian Upland. It flows into the Oka below Ryazan. About 90 small rivers flow into the Pronya. The length of the river is 336 km, the basin

area is 10.2 thousand km^2 — the Pronya is the 5th in terms of the basin area and the 6th longest tributary of the Oka. The main tributaries are Kerd, Ranova (right) and Zhraka, Markovka (left). The Pronya is a shallow river (the depths rarely exceed 2.0 m). The river is predominantly fed through snow. Its water quality corresponds to low-polluted rivers [1]. Hydrochemical indicators are shown in Table 1.

Table 1

Hydrochemical indicators of the Pronya River [2,3]

Chemical indicators	the Pronya, the town of Novomichurinsk	the Pronya, the town of Pronsk	MPC
2010			
Transparency	transparent	transparent	20
Colour	colourless	colourless	6,5–8,5
Ammonia (by nitrogen) mg/dm^3	0,68	0,78	1,5
Nitrites (by nitrogen), mg/dm^3	0,007	0,054	1,0
Nitrates (by nitrogen), mg/dm^3	0,7	1,0	1,0
Sulfates, mg/dm^3	78	85	500
Chlorides, mg/dm^3	24,81	30,86	350
Petroleum products, mg/dm^3	0,032	0,089	0,01 до 0,20
2012			
Transparency	transparent	transparent	20
Colour	colourless	colourless	6,5–8,5
Ammonia (by nitrogen) mg/dm^3	1,49	1,61	1,5
Nitrites (by nitrogen), mg/dm^3	0,015	0,059	1,0
Nitrates (by nitrogen), mg/dm^3	0,9	1,9	1,0
Sulfates, mg/dm^3	98	102	500
Chlorides, mg/dm^3	26,23	31,90	350
Petroleum products, mg/dm^3	0,045	0,092	0,01 до 0,20
2021			
Transparency	transparent	transparent	20
Colour	colourless	colourless	6,5-8,5
Ammonia (by nitrogen) mg/dm^3	1,67	1,45	1,5
Nitrites (by nitrogen), mg/dm^3	0,017	0,054	1,0
Nitrates (by nitrogen), mg/dm^3	0,8	1,1	1,0
Sulfates, mg/dm^3	99	105	500
Chlorides, mg/dm^3	25,45	32,6	350
Petroleum products, mg/dm^3	0,067	0,124	0,01 до 0,20

As can be seen from Table 1 above, the Pronya River was polluted with ammonia and nitrates in 2021. According to the results of chemical studies in 2012, it was found that the river was polluted with ammonia and phosphates, and at the source with oil products [2].

The hydrochemical indicators of the river are greatly affected by wastewater of industrial enterprises, therefore a biocenosis of free-living and parasitic organisms has developed in the river, which is characteristic of eutrophic bodies of water [4].

Table 2 presents environmental parameters and shows that the river has high indicators of feed biomass.

Table 2

Environmental parameters of the Pronya River [4]

Transparency, m	Biomass of food organisms		Fish capacity, kg/ha	Carlson's trophic index
	zooplankton, mg/m^3	benthos, mg/m^2		
1,0	4,9–7,1	4,0–45,3	80–100	60,0

The following recreational activities prevail on the river:

– beach recreation,

– fishing,

– picnic recreation.

Recreation negatively affects this body of water. A huge amount of rubbish enters the river in summer seasons from picnic recreation on the Pronya, as well as from fishermen and swimmers. The peak of recreational activity falls on May-October. In July, such activity is maximum, especially on weekends.

Figure 2 identifies seven major water management zones in the basin. There are 15 enterprises in this area, which are one of the sources of pollution of the river [5].

The total number of agricultural enterprises and farms in the Pronya district is 4,495. The available land of the Pronya district is 106,960 hectares, of which agricultural land is 86,837 hectares [6].

Agriculture pollutes the river with pesticides, organic and mineral substances, heavy metals, and ammonia. Irrigation also negatively affects the river.

Chemicals entering the Pronya from agricultural and industrial enterprises negatively affect its inhabitants as well.

The norm of nitrites is not more than 0.2 mg / l. The permissible limit is 0.3 mg / l. Nitrites can quickly accumulate in the muscle tissue and internal organs of fish reducing their quality. The degree of accumulation of nitrites in fish depends on their content in water [7].

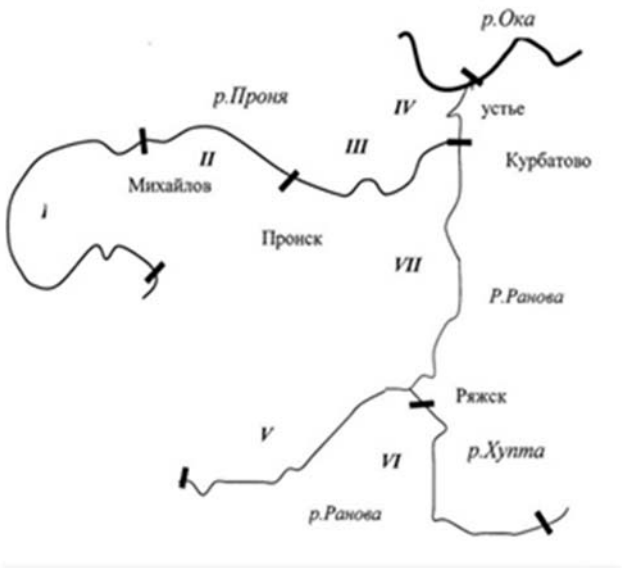

Figure 2. Water management zoning of the basin [5]

Ammonia is present in small quantities in all reservoirs. Ammonia is the strongest poison for fish. Maximum permissible concentration of ammonia is 0.1 mg/l. In concentrations of 0.2–1.0 mg/l, it is toxic to most fish (Table 3) [8].

Table 3

Fatal concentration of ammonia for some fish species living in the Pronya [9]

Fish species	Fatal concentration of ammonia mg/l
River perch	0,6
Chub	1,0
Carp and tench	2,0

Acute ammonia poisoning occurs at a concentration of, for example, 1.0–1.2 mg/l for chubs. To a large extent, the oxygen content affects the life span of fish living in water with dissolved ammonia [9].

Let us now consider the species composition of fish in the upper reaches of the Pronya River (Table 4).

Table 4

Species composition of fish in the upper reaches of the Pronya river [10]

Species of fish	Upper reach – I		Upper reach – II		Upper reach – III		Total	
	abs.	%	abs.	%	abs.	%	abs.	%
Bream	3	0,34	–	–	–	–	3	0,09
Clam	607	68,98	42	15,73	67	3,11	716	21,71
Gustard	1	0,11	–	–	–	–	1	0,03
Common gudgeon	–	–	10	3,75	97	4,51	107	3,24
Belica	–	–	1	0.37	–	–	1	0,03
Chub	–	–	3	1,12	3	0,14	6	0,18
Common minnow	–	–	133	49,81	–	–	133	4,03
Bitterling	–	–	17	6,37	1981	92,06	1998	60,56
Roach	154	17,50	37	13,86	2	0,09	193	5,85
Bearded stone loach	–	–	20	7,49	–	–	20	0,61
Common pike	3	0,34	–	–	2	0,09	5	0,15
Common ruffe	2	0,23	–	–	–	–	2	0,06
River perch	110	12,50	4	1,50	–	–	114	3,46
Total	880	100,0	2152	100,0	2152	100,0	3299	100,0
Total types	7		9		6		12	

In total, 13 species of fish were identified in the upper reaches of the Pronya River, the ratio of which varied greatly. In the middle and lower reaches of the river, the number of ichthyofauna was higher.

The pollution of the river with rubbish has a negative effect on hydrobionts. Rubbish often becomes food for fish, leading to disease and death. Solid inorganic rubbish lies in huge quantities on the banks of the river and enters the water. Vacationers dump plastic bags and bottles into the river. Toxic compounds from plastic get into fish organisms and accumulate in tissues.

Fishing in the Ryazan region is popular all year round. River poaching is a problem here since many people go fishing not only for recreation. Many species are disappearing due to poaching.

4. CONCLUSIONS

So, the following conclusions can be drawn:

1. The Pronya corresponds to slightly polluted rivers in terms of water quality and is a eutrophic body of water;

2. The main anthropogenic load on the river comes from recreational activities, agriculture and industrial enterprises;

3. Rubbish pollution of the banks, poaching, increased content of nitrites and ammonia has the main anthropogenic impact on the hydrobionts of the Pronya.

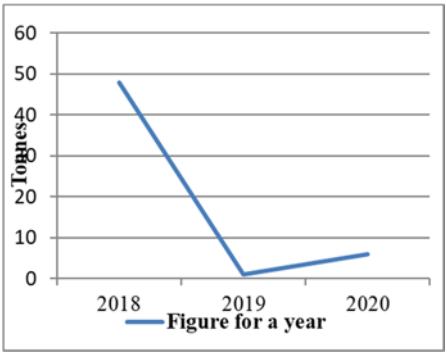

Figure 3. Information about fishing in the Ryazan region [11]

Nowadays, people have become more responsible about the environment, but unfortunately, the reservoirs of our country continue to experience a large anthropogenic load, which is the fault of not only enterprises, but also recreants. The results obtained require further scientific research in this direction.

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ASSESSMENT OF FLOOD IMPACT RISK ON ENVIRONMENTAL MANAGEMENT PLANNING IN PRIMORSKY KRAI

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Abstract: All over the world there is a dynamic development and an increase in the territories of cities. This requires space and resources. In this case, there is deforestation and development of mining sites, which in turn directly or indirectly affects the hydrological system. All this affects not only

surface, but also groundwater. Due to the colossal anthropogenic load, climate change and changing climatic zones, “failures” occur.

In this case, the word “failure” means floods, which entail not only large financial losses, but also the death of a large number of people. Natural disasters, namely floods, cause irreparable harm to the economy, affect the population, as they cause loss, as well as environmental damage and affect large areas. This article describes the assessment of the impact of floods on environmental planning in Primorsky Krai.

Key words: flood, rain flood, nature management, impact of floods, statistic GIS technologies.

1. INTRODUCTION

The **relevance** of this work is that currently, the topic of floods and their assessment is gaining momentum. In addition to the material damage that it entails, people suffer, their health and well-being. [1] The case with the epidemiological situation is deteriorating, as the waters diverge for many kilometers. It is extremely important to assess the risks for planning nature management, since it depends on whether people will live in a given territory, what are the pros and cons, what changes have occurred in general in this subject, and so on. [6]

The purpose of the work is a theoretical substantiation and assessment of the impact of floods on nature management planning in Primorsky Krai.

2. METHODOLOGY

To achieve the set goal, it is necessary to solve the following tasks:

• To analyze the nature of the occurrence of floods and their characteristics;

• To study the features of nature management in the territory of Primorsky Krai.

• To assess the impact of floods on nature management using GIS technologies. [2]

Primorsky Krai is located in the south of the Far East, in the southeastern part of the Russian Federation. In the north it borders on Khabarovsky Krai, in the west — on China, in the southwest — on North Korea, from the south and east it is washed by the Sea of Japan. [10]

The largest lake in Primorye is Lake Khanka. Its area is 4190 square meters, depth — up to 10.6 m. The main river is the Ussuri, part

of which flows along the border with China. On the western slopes of the Sikhote-Alin, the rivers Bikin, Iman and others, relatively calm in their lower reaches, belong to the Ussuri basin. However, their course takes on a rather stormy character during torrential floods. [9]

For a more accurate understanding of the impact of floods, one should consider the operational data of the Ministry of Emergency Situations on flooding in Russia, and specifically in the Primorsky Krai for 2013–2020 and the impact they have. [7] According to these data, about 420 floods occurred in Primorsky Krai.

According to the statistics, the most common cause of flooding in Primorsky Krai is rain. This fact is directly related to the geographical location of this place, climatic features and the presence of large water bodies adjacent to the territory. It is worth noting that it is the private sector that most often suffers, since this territory is characterized by a large number of one-story buildings and agricultural land.

In recent years, the largest floods in terms of the rise in water in the rivers occurred in the period June-September. Floods were observed almost throughout the entire territory of the region, and in the basins of such rivers as Razdolnaya, Ussuri, Bolshaya Ussurka, Malinovka, Komissarovka and the rivers of the Khasansky district, they took on the character of large floods and flooded a significant number of adjacent territories. Thus, in the territories of the Ussuriysk urban district, Nadezhdinsky and Mikhailovsky districts, the total area of plots occupied by water from July 27 to August 8 increased by 3780 hectares. [8] An assessment of even a small flood area showed that this phenomenon has a significant impact on the territory of Primorsky Krai. That is, based on this impact, it can be predicted that the overall impact on the entire region will be very significant.

To study flood zones, images from the Sentinel-1 satellite are used, which were obtained in the C band with the Interferometric Wide Swath (IW) mode and VV polarization. [2] The time period of the study is from 2015 to 2021. During the flooding period — August — from 2 to 4 satellite images were obtained for each year. Radar images were processed using the SNAP open source software developed by the European Space Agency.

With the help of radar images from the Sentinel-1 satellite, which were pre-processed, the flooded areas were identified in the QGIS program, and integral indicators of the flooded area near the city of Ussuriysk for 2015–2021 were identified.

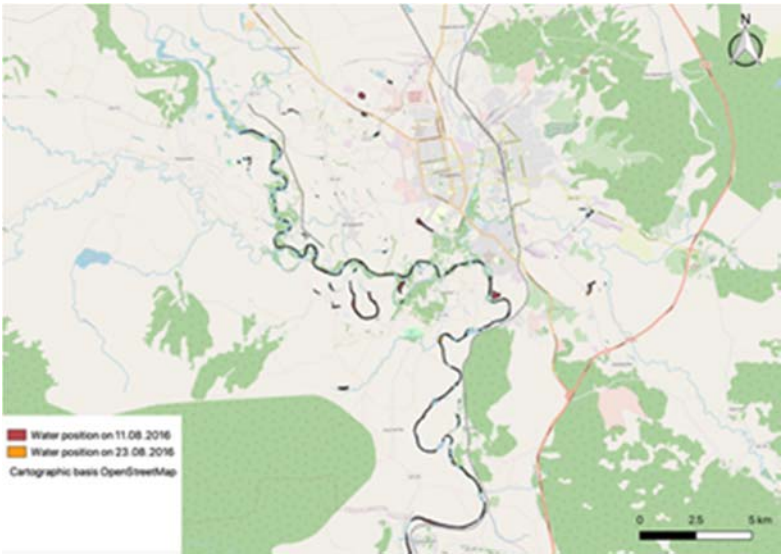

Figure 1. Flooding zone and water position at low water in 2015

Based on the obtained schemes and integrated indicators of the area of flooding near the city of Ussuriysk, it can be noted that extensive flooding of the territory does not occur every year. So, in 2015, 2017, 2018, 2019, a much larger amount of territory turned out to be flooded than in 2016, 2020, 2021.

Based on the data on the number of floods in Primorsky Krai for the period 2015–2020, a calculation was made of the forecast number of floods with a link between low and high probability (based on the moving average method). [4] As can be seen from the graph, a more accurate and plausible forecast was obtained with a high probability reference, according to which 157 floods will occur in 2022 and about 17.8 square kilometers will be flooded. According to the Federal State Budgetary Institution "Gidrospetsgeologiya", in 2022 the activity of flooding of the populated areas of the Primorsky Krai is predicted to be medium. [11]

3. RESULTS AND CONCLUSIONS

1. For Primorsky Krai, floods due to heavy precipitation (rain floods) are the highest priority. [5] The rise and flood of rivers is the main

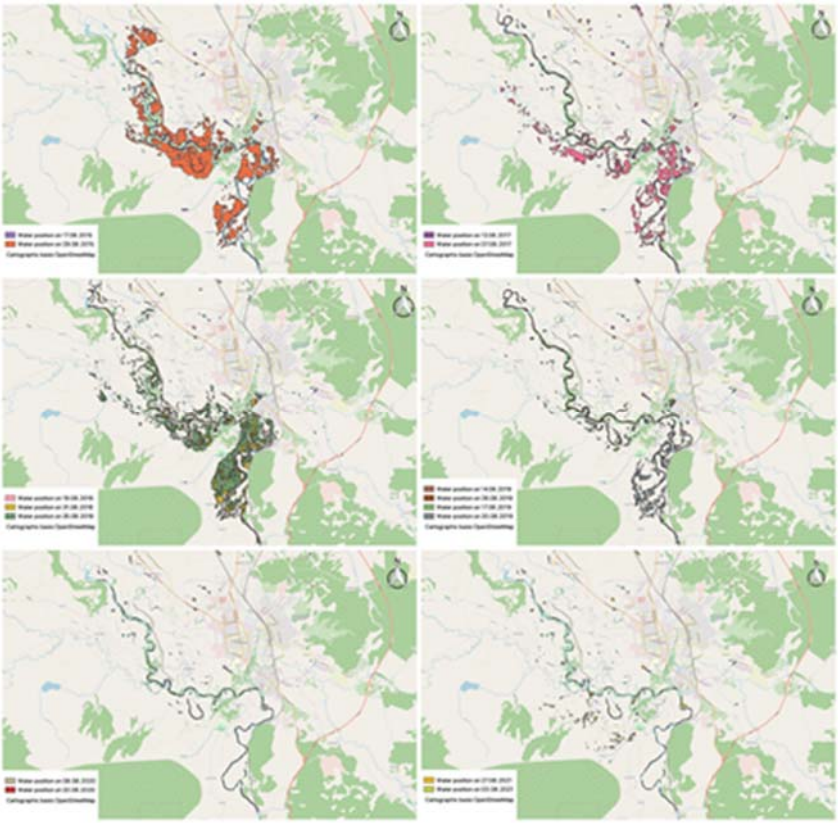

Figure 2. Flooding zone and water position at low water in 2016-2021

Figure 3. Projected flood area in 2022

cause of flood development. The territories suffering from floods are mostly located in the southern part of the subject.

2. Among the flooded areas of Primorsky Krai, the main areas at risk are agricultural land use and populated areas: household plots, roads, residential buildings, etc. It is worth noting that it is the private sector that most often suffers, since this territory is characterized by one-story buildings and agricultural land.

3. According to calculations, with a 95% probability, 157 floods will occur in 2022 and a large number of agricultural land use areas will be flooded, which is 17.8 square kilometers.

4. Consequently, long-term flooding of populated areas is observed and predicted, which, according to calculations, will not decrease in the future. What does it say about the recommended transfer of settlements from these areas. [3]

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ASSESSMENT OF THE IMPACT OF INDUSTRIAL WASTEWATER FROM THE OIL AND GAS CONDENSATE FIELD OF MEDVEZHYE ON THE STATE OF THE WATER OF THE BOLSHOY YARUDEY RIVER

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Abstract: The article highlights the influence of industrial wastewater from the Medvezhye deposit on the quality of the Bolshoy Yarudey River. The analysis of the chemical composition of water by 13 indicators was carried out. In order to minimize chemical effects on a water body, the method of pumping wastewater into the reservoir has been studied and implemented.

Keywords: wastewater, Medvezhye deposit, Bolshoy Yarudey river, chemical indicators

1. INTRODUCTION

In connection with the intensive development of the oil and gas sector in the Russian Federation, in accordance with the Energy Strategy of Russia until 2030, the issue of treating industrial wastewater from this industry is regularly raised.

The deteriorating environmental situation makes it necessary to tighten the requirements for the discharge of wastewater and the quality of their treatment.

The impact of the oil and gas complex on surface water is associated with their use for industrial and domestic water supply, their

use as wastewater receivers (both organized spillways and diffuse pollution) [1].

Previously, when designing production, the formation of industrial effluents and their subsequent treatment and disposal was not taken into consideration. As a rule, a simple technique was implemented: wastewater was diverted to the nearest point of reception (reservoir). The consequences of the discharge of industrial effluents were not calculated.

Over the past ten years, oil and gas companies have been monitoring the chemical composition of water in water bodies into which industrial wastewater is discharged. In this regard, enterprises faced several problems since the concentrations of many substances exceeded the maximum permissible values.

To minimize the likelihood of pollution of water bodies with waste oil and oil products coming with industrial effluents from enterprises of the fuel and energy complex, it is necessary to pay special attention to ensuring that wastewater treatment from oil products is as efficient as possible.

2. METHODOLOGY

Surface water monitoring at the wastewater discharge sites of the Medvezhye deposit (500 m upstream and 500 m downstream from the wastewater discharge sites) was carried out within the framework of the Surface Water Research Program at the facilities of Gazprom Dobycha Nadym LLC 4 times a year in the summer-autumn period (June-September) at 4 control points, of these, 2 are conditional control, 2 are control.

The authors took part in sampling in 2021. A point sample was taken in a volume sufficient for the subsequent determination of the planned program indicators of the chemical composition of water. Prepared glass vessels or polyethylene containers were used for storage and transportation.

Each sampling point was photographed at the surface water sampling site. At the sampling site, water sampling certificates were drawn up indicating the necessary above-mentioned information. Containers with samples in compliance with the temperature regime in the refrigerator bag were promptly delivered to the laboratory for quantitative chemical analysis.

According to the monitoring data of the Gazprom Dobycha Nadym Engineering and Technical Center, the authors analyzed them [2].

The analysis was performed on 13 indicators: pH, BPK5, suspended solids, petroleum products, ammonia, phosphates, nitrates, iron, sulfates, APAV, manganese, chlorides, phenols.

The obtained values were compared with the standards of maximum permissible concentrations of harmful substances in the waters of water bodies of fishery significance.

3. RESULTS

3.1. Analysis of the results of monitoring the chemical composition of the Bolshoy Yarudey river water as a result of industrial wastewater discharge

According to the monitoring data of the Gazprom Dobycha Nadym Engineering and Technical Center, the analysis was carried out [2].

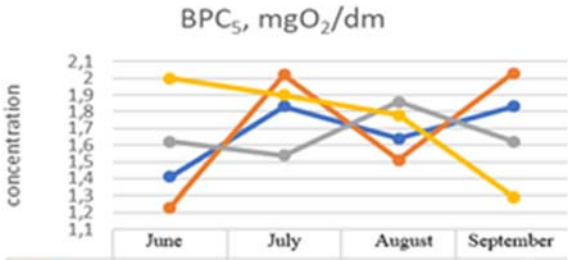
The analysis featured 13 indicators: pH, BPK5, suspended solids, petroleum products, ammonia, phosphates, nitrates, iron, sulfates, APAV, manganese, chlorides, phenols. Standards of surface water quality in accordance with the order of the Ministry of Agriculture "On approval of water quality standards of water bodies of fishery significance, including standards of maximum permissible concentrations of harmful substances in the waters of water bodies of fishery significance" dated 13.12.2016 [3].

The obtained values were compared with the standards of maximum permissible concentrations of harmful substances in the waters of water bodies of fishery significance.

We will showcase two indicators: BPK5 and petroleum products. Biochemical oxygen consumption (BPK5) is an indicator of an increased organic content. The Bolshoy Yarudey River is a natural water body and it is obvious that it contains a certain percentage of organic compounds — animal remains, dead plants, etc. Their destruction (natural purification of the substance) is carried out by bacteria. The process is called anaerobic biochemical oxidation. Its result is the release of carbon dioxide. In this case, oxidation takes place with the participation of O2 dissolved in the liquid. The more organic inclusions are, the more oxygen is needed for their processing.

The maximum permissible value of the BPK5 indicator for fisheries reservoirs should not exceed 2.1 mgO2/dm3.

The dynamics of the BPK5 indicator in the water of the Bolshoy Yarudey River for 2018–2021 after wastewater discharge into a water body is shown in Figure 1.



	June	July	August	September
2018	1,41	1,83	1,64	1,83
2019	1,23	2,02	1,51	2,03
2020	1,62	1,54	1,86	1,62
2021	2	1,9	1,78	1,29

Figure 1. The dynamics of the BPK5 indicator in the water of the Bolshoy Yarudey River for 2018–2021 after wastewater discharge into a water body

Petroleum products are mixtures of hydrocarbons, as well as individual chemical compounds obtained from oil and petroleum gases. Petroleum products include various types of fuels, lubricants, electrical insulating media, solvents, petrochemical raw materials.

At the Medvezhye field, operations are constantly carried out to clean up oil and petroleum products, which is the main reason for possible contamination of wastewater.

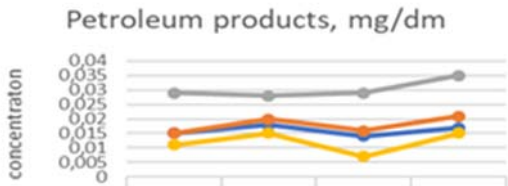
The maximum permissible concentration of petroleum products for fishery reservoirs should not exceed 0.050 mg/dm3.

The dynamics of concentrations of petroleum products in the water of the Bolshoy Yarudey River for 2018–2021 after wastewater discharge into a water body is shown in Figure 2.

Thus, it can be concluded that the actual detected concentrations of petroleum products in the period of 2018–2021 did not exceed the maximum permissible value.

The highest rate was observed in 2020, since in the summer, during sampling, a process called “small respiration” occurred, which was caused by temperature differences in the hull and the external environment.

This is a common occurrence among land-based reservoirs. That is, if it is hot outside the storage, its walls heat up along with the oil. It, in turn, begins to evaporate, displacing the resulting pressure in the vessel.



	June	July	August	September
2018	0,015	0,018	0,014	0,017
2019	0,015	0,02	0,016	0,021
2020	0,029	0,028	0,029	0,035
2021	0,011	0,015	0,007	0,015

Figure 2. The dynamics of the Petroleum products indicator in the water of the Bolshoy Yarudey River for 2018–2021 after wastewater discharge into a water body

The reason is the violation of the regulations for cleaning tanks when switching to another type of resource, the frequent change of varieties of products passed through the park, the lack of a high–quality pipeline preparation program for pumping different types of material.

3.2. Water injection into the oil reservoir

One of the most effective ways to minimize industrial wastewater discharge is to leak out of oil reservoirs, or pump water into the reservoir. A leak is a technological process, the meaning of which is to pump water into an oil–bearing reservoir to maintain intra-reservoir pressure and push oil to the bottom of the well.

The use of the flooding system in the development of oil fields allows increasing oil recovery and will reduce the discharge of wastewater into reservoirs.

Water of various characteristics and composition is used for injection into the reservoir. To extract one ton of oil to the surface, it takes about 1.5–2.5 cubic meters of water, depending on the type of flooding.

The method of cyclic flooding is used at the Medvezhye deposit, based on the idea that periodic injection of water into the reservoir instead of continuous can cause a redistribution of pressures in protoplasts of different permeability. This means that from the zones saturated with oil and having low permeability, with a decrease in pressure caused by the cessation of pumping, the flow of oil into the zones of increased permeability will begin. The latter, as a rule, are more watered and, due to the better characteristics, the pressure decreases faster in them. In addition, capillary forces create additional resistance to the movement of water in low-permeable pore channels, which favors the movement of oil [4,5].

3.3.Comparative analysis of monitoring results for the period 2018–2019, due to the use of different methods of wastewater disposal

Having analyzed the materials collected in production practice and data from the Engineering and Technical Center of Gazprom Dobycha Nadym LLC, it can be concluded that in the period 2020–2021, the state of the river is better in terms of main indicators than in the 2018–2019 research period.

This is because in 2019, in order to ensure the maintenance of intra-reservoir pressure and pushing oil to the bottom of the well, which increases oil recovery, the company began to use the method of pumping water into the oil reservoir.

The use of the institution system in the development of oil fields allows not only increasing oil recovery, but also reducing the amount of wastewater discharged into the reservoir.

Consequently, with the introduction of this method, the company managed to minimize the discharge of industrial wastewater into the Bolshoy Yarudey River, which positively affects the quality and chemical composition in this reservoir.

This improvement is observed in 9 out of 13 indicators. The results are presented in table 1.

Having analyzed the materials collected in production practice and data from the Engineering and Technical Center of Gazprom Dobycha Nadym LLC, it can be concluded that in the 2020–2021 period, the state of the river is better in terms of main indicators than in the research period of 2018–2019. This is due to the fact that in 2019, in order to ensure the maintenance of intra-reservoir pressure and pushing oil to the bottom of

the well, which increases oil recovery, the company began to use the method of pumping water into the oil reservoir. The use of the institution system in the development of oil fields allows increasing oil recovery as well as reducing the amount of wastewater discharged into the reservoir.

Table 1

Average annual values of hydrochemical indicators of water in the Bolshoy Yarudey River after industrial wastewater discharge for 2018–2021

No. p/p	Index	Annual average				MACS
		2018	**2019**	**2020**	**2021**	
1	BPC_5, mgO_2/dm	1,67	1,69	1,66	1,74	2,1
2	petroleum products, mg/dm	0,016	0,018	0,030	0,012	0,050

Conseuently, with the introduction of this method, the company managed to minimize the discharge of industrial wastewater into the Bolshoy Yarudey River, which positively affects the quality and chemical composition in this reservoir.

4. CONCLUSIONS

Based on the analysis of the results of monitoring the chemical composition of the water of the Bolshoy Yarudey River as a result of industrial wastewater discharge and the comparative characteristics of the results and due to the use of different methods of industrial wastewater disposal, the following conclusions can be drawn:

1) Analysis of the results of monitoring the water quality of the Bolshoy Yarudey River for the period of 2018–2021 showed that in the 2020–2021 period, the state of the river improved according to 9 out of 13 estimated indicators of surface water quality. This means that reservoir injection is an effective way to minimize the impact of wastewater on the water of the Bolshaya Yarudey River.

2) In the period of 2018–2019, non-compliance with the following standards was observed: hydrogen index, iron, suspended solids, manganese. Based on these data, it can be concluded that the treatment facilities at the oil and gas condensate field “Medvezhye” need reconstruction, which implies the implementation of measures aimed at the resumption of existing structures. This approach towards the improvement of the efficiency of wastewater treatment plants is time-consuming and costly.

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ISOTOPIC COMPOSITION OF OXYGEN AND HYDROGEN OF WATERS IN THE DEEP-WATER TROUGHS OF THE KARA SEA

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Abstract: Oxygen and hydrogen isotope geochemistry methods have been applied to study sea waters in the areas of the deep-water troughs of St. Anna and Voronin, which are located in the Kara Sea.

Key words: oxygen isotopes, hydrogen isotopes, salinity, the Saint Anna Trough, the Voronin Trough, Arctic Ocean.

1. INTRODUCTION

The problem of identification of water masses, processes of their mixing and formation of currents in Arctic waters occupies one of the central places in the study of the World Ocean. Poor study of isotopic ($\delta^{18}O$ and δD) parameters of water masses of Russian Arctic shelf is a big gap in modern knowledge system. It is especially relevant for studying the processes of distribution of river flow components in the Kara Sea.

In this paper we studied seawater of the St. Anna and Voronin deep-water troughs using oxygen and hydrogen isotope geochemistry methods, which allow us to solve genetic problems in the hydrology of marine basins at a high evidential level [1].

The development of modern methods of isotope geochemistry makes it possible to use natural tracers, such as the isotopic composition of oxygen and hydrogen, in studying the dynamics of sea water masses. Isotopic methods become most meaningful when applied in combination with commonly used hydrophysical parameters, primarily salinity [2].

The aim of this work is to study the processes taking place in the sea waters in the deep trough zone, by the example of the St. Anna and Voronin troughs located in the northeastern part of the Kara Sea. The study area is extremely important, because in these troughs there is an interaction of waters of different origin. In addition, the St. Anna and Voronin troughs are a conductor of Atlantic waters flowing into the Arctic Ocean, the flow of which has recently been constantly increasing [3]. The study of the oxygen and hydrogen isotope composition of the waters in these troughs is of key importance in the understanding of the processes associated with the climate change and the shrinking of the Arctic Ocean ice cover.

2. METHODOLOGY

The material for the studies was selected during the 63rd (2015) and 66th (2016) Arctic voyages of the research vessel Akademik Mstislav Keldysh to the Kara Sea area. The layout of the studied stations is shown in Fig. 1. The vertical profile of temperature, salinity, δD and $\delta^{18}O$ distribution was studied for each station.

Oxygen isotope analysis was carried out using the DELTA V+ instrumental complex (Thermo, Germany) containing the GasBench II

option and working in the constant helium flow mode. Hydrogen isotope analysis was carried out using the waters reduction with the metallic chromium (H/Device option) and measuring in the double inlet mode using the DELTAplus mass spectrometer (Thermo, Germany). All $\delta^{18}O$ and δD values were calibrated in the V-SMOW-V-SLAP scale and determined with an accuracy of ±0.05 and ±0.3‰, respectively [4].

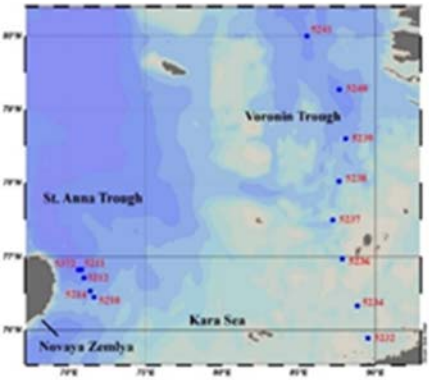

Figure 1. Location of stations studied in the 63rd and 66th voyages of the research vessel Akademik Mstislav Keldysh.

3. RESULTS

Analysis of isotopic ($\delta^{18}O$, δD) and salinity data in the St. Anne's trough showed that $\delta^{18}O$ and δD values, as well as salinity, change similarly to each other. All these values ($\delta^{18}O$, δD, S) are increasing with depth, due to they are all conservative parameters. In the surface layer (depth 0-4 m) the salinity of waters is reduced, to S ≈ 20,72 and 29,47 psu at station 5210, to S ≈ 25,70 psu at station 5211 and to S ≈ 19,54 psu at station 5214 in comparison with the average salinity of Atlantic waters circulating in the Barents Sea (S = 34,90 psu [5]). The similar dynamics of distribution of $\delta^{18}O$, δD and S values is also observed for waters of all studied stations in the Voronin trough, which increase with depth. At depths of 0-18 m water salinity is decreased: at station 5236 S ≈ 24,32, 28,71 and 29,34 psu; at station 5237 S ≈ 26,36, 28,17 and 29,49 psu; at station 5238 S ≈ 26,26 psu; at station 5239 S ≈ 26,71 and 27,27 psu; at station 5240 S ≈ 27,39, 28,72 and 29,42 psu; at station 5241 S ≈ 29,13

and 29,15 psu. The salinity decrease in these deep-water troughs is due to the two-component mixing of modified Atlantic waters coming from the Barents Sea with estuarine waters of the Yenisei and Ob [4].

The lowest $\delta^{18}O$ and δD values are also observed in surface waters. For example, for St. Anna trough at station 5210, located closest to the mouth of Ob, they are $\delta^{18}O$ = -6,30 ‰ and δD = -47,58 ‰, and at the maximum distance — at station 5372 these values increase to 0,24 ‰ and 0,36 ‰ respectively [6]. For the Voronin trough, the lowest values of δ18O (-5.46 ‰) and δD (-41.75 ‰) are presented at station 5236, located in the area of water flows from Ob. At the maximum distance - at station 5241, these values also increase to -1.88 ‰ and -15.15 ‰, respectively.

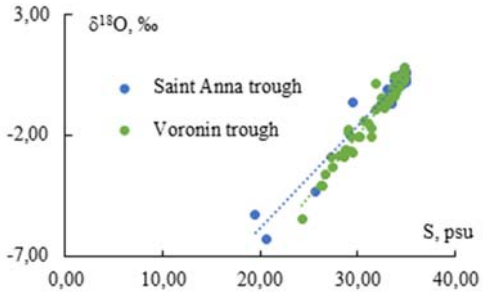

Figure 2. Relation of oxygen isotope composition to salinity in the St. Anna and Voronin troughs

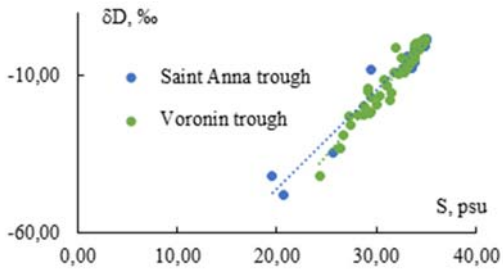

Figure 3. Relation of hydrogen isotope composition to salinity in the St. Anna and Voronin troughs

In waters of all studied stations of St. Anna and Voronin troughs increase of $\delta^{18}O$ and δD values with salinity increase is observed, that usually indicates desalinization of sea waters. However, there is a violation of linear dependence between these parameters, which is characteristic of two-component mixing (Fig. 2, 3). In other words, the behavior of $\delta^{18}O$ and δD relative to salinity is not completely conservative. This distortion of the relation between isotopic composition of waters and salinity is related to the processes of ice formation and melting.

4. CONCLUSIONS

The data obtained for seawater in the zone of the deep-water troughs of St. Anna and Voronin show that, they are the product of two-component mixing of modified Atlantic waters with the Ob estuarine waters.

The desalinized layer of surface waters is characterized by sharp vertical gradients of salinity and isotope parameters and is unevenly distributed in space.

The observed distortions in the linear relationship between the isotopic composition of water and salinity are apparently caused by ice formation and melting processes.

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WATER RESOURCES ECOLOGY AND PROSPECTS FOR SUSTAINABLE DEVELOPMENT

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Abstract: Nowadays water resources are under great strain, primarily from human activity. In many countries there is a problem of lack of drinking water, and the available resources are polluted and dangerous to use. There are many ways to minimize the shortage of water resources, but for success they must be applied in a complex.

Key words: pollution, water resources, waste, water treatment, water shortage.

1. INTRODUCTION

The most important natural environment in which life originated and without which its existence is impossible is the aquatic environment. It determines the well-being of a person, satisfying his physiological needs of both a biological species and a social being and performing various functions here (hygienic, aesthetic, transport, technological, etc.). In this regard, the safety of mankind and the prospects for its existence are fully determined by the state of the aquatic environment. It is no exaggeration to say that high-quality water that meets sanitary, hygienic and epidemiological requirements is one of the indispensable conditions for the safe life of people.

In the process of development of human civilization, the need for water began to increase dramatically — starting from water supply and sewerage, and ending with technical needs in various industrial processes. Unfortunately, not only water consumption increases, but also the degree of pollution of water resources. Water and ecology are inextricably linked with each other — in fact, one of the main indicators of the ecological situation on the planet is the state of water resources. That is why it is necessary to pay the greatest attention to the ecology of reservoirs and prevent not only their destruction, but also pollution [1,2].

2. METHODOLOGY

The hydrosphere of the Earth is 97.5% represented by the salty waters of the World Ocean, mineralized groundwater and the waters of salt lakes. Fresh water accounts for only 2.5%, which is 35 million km^3. For every inhabitant of the planet, there is about 6 million km^3 of fresh water, but the vast majority of this volume is inaccessible to humans (it is located in glaciers, underground ice, permanent snow cover and deep aquifers underground that do not belong to the zone of active water exchange).

In the past, water pollution in developing countries occurred mainly from the discharge of untreated wastewater. These problems are now more complex as a result of the production of hazardous industrial waste and the rapidly increasing use of pesticides in agriculture. In fact, water pollution today in some developing countries, at least developing a new industry, is a more serious problem than in developed countries. Unfortunately, developing countries as a whole are lagging far behind in controlling their main sources of pollution. As one of the consequences, the state of the environment in developing countries is constantly deteriorating.

The most difficult situation is observed in Asia, where more than 50% of the population lives, but it has only 36% of water resources. The acute shortage of clean drinking water is experienced by residents of 80 countries of the world. In many states, the water supply is already normalized. According to the hydrological classification, countries with 1000-1700 m^3 of renewable water per year per person live in conditions of water stress, and less than 1000 m^3 — in conditions of water scarcity. The problem of providing people with water and sewerage services is very acute: 1.1 billion people do not have access to clean fresh water, 65% of them in Asia, 27% in Africa, 6% in Latin America and the Caribbean and 2% in Europe. 2.4 billion people live in unsatisfactory sanitary conditions

(without sewerage), 80% of them in Asia, 13% in Africa, 5% in Latin America and the Caribbean, 2% in Europe. With the increase in the population, the volume of water involved in the sphere of economic activity is growing (its consumption has increased 6 times over the XX century, and the Earth's population has increased 4 times). Half of the population (in Europe and America — 70%) lives in large and small cities, which, as a rule, have economic opportunities to establish water supply and sewage construction, but at the same time concentrate and multiply waste. The mass of pollutants of anthropogenic origin dumped into water bodies is growing (currently about 6 billion tons of waste are dumped into rivers and lakes of the world every day). About 50% of the population of developing countries are forced to take water from polluted sources. UN experts predict that if this trend continues, then in 20 years water consumption per capita will decrease by 1/3. Unsatisfactory quality of drinking water poses a real threat to the life and health of millions of people, their well-being. Every year in the world, 500 million people get sick and 10–18 million people die due to poor-quality water.

The main consumer of water resources is agriculture (primarily irrigation) — 70%, 22% is used in industry, 8% of water is used for household needs. The food supply of the population is carried out at the expense of products of agriculture, animal husbandry, aquaculture and forestry. In the 1990s, countries with scarce water resources turned to two strategies: pumping out groundwater reserves to maintain or expand agricultural production and increase food imports. Pumping of groundwater occurs much faster than its reproduction (recovery is slow — for about 1400 years). It is known that more than 50% of usable water has already been pumped out. Only a few countries can resort to importing food. If the majority of states turn to it, it is likely that world markets will not be able to meet the increased demand, since the number of food exporting countries is rapidly declining [1,2,5].

3. RESULTS

Current trends in the field of natural water purification are reduced to the following points:

1. Aluminum oxychloride of various grades is being used more and more widely at water supply stations. The advantages of oxychloride are known, but in some cases, depending on the quality of natural water, the most optimal coagulant for specific conditions is selected.

2. The conditions of mixing reagents with water have a significant impact on the water purification process. To intensify the mixing processes, it is advisable to use mechanical devices to ensure rapid mixing in mixers and slow flocculation in chambers, which can significantly increase the efficiency of water settling, reduce coagulant doses and improve the quality of drinking water.

3. The method of water purification by pressure flotation is widely used in Scandinavian countries and in Western European countries.

4. Ozonation is used in world practice to purify water from anthropogenic pollution. Technologies for the combined use of ozone, UV irradiation, and hydrogen peroxide are promising. At the same time, the most effective is the use of ozone in combination with final sorption purification on active coals. Ozonation technology provides almost complete removal of organic pollutants from the water.

5. Membrane methods of water purification, which were previously used for desalination and removal of excess concentrations of metals, hardness salts and organic pollutants for small-capacity plants and small water treatment plants

6. Great difficulties exist in the treatment of groundwater containing high concentrations of iron, organic pollution of natural and anthropogenic origin. Purification of such waters should also be carried out using reagents, and in some cases with the use of ozone and activated carbon [3, 4].

4. CONCLUSIONS

Most civilized countries of the world are trying to use water rationally in various ways. The ways to overcome water scarcity include:

1. Installation of meters that will correctly and accurately calculate the amount of water used.

2. Creation of a solid information base, dissemination of information about water scarcity in society through the media, journalism, etc.

3. Improvement of the sewer system.

4. Economy. Simple rules for saving water by the population can help significantly reduce its costs for more useful purposes.

5. Creation of reservoirs for fresh water.

6. Introduction of sanctions for violation of water legislation.

7. Desalination of salty or chemical detoxification of dirty water. If earlier aggressive means of the chemical industry were used to destroy microbes, now, as a rule, harmless compounds of iodine or chlorine are common.

Nowadays the problem of water disinfection is solved in various directions using methods of UV irradiation, ozonation; the use of chlorine-containing reagents: chlorine, chlorine dioxide and sodium hypochlorite.

The main source of water pollution is human activity. Ways to solve the problem lie in the field of wastewater treatment, preventing pollutants from entering reservoirs and soil. In order to completely solve the problem of water pollution, it is necessary to apply an integrated approach. Work on reducing harmful emissions into the atmosphere and personal culture of water use also play a role. Since the problem is global, joint efforts of all countries are needed [3,5].

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BIOINDICATION ASSESSMENT OF ANGARSK POND ENVIRONMENTAL CONDITION (VOLGOGRAD)

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Abstract: The article is devoted to bioindication methods of freshwater sources. The method based on Ashikhmina's classification makes it possible to determine the quality level of the test sample. By the results of the tests, the 3rd

level of water quality was determined. This level is unsatisfactory. To improve the water quality, a method of creating a bioplato was proposed.

Key words: environment, reservoirs, ponds, urban environment, ecological condition, ecological monitoring, bioindication, bioindicator, bioplato, freshwater algae

1. INTRODUCTION

The importance of this research topic is conditioned by the fact that without freshwater, many living organisms on the planet simply cannot exist, the problem of freshwater resources is becoming more acute every year within the framework of both global and local problems. That is why it is so important to protect, preserve, maintain and rehabilitate the existing water bodies.

The aim of this paper is bioindication and biomonitoring of Angarsk Pond. To achieve this goal, several tasks were set:

1. Select the appropriate biological research method.
2. Take and analyze samples using the selected method.
3. Analyze the results obtained.
4. Determine the pollution Level.
5. Suggest methods for the rehabilitation of the reservoir.

The object of our study is Angarsk Pond.

The subject of our study is the intensity of anthropogenic pollution of the pond.

2. METHODOLOGY

The selected samples of the studied water were made in accordance with the standards of GOST 31942–2012 [1].

The method of biological research selected by us is based on the application of T.Ya. Ashikhmina's classification (table 1) and the crushed drop method. The table developed by Ashikhmina T.Ya. contains 4 pollution levels and a list of algae species-indicators of this pollution class [2].

Using a dropper pipette from the water sample under study, it is necessary to take 0.5 ml of liquid from the very bottom of the container, apply 1 drop to the slide, then place a cover glass on the drop and install the glasses on the microscope slide. The multiplicity of repetitions is 5-10 times. After that, it is necessary to count and identify all the algae found and determine their species [3].

Table 1

Classification by T.Ya. Ashikhmina [2]

The pollution degree of the reservoir	Freshwater algae name
Clean reservoirs	*Anabena, diatom*
Moderately polluted	*Diatom, navicula, cladophora, ulotrix, spiro gyra, melozyra, scenedesmus, klosterium*
Relatively clean reservoirs	*Chlamydomonas, navicula, closterium*
Heavily polluted	*Chlorella, euglena green*

3. RESULTS

After conducting research using the bioindication method, 20 species of algae were identified, 8 of which are indicative species (*Anabaena, Navicula, Ulothrix, Closterium, Chlamydomonas, Euglena viridis, Ceratium, Scenedesmus*) [4].

Figure 1. Photo of Euglena viridis.

According to table 1 and the results of seasonal and annual monitoring, the water of Angarsk Pond belongs to the 3rd pollution class — a relatively clean reservoir. A mention should be made to note

that during the entire study there was a one-time detection of *Euglena viridis* (Figure 1) in the samples, however, this indicator species was detected once, which does not imply that the reservoir is classified as Class 4 pollution. The presence of Anabaena, *Ulothrix, Scenedesmus,* characterizes the pond water as Class 3 — a moderately polluted reservoir. Nevertheless, the number of listed indicator algae is insufficient in comparison with the constant presence of Chlamydomonas, which does not give a chance of designating the reservoir as Class 2.

4. CONCLUSIONS

Analyzing the data for year-round monitoring in 2020 and the winter-spring period of 2021, we can highlight the core conclusions.

In winter, a plummet in the number of many algae is noticeable, including their absence. *Ulothrix, Navicula, Scenedesmus, Anabaena Spiroides, Monoraphidium setiforme, Synedra, Microcystis Cyanobacteria* have decreased several times, and *Epistylis bimarginata, Ceratium, Stentor, Rotifera, Closterium limneticum* and *Euglena viridis* are not observed at all.

The presence of *Coleps* was recorded as a consequence of domestic or mixed sewage discharges.

There was an increase in the number of some algae. The presence of *Peridinium* has increased, which is explained by the predominant development of this species in the cold season. *Pediastrum duplex, Cyclotella meneghiniana* are representatives of diatoms that are adapted to extreme living conditions, thanks to a special silica shell.

As a result, it was highlighted that in its usual state, Chlamydomonas have an autotrophic type of nutrition, and, with a decrease in light, the algae switch to heterotrophic nutrition, for example, at night. Nevertheless, we found that in the summer of 2020, sewage got into Angarsk Pond (this proves the presence of *Coleps*), therefore, a large amount of organic and inorganic pollutants entered the reservoir. As a result, the penetration of sunlight into the water body decreased, which led to a change in the type of nutrition of *Chlamydomonas*.

To rehabilitate a reservoir and prevent further pollution, we propose a method of creating a bioplato. Biological plateau — the creation of a natural filter, with the help of certain plants — eurybionts. Eurybionts perform the function of cleaning the pond from pollutants and strengthening the formed green “shield” of the Angarsk reservoir.

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MONITORING OF WATER BODIES IN THE RESIDENTIAL AREA NEAR URANIUM MINING AND PROCESSING FACILITIES

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Abstract: The study is devoted to monitoring the volumetric activity of radon in natural waters in the area inhabited by the population of Lermontov, as a potentially radionuclide-dangerous territory.

Key words: radionuclides, volumetric activity, natural water, drinking water.

1. INTRODUCTION

The relevance of the work lies in the fact that fresh surface water and groundwater are the main sources of drinking water supply for the population Therefore, controlling the radiation safety of water is one of the most important tasks in the field of preserving public health.

The greatest contribution to internal dose of radiation due to drinking water is made by natural radionuclides 222Rn, 226Ra, 238U. The content of radionuclides in natural waters varies over a wide range.

There are territories in Russia that are potentially radionuclide dangerous. Lermontov is one of these territories whose water supply faces problems: there are few surface sources of drinking water, ground

and surface natural waters have an increased content of natural RH, so assessment of the state of water in the territory is an important and urgent task. For this purpose, it is necessary to monitor the volumetric activity of 222Rn in natural waters on the territory of the population in potentially radon-risky areas.

The purpose of this work is to monitor the volumetric activity of 222Rn and 226Ra in natural waters, which may be used by the population of the city Lermontov for unauthorized drinking water supply.

The object of the study in the work is the natural drinking surface waters, potential unauthorized sources of drinking water consumption by the population, on the territory of Lermontov, Stavropol Territory, located in the area of the Lermontov Industrial Association "Almaz" heritage site.

2. METHODOLOGY

In the course of the study on the territory of the city we carried out measurements of volumetric activity 222Rn and 226Ra in drinking natural waters. Measurement of water samples was carried out with a measuring complex "Camera". It was based on sampling with a sorption column with activated carbon, open at one end, with subsequent measurement of carbon activity by β- or γ-radiation of short-lived DPR 222Rn [2].

Radioecological assessment was performed in accordance with the intervention levels: 222Rn=60 Bq/kg and 226Ra=0.49 Bq/kg, established in NRB-99/2009 [1].

Sampling was carried out at points located within the residential area of Lermontov and represent different objects of surface water and one point refers to the sources of groundwater "Upper Spring". We sampled 8 water bodies of natural drinking water, 21 water samples were taken.

For statistical processing of the obtained data, we used the Microsoft Excel 2010 program. We plotted histograms of data frequency distribution and quantile-quantile diagrams for the obtained values of volumetric activity 222Rn in water samples.

3. RESULTS

Statistical processing showed the law of lognormal distribution; the median was used for the mean trend.

Median volumetric activity of 222Rn was 0.40 (<0.3–1.46), median volumetric activity of 226Ra was 0.29 (<0.3–0.32).

Radioecological assessment of drinking natural water quality was made and it was found that the water bodies in the residential area of the town meet the radiation safety requirements: 222Rn and 226Ra exceedance of AL in water was not detected. The maximum concentrations of 222Rn (7.30 Bq/kg) and 226Ra (0.40 Bq/kg) were in the water body "Ostrogorka pond", in the south-eastern part of Lermontov. VARn and VARa in the water from the centralized water supply system are below the minimum detectable activity (MDA). The results obtained are presented in the table.

Table 1

Volumetric activity of 222Rn and 226Ra in natural waters in the Lermontov Industrial Association "Almaz" heritage site

№	VA 222Rn, Bq/kg	Arit.mean, Bq/kg	±Δ	VA 226Ra, Bq/kg	Arit.mean, Bq/kg	±Δ	Subjects of research
ALiwater, Bq/kg	60			0,49			
1 2 3	0,23 0,25 0,29	0,27	0,08	0,20 0,32 0,34	0,33	0,07	Upper source
4 5 6	1,12 1,28 1,31	1,2	0,04	0,21 0,22 0,25	0,22	0,06	Creek, from the lake "City"
7 8 9	0,40 0,38 0,36	0,38	0,09	0,20 0,19 0,18	0,31	0,07	Watered Lake
10 11 12 13 14	0,33 0,32 0,29 0,31 0,30	0,32	-	0,20 0,33 0,32 0,33 0,37	0,33	0,08	City Lake
15 16 17 18	6,15 6,47 6,29 7,30	6,5	0,12	0,20 0,31 0,29 0,40	0,33	0,07	Ostrogorka pond
19 20 21	3,22 3,59 3,32	3,4	0,10	0,20 0,37 0,33	0,3	0,06	19 Volkova str.

As a result of the study of natural waters of the city of Lermontov no exceedances of AL were found in any of the studied water bodies. On this basis, we can conclude that no protective measures are required at the moment. The water is suitable for drinking and recreational purposes. However, since the natural waters on the territory of Lermontov originate on the territory of Beshtau Mountain, where the Beshtaugor uranium deposit was developed, in the future it is recommended to permanently monitor the condition of natural waters on the territory of Lermontov residential area.

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MONITORING OF NATURAL RADIONUCLIDES IN WATER BODIES IN A RADON-HAZARDOUS AREA

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Abstract: The study is dedicated to the radioecological assessment of water bodies located in the territory of the legacy site LIA "Almaz"

Key words: radioecological assessment, radionuclides, radioactivity of natural waters, legacy site

1. INTRODUCTION

The development of uranium mines and the activities of uranium processing plants are unavoidably accompanied by radioactive contamination of the environment. An indicator of the radioactive contamination of the territory is the excess of radiation values over the

natural background radiation. The main radionuclides entering the environment during the operation of uranium mines are radionuclides of the ^{238}U, ^{235}U, and ^{232}Th decay series nuclides. The total radioactivity is formed by the ^{238}U decay series nuclides, whose most active daughters are ^{230}Th, ^{226}Ra, ^{222}Rn, etc [1].

At the Lermontov Industrial Association "Almaz" until 1975 the Beshtagorodskoye uranium site was developed. Upon the end of its development full-scale reclamation of the territory was not carried out. Some dumps and adits remain open, which leads to the release of drainage water with increased content of natural uranium radionuclides to the surface. Degradation of the created engineering barriers leads to the inflow of drainage water into surface water bodies used by the population for recreational purposes, and pollution of potential sources of drinking water supply.

2. METHODOLOGY

Samples of water were collected from 16 points including surface and ground water bodies. Volumetric activity (VA) of ^{222}Rn, ^{226}Ra и ^{238}U in water and specific activity of ^{226}Ra, ^{232}Th, ^{40}K in bottom sediments was measured. Radioecological assessment of water was performed in comparison with action levels for drinking water and values of effective specific activity of natural radionuclides established in NRB-99/2009 [2]. The annual effective dose for water must not exceed 0.1 mSv/year for the population [3].

3. RESULTS

The objects with elevated content of natural radionuclides were identified. The volumetric activity of ^{222}Rn (411 Bq/kg) and ^{226}Ra (6.2 Bq/kg) is maximal in water bodies in the area of mine №16; action levels in water exceed by ^{222}Rn 7 times and by ^{226}Ra 13 times. In bottom sediments, which are the depositing environment for radionuclides, the effective specific activity values were in the range of 1102 - 2540 Bq/kg, which allows us to refer them to the III–IV class of industrial waste and excludes the possibility of their use without special permission.

In water from the spring "Monastyrsky" used for drinking purposes — the content of ^{222}Rn (218 Bq / kg) and ^{226}Ra (1.1 Bq / kg), exceeds the action levels in 4 and 2 times respectively.

The average annual effective dose was calculated. We detected an excess of 8–13 times (0.86–1.3 mSv/year) in the water from adit № 16 and 2 times (0.2 mSv/year) in the spring “Monastyrsky”.

Considering the possibility of potential use by the local population of water bodies with increased content of natural radionuclides, we determined the potential radiation risk for human health during recreational use of water bodies. The calculation was performed for the ingestion and immersion ways of radionuclides impact on humans. For this model, a restriction was made on the inhalation way of exposure, due to the presence of recreator in the open air.

Carcinogenic risk of exposure to radiation from water bodies with elevated effective specific activity values is due to the high content of ^{226}Ra in the ingestive way of exposure, which makes the main contribution to the potential carcinogenic risk and varies from $1.0*10^{-3}$ to 1.0 and is unacceptable for the population. Lifetime carcinogenic risk values due to external exposure due to human immersion in water are not higher than $1.0*10^{-6}$ and are classified as “low” and do not differ from everyday risks.

4. CONCLUSIONS

At the LIA “Almaz” heritage site natural waters are characterized by increased content of ^{222}Rn and ^{226}Ra. Therefore, there is a need to inform the public about the radioecological state of water bodies on the territory of the heritage site. Particular attention should be paid to water bodies located in the area of adit № 16 — it is necessary to take measures to limit the access of the population and recreator to this area and to the sediment ponds.

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BIOECOLOGICAL ASSESSMENT OF THE SURVIVAL| OF MICROORGANISMS AT VARIOUS STAGES OF WASTEWATER TREATMENT

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Abstract: Insufficient purification of discharged wastewater can lead to bacterial and other pollution, therefore it plays an important role in the environmental aspect. This article presents the results of the analysis of wastewater samples after different stages of purification at the treatment facilities of the city of Moscow.

Key words: microorganisms, bacteria, wastewater, treatment facility, microbiological studies.

1. INTRODUCTION

In the summer of 2022, our summer practical training took place in the Federal State Budgetary Institution "Centre for Strategic Planning and Management of Biomedical Health Risks" of the Federal Medical Biological Agency, Laboratory of microbiology and parasitology. During the practice, we examined and analyzed selected samples of wastewater from Lyubertsy and Zelenograd treatment facilities.

Lyubertsy treatment facilities have a «traditional technological scheme of complete biological purification: the first stage is mechanical purification, including straining water on grids, trapping mineral impurities in sand traps and settling water in primary sedimentation tanks; the second stage is biological water purification in aerotanks and secondary sedimentation tanks». These processes can be compared to the processes of self–purification in natural reservoirs [1].

The main difference between the stages of wastewater treatment at Zelenograd treatment facilities and at Lyubertsy treatment facilities is the presence of returnable activated sludge in aerotanks. In addition, phosphorus pools are used instead of primary settling tanks in Zelenograd [1].

2. METHODOLOGY

2.1. Wastewater sampling

Water samples were taken at 5 points: 1 — after the gratings, 2 — after ultraviolet disinfection, 3 — the discharge channel, 4 — the river before the water outlet, 5 — the river after the water outlet [2, 3].

Water sampling was carried out outside of our control and on the day of sampling was transferred to the laboratory.

2.2. Sample preparation by filtration method

The samples were subjected to a two-stage concentration using MMN+ filter membranes and a filtration plant with a tangential-radial method of water supply. After the filtration was completed, the membrane was removed from the installation and placed in a Petri dish on a certain nutrient medium. The Petri dishes were placed in a thermostat at a temperature of 29–35°C to allow the colonies to grow. After removing the Petri dishes from the thermostat, we counted the results (the number of colonies grown).

2.3. Identification of microorganisms

The samples were examined for coliform bacteria (microorganisms of the Enterobacteriaceae family (Escherichia, Citrobacter, Klebsiella and Enterobacter, Serratia and Hafnia)), E. coli, Enterococci (Enterococcus faecalis, E. faecium) and pathogens of intestinal infection of bacterial nature.

To identify bacteria, we used the method of time-of-flight mass spectrometry with matrix-activated laser desorption/ionization based on the MALDI-ToF MS platform with subsequent spectrum analysis using the VITEK MS database. In fact, the method is based on measuring the ratio of the mass of charged matter particles to their charge, which makes it possible to compare the sample particles with the base and identify them with an accuracy of up to 95%.

3. RESULTS

Based on the results, we can say that the number of detected microorganisms at each stage corresponds to a step-by-step scheme of wastewater treatment (Tab. 1).

As we can see, the highest indicators of the number of all detected microorganisms are at the first and fourth points (after the gratings and the river before the water outlet) at both stations, because the samples at these points were the original ones, the water was untreated. The smallest number of bacteria detected was at the third and fifth sampling points (the discharge channel and the river after the water outlet).

The differences in data at the two stations can be explained by the different number of stages and methods of purification. Thus, at the Zelenograd wastewater treatment facilities at the stage of ultraviolet disinfection fewer microorganisms were detected than at the Lyubertsy wastewater treatment facilities, since the water passes through two additional aeration tanks (phosphorus removal and nitridenitrification).

Pathogens were not detected at any of the purification stages at both stations.

Table 1

Summary table of the number of detected microorganisms at each point (CFU/100 cm^3)

	after the gratings		after UV disinfection		the discharge channel		the river before the water outlet		the river after the water outlet	
	ZTF[1]	LTF[2]	ZTF	LTF	ZTF	LTF	ZTF	LTF	ZTF	LTF
Coliform bacteria	$1*10^{10}$	$6,5*10^{6}$	247	103	15	233	$4*10^{4}$	$3,3*10^{4}$	61	850
E. coli	$1*10^{10}$	$3*10^{6}$	9	40	11	175	$5*10^{3}$	$2,3*10^{4}$	0	0
Enterococci	$6*10^{6}$	$3*10^{6}$	$3*10^{3}$	73	1	200	184	104	0	42
Pathogens of intestinal infection of bacterial nature	–	–	–	–	–	–	–	–	–	–

ZTF[1] — Zelenograd treatment facilities; LTF[2] — Lyubertsy treatment facilities

4. CONCLUSIONS

Nowadays, due to the rapidly developing industries, the growth of the settlements and population, along with the process of water use, the volume of wastewater is increasing. That is why the development of a modern system of purification of domestic and industrial wastewater is

of particular importance, providing a high degree of protection of the environment around us from all kinds of pollution.

As the result of the conducted research, we came to the conclusion that Zelenograd and Lyubertsy treatment facilities, which are under the authority of Mosvodokanal, successfully cope with their functions, providing high-quality treatment of domestic and industrial wastewater before they are discharged into the Moskva River.

In conclusion, the effective removal of all kinds of pollutants, including microbiological, from wastewater will ensure the most favorable conditions for the use of water resources in all spheres of anthropogenic activity.

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HISTORY OF THE DEVELOPMENT OF WASTEWATER TREATMENT BY MICROALGAE

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Abstract: This work is devoted to a literary review of the historical development of wastewater treatment methods by microalgae.

Key words: microalgae, the history of algology, wastewater.

INTRODUCTION

Algae, which have always been considered useful (as food, feed, or fertilizers), have now begun to be considered a resource of paramount importance, since it does not require much effort to produce, but at the same time contains a large number of valuable molecules (such as lipids (oils), proteins and carbohydrates (sugars)), produces carotenoids,

antioxidants, fatty acids, enzymes, polymers, peptides, toxins. It also produces about half of atmospheric oxygen and simultaneously uses greenhouse gas carbon dioxide for photoautotrophic growth. In addition, microalgae can be used by humans to produce ethanol or biodiesel, bio-oil, and bio-coal, to produce pharmaceuticals and cosmetics, as well as for wastewater treatment.

In this context, algae and, in particular, microalgae represent a new biological resource of great importance for its potential application in various fields, from food and feed production to wastewater treatment and bio-oil production.

From environmental point of view, one of the most promising ways of using microalgae is wastewater treatment.

In this regard, determining the stages of formation of the wastewater treatment process by microalgae and understanding the current level of development of this area becomes a priority task.

The purpose of the research is to describe the main milestones in the development of wastewater treatment by microalgae.

1. METHODOLOGY

To write this study, a search for literary data was carried out using the method of continuous viewing of the array of available materials related to the history of the development of algology.

2. RESULTS

The post-war economic boom caused a surge in scientific research around the world [1]. During this time, three important factors have had a great impact on the development of wastewater treatment systems from microalgae: fear of lack of food, real-estate bubble and growing eco-awareness [2–6].

All this prompted the United States to invest heavily in non-military projects as an effort to increase resource extraction [7]. This funding has spurred interest in new areas of technology and science: one of these areas is the mass cultivation of microalgae, especially for food production and wastewater treatment.

1. Mass cultivation of microalgae

Experiments on the mass cultivation of microalgae began in the late 1940s and quickly introduced microalgae as a food source that could

end world hunger and support an ever-growing population. Early experiments confirmed the advantages of microalgae over traditional crops: fast growth rate, high protein content and the ability to use non-arable resources for growth [2]. In 1948, the Carnegie Institution of Washington funded research on the mass production of chlorella microalgae. This study was followed by the first experimental microalgae growing plant (Fig. 1) at the Massachusetts Institute of Technology (MIT) in 1951 [8] and continued by other major research institutes in the USA and other countries.

Figure 1. The first microalgae growing plant, MIT, 1951

2. Early research of wastewater treatment with microalgae

Early studies of microalgae for their use in wastewater were conducted to test their ability to aerate and treat wastewater. As a result of this study, specialized systems of open ponds for the cultivation of microalgae and subsequent wastewater treatment — called ponds with a high content of algae (HRAPs) — were developed. The design of such systems was based on observations of the growth of microalgae growing in natural pond systems, as well as in wastewater stabilization ponds. Researchers have also begun to study microalgae grown in wastewater as a potential food source. The idea of combining wastewater treatment

and food production using microalgae was briefly studied but abandoned for several reasons. Research has begun on the use of microalgae grown in wastewater to produce energy (methane), as well as oxygen generators for biochemical fuel cells. While low energy costs prompted the abandonment of these ideas, they provided a fundamental understanding of renewable energy production for researchers in the following decades [9, 10].

By the mid-1960s, the search for new food sources, including from microalgae, had reduced priority, since the development of birth control helped to curb uncontrolled population growth, but the use of microalgae did not go off the agenda — waste recycling using microalgae became a popular research topic [2].

3. Recycling of microalgae wastein life support systems

Due to the beginning of the nuclear arms race between the USA and the USSR, the need to search for methods of maintaining human life in controlled conditions, such as nuclear submarines and space capsules, has become a difficult engineering task [11–14]. At the same time, microalgae have shown the potential to close the cycle of life support systems.

These Controlled Environmental life support systems (CELSS) would require constant recycling of waste to restore the necessary stocks for several days, months or possibly years at a time [9]. Methods that complement the processing of human metabolic waste have shown the effectiveness of microalgae in many aspects of life support. In particular, the regenerative properties of microalgae have been discovered (i.e., removal of carbon dioxide from the air while replenishing the cabin with oxygen), as well as nutritional properties for feeding the ship's crew members and the possibility of water purification.

The strain of microalgae *C. sorokiniana UTEX 1230*, showed great prospects for use for CELSS and was used almost exclusively by NASA due to its high growth rate, heat resistance and ability to grow on various substrates. This strain later became a popular organism for studying wastewater treatment by microalgae [16].

In the USSR, experiments were also conducted using microalgae for air regeneration, as well as for the removal of food and waste [17].

In the 1970s, experiments using CELSS Bios-3 showed that people can survive in confined environments using plants and microalgae for

water, air, and partial regeneration of nutrients from human waste using biological systems [18].

While microalgae life support systems have been designed and tested on Earth, the idea of using them for submarines and spaceships has never arisen. These systems turned out to be not as reliable as the chemical and physical processes that were later used both in the USA and in the USSR. Since the space race subsided in the early 1970s, research on the use of microalgae for wastewater treatment continued but was focused on use on a municipal scale [15].

Further concern about the environmental consequences of anthropogenic pollution has prompted new areas of research and methods of using microalgae for waste treatment.

4. Wastewater treatment with microalgae nowadays

Since then, the international community has supported in-depth research into the development of microalgae wastewater treatment methods. These efforts include the use of various types of wastewaters, as well as their integration with immobilized systems. Most of these studies have focused on the use of microalgae grown on wastewater for subsequent use as biofuels [19]. The continuing interest in microalgae is due to the desire for environmental sustainability, fuel safety and the fight against climate change. Currently, there are a great many microalgae-related corporations and startups that are trying to introduce the most effective ideas for the use of microalgae in completely different areas.

3. CONCLUSIONS

Thus, the use of microalgae for wastewater treatment has long been considered an effective method of cleaning waste streams while simultaneously producing high-quality microalgae biomass. Research into the use of microalgae for waste treatment systems has been conducted for more than a century and has been closely linked to political and economic events. Currently, environmental awareness of the population and fuel safety necessitate research and development in the field of wastewater treatment from microalgae. Although large-scale treatment facilities have not yet become widespread, it is expected that a combination of technological progress, as well as socio-political pressure, may lead to the development of these opportunities soon.

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FORMATION OF ANAEROBIC ZONES IN SURFACE-FLOW CONSTRUCTED WETLANDS UNDER DIFFERENT CONTENTS IN ORGANIC MATTER IN BOTTOM SEDIMENTS

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Abstract: The functioning of a phyto-treatment facility (FOS) of an open type in the territory of Moscow was studied. The functional zones of the FOS are distinguished by the content of organic matter in bottom sediments and the content of dissolved oxygen in water. The relationship between the content of organic matter and the oxygen regime of FOS was revealed.

Key Words: constructed wetlands, bottom sediments

1. INTRODUCTION

Currently, the importance of choosing an effective solution for surface runoff water treatment is increasing. Water purification with the use of phyto-purification systems has been actively developing in the world since the 70s of the XX century. These systems are called Constructed Wetlands — artificial or constructed swamps [4]. They are widely used in European and Asian countries, in America and Australia. In Russia, there are single effective cleaning systems with an open water surface. For Russian-speaking specialists, the term "Phyto-treatment plant" (PHOS) was introduced, since modern Constructed Wetlands no longer resemble swamps in their generally accepted understanding [1–3]. The phyto-treatment facility takes into account the mandatory use of vegetation as one of its main components. During the environmental assessment of the FOS, one of the most informative objects is bottom sediments. They can form functional zones in the FOS, as well as remove

biogenic elements or create conditions for their removal. One of the important factors that forms the oxygen regime of water is the content of organic matter in bottom sediments, on which the direction of water purification processes in the FOS depends. Therefore, the assessment of the role of organic substances in the bottom sediments of the FOS as a system that forms the oxygen regime seems relevant.

2. METHODOLOGY

The object of research is an open-type gabion phyto-treatment facility. It is located in the area of the Third Transport Ring. It is intended for the passage of surface water runoff formed as a result of mixing part of the flow of the Krovyanka River and from the roadbed of the Third Transport Ring.

Figure 1. Phyto-treatment facility on the Krovyanka river on the 3rd transport ring, Moscow (project of NPO Ecolandshaft, 1998)

Work on the study of the functioning of the FOS was carried out in different seasons of the year from June to December: sampling of bottom sediments (June, October) and water samples at the inlet and outlet, taking into account various weather conditions. The entire area of the structure was conditionally divided into transects, each of which includes 1–3 measurement points — depending on the width (44 points in total). The following measurements were carried out at each point: depth, cm; temperature from the surface, at a depth of (5 cm from the bottom); dissolved oxygen (RC) from the surface, at a depth of (5 cm from the bottom); pH from the surface; electrical conductivity from the surface; samples of bottom sediments were taken. Instruments: electrical conductivity was measured by a WTW Cond 330i conductometer,

oxygen and temperature by a WTW Oxi 330i oximeter, pH by a WTW pH 330i pH meter. Samples of bottom sediments with a humidity of 95-97% were taken using a bottom sediment sampler. Sampling was carried out from a depth of 10–15 cm. The samples were placed in plastic containers for further transportation to the laboratory. Determination of ash content in bottom sediments was carried out by gravimetric method based on calcination at (600–7000 C) to a constant mass.

3. RESULTS

In the month of June, in the studied area of the phyto-treatment plant, the differentiation in the content of organic matter in bottom sediments varies in the range from 6 to 23%. In October, the picture is different: there is a zone in which the content of organic matter reaches almost 60%, the rest vary from 7 to 40%, that is, in the autumn period, organic matter in bottom sediments contains about 2 times more than in summer. This is due to the death of biomass in the FOS, and the formation of bottom sediments with a higher content of organic matter. In the bottom sediments, from autumn to mid-summer, organic matter decomposes in the upper layer of 10–15 cm, which was selected for analysis. The dissolved oxygen content both from the surface and at the bottom is higher in October than in June. This is due to the temperature of the water: the colder the water, the greater the solubility of oxygen. In June, the range of values varies from 3.37 to 5.22; in October — from 9.87 to 16.

The reason for the supersaturation of water with dissolved oxygen is that in addition to the process of biochemical consumption in October, the process of photosynthesis of phytoplankton was observed. Blue-green algae fall to the bottom of the FOS, which release oxygen during photosynthesis. This is reflected in the color of the water, and is also confirmed by experimental data on the structure of the bacterial community of bottom sediments.

The assessment of the efficiency of cleaning the FOS by chemical oxygen consumption (COD) showed that the facility removes from 0 to 25% of organic matter. The difference in removal efficiency is related to the natural cycle of growth and death of plant biomass. In September-October — the maximum biomass, with the maximum possible filtering effect: the biomass begins to die off and forms a dense natural filter that actively retains suspended organic substances.

The results of the analysis of suspended solids (BB) indicate the presence of sedimentation of organic substances with their subsequent transformation in the functional zones of the FOS, however, not in all seasons. In the winter and autumn periods, the maximum removal of suspended substances occurs, in the summer there is an increase in suspended substances in the FOS due to an increase in biomass. Thus, the FOS functions most effectively for the removal of organic matter in late summer — autumn. In June, the organic matter content in bottom sediments ranges from 6 to 23%, in October from 7 to 40 (max 60)%. At the same time, in October there are not only significantly more organic substances in the bottom sediments, but also the quality of this substance is very different from June. In October, the proportion of living blue-green algae is significant.

4. CONCLUSIONS

Bottom sediments are an important functional component of natural and anthropogenic reservoirs, which not only accumulate organic substances, but also form specific oxygen conditions in the bottom layer. Organic matter of bottom sediments, biochemically oxidized, consumes dissolved oxygen from the water column of the FOS, forming a zone with a lack of oxygen in the bottom layer with a capacity of at least 10–15 cm. The dependence of the concentration of dissolved oxygen in the water area of the phyto-treatment plant on the content of organic matter in bottom sediments varies in different seasons: a) during the summer period: with an increase in the content of organic matter in the bottom sediments, the gradient of dissolved oxygen increases. b) in the autumn period: there is no dependence. An important process of oxygen regime formation in late summer — autumn is the intake of dissolved oxygen during photosynthesis of blue-green algae.

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ENVIRONMENTAL CONSEQUENCES OF POLLUTION OF NATURAL ENVIRONMENTS BY OIL AND OIL PRODUCTS

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Abstract: Oil spills have a significant impact on the marine environment, as they cause the death of living organisms from physical asphyxiation and as a result of toxic effects on them. The level of negative impact most often depends on the amount and type of spilled oil, environmental conditions and the susceptibility of organisms and their habitats to its effects. This paper describes the consequences of oil spills and subsequent measures to combat the consequences of such accidents on flora, fauna and their habitats.

Key words: oil pollution, marine environment, oil spill, ecology.

INTRODUCTION

The effects of oil spills on the marine environment can be very different. A major accident could have severe environmental impacts and severe consequences for ecosystems and people living along the affected coast. One of the main problems is that it is often extremely difficult to objectively assess the real consequences of a spill and measures to eliminate it.

1. METHODOLOGY

This paper uses such technique as theoretical one (reading and analysis of literature and articles).

2. RESULTS

2.1. Oil spill mechanisms

The nature and duration of the consequences of oil spills depend on many factors. These include the amount and type of oil spilled, its

behavior in the marine environment, the environmental conditions and physical characteristics at the site of the spill, and the time factor, of which the season and prevailing weather conditions are particularly important. Other key factors include the biological composition of the affected environment, the ecological importance of the species included in it, and their susceptibility to oil pollution. The consequences of a spill are also largely determined by the choice of cleaning methods and the efficiency of the necessary work [1].

In addition, the possible consequences of an oil spill depend on the rate of dissolution and dispersion of the pollutant in the water as a result of natural processes. These parameters determine the area of distribution of pollution and the likelihood of prolonged exposure to elevated concentrations of oil or its toxic components on vulnerable organisms. An equally important factor is the degree of vulnerability and susceptibility of organisms to oil pollution. Vulnerable organisms are organisms that tend to live near the surface of the water or near the coastline, which increases the likelihood of their contact with oil. Susceptible are those that are more affected by contact with oil or its chemical components. Less susceptible organisms are more likely to survive short-term exposure to oil. Some countries have developed coastline maps and indices corresponding to habitats with varying degrees of susceptibility. For example, the susceptibility indices for mangroves and salt marshes shown on such maps are higher, while for sandy beaches the index is lower.

A spill of a large volume of persistent oil, such as heavy fuel oil, can cause severe suffocation damage to organisms in intertidal coastal areas. Heavy fuel oils and other types of high-viscosity oils, characterized by low solubility in water, have a lower toxic effect due to the low bioavailability of their chemical components.

The chemical components of kerosene or other light oils, on the other hand, are more bioavailable and more likely to cause toxic damage. On the other hand, this type of oil dissipates quickly through evaporation and dispersion, so light oil may cause less damage if vulnerable natural resources are sufficiently removed from the spill site. On the other hand, the most significant and long lasting effects occur when the dissolution of oil is slowed down, for example if the pollutant remains trapped in silt deposits or protected areas. Even if the intensity of exposure is below the level that causes the death of organisms, the presence of toxic

components can lead to a condition close to fatal, for example, nutritional or reproductive disorders [2].

2.2. Marine restoration

The ability of the marine environment to recover from severe disturbances is related to its complexity and resilience. Recovery from devastating natural events such as hurricanes or tsunamis demonstrates that, over time, ecosystems regenerate even after severe damage accompanied by large-scale loss of organisms. Opinions differ considerably regarding the definition of the term "restoration" and the state in which an ecosystem can be considered restored. However, it is widely recognized that, due to the natural variability of ecosystems, a return to the same state that the system was in before the oil spill is unlikely. Most definitions of "recovery" are reduced to the re-establishment of a community of flora and fauna that is inherent in a given habitat and functions normally in terms of biological diversity and productivity [1].

This principle can be illustrated by the mismanaged clean-up operations following the 1967 TORREY CANYON wreck off the coast of England, when significant environmental damage was caused by the use of toxic cleaning agents on rocky shores. And although the effects of the damage were traced for another two decades, the overall functioning of the ecosystem, its biological diversity and productivity recovered within a period of one to two years. According to the above definition, the rocky shore community recovered within two years. However, if we consider the age distribution in the ecosystem, then the limitations arising from this definition become obvious. Before the accident, organisms of all ages were present in the ecosystem: from young to adults. Newly emerged plants and animals belong to a narrow age range, so such a community is initially less stable.

A similar situation develops when mangroves are damaged, both as a result of an oil spill and under the influence of natural factors, for example, a tropical storm. Over time, damaged areas will be colonized by young plants from nearby areas. However, all successor plants will be approximately the same age and will not be able to provide full ecological functionality until they reach maturity. These observations force a distinction between impacts and damages, as in some cases, impacts that are less significant in terms of the normal functioning of the

ecosystem can be detected after the ecosystem has recovered from damage from pollution.

In the course of evolution, recovery mechanisms have been formed that allow organisms to avoid extermination by predators or extinction for other reasons. For example, one of the most important breeding strategies for marine organisms is spawning over vast areas, when a huge number of eggs and larvae are deposited in plankton and carried by currents. In most cases, out of millions, only a few individuals reach maturity. High fecundity provides an excess number of young animals, and, accordingly, a significant reserve is created not only for the formation of colonies in new territories and the settlement of territories contaminated after an oil spill, but also for replacing the dead individuals of the population. However, for longer-lived species that take several years to reach sexual maturity and have only a few young, recovery from pollution will take a much longer period.

Typically, in most cases, recovery takes several seasonal cycles, and for many habitats of organisms is from one to three years.

2.3. Marine environment

The following sections discuss the various types of damage that occur in various environments when oil is spilled from ships.

Most oil floats on the sea surface and is carried by waves, wind and currents over long distances. Some low-viscosity oils naturally disperse in the upper layers of the water column (up to several meters deep), especially in breaking waves, and quickly dissolve. If the release of oil continues for some time, then the concentration of suspended oil in the upper layers of the water column can be maintained at a level close to the level of the release. Despite this, the impact of oil spills on species living in the lower water column or on the seafloor appears to be small, but damage can be caused by sunken wreckage, a very heavy oil spill, or tarry residues from oil fires [3].

2.4. Coastlines

Of all the components of the marine environment, coastlines are the most affected by oil. However, many coastal flora and fauna are resilient to such catastrophes, as they endure the tidal cycle. This resilience provides most shoreline dwellers with the ability to tolerate and recover from oil spills.

2.5. Rocky and sandy shores

Rocky and sandy shores are washed by waves and tidal currents, therefore they are considered the most resistant to the effects of spilled oil. Such washing, as a rule, promotes fast natural self-cleaning. A typical example of the impact on a rocky coast in a temperate climate is the temporary disappearance of the limpet, a key species of marine molluscs. On the sandy shores of the tropics and subtropics, an ecological niche similar to sea limpets is occupied by ghost crabs, which also die in large numbers when oil enters the coastline. However, just a few weeks after the coastline is cleared, the crab colonies on the beaches are restored to the same numbers as before the accident.

2.6. Muddy shores

Fine sand and silt are found on shores protected from waves, for example, in estuaries. Fine-grained soil is not as heavily oiled as other types, but oil can still flake into storm-lifted soil or seep into wormholes and open plant stems. Pollutants that have penetrated fine-grained soil remain there for many years.

2.7. Salt marshes

The upper boundaries of the soft, silty shores are often covered with vegetation characteristic of salt marshes, which consists of perennials, succulent annuals and herbs. The impact of oil spills on salt marshes depends on the time of year and, accordingly, the period of plant growth. A single spill usually causes only temporary effects, but frequent oil exposure or improper clean-up operations such as trampling, heavy equipment, or contaminated soil removal cause long-term damage. Clearing salt marshes carries the risk of additional damage, so it's usually best to wait for these marshes to clear naturally.

2.8. Mangroves

Mangrove habitats make them the most vulnerable to oil spills. Mangroves are extremely susceptible to oil pollution, which is largely determined by the soil in which they grow. Typically, these species grow in dense anaerobic silt deposits and obtain oxygen through tiny pores on the respiratory roots. Extensive accumulations of oil near the root system lead to blockage of oxygen access and possible death of plants. However,

in sediments that are open to air and more or less free water exchange, oxygen enters the root system from sea water, so plants are less susceptible to suffocation during a spill. The toxic components of oil, especially in light oil products, affect the plant's ability to maintain the salt balance that allows them to survive in salt water [2].

An oil spill can directly affect the organisms that live in the mangrove ecosystem, or cause loss of habitual habitat in the long term. The natural restoration of a complex mangrove ecosystem takes a long time, so it is important to carry out special rehabilitation measures to speed up this process.

3. CONCLUSIONS

The marine environment has the strongest ability to naturally recover from major disasters caused not only by natural events but also by oil spills. Physical suffocation and toxicity are the main mechanisms for the negative impact of oil on the environment, but the extent of this impact depends to a large extent on the type of spilled oil and the speed of its spread relative to the location of resources susceptible to oil pollution. The most vulnerable organisms are the inhabitants of the sea surface and coastline. Salt marshes and mangroves represent the most vulnerable coastal habitats. However, even if the short-term impact is significant, long-term damage is unlikely even for major accidents. Observations show that long-term damage usually depends on the geographical isolation of areas where conditions favor the preservation of oil accumulations for a long time. Effective planning and execution of oil spill response operations contribute to mitigation of negative impacts. Well-prepared and thoughtful rehabilitation measures can sometimes speed up natural recovery processes.

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ECOLOGICAL PROBLEMS OF SMALL RIVERS IN MOSCOW AND WAYS TO SOLVE THEM: CASE STUDY OF THE SAMORODINKA RIVER

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Abstract: The paper analyzes the environmental problems of small rivers in Moscow on the example of the Samorodinka River and gives a brief description of it; it also offers recommendations for improving the ecological situation of the Samorodinka River basin and prevent its further pollution.

Key words: geo-ecological assessment, small rivers, pollution

1. INTRODUCTION

Small rivers are the most vulnerable to pollution, so a comprehensive geo-ecological assessment of small river basins is an urgent problem. The resources of small rivers are very diverse, and they need constant environmental control.

This paper examines the environmental problems of small rivers on the example of the Samorodinka River which flows through the city of Moscow [1].

This river is located in the south-west and west of Moscow; it originates in the Belyaevo district and flows into the river Ochakovka (then thr Ramenka, the Setun, and the Moscow River), and is the right and quite a large tributary (Fig. 1). Previously the villages of Belyaevo and Nikolskoye were located here.

The length of the Samorodinka River is about 7 km and most of it is contained in underground sewers. About 3.5 km it flows on the ground and this part of the river was studied. Its basin area is 11 km^2, the riverbed is heavily changed. Several unnamed streams flow into the river [2].

2. METHODOLOGY

Empirical methods (field studies of the area), review of various sources of information and analysis of the information obtained, as well as cartographic methods were used in our research.

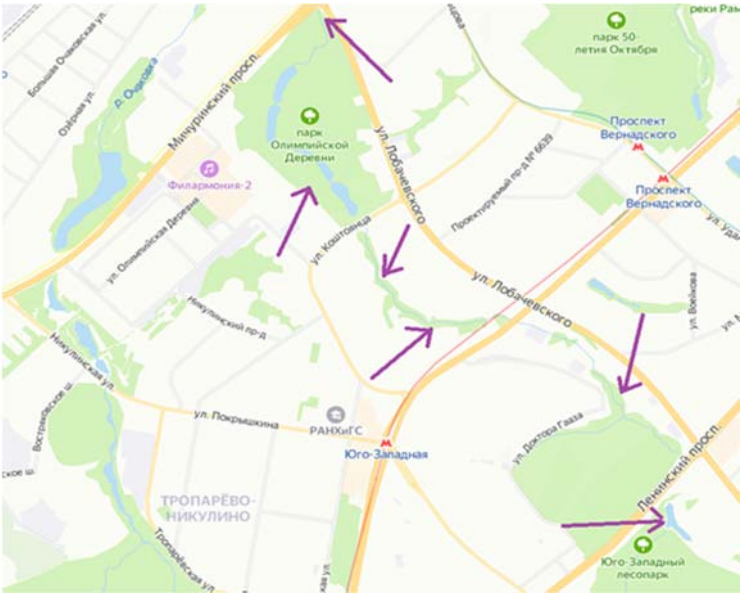

Figure 1. The Samorodinka River on the map of Moscow (scale 1:30 000)

3. RESULTS

Since the river is contained in underground sewers, its condition can be assessed as irreversible, for the river will never return to its former state. In areas where it flows on the ground the condition is different. The basin of the Samorodinka river in the territory of South-West Forest Park (section 1) is cleaner than in the territory after Vernadsky Avenue (section 2). Despite the work done to improve the state of the river, its basin in this area is more exposed to pollution.

3.1. The main environmental problems in the Samorodinka River basin

The main environmental problems of the Samorodinka River are surface runoff into the river from roads, pollution of the basin with plastic and construction waste, places for recreational fires in Southwest Forest Park, erosion of banks and landslides, growth of *Heracleum sosnowskyi,* or Sosnowsky's hogweed, which is an invasive species, windfall and neglected areas. Presence of oil stains was found during the field studies

on the 12th of March 2022, as well as a stream of unknown origin with excessive iron content in water.

3.2. Recommendations for improving the environmental situation and preventing further pollution of the Samorodinka River basin

To prevent overgrowth of the meadow area of Section 1 of the Samorodinka riverbank with weeds and Sosnovsky's hogweed, the right side of Southwest Forest Park should be improved, regular mowing of weeds and creation of at least one dirt trail should be provided. Also, a small playground, recreation areas for barbecues and food stalls should be organized.

It is necessary to engage volunteers in regular supervision of the Southwest Forest Park area to prevent fires in undesignated areas and littering; it is necessary to organize clean-up events at least twice a year to clean the river floodplain, riverbanks, and the forest park from litter.

The district authorities should improve the area from Vernadsky Avenue to Koshtoyantsa Street, organize cleaning of the area from construction waste, carry out additional work to strengthen the banks to prevent erosion and landslides, equip the drainage of storm water into the river with filters, check the water composition of some tributaries, and if they do not meet the standards, the authorities should determine the sources of pollution and take measures to comply with the standards.

4. CONCLUSIONS

Geo-ecological assessment of the Samorodinka river basin is a mechanism for determining the condition of the water body. The identified environmental problems require their solution since the Samorodinka River is a major tributary of the Ochakovka River and belongs to the basin of the Moscow River.

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ИСПОЛЬЗОВАНИЕ НАНОТЕХНОЛОГИЙ ДЛЯ ОЧИСТКИ ВОДНЫХ РЕСУРСОВ

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THE USE OF NANOTECHNOLOGY FOR WATER PURIFICATION

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Аннотация: В статье рассматриваются возможности использования нанотехнологий в качестве средств очистки водных ресурсов от тяжёлых металлов и других видов загрязнений. В этой статье представлен обзор использования наноматериалов в очистке воды, а именно последние достижения в разработке новых наноразмерных материалов и процессов для обработки поверхностных вод, грунтовых вод и промышленных сточных вод. Автор приходит к выводу, что использование нанотехнологий является перспективным направлением для изучения.

Ключевые слова: очистка воды, нанотехнологии, наночастицы.

1. ВВЕДЕНИЕ

Современные достижения в области нанонауки позволяют предположить, что многие из нынешних проблем, связанных с качеством воды, могут быть решены с помощью наносорбентов, наноструктурированных мембран и наночастиц, улучшающих фильтрацию и других материалов. Инновации в области разработки новых технологий опреснения воды относятся к числу наиболее интересных и перспективных. Кроме того, материалы, получаемые с помощью нанотехнологий, которые снижают концентрацию токсичных соединений, могут способствовать достижению нужного качества воды и рекомендаций по вопросам здравоохранения.

На данный момент использование наночастиц и наноматериалов для водоочистки является перспективным, поскольку позволяет обойти основные ограничения, связанные с традиционными методами очистки воды, такими как использования явлений обратного осмоса, флотации, адсорбции, электролиза, перегонки, коагуляции, различных видов фильтрации и т.д.

2. МЕТОДОЛОГИЯ

Цель данного исследования — провести анализ свежих научных источников и систематизировать полученные сведения о возможностях очистки воды с помощью нанотехнологий.

Наночастицы — это частицы, критический размер которых хотя бы в одном из трёх направлений в размерности до 100 нанометров, что приводит к скачкообразному изменению свойств материалов из-за влияния различных размерных эффектов. «Свойства наноматериалов могут отличаться от свойств тех же материалов в микро- или макро-масштабах» [1]. В работе Абаевой Е.А. подчёркивается, что нанотехнологии являются именно комплексом из наноматериалов и аппаратов их использующих, отличительной особенностью данных материалов наличие в своём составе частиц размером в пределах от 10 до 100 нм [2].

Вода является одним из важнейших ресурсов для человечества, однако обеспечить все человечество необходимой водой не представляется возможным из-за изменений климата, роста численности населения земли и других причин. Поэтому новые способы водоочистки активно обсуждаются в научных кругах, более того также рассматриваются различные возможности улучшения существующих методов очистки от тяжёлых металлов, природных органических веществ, микробиологических загрязнителей, а также фосфатов, пестицидов, нитратов, сульфатов, фенолов и многих других химических веществ [3]. Концентрации, размеры и количество примесей широко варьируются, зависят от источника загрязнения, поэтому можно сказать, что не существует единого метода достаточного для удаления всех загрязнителей, более того высокие эксплуатационные расходы препятствуют использованию сложных методов. Поэтому считается, что использование нанотехнологий позволит усовершенствовать уже имеющие способы очистки и обнаружения загрязнителей.

К примеру, в работах Мусихина С.Ф. и Ершова А.В., Демьянова А.А. рассматриваются возможности использования полупроводниковых и металлических наночастиц в качестве уникальных флуоресцентных биосенсоров, которые могут детектировать органические вещества, ионов тяжёлых металлов [4, 5]. В свою очередь для улучшения процессов фильтрации наночастицы могут использоваться в качестве адсорбентов или нанофильтрационных мембран

[5]. Наноматериалы являются хорошими адсорбентами за счёт большого количеством активных поверхностных центров адсорбции, высокой удельной площадью поверхности наночастиц. Однако одно из самых больших преимуществ нанотехнологий может быть реализовано в фильтрационных системах, которые разрабатываются для превращения солёной воды в пресную, а сточных вод до воды нужной чистоты.

2. РЕЗУЛЬТАТЫ

На данный момент востребованными наноматериалами для очистки воды являются: углеродные нанотрубки, фуллерены, нанопроволки, комплексы наносеребра, наночастицы цеолита, а также наночастицы оксидов титана, магния, одновалентной меди и т.д. Наночастицы оксидов металлов являются аналогами адсорбентов тяжёлых металлов, но с более высокими показателями адсорбционной ёмкости, более того могут быть формованы в гранулы без изменения свойств, что удобно для промышленного и бытового использования [6]. Наносорбентов на основе оксидов железа, диоксида титана, оксида цинка и алюминия, действие таких адсорбентов заключается в взаимодействии кислорода и тяжёлых металлов в загрязнённой воде[3]. Такие адсорбенты эффективно удаляют не только ионы тяжёлых металлов, но и радионуклеотиды, более того их можно использовать в фильтрах среды, реакторах шлама, в виде порошках или гранул.

Основной принцип очистки воды с помощью наночастиц, используемых в качестве адсорбентов, наноразмерных нековалентных ионов или нанофильтрационных мембран, заключается в отделении и последующем удалении загрязняющих веществ из воды, тогда как наночастицы, используемые в качестве катализаторов химического или фотохимического окисления, влияют на разрушение присутствующих загрязняющих веществ. «Наночастицы могут изолировать загрязняющие вещества сточных вод за счет протекания процессов адсорбции и комплексообразования, иммобилизуя или преобразовывая их в экологически безопасные, устойчивые соединения»[7, с.1].

3. ВЫВОДЫ

Таким образом, наноматериалы могут являться перспективными и востребованными материалами для очистки водных ресур-

сов необходимых для различного рода нужд. Наночастицы могут уничтожать ионы металлов, анионы, органические соединения и микроорганизмы в водных ресурсах. Дозы наночастиц, необходимые для очистки воды, низкие, что делает их применение относительно экономичным и перспективным.

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SOIL CONTAMINATION AND LANDSCAPE RESEARCH

CHARACTERISTICS OF SOILS WITH VARYING DEGREES OF ANTHROPOGENIC DISTURBANCE IN TERMS OF HYDROLYTIC ACIDITY

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Abstract: This paper tackles the problem of soil quality. It examines how the hydrolytic acidity index changes depending on the anthropogenic disturbance.

The authors studied samples of urban soil, soils of a summer house plot, agricultural land, urban park areas in the Volgograd, Moscow, Kaluga, and Kursk Regions.

Key words: urban soil, strong anthropogenic load, hydrolytic acidity, acidity index, soils of a summer house plot, agricultural land, urban park area.

1. INTRODUCTION

In modern conditions the anthropogenic impact on the soil cover is rapidly increasing and significantly affects not only the soil fertility, but also the related environmental objects. At the same time, it should be noted that soil is primarily a resource that provides for the needs of our society in most agricultural products, so the degradation of agricultural land poses a direct threat to the existence of our civilization [6]. In the Russian Federation, the problem of soil contamination and degradation has recently become particularly acute, being one of the key factors ensuring the country's food security in the face of sanction pressure and the general instability of the political and economic situation in the world. It should be noted that one of the factors affecting soil fertility is

a change in physical and chemical parameters of soils, such as hydrolytic acidity, which makes the topic of this work relevant [1–2].

The purpose of my work is to study changes in the value of hydrolytic acidity of soils in Moscow, Kaluga, Kursk, and Volgograd Regions, depending on different types of their economic use.

To achieve this goal, the following tasks were set and accomplished:

1. Select soil samples from the study areas that have been subjected to different anthropogenic impacts (dacha plots, urban parks, agricultural land) and conduct their sample preparation for the analysis of hydrolytic acidity.

2. Conduct a measurement of hydrolytic acidity in the selected soil samples.

3. Determine the correlation between the hydrolytic acidity index and the degree of anthropogenic soil disturbance using statistical analysis methods.

2. METHODOLOGY

The objects of the study in the work are samples of urban soil, soils of a summer house plot, agricultural land, urban park area in the Volgograd, Moscow, Kaluga, and Kursk Regions.

To determine the hydrolytic acidity of soils, the Kappen method was used, based on treating the soil with a sodium acetic acid solution of a concentration of (CH COONa) = 1 mol/dm with a soil-to-solution ratio of 1:2.5 for mineral soil and 1:150 for peat and other organic horizons of soils and rocks [3].

Ten samples were analyzed in each region — Volgograd Oblast, Kotovo and Kursk, Kirpichnaya St. It can be concluded that the urban soil samples are exposed to a low degree of anthropogenic load, therefore, measures to restore the top fertile layers are not required. A similar situation is in Volgograd Oblast, where the hydrolytic acidity indicator showed that there are processes of alkalinization, and measures will be required if the situation deteriorates and the anthropogenic load increases [4].

3. RESULTS

The samples taken in the Moscow Region gave the following results: Zyuzina settlement, the index is 5.21 millimole [ˈmılıməlı] /100 grams and SNT Luzhok — 2.78 millimole /100 grams. Analyzing the pH

values obtained, we can say that the soil samples from the dacha plots are subjected to strong anthropogenic load, due to widespread economic activities in these territories. In addition, the presented values indicate a stronger anthropogenic load in Stupino District of Moscow suburbs in comparison with Ramensky District [5].

Also, sampling was carried out in the agricultural lands of Kaluga and Moscow Regions. The data obtained are similar and amount to approximately 1.03 and 1.20 mol/ 100 grams, respectively. According to the pH values obtained, we can conclude that the samples of agricultural soils are subjected to anthropogenic influence to a lesser extent, and therefore the soil indicators are characterized by a neutral acidity index and do not need to be restored [6].

Based on the pH values obtained, we can conclude that the results obtained are differentiated, since in Izmaylovsky Park there is a pronounced manifestation of anthropogenic impact due to a regular modification of natural landscapes there (artificial soil acidification is observed), such as the construction of recreation areas, playgrounds, power lines, paths, etc. While on the territory of the Mnevnikovskaya Floodplain there are slight processes of alkalization caused by the construction of engineering structures: the construction of embankments, children's recreational playgrounds, sports fields, etc. These activities cannot but affect the upper fertile horizons of soils.

Based on the values of soil hydrolytic acidity, the highest indicator of hydrolytic acidity is in the soils of dacha plots and park zones. Also, there are differences within the same type of anthropogenic impact, but for different types of soils. In particular, the hydrolytic acidity index on the territory of Izmailovsky Park is significantly higher than that on the territory of Mnevnikovskaya Floodplain. A comparison of soils of dacha plots in Moscow Region shows that the hydrolytic acidity index in Ramensky District is higher than that in Stupinsky District.

4. CONCLUSIONS

According to the results of the study the following conclusions can be drawn:

1. Hydrolytic acidity has a direct dependence on anthropogenic disturbance. It is shown that hydrolytic acidity has a direct dependence on the nature of anthropogenic disturbance. In dacha plots and park areas, the obtained values of hydrolytic acidity are markedly higher than in the same soils of urban and agricultural zones.

2. It was found that with the growth of anthropogenic impact on the soil and the degree of its degradation, the indicator of soil hydrolytic acidity also increases.

3. Significant differences of hydrolytic acidity for different genetic types of soils within the same type of anthropogenic impact were revealed. In particular, the hydrolytic acidity index on the territory of Izmailovsky Park is significantly higher than on the territory of Mnevnikovskaya Floodplain. Comparison of soils of dacha plots in Moscow Region showed that the hydrolytic acidity index in Ramensky District is higher than that in Stupinsky District.

Consequently, we can say that the more anthropogenic impact the soil is exposed to, the higher the indicator of its hydrolytic acidity.

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DISTRIBUTION OF PETROLEUM PRODUCTS AND BENZO(A)PYRENE IN THE SOILS OF THE NEKRASOVKA DISTRICT, MOSCOW

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Abstract: The soils in megacities accumulate petroleum products and benzo(a)pyrene, which are highly toxic. In addition, they change the properties

of soils, which can further lead to their degradation. So, it is necessary to monitor the soil of residential areas for pollutants. The purpose of this study was to assess the distribution and sources of petroleum products and benzo(a)pyrene in the soils of the Nekrasovka district, Moscow, exposed to excessive technogenic effects.

Key words: petroleum products, benzo(a)pyrene, soil pollution, accumulation, degradation, fluorimetric method of analysis, the method of high-performance liquid chromatography (HPLC)

1. INTRODUCTION

The soils of such megacities as Moscow actively accumulate petroleum products (PP) and benzo(a)pyrene (B(a)p), which are highly toxic and pose a threat to public health. In addition, they change the morphological, geochemical, physical, and physico-chemical properties of soils, which can further lead to their degradation. So, it is necessary to monitor the soil of residential areas for pollutants [1-2].

The Nekrasovka district began to be actively built up after joining Moscow in 2011, exposing the soil to excessive technogenic effects. Also, the research area is exposed to a high impact from the Lyubertsy sewage treatment plants, Incinerator №4 and four landfills. Thus, the purpose of this study was to assess the distribution of petroleum products and benzo(a)pyrene in the soils of the study area. To achieve this goal, the following tasks were set:

1. To conduct a theoretical analysis of the transformation and accumulation of petroleum products and benzo(a)pyrene in the soils.
2. To select soil sampling points depending on the functional load and the distance from the objects of negative impact in the Nekrasovka.
3. To determine the mass fractions of petroleum products and benzo(a)pyrene in the selected soil samples.
4. To analyze the distribution of these pollutants in the soil.
5. To identify the main sources of petroleum products and benzo(a)pyrene and to define unfavorable areas from the point of view of environmental safety.

Despite the fact that there is a lot of data on petroleum products and benzo(a)pyrene in soils in the literature, some issues remain unresolved:

1. Inaccuracy of the term “petroleum products”.
2. The absence of a single international standard for permissible concentrations of petroleum products and benzo(a)pyrene in soils (due to the heterogeneity of climatic conditions, soil characteristics, as well as

technogenic impacts affecting the morphological, physico-chemical, and other properties of soils)

3. The absence of relevant documents in the Russian Federation on rationing the content of petroleum products in the soil.

2. METHODOLOGY

The soils of residential, recreational, and industrial landscapes (urbanozems) of the Nekrasovka District were selected as objects of research. To identify the spatial accumulation and migration of petroleum products and benzo(a)pyrene in the soil cover on the territory of the Nekrasovka District, 7 sampling sites were selected, different in their functional load and the distance from the objects of negative impact on the environment. At each site, 5 samples were taken by the envelope method.

Methods of chemical analysis of soil samples for the content of pollutants were used in the work. The selection, transportation of soil samples, their storage and sample preparation were carried out in accordance with GOST 17.4.4.02–2017. In laboratory conditions, the mass content of petroleum products in the soil samples was determined by the fluorimetric method on the liquid analyzer "Fluorat-02". Determination of the mass fraction of benzo(a)pyrene in the soil samples was carried out by the method of high-performance liquid chromatography (HPLC) [3].

3. RESULTS

3.1. The content of petroleum products in the soils of the Nekrasovka district, Moscow

The conducted studies showed that the soils of this territory are unevenly polluted. According to the results of the laboratory study, more than 50% of the samples are not contaminated or slightly contaminated with petroleum products, and only the samples from Site №3 taken near the sodium hypochlorite production plant belong to a very high-level of contamination (Fig. 1).

At the same time, 63% are contaminated with benzo(a)pyrene and exceed the MPC. The large number of samples contaminated with benzo(a)pyrene is associated with increased resistance of the pollutant in the environment.

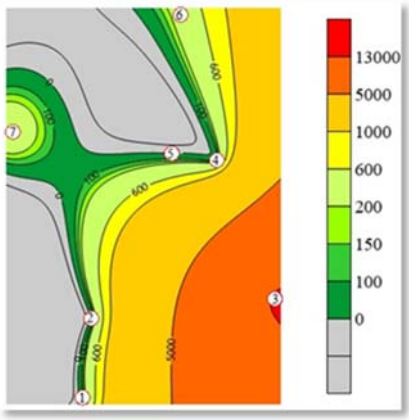

Figure 1. Distribution map of Petroleum Products in soils in the Nekrasovka district

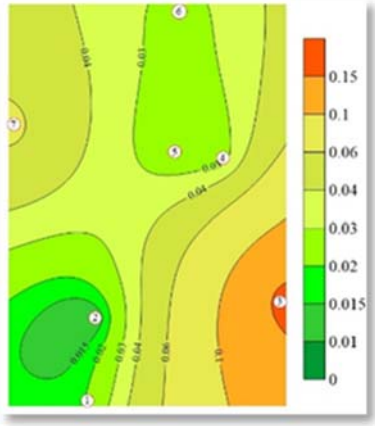

Figure 2. Distribution map of Benzo(a)pyrene in soils in the Nekrasovka district

3.2. The content of benzo(a)pyrene in the soils of the Nekrasovka district, Moscow

Analysis of the distribution of pollutants showed that soils heavily contaminated with petroleum products also exceed the MPC value for benzo(a)pyrene by several times. This statement proves that both pollutants enter the soil with emissions from industrial enterprises and motor transport. Exceedance of the regulatory values for benzo(a)pyrene on almost the entire territory confirms that there was oil pollution in the past and shows that it is more stable in the environment than petroleum products (Fig. 2).

3.3. Research results and their discussion

Analysis of the distribution of pollutants showed that soils heavily contaminated with petroleum products also exceed the MPC value for benzo(a)pyrene by several times. This statement proves that both pollutants enter the soil with emissions from industrial enterprises and motor transport. Exceedance of the regulatory values for benzo(a)pyrene on almost the entire territory confirms that there was oil pollution in the past and shows that it is more stable in the environment than petroleum products [4–5].

According to the results of the study, the total indicator of soil pollution (Zc) was calculated. This result varies from 0 to 21. Soils with Zc values exceeding 16 can negatively affect the general morbidity of the population, the bio-productivity of soils and the state of vegetation cover.

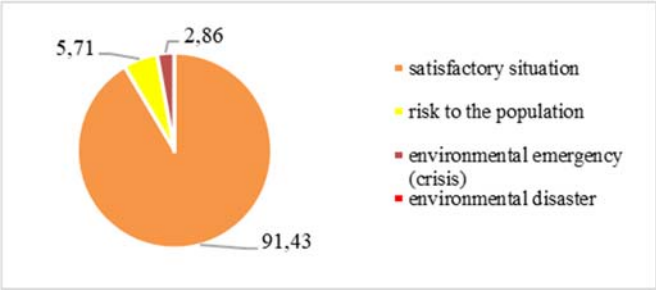

Figure 3. Diagram of the assessment of the situation by the total indicator of soil pollution (Zc) in the Nekrasovka district of Moscow

4. CONCLUSIONS

1. It was revealed that the transformation of petroleum products and Benzo(a)pyrene in soils occurs vertically under the influence of gravitational forces and horizontally under the action of capillary and surface forces.

2. It was revealed that when these pollutants enter the soil, the content of mobile nitrogen and phosphorus compounds decreases, salinization occurs, and the water-air regime worsens. In addition, the geochemical balance is disturbed.

3. It was found that the content of petroleum products varies from 2.85 mg/kg at point № 25 (residential area — Hockey court and playgrounds near the residential complex Nekrasovka) to 27375 mg/kg at point №15 (industrial area — field near the plant for the production of sodium hypochlorite), benzo(a)pyrene – from 0.0065 mg/kg at point № 10 (recreational zone – Park “Merchant lands”) to 0.215 mg/kg at point № 14 (industrial zone — a field near the sodium hypochlorite production plant).

4. An uneven distribution of pollutants was revealed, for example, at Point №14 near the industrial zone (a field near a sodium hypochlorite

production plant), the MPC for petroleum products was exceeded by 15 times and for benzo(a)pyrene — by 11 times. And at Point №10, the recreational zone (Merchant Lands Park), for petroleum products, the share of MPC is 0.01, for benzo(a)pyrene — 0.3 MPC.

5. It has been established that the main sources of petroleum products and benzo(a)pyrene are the sodium hypochlorite production plant, the Lyubertsy sewage treatment plants, the former Nekrasovka landfill and the construction of the North-Eastern Chord.

6. It was revealed that the total indicator of soil pollution (Zc) in the Nekrasovka district is 3.7, so the situation there can be assessed as satisfactory.

7. It is noted that the most unfavourable site from the point of view of environmental safety is Site № 3 — a field near a sodium hypochlorite production plant, an industrial area.

Practical recommendations:

1. The MPC for petroleum products in the soil should be established.

2. At the moment regular monitoring of the soil cover for the content of petroleum products and benzo(a)pyrene is only carried out near the former Nekrasovka landfill, however it is necessary to carry it out in various functional zones in the Nekrasovka district.

3. The soil cover of the field near the plant for the production of sodium hypochlorite should be recultivated using bacteria-oil destructors. The bioremediation process will take 12–18 months. The residues of pollutants can be eliminated by seeding oil-resistant grasses: *Trifolium repens* (creeping clover), *Rumex sp.* (sorrel), *Carex sp.* (sedge).

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SELECTION OF STRUCTURATORS FOR BIOREMEDIATION PROCESSES OF OIL CONTAMINATED SOILS

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Abstract: Various structurators (additives) used in the bioremediation of contaminated soils are considered. An analysis of common structurants (additives) used for bioremediation is presented, as well as the results of laboratory and industrial studies obtained during the bioremediation of contaminated soil using additives in various percentages. Additionally, a lysimetric experiment for four structurators is presented in order to assess possible secondary contamination when a structurator is introduced into the soil. According to the characteristics obtained, an additive (structurator) was chosen that is distinguished by the greatest efficiency — lowland peat.

Key words: soil pollution, oil products, structurants, additives, sorbents

INTRODUCTION

Bioremediation is a technology based on the natural processes of self-healing and self-purification of soils. These processes are carried out by microorganisms, fungi, algae, plants and/or their enzymes [1].

Various structurators (additives) are used to intensify the bioremediation process. There are structurators of natural origin (peat, sawdust, sphagnum moss, straw, humic preparations, etc.) and artificial (polymer sorbents of various brands), as well as various types of

modified natural sorbents based on glauconite and other substances. Production and consumption waste (brewing production, waste activated sludge, construction waste, food waste) can be used as structurators. At the same time, the efficiency of bioremediation directly depends not only on the chemical and fractional composition of oil, on the type of soil, but also on the listed structurators (additives) used to intensify the process.

1. METODOLOGY

To assess the potential of using various structurants in the bioremediation of oil-contaminated soils in laboratory conditions, the following were evaluated: high-moor and low-lying peat, horse manure, biohumus, excess sludge from biological treatment facilities, return sludge from biological treatment facilities, pre-dried sphagnum moss (Sphagnum (L.)), as well as organic food waste (cleaning of fruit and vegetable crops).

To assess the potential for the use of various structurants in the bioremediation of oil-contaminated soils, the following were evaluated: high-moor peat and lowland peat, horse manure, biohumus, sludge from biological treatment facilities mixed with mechanical treatment sludge from household and mixed wastewater from treatment facilities in Staraya Kupavna, Moscow Region , return sludge treatment facilities in the village. Tuchkovo, Moscow region, pre-dried sphagnum moss (Sphagnum (L.)), as well as organic food waste (cleaning of fruit and vegetable crops).

The soil taken from the Ponomarevsky sludge reservoir located in the Orenburg region was used as the contaminated soil. For research, 2 samples were taken weighing 35 kg and 23 kg with an oil content of 18% and 21.3%, pH 8.1 and pH 8.2, respectively.

As an oil destructor in laboratory and industrial conditions, the drug “Oil Destructor, Microbiological Preparation“ was used, produced according to TU 20.59.59-004-41289053-2019 brand Center, intended for use at temperatures from plus 5° C to plus 30° C, manufactured by LLC “NPO Volga-Ecology“[4].

Within four months after mixing in various ratios of structurators with the initial soil, mixing was carried out 1–2 times a week, and the humidity was controlled and maintained at a level of 65–80%.

The following structurators were chosen for industrial tests: high-moor peat, lowland peat, horse manure, biohumus, glauconite. Tests

under industrial conditions were carried out at the Ponomarevsky sludge collector from May to October (6 months). The tests were carried out with similar soil. As a means of mechanization, an excavator with a bucket was used. Humidity was maintained at a level similar to the laboratory. The amount of introduced structurants was 5 and 10%, respectively. Fig.1 shows a collar where the contaminated soil and the structurator and oil destructor have already been mixed.

The results of laboratory studies are presented in Table 2.

Figure 1. Hill (oil-contaminated soil, lowland peat structurator, oil destructor).

Table 2

Effectiveness of prosses of bioremediation, % of purification

Structurators	The amount of the structurator entered					
	0,5%	1,5%	3%	5%	10%	20%
Highbog peat	–	–	–	75,3	81,8	91,8
Highbog peat (activated)	–	–	–	79,2	–	–
Lowland peat	–	–	–	**90,1**	**94,2**	**95,3**
Horse manure	–	–	–	75,4	82,6	88,2
Biohumus	–	–	–	–	88,1	93,6
Sphagnum moss (*Sphagnum (L.*))	50,4	55,3	59,8	–	–	–
Excess sludge	–	–	59,8	63,75	58,2	–
Return sludge	–	–	–	–	68,6	74,6
Organic food waste	–	–	22,1	15,83	18,7	–

These results were confirmed by industrial tests, where also lowland peat showed its effectiveness in a percentage of 89.9% when applied in an amount of 10%, biohumus showed an efficiency of 86%.

In addition, to assess the possibility of secondary contamination of soils and soils with substances leached from potential structurants, a lysimetric experiment was set up to study the dynamics of leaching and transfer of substances of various structurators into the soil under the influence of atmospheric precipitation, and to assess possible secondary soil contamination due to the introduction of a structurator.

For the experiment, four structurants were selected, determined according to the results of laboratory studies as the most effective: high-moor peat, lowland peat, biohumus and horse manure.

The average annual precipitation was taken for the Orenburg region [6], and then the water-holding capacity of each structurator was determined.

Based on the moisture capacity and weight of each structurator, the volume of a single spill per day was calculated.

The resulting extract was analyzed for the following indicators: active reaction (pH), color, hardness, electrical conductivity, permanganate oxidizability, ammonium ions, chlorides, sulfates, nitrates, total iron, manganese.

The results of the lysimetric experiment for some indicators are presented in Table 1.

Table 1

Concentrations of different indicators at the end of lysimetric experiment

Indicators	Structurators				MPC
	Highbog peat	Lowland peat	Vermiculite	Horse manure	
Ammonium ions, mg/l	1,5	0,3	0	0	0,5
Nitrate ions, мг/л	7	7	300	500	40
Permanganate oxidisabillity, mg O_2/l	10	4	100	200	–
Sulfate ions, mg/l	100	100	5000	2500	100
Chlorides, mg/l	30	10	500	1000	300
Hardness, grad.	2,64	2,97	313,5	396	-
pH, unit pH	5,8	7,1	7,8	8,2	= ambient

Based on the data obtained, it was found that the best characteristics as a structurator (additive) are lowland peat.

2. RESULTS

The introduction of lowland peat showed the best result when it was applied separately, both in industrial and laboratory conditions. In addition, it was proved that the dynamics of leaching and transfer of substances into the soil is also lower for lowland peat.

At the same time, in the absence of the possibility of purchasing lowland peat, other types of additives (structurators) can be used: high-moor peat, biohumus, horse manure. In addition, it is possible to use, among other things, active excess sludge and return sludge as a structurant, however, it is necessary to strictly observe the proportions of their addition so as not to reduce the quality of the process.

3. CONCLUSIONS

The obtained results of laboratory and industrial tests made it possible to prioritize the use of additives and structurants to intensify the process of bioremediation of oil-contaminated soils. The best results were obtained using lowland peat.

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USING GEOCHEMICAL INDICATORS TO DETERMINE THE DEGREE OF OVERGROWTH OF DESERTS (USING PRIMARY DATA ON THE EXAMPLE OF THE SARYKUM SAND COMPLEX)

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Abstract: Based on the primary data, chemical and mineralogical compositions were obtained. Using the geochemical data, various indices were calculated. It is proposed to use the WIS index to study and monitor the process of desert overgrowth.

Key words: Sarykum, desert overgrowth, geochemistry, biogeochemistry, geochemical indicators

1. INTRODUCTION

Fast climate changes, expressed in warming and increasing precipitation, lead to global changes in natural areas [1]. For example, there is an active overgrowth of deserts and sandy complexes, which leads to the destruction of desert biomes. Desert overgrowth is more subject to the Sahara territory. In Russia, overgrowing of deserts is mainly in the south, especially for the Caspian lowlands and the Zabaikalsky region.

One of these objects affected by active overgrowth is the Sarykum sand complex [2]. At the moment, monitoring is limited to field studies, which include geobotanical and zoological studies, but these methods are long-term and time-consuming. For a detailed study of this process it is necessary to develop other methods. In this regard, there is a necessity to find new methods of analysis and monitoring of the territory. This paper provides a comparison of different indices of geochemical weathering and proposes the use of a new method of geochemical indication of desert overgrowth.

2. METHODOLOGY

At the Sarykum sand complex, 34 soil samples were taken from different heights at different levels of vegetation. The sampling points are shown in Fig. 1. Chemical composition of 14 samples (content of main oxides and trace elements) in crushed form was determined by X-ray fluorescence analysis on the Axious Advanced PW 4400/04 (Philips). The mineral composition was determined on a Tescan Mira 3 scanning electron microscope. The chemical composition of the minerals was investigated using a BSE detector. The results of mineralogical analysis were processed in the program AzTec Oxford Instruments NanoAnalysis. The work was done at the Vernadsky Institute of Geochemistry and analytical chemistry of RAS.

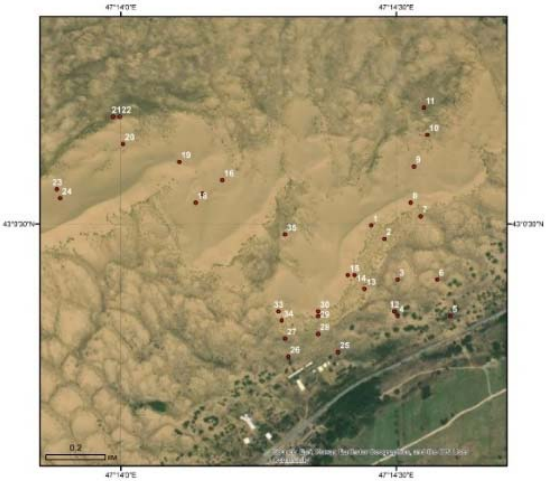

Figure 1. Sampling points for soil and carbonate crusts.

2. RESULTS

The results of examination of 14 points by XRF method are presented as primary data. Materials from 4 points on a scanning electron microscope were also examined as primary data. The received data are presented earlier [3]. Since there is currently no methodology for assessing biological weathering, indices such as Chemical index of alteration (CIA) [4], Chemical index of weathering (CIW) [5], Plagioclase Index of alteration (PIA) [6] and Weathering Intensity Scale

(WIS) [7] were used to assess the degree of desert overgrowth. The following equations are used to calculate the first three indices:

$$CIA = \{Al2O3 / (Al2O3 + CaO* + Na2O + K2O)\} \text{ x } 100$$

$$PIA = \{(Al2O3 - K2O)/((Al2O3 - K2O) + CaO* + Na2O)\} \text{ x } 100$$

$$CIW = \{Al2O3 / (Al2O3 + CaO* + Na2O)\} \text{ x } 100$$

In the presented equations the basic oxides are expressed in molar fractions, and CaO* is the content of CaO included in the silicate fraction. To quantify the CaO* content, subtract the molar fractions of P_2O_5 from the molar fraction of total CaO. After subtraction, if the remaining number of moles is less than the molar fraction of Na_2O, the remaining number of moles is treated as the molar fraction of CaO of the silicate fraction. If the remaining number of moles is greater than the molar fraction of Na_2O, then the molar fraction of Na2O is considered to be the molar fraction of CaO of the silicate fraction (CaO*).

A different methodology is required for calculating WIS. The general view can be reduced as:

$$WIS = (Al2O3 + Fe2O3)/((Al2O3 + Fe2O3) + Mg2O + \\ +(Na2O + K2O + 2 * CaO))$$

But this equation can take into account the silica component (SiO4) in the sample. For this purpose an approach based on the system M+-4Si-R2+ (M+ = Na+ + K+ + 2Ca2+; 4Si = Si/4; R2+ = Fe2+ + Mg2+) is carried out. In these coordinates the chemical compositions of weathered granite, basic and ultrabasic rocks define clearly separate trends, which all converge to the 4Si pole, namely the composition of kaolinite (chlorite is located near the R2+ pole). Consequently, the intensity of change for a given parent rock can be measured by the migration of its chemical composition toward the kaolinite pole: 4Si% $[(4Si_{\text{weathered samples}} - 4Si_{\text{unweathered samples}}) \text{ x } 100]/(100 - 4Si_{\text{unweathered samples}})$. When this model is considered, the final stage of weathering is reduced to the progressive accumulation of insoluble components R3+ (R3+ = Al3+ + Fe3+).

Three areas (points 12–15; 21–19; 25, 28–30, see Fig. 1) in which the level of level of vegetation decreases with increasing height were

selected to assess desert overgrowth. Next, the weathering indices used were calculated for each point in the plots and compared to the level of projective cover. The calculations of the basic indices (CIA, PIA, CIW) show no correlation with the vegetation level (Fig. 2), which shows the absence of a general, similar trend of weathering trends.

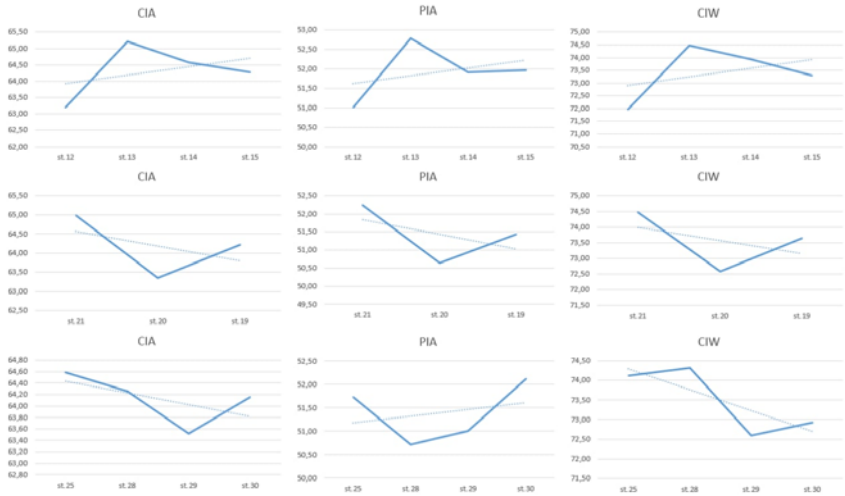

Figure 2. The results of calculations of the CIA, PIA, and CIW indices correlated with the level of vegetation. The solid lines indicate the results of the calculation of the indices, the dotted lines show the trend lines of the weathering processes. The graphs are made from the point with the highest level of vegetation to the point with no vegetation.

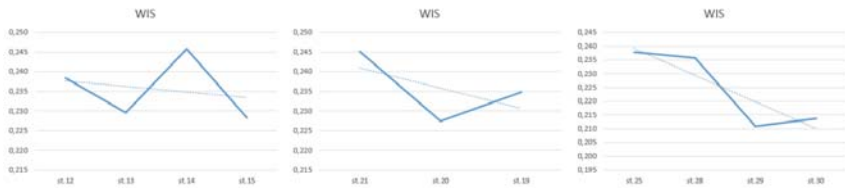

Figure 3. The results of calculations of the WIS index correlated with the level of vegetation. The solid lines indicate the results of the calculation of the indices, the dotted lines show the trend lines of the weathering processes. The graphs are made from the point with the highest level of vegetation to the point with no vegetation

The results of the WIS calculations, which take into account the silica component SiO_4, are more representative (Fig. 3). This can be explained by the increased decay of aluminosilicate minerals, which may be related to biological activity. For all studied sites, there is a general trend for the index to increase with the level of vegetation.

3. CONCLUSIONS

The study shows that to assess biological weathering, it is promising to use WIS as a geochemical indication of desert overgrowth. In the future, it is planned to obtain new statistical data and systematization of the obtained results.

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DETERMINATION OF THE POTENTIAL FOR BIOGAS GENERATION FROM MUNICIPAL SOLID WASTE THROUGHOUT THE LIFE CYCLE ON THE EXAMPLE OF THE TORBEEVO LANDFILL

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Abstract: At the global level, landfills are the third source of greenhouse gases in terms of the total impact on the atmosphere, generating 11% of the global amount of methane emissions [4]. The potential impact of methane (CH_4) on global climate change, according to various estimates, is from 20 times to 84 times [2] greater than the impact of carbon dioxide (CO_2), so the capture and further utilization of CH_4 is one of the important ways to prevent global warming [5]. The most effective method is degassing systems based on equipping landfills with biogas extraction complexes, drying it and using it, for example, to generate electricity. To create this system, it is necessary to understand the volume of generated biogas. For these purposes, there are mathematical methods for estimating the volume of generated gas. In the article, for comparison, two methods will be considered and calculations based on data from the Torbeevo MSW landfill will be carried out.

Key words: MSW — municipal solid waste Q — specific output of biogas for the period of its active generation, kg/kg of waste; DOCj — different content of biodegradable carbon; F — Methane content in biogas (landfill gas); Y is the content of carbohydrate-like substances in waste organics, %; DOCf is the fraction of biodegradable carbon.

INTRODUCTION

The solid municipal waste landfill (hereinafter referred to as MSW) is a bioreactor in which biological, chemical and physical processes take place.

During operation, most of the pollutant emissions from the landfill are due to emissions of multi-component biogas and the formation of leachate. However, after landfill reclamation, the process of leachate formation slows down and emissions into the atmosphere become the main source of environmental impact.

All waste, depending on the processes underlying their decomposition, can be divided into the following types:

– biodegradable MSW fractions, which include food, garden and park waste, paper, wood, some types of textiles;

– MSW fractions subject to chemical and photochemical degradation — ferrous and non-ferrous metals, plastics;

– ballast fractions — stones, glass, building materials.

All models of waste biodegradation are based on the analysis of waste biodegradation processes, where biochemical processes occurring under anaerobic conditions play a predominant role in waste decomposition.

Anaerobic decomposition is mainly cellulose-containing waste (paper, garden waste, wood, fabric). It has been established that it is during the anaerobic degradation of cellulose and hemicellulose that 91% of the methane potential of most wastes is formed.

When describing the processes of anaerobic biodegradation of waste at MSW landfills, the following main phases are distinguished: hydrolysis, acetogenesis, active methanogenesis, stable phase of methanogenesis, and complete assimilation [8].

Up to several hundred species of bacteria take part in these processes, most of which are hydrolytic, fermentative, syntrophic, and methane groups.

One of the determining factors in the rate of methanogenesis is the moisture content of the waste in the massif, which greatly accelerates the formation of methane. Additional humidification of the waste by recycling the filtrate or adding pure water leads to an acceleration of gas formation and an increase in the volume of methane formation [7].

Methods for calculating the volumes of emitted gas

Various methods have been developed to determine the volumes of gas released from the body of MSW landfills.

The article will consider two methods for determining the volume of biogas generation (based on the assessment of indicators that have the most impact and lead to the intensification of landfill gas formation):

The first “Methodology for calculating the quantitative characteristics of emissions of pollutants into the atmosphere from landfills of solid household and industrial waste” — 2004 by Abramov N.F., and co-authors [1].

The second is the 1st order decomposition model of the Intergovernmental Panel on Climate Change (IPCC) in the latest edition dated 2017 [6].

At the basis of the methodology of Abramov N.F. lies the study of the volume of data obtained from the results of measurements at many test sites of the Moscow region and laboratory studies.

The methodology includes an assessment of various factors, such as:

- climatic conditions;
- Working (active) part of the landfill;
- The life of the landfill;
- The amount of buried waste;
- The thickness of the layer of stored waste;
- Morphological composition of imported waste;
- Humidity of the waste;
- The content of the organic component in the waste;
- The content of fat-like, carbohydrate-like and protein substances in organic waste;
- Waste disposal technology.

The specific yield of biogas for the period of its active stabilized generation during methane fermentation according to this method is determined by the equation:

$$Q = 10^{-4} R\,(0{,}92\,F + 0{,}62\,Y + 0{,}34\,B)$$

where: Q — specific output of biogas for the period of its active generation, kg/kg of waste;

- R is the content of the organic component in the waste, %;
- F is the content of fat-like substances in waste organics, %;
- Y is the content of carbohydrate-like substances in waste organics, %;
- B is the content of protein substances in waste organics, %.

The above equation is written in relation to dry waste matter. In real conditions, the waste entering the landfills contains moisture, which does not participate in the gas synthesis process. To take this factor into account, the methodology has an indicator W — which describes the average moisture content of the waste in%.

Considering the above, the equation for the biogas yield during methane fermentation of real wet waste takes the form:

$$Q = 10^{-6} R\ (100 - W)\ (0{,}92\ F + 0{,}62\ Y + 0{,}34\ B)$$

Gross emission of the i-th pollutant from the landfill is determined by the formula:

Gtot.=Mtot tons/year

where: indicators a, and b, correspond to periods of warm and cold seasons in months (a at tav month..> 8 □C; at 0< tav month ≤ 8 □C).

The peculiarity of this method is that it does not consider other climatic indicators other than temperature, for example, there is no amount of precipitation. It also does not consider the presence of additional equipment that can increase the efficiency of methane formation or, on the contrary, reduce it.

This method will show the most accurate indicators when estimating landfill gas emissions from non-equipped landfills (landfills).

The second method for calculating emissions — the IPCC/IPCC 1st Order Multiphase Decomposition Model was developed by the IPCC group of international experts on climate change for the preparation of national reports on greenhouse gas emissions from MSW landfills and is considered to be the most universal model today.

The model distinguishes several types of waste with individual decomposition constants kj and different content of biodegradable carbon (DOCj) and uses correction factors to account for methane oxidation in the surface layer. The advantage of the model is the ability to take into account the composition of waste, climatic conditions and, to some extent, the features of waste disposal at MSW landfills.

According to the model, the yield of methane largely depends on the residual amount of decomposable waste that can participate in methanogenesis:

MEсн4,y=(1-OX)*16/12*F*DOCf*MCF*Wj,x*DOCj*e^(-kj(y-x))*(1-e^(-kj)

where: MEch4,y — methane emission per year; t/year;

- OX is the coefficient of methane oxidation in the surface layer;
- MCF is the methane generation correction factor, which determines the proportion of MSW under anaerobic conditions;
- F — Methane content in biogas (landfill gas); %;
- DOCf is the fraction of biodegradable carbon;

- X is the period of waste disposal at the landfill; (from x=1 to x=y);
- Wj,x is the amount of waste of category j, taken to the landfill in year x, tons;
- K is the rate of methane formation; year(-k);
- Y is the period for which emissions are calculated; year.

The coefficient DOCj and kj depend on the type of waste (fast, medium or slow decomposing waste) and the climate of the area where the landfill is located (average annual ambient temperature and the ratio of average annual rainfall to potential evapotranspiration). An assessment of the content of the organic fraction and biodegradable carbon in the original MSW is given in Table 1.

Table 1

Content of organically degradable components in waste disposed to landfills

Waste categories	DOCj(%w)	DOCj	kj,1/year
Rapidly degradable (food waste)	0.15	15	0.185
Moderately degradable (garden and park waste)	0.2	20	0.1
Slowly decomposing (paper, cardboard)	0.4	40	0.06
Textiles	0.24	24	0.06
Wood	0.43	43	0.03

The MCF coefficient is used to adjust the methane production rates at MSW landfills depending on the conditions at the landfill, in the case of the Torbeevo MSW landfill, the default indicator is used.

The MCF characterizes the fact that unmanaged landfills produce less methane from a given amount of waste than landfills, because most of the waste is aerobically decomposed in the upper layers of the landfill.

Based on the above, it can be judged that this method has an advantage over the first. It evaluates a much larger number of indicators, which allows a more accurate inventory of methane emissions, it is also easy to learn and has explanations for each indicator involved in the calculations.

The disadvantage is that the training manual contains a set of coefficients that affect the result, however, the values of these coefficients vary depending on the presence or absence of any indicator. The most negative example of the gradation of indicators is the MCF

coefficient described in Table 4, according to which, to classify a landfill as an anaerobic MSW disposal site, the presence of one of three indicators is necessary: the presence of a covering material, mechanical compaction, waste leveling, although all these indicators affect the creation of waste to a different extent. anaerobic environment.

Calculation of the volume of biogas production

The first method of calculation is based on the "Methodology for calculating the quantitative characteristics of emissions of pollutants into the atmosphere from solid domestic and industrial waste landfills" [35].

Table 2

General data of the MSW landfill "Torbeevo" necessary for calculations

Indicator	Value
The age of the landfill (operation period)	27 years (1994–2020)
The volume of accumulated MSW over the past 20 years	4,148 thousand tons
The volume of waste imported over the past 2 years	720 thousand tons
Statistical indicators of the composition of waste components removed to landfills in Moscow and the Moscow Region	Food waste — 30%
	Paper, cardboard —38%
	Textile — 1.5%
	Wood — 5.5%

The specific yield of biogas for the period of its active stabilized generation during methane fermentation is determined by the equation:

$$Q = 10^{-6}R\ (100 - W)\ (0{,}92\ F + 0{,}62\ Y + 0{,}34\ B)$$

Quantitative yield of biogas per year, related to one ton of buried waste:

R ud. = kg / t waste. in year

Biogas is actively produced by wastes brought to the landfill over the past 20 years (tsa) minus the last 2 years, i.e., for 18 years: 3,450,000 tons.

Total maximum one-time release of biogas from the landfill:

Mtot. = = 1392.66 g/s

Gross biogas emissions:

Gtot = t/ year

Based on all the indicators described above, the calculation of the volumes of methane produced for 2021 was carried out in the Excel system. The value of the indicator was 13.9 thousand tons of methane.

The second calculation method is the IPCC/IPCC 1st order multiphase decomposition model developed by the IPCC group of international experts on climate change.

According to the model, the output of methane to a greater extent depends on the residual volume of decomposed waste, the calculations are carried out according to the formula:

$$MEсн4,y=(1-OX)*16/12*F*DOCf*MCF*Wj,x* \\ *DOCj*e^{(-kj(y-x))}*(1-e^{(-kj)})$$

Since 2008, a line for sorting incoming waste has been operating at the landfill, waste paper has been separated in the amount of 250–300 tons per month, you can get an approximate volume of selected paper and cardboard for the period 2008–2021, it is 39.6 thousand tons.

Table 3

The amount of accumulated waste by category j, taken to the landfill at the time of closure (Σ Wj,x) (January 2021)

Waste component	% mass of imported volume	Decomposition period, years	Accumulated volume
Food waste	30	5,4	200 thousand tons
Paper, cardboard	38	16,7	thousand tons
Textile	1,5	16,7	thousand tons
Timber	5,5	33,3	thousand tons
Amount			1056,1 thousand tons

Based on all the indicators described above, the calculation of the volumes of methane produced for 2021 was carried out in the Excel system. The value of the indicator was **13 thousand tons of methane**.

CONCLUSION

The spread of values after calculations by two methods was 6.5%, which may indicate the reliability of the calculations. The difference in

the results is due to different approaches to assessing climatic conditions in the polygon and different methods for determining the volume of active methanogenic mass. It can be concluded that the use of the average value of the calculation results of these methods makes it possible to obtain a reliable indicator of methane generation by MSW landfills.

Table 4

The meaning of variables, characterizing the conditions at the test site and around the test site

Indicators	Value	Description
OX	0,05	Reflects the amount of methane that is oxidized in the soil or other material covering the waste.
MCF	1	According to the methodology, the Torbeevo landfill can be classified as an anaerobic site for MSW disposal.
F	0,5	Average value of the proportion of methane in the resulting biogas.
DOCf	0,5	Percentage of biodegradable carbon.

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CROWN PROFILE MODELING FOR LARIX OLGENSIS PLANTATION BASED ON ULS-TLS

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Abstract: Based on Terrestrial Laser Scanning (TLS) and Unmanned Aerial Vehicle Laser Scanning (ULS), the fused point cloud data (ULS-TLS) were used to extract fine-scale crown structural information and model the crown profile of *Larix olgensis* plantation in Maoershan Experimental Forest Farm of Northeast Forestry University. Individual tree crowns were segmented by the Comparative Shortest Path (CSP). The largest crown profile points with 95% percentile percentiles were selected and the crown profile model variables were extracted, including the relative depth into the crown of interest (RDINC), outer crown radius (OR) and the largest canopy radius (LCR). Then use these variables to model the crown profile. The R^2 of the five crown profile models is above 0.5, among them, four crown profile models (parabola equation, Mitscherlich equation, power equation and modified Weibull function model) have similar accuracy while the logarithmic equation has the worst performance (R^2=0.52, RMSE= 0.587m). This study provides an efficient solution for the construction of canopy three-dimensional structure by multi-platform LiDAR data.

Key words: TLS; ULS; Crown profile; *Larix olgensis* Henry.

1. INTRODUCTION

The crown is essential for the biological processes of transpiration, respiration, and photosynthesis carried out by growing trees [1]. The three-dimensional structure of the crown can reflect the growth stage of

trees as well as the competitiveness and vigor of the trees [2]. The crown shape is an important piece of information, it is actually a curve that can be defined mathematically by utilizing a specific form of the crown profile, which is an equation used to simulate how the crown shape changes over time [3]. One of the three main silvicultural conifer species in Heilongjiang Province and a significant and ecological species in Northeast China is the *Larix olgensis* Henry [4]. The management of Henry depends on the accurate extraction of crown details, and conventional forestry surveys are destructive which is time consuming and labor intensive. LiDAR technology has emerged as a crucial technique of forest surveying in recent years, overcoming the limitations of conventional survey techniques. Terrestrial Laser Scanning (TLS) can better extract ground information, especially the DBH [2]. Unmanned Aerial Vehicle Laser Scanning (ULS) platform which has light sensors can measure the top-to-bottom forest structure and then accurately measure variables like tree height and crown area [5]. As a result, the combination of resampled TLS and ULS data can enhance each other's strengths and increase the precision of information extraction from the upper canopy and understory simultaneously, enhancing the precision of estimating forest characteristics from TLS trees and ULS data.

2. STUDY AREA AND DATASETS

2.1. Study area

The study area is located in Maoershan Experimental Forest Farm of Northeast Forestry University, Shangzhi City, Heilongjiang Province, which ranges from 127°29′ to 127°44′E, 45°14′ to 45°29′N. *Larix olgensis* Henry can reach up to 30 m in height at maturity and has characteristics of straight trunk, good natural branching, easy planting, high survival rate. Based on the above characteristics, *Larix olgensis* Henry has become one of the main afforestation species in Maoershan Experimental Forest Farm [3-4].

2.2. Datasets

Three types of data were used for the study, including five field-measured *Larix olgensis* plantation (30×30m) reference data acquired in 2020, Unmanned Aerial Vehicle Laser Scanning (ULS) and Terrestrial Laser Scanning (TLS) data. The field-measured data includes diameter

at breast height (DBH, cm), tree height (H, m), tree location, crown diameter (CD, m) tree species and so on. The ULS data and TLS data were acquired by Feima D200 UAV with LiDAR200 system. and Riegl VZ-400i in September 2020.

Table 1

Descriptive statistics for 5 plots

	Mean	Median	Std	Min	Max
H (m)	19.57	18.00	5.54	11.58	24.30
DBH (cm)	21.92	18.48	7.81	11.42	35.02
CD (m)	3.68	3.542	1.12	1.488	6.42

3. METHODOLOGY

3.1. Individual tree segmentation

The raw LiDAR data has a number of noise points and don't match, so the TLS and ULS data were pre-processed, registered and fused to generate a ULS-TLS dataset. Based on the ULS-TLS data, the Comparative Shortest-Path (CSP) algorithms was applied to delineate individual trees in this study, which detected tree trunks bottom-up. The 1:1 matching rule between detected and reference trees was developed by Reitberger [6].

3.2. Crown profile model

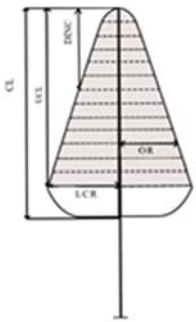

Fig. 1. Schematic representation of the crown variables used for crown profile modelling

The crown outer profile model is a curve equation used to simulate the crown shape change pattern with the radius at different height of the

crown as the dependent variable and the distance from the top of the tree at certain location as a function of the independent variable [7]. Therefore, the crown profile requires the radius at different depths of the crown. In this study, the individual tree crown variables extracted are the outer canopy radius (OR) and the relative depth into the crown (RDINC), which equal to DINC divides CL, the crown profile variables are shown in Figure 1. Since we only simulate the upper canopy profile in this study, the upper crown length (UCL) is used instead of CL.

In this study, five equations were used to model the canopy profile of long white larch including: quadratic parabola (1), Mitscherlich equation (2), power function equation (3), modified Weibull function (4), and logarithmic function (5).

$$OR = a + bRDINC + cRDINC^2 \quad (1)$$

$$OR = a + b(1 - e^{cRDINC}) \quad (2)$$

$$OR = a + bRDINC^c \quad (3)$$

$$OR = c(\frac{b}{a})(\frac{RDINC}{a}) + bRDINC^c \quad (4)$$

$$OR = a + b\ln RDINC \quad (5)$$

Where OR is outer radius, RDINC is relative depth into the crown and a, b, c are parameters of the equation.

3.3. Accuracy assessment

In order to evaluate the accuracy of individual trees segmentation and parameter estimation, this study applied Recall (r), Precision (p) and F-Score to assess the accuracy. Coefficient of determination (R^2) root mean square error (RMSE), Mean Error (ME), Mean Absolute Error (MAE) and Mean Absolute Percentage Error (MAPE) were applied to assess the accuracy of crown profile models.

4. RESULTS

4.1. Individual tree segmentation

The results of individual tree segmentation were shown in table 2. In general, the average *F-score* of CSP reached up to 0.71. The reason why the *p* value was better than *r* value was that CSP had fewer FP value.

Table 2

The accuracy assessment for two algorithms at 5 plots

	n	*r*	*p*	*F*-score
Plot 1	86	0.62	0.77	0.68
Plot 2	59	0.73	0.93	0.82
Plot 3	65	0.63	0.72	0.67
Plot 4	82	0.61	0.88	0.72
Plot 5	70	0.63	0.8	0.70

4.2.Crown profile modeling

4.2.1. Profile outer points and variables extracting

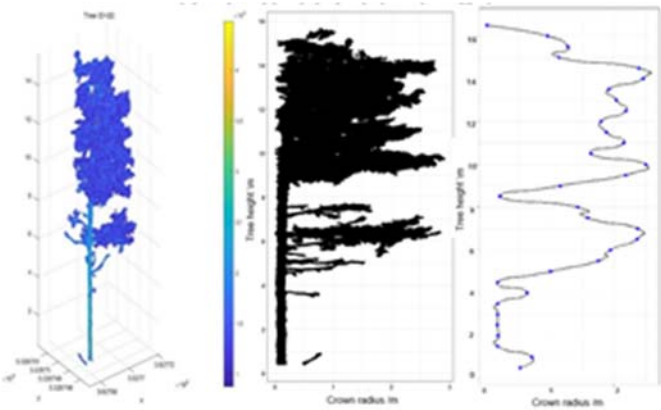

Fig. 2. (*a*) *Individual tree point clouds* (*b*) *3D space to 2D space* (*c*) *determination of the largest crown radius*

The construction of crown profile model requires the outer point cloud of the tree crown as a sample to acquire the model variables. According to the studies [3], stratifying the point cloud data and determining the outer crown by a certain width percentile is a better method. Based on the feature of stratification of *Larix olgensis* by whorls of branches every 0.5 m [3], and to exclude the influence of some outliers, this study chooses the crown profile points of each layer by 95th width percentiles. The crown profile points were extracted from 114 sample trees obtained after purification, and 1,897 outer points were

extracted. The sample trees were randomly assigned according to 3:1 for the training and testing of the model.

By using the Spline method to construct 10,000 interpolated crown profile points for each tree using the 95th width percentiles, the height of the LCR was calculated. The result is depicted in Figure 3 (c). To determine the UCL, the height of each sample tree's largest crown radius (LCR) above 5 m was measured and deducted from the sample tree's height. The depth into the crown (DINC) is the vertical distance from the selected crown point to the top of the crown.

4.2.2. Crown profile modeling and comparison

The crown profile points of 114 sample trees were extracted for this study using the 95th width percentiles. Five equations (parabola equation, Mitscherlich equation, power equation and modified Weibull equation and logarithmic equation) were implemented. In general, the distribution of crown profile points is dispersed but similar to larch in shape, and the LCR gradually rises with the RDINC. There is no discernible difference among the curves of the four equations, with the exception of the logarithmic equation.

Table 3

Estimates of the parameters, goodness-of-fit statistics and validation results for the five crown profile models

	Param	Estimate	Std	Goodness-of-Fit		Test Data		
			Error	R^2	RMSE(m)	ME	MAE	MAPE
1	a	0.47	0.045	0.56	0.573	-0.03	0.42	0.267
	b	4.48	0.209					
	c	-2.346	0.202					
2	a	0.262	0.113	0.57	0.562	-0.02	0.41	0.262
	b	2.616	0.111					
	c	2.583	0.359					
3	a	2.835	0.051	0.55	0.569	-0.01	0.43	0.28
	b	0.457	0.024					
4	a	2.071	0.466	0.55	0.564	-0.02	0.42	0.265
	b	1.612	0.058					
	c	7.297	2.037					
5	a	2.616	0.039	0.52	0.587	0.01	0.44	0.307
	b	0.69	0.03					

The model parameters and the goodness of fit of the curves generated from the 95th width percentile points are given in Table 3. It is noteworthy that all parameters were significant ($p < 0.05$), and the results of the goodness-of-fit statistics for the four models illustrate that all crown profile models had a normal goodness of fit ($R^2 > 0.51$). There is no discernible difference among the four equations, with the exception of the logarithmic equation. In relative comparison, the Mitscherlich equation is slightly better with an R^2 of 0.57 and a RMSE value of 0.562 m, and the logarithmic function model performs worst with an R^2 of 0.52 and a RMSE value of 0.587 m. In terms of the ME, the four equations are not significantly over- and under-estimated. The Mitscherlich equation had the smallest MAE and MAPE while the logarithmic equation had the largest.

5. CONCLUSIONS AND DISCUSSION

Due to the high trunk detection rate, accurate understory structure and DBH acquired from ULS-TLS data, the CSP algorithm has a good accuracy of segmentation of individual tree. Of the 5 equations, the Mitscherlich equation had the highest accuracy. The results of the crown profile models showed that the overall fitting curves of the five models did not differ significantly, and the R^2 of all five models was just higher than 0.5, which was not a good result. We found that despite segmented trees and field-measured trees being in the same location, individual tree point clouds were incomplete or had mistakenly segmented other trees as their own due to the high stand density.

Because the height of the LCR was not measured, the conclusions retrieved in this study could not be confirmed. Second, there are a lot of incomplete canopies as a result of bad weather. In subsequent study, we will aim to address the mentioned problems. Future study will also take into account alternative models that can represent more complicated information, and the emphasis of the research will move to extracting valid information from TLS data, which conveys complex information.

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ENERGY-SAVING, ENVIRONMENTALLY FRIENDLY CHEMICAL AND TECHNOLOGICAL PROCESSES

INSECT PROTEIN AS A STEP TOWARDS ZERO-WASTE PRODUCTION OF ANIMAL FEED

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Abstract: The article discusses the possibility of using insect protein-based feeds for monogastric farm animals. The author describes the course of the experiment on adding flour from Hermetia illucens larvae to the diet of dogs and concludes that objective animal observation data (assessment of health, feed consumption, body weight, skin turgor and hair quality) indicate the safety and prospects of using insect protein to produce zero-waste feed.

Key words: insect protein, entomoprotein, animal feed, bioconversion.

1. INTRODUCTION

In the world, technologies for the use of insect biomass in agriculture are a current trend, and they are experiencing a period of rapid growth. In Russia, everything is not so clear and there are only ideas. Our country lags behind developed countries in the efficiency of feed production, and we almost do not use insect flour, but research and experiments are underway. Previously, the production of animal feed using insects was banned in Europe, but the ban has been lifted since 2017.

The ability of fly larvae to recycle organic waste is very valuable for the modern world. These insects are able to provide mankind with inexpensive protein rich in amino acids and make zero-waste production possible [1].

The larvae of Hermetia illucuns can feed on bacteria that colonize the substrate and produce microbial compost, and black soldier fly larvae are excellent sources of protein and can be reused in animal feed [2].

Based on the conclusions of many studies, we can say with confidence that only 1.8 kg of substrate is needed to obtain 1 kg of insect biomass. With farm animals the situation is different, for example, a cow needs to consume up to 10 kg of feed to gain 1 kg of live weight, a pig needs 3 kg, and a bird needs up to 2 kg.

Currently, the possibility of using insect protein-based feeds for monogastric animals, mainly farm birds (chickens, turkeys), cattle and pigs is being studied.

The most suitable and frequently used insects in the production of animal feed are larvae of black soldier flies, larvae of house flies, and crickets.

2. METHODOLOGY

The methodological basis of the study is:

1. Information base (analytical information materials, official Internet resources, etc.);
2. Methods of observation, analytics, etc.

3. RESULTS

In early 2022, the author conducted an experiment on adding flour from Hermetia illucens larvae to the diet of 10 dogs at Moscow State University of Technology and Management. To obtain Hermetia illucens powder, live larvae were frozen to hibernation, dried to retain 10% moisture, and then ground in a coffee grinder to powder.

According to the results of the sanitary and environmental expertise and the conclusion of the laboratory, the physico-chemical parameters of a complete diet with the addition of flour from Hermetia illucens larvae were determined (Table 1).

Based on the table, we can conclude that the diet of the dogs during the experiment was complete.

Dog owners filled out diaries of observations on the amount of food eaten per day, assessed the feed consumption on a 5-point scale, monitored the activity of the pet and the digestibility of feed and water.

Veterinarians from the experimental group assessed the condition of the animals at the beginning and throughout the experiment every 10 days (by assessing body weight, skin turgor and hair quality).

Table 1

Physico-chemical parameters of the complete diet of dogs with the addition of flour from Hermetia illucens

Parameter name	Parameter value for dogs
Mass fraction of crude protein, %	0,31
Mass fraction of crude fiber, %	5,6
Mass fraction of crude fat, % not less	6,4
Mass fraction of crude ash, % max	9,8
Mass fraction of calcium, %	0,9
Mass fraction of phosphorus, %	0,7
Mass fraction of sodium, %	0,3
Mass fraction of chlorides, %	0,24
Mass fraction of lysine, %	1,7
Mass fraction of methionine and cysteine (in total), %	0,8
Mass fraction of tryptophan, %	0,2
Vitamin A content, ME/kg	5000
Vitamin D content, ME/kg	500
Vitamin E content, ME/kg	30

Table 2

Feed consumption indicators

Indicators of feed consumption according to a 5-point scale			
0 day	10 day	20 day	30 day
4,3±0,12	4,3±0,15	4,3±0,17	4,3±0,19

The feed with the addition of flour from Hermetia illucens was perfectly eaten by dogs.

Table 3

Indicators of hair condition according to a 5-point assessment

Indicators of hair condition according to 5-point scale			
0 day	10 day	20 day	30 day
4,0±0,11	4,1±0,17	4,1±0,15	4,1±0,17

The hair of the dogs improved when consuming this supplement with their food.

4. CONCLUSIONS

Consumption of the flour with feed was quite high (4.3 points). The addition of flour from Hermetia illucens larvae to the diet did not affect the dogs' health, all dogs were healthy and active during the experiment, and the dogs' hair improved from 4 to 4.3 points.

Thanks to insect protein, zero-waste feed production is quite realistic. For example, the total amount of waste in Moscow is 8.5 million tons of MSW per year and approximately 0.68 million tons are organic, due to the substrate from which, 34,000 tons of feed from larvae or worms can be obtained [3].

The world is undergoing a transition to a closed-cycle economy with a developed system of raw materials recycling. Accordingly, further studies of human and animal consumption of alternative insect protein will help feed the growing population of humans and their pets cheaply and without harm to the environment.

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UTILIZATION OF MAGNESIUM-ALUMINUM WASTE WITH THE RELEASE OF HYDROGEN AS AN ENERGY CARRIER

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Abstract: The use of hydrogen fuel and waste disposal are among the most important tasks of modern sustainable development of humanity. Therefore, this article focuses on one of the approaches of utilization of magnesium-aluminum waste with simultaneous release of hydrogen and methods of its intensification.

Key words: waste disposal, hydrogen, alternative fuel, hydrogen-generating material.

INTRODUCTION

Nowadays, the world community pays special attention to the development of hydrogen technologies. The use of hydrogen fuel is an alternative to non-renewable energy sources due to its environmental friendliness and energy intensity, thereby its use contributes to the sustainable development of the biosphere. There are several ways to produce hydrogen presently, e.g. steam conversion of methane and natural gas or coal gasification. In addition to the well-known production, one of the alternative ways to generate hydrogen is the oxidation of magnesium and aluminum in an aqueous medium.

At the same time, an equally urgent issue at present is the problem of waste disposal. As a result, this work is devoted simultaneously to two strategic objectives in the field of sustainable development: obtaining an alternative energy source and waste disposal, which corresponds to the goals prescribed in the National Project "Ecology" and the goals in the field of sustainable development.

METHODOLOGY

The purpose of this work is to investigate the effect of the concentration of the activating alloy and the ball-milling time of hydrogen-generating materials based on magnesium-aluminum waste on the processes of hydrogen generation by oxidation them in an aqueous salt solution at different temperatures.

To achieve this goal, the following task were set: study of the dependence of the amount of hydrogen yield and the maximum rate of its generation during the oxidation of powder materials based on magnesium-aluminum waste, depending on the presence of added substances, the ball-milling time of the material under study, different temperature conditions of the experiment.

There is an alternative method for producing hydrogen – obtaining it by oxidation of metals, in particular aluminum and magnesium, in aqueous media.

The amount of reaction products formed can be predicted theoretically, but the actual value may differ from the theoretical one since not all metal will react with water. This is due to the formation of a dense, water-permeable product layer on the metal surface, which prevents the full course of the reaction. In addition, the metal surface in contact with air

is starting to get covered with a passivating oxide film, which prevents the rapid onset of the reaction. Therefore, to increase the efficiency of hydrogen generation, it is necessary to ensure the removal or violation of the continuity of the product layer and the passivating oxide film. One of the methods of activation of metals was analyzed, namely, grinding in a ball mill, which, according to the work of the predecessors, proved to be effective in increasing the reactivity of metals, as well as safe and environmenttally friendly due to the absence of hazardous chemicals when used.

RESULTS AND CONCLUSIONS

Various grinding parameters have been studied. It was experimentally established that an increase in the grinding time and the size of the balls lead to an acceleration of the oxidation process of the obtained aluminum particles and, accordingly, a faster yield of hydrogen.

The effect of various substances added to magnesium and aluminum-based materials on hydrogen yield during oxidation has been studied. Thus, particles of added substances by mechanical action destroy the passivating oxide layer, which contributes to increased corrosion of metals with the release of hydrogen.

Part of the experiments was aimed at grinding waste without adding other substances. It was found out that at room temperature, the resulting powder reacts with pure water in a small amount, and the grinding time was determined, after which further costs for the continuation of grinding are not profitable — 15 hours. A shorter grinding time increases the rate of hydrogen release and its amount.

In addition, to intensify the process, oxidation experiments were carried out at temperatures above room temperature. As expected, there is a pronounced dependence of the yield and rate of hydrogen yield on temperature. With an increase in temperature, an increase in the values of these parameters is observed.

Thus, a review of existing works has shown that the efficient production of hydrogen can be achieved by using magnesium and aluminum-based waste activated by grinding with the addition of other substances as an energy carrier.

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ASSESSMENT OF THE FEASIBILITY OF BIOLOGICAL RECLAMATION WITH MINE WATER IRRIGATION ON THE TERRITORY OF ROCK DUMPS OF COAL-PROCESSING ENTERPRISES ON THE EXAMPLE OF ALFALFA CHANGEABLE

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Abstract: The paper evaluates the feasibility of biological reclamation with mine water irrigation on the territory of rock dumps of coal-enriching enterprises using the results of determining the germination and germination energy of seeds with mine water irrigation on the example of alfalfa changeable.
Keywords: dump rock, mine waters, reclamation, phytotoxicity.

1. INTRODUCTION

The issues of reclamation of lands disturbed by coal-enriching works, especially dumping, are regulated by a number of legal documents that were developed and adopted during the 1980s and 1990s, when increased attention was paid to environmental protection. Accordingly, these regulatory requirements have long lost their relevance. The design of coal enrichment waste dumps and sludge storage facilities requires other methodological approaches harmonized with the norms of industrialized countries [1].

The lack of scientifically sound standards for the reclamation of territories violated by coal-processing enterprises is especially acutely felt when designing dumps on the territory of Donbass.

The shortage of water resources in the territory of Donbass leads to the search for alternative sources of irrigation of agricultural crops grown on the territory of the rock dump. Such a source can be discharged mine water from ground horizontal sedimentation tanks [2].

The purpose of the study is to assess the feasibility of biological reclamation with mine water irrigation on the territory of rock dumps of coal-processing enterprises on the example of alfalfa changeable.

As comparative objects of research, the dumps of the coal-processing plant “Proletarskaya”, Makeyevka and the coal-processing plant “Shakhterskaya”, Shakhtersk, DNR were selected.

2. METHODOLOGY

The assessment of the feasibility of biological reclamation with mine water irrigation on the territory of rock dumps of coal-enriching enterprises is based on the results of chemical analysis to determine the germination and germination energy of seeds in rock with mine water irrigation on the example of alfalfa changeable.

To determine germination and germination energy, 30 seeds of a test culture (alfalfa changeable) were selected in 3 samples with a control soil sample with irrigation with tap water, mine water and mine water

with the addition of carbamide (ST, SM, SMC); 3 samples with a mixture of soil and rock in a ratio of 1:4 with irrigation tap water, mine water and mine water with the addition of carbamide (1:4 T, 1:4 M, 1:4 MC); 3 samples with a mixture of soil and rock in a ratio of 1:2 with irrigation with tap water, mine water and mine water with the addition of carbamide (1:2 T, 1:2 M, 1:2 MC); 3 samples with a mixture of soil and rock in a ratio of 1:1 with irrigation with tap water, mine water and mine

3. RESULTS

Thus, based on the calculated values of the soil inhibition coefficient, a high level of suppression of the root and ground parts of plants was observed in the sample 1:4 MC, while in the sample 1:4 T germination was not observed at all. The choice of a 1:2 ratio of soil and rock for reclamation is impractical due to the absence of seedlings in the 1:2 MC sample and the suppression of substrates in the 1:2 T and 1:2 M samples. In the 1:1 samples, there was also a lack of germination in the sample with mine water irrigation and suppression of substrates with mine water irrigation with the addition of carbamide. The best indicators and a relatively large number of seedlings were observed in the 1:4 sample with mine water irrigation, this scheme was chosen for the biological stage of reclamation.

During 10 days, seed germination was observed in all samples except 1:4 T, 1:2 MC, 1:1 M. The results of the studies are presented in Table 1.

Figure 1 shows the report photos from the site of the experiment.

4. CONCLUSIONS

The best indicators and a relatively large number of seedlings were observed in the 1:4 sample with mine water irrigation, this scheme was chosen for the biological stage of reclamation.

Irrigation with mine waters with a high manganese content of a mixture of soil and rock may increase the efficiency of nitrogen fertilizers used in the process of reclamation of the rock dump area. Thus, irrigation of reclamation territory.

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Table 1

Results of determination of germination and germination energy of seeds of test culture (alfalfa variable)

Meaning. indicator	Term from sowing, days	Length of the root part, cm	The length of the ground. parts, cm	Sheet width, cm	The diameter of the stem at the base., cm	Numb. germinated seeds, pcs	Coef. inhibition (ki)
ST	10	1,4	3,9	0,3	0,1	14	2,8
SM	10	2,9	3,1	0,4	0,1	13	0,1
SMC	10	1,3	2	0,3	0,1	12	1,5
1:4 T	10	–	–	–	–	–	–
1:4 M	10	1,5	3	0,3	0,1	13	2
1:4 MC	10	0,4	1,8	0,2	0,1	10	2
1:2 T	10	0,8	1,6	0,3	0,1	11	4,5
1:2 M	10	0,3	1,4	0,2	0,1	10	1,3
1:2 MC	10	–	–	–	–	–	–
1:1 T	10	1,2	3	0,3	0,1	13	2,5
1:1 M	10	–	–	–	–	–	–
1:1 MC	10	0,4	1,6	0,2	0,1	12	4

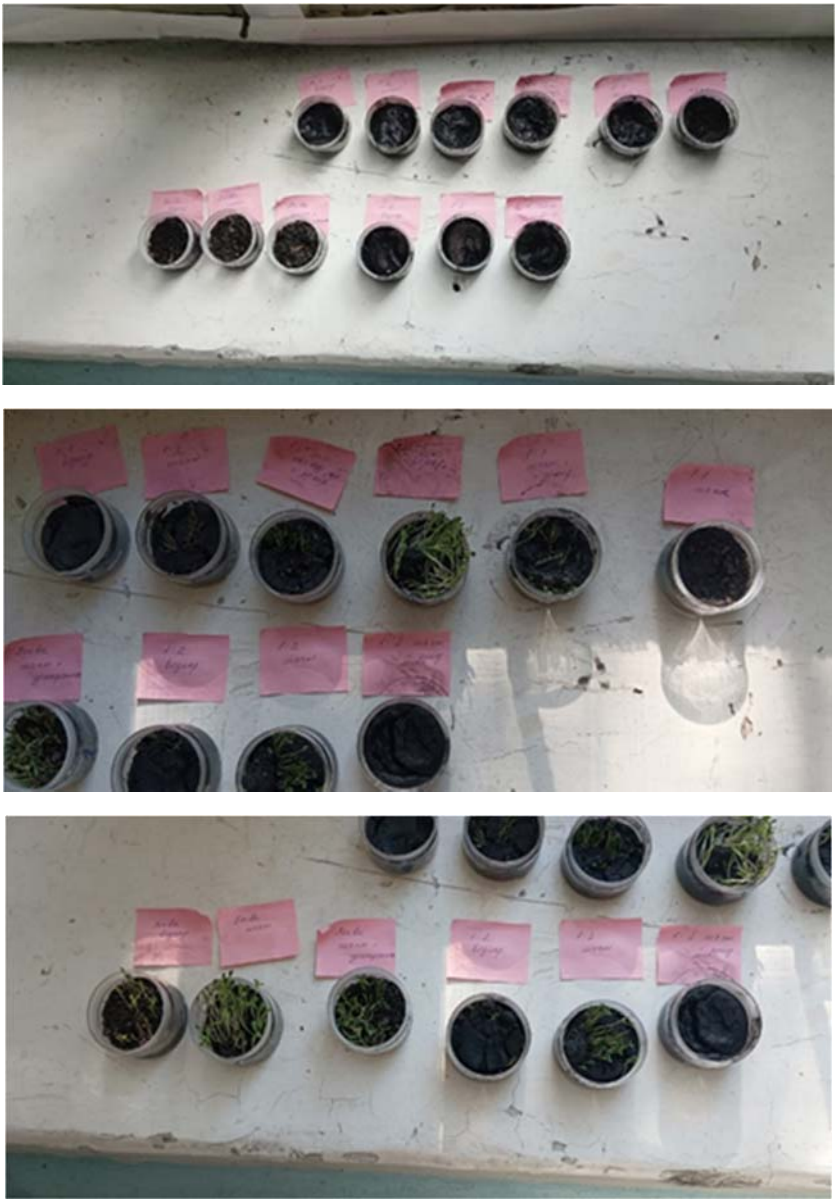

Figure 1. Report photos from the site of the experiment
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IMPROVING THE TECHNOLOGY OF ANAEROBIC DIGESTION OF THE ORGANIC PART OF MUNICIPAL SOLID WASTE

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Abstract: Solid municipal waste (MSW) makes up the largest part of consumer waste. It negatively affects the environment and human health, so, it must be disposed of. Only 5% of MSW is disposed of and the rest of it is buried.

In this paper, the author compares three modern technologies of MSW organic part (wet components) disposal. They are composting, plasma gasification, and anaerobic digestion. The latter is considered the most efficient and environmentally friendly.

Key words: municipal solid waste disposal, MSW organic part, wet components, composting, plasma gasification, anaerobic digestion.

1. INTRODUCTION

Solid municipal waste (MSW) includes items or goods that have lost their consumer properties, which make up the largest part of consumer waste. Waste negatively affects the environmental situation and human health, so they need to be disposed of.

The relevance of this work lies in the fact that only 5% of MSW is disposed of and the rest of it is buried.

In this paper, the technology of anaerobic digestion of the organic part (wet components) of MSW will be considered [1–2].

The improvement of this technology implies bringing the characteristics of the wet components of MSW to the characteristics of sewage sludge from primary settling tanks. These characteristics will include humidity (95%) and particle size (no more than 5 mm).

The purpose of the study is to evaluate the technological, economic, and environmental aspects of introducing the improved anaerobic digestion technology.

The tasks of the study are as follows:

1) to analyze modern technologies for the disposal of wet waste components in terms of environmental, technical and economic indicators

2) to calculate the energy efficiency of the proposed solution

3) to calculate the economic efficiency of the proposed solution.

2. METHODOLOGY

The methods for calculating energy efficiency were taken from the article by R.Kh. Gumerova and V.A. Chernyakhovsky "The possibility of using a biogas plant for the disposal of waste from industrial enterprises".

The values of the methane tank height were taken from the book by S.V. Yakovlev, Ya.A. Karelin, A.I. Zhukov, S.K. Kolobanov "Sewerage".

The methodology for calculating economic efficiency was taken from the presentation in the discipline "Recycling of production and consumption waste".

3. RESULTS

3.1. Comparative analysis of modern technologies for the disposal of wet waste components

From the comparison in Table 1, we can conclude that anaerobic digestion is the most environmentally friendly method of MSW processing [3].

It follows from the data in Table 2 that the use of anaerobic digestion technology is associated with lower unit costs and higher unit income [4].

Table 1

Environmental indicators of technologies for the disposal of wet MSW components

INDICATORS	TECHNOLOGY		
	Composting	**Plasma gasification**	**Anaerobic digestion**
Degree and term of neutralization	For 2 days (except for spore-forming ones)	Fool decontaminatin in 1 hour	Fool decontamination in 1 hour
Presence of production waste, % of masses of waste	20–25 (non-compostable fractions)	15–20 (fine dust, sublimates of heavy metals)	0
Soil pollution	Hardly ever	Hardly ever	No
Groundwater pollution	No	No	No
Air pollution	No	Heavy metals	Within the limits

Table 2

Technical and economic indicators of technologies for the disposal of wet MSW components

Indicators	Units	Technology		
		Composting	Plasma gasification	Anaerobic digestion
Unit capital investments	thousand roubles/1 ton of MSW per year	15,5–18,0	20–24	0,9–1,4
Unit operating costs	roubles/1 ton of MSW	1200–1400	2000–2500	746–1118
Unit income of the enterprise	roubles/1 ton of MSW	210	240	596–1193

3.2. Energy efficiency

Table 3

Technical data of the methane tank and energy efficiency

Indicator, unit of measurement	Value
The volume of the methane tank, m3	1600
Diameter of the methane tank, m	15
The height of the methane tank, m	12,45
Daily output of biogas, m3/day	5600
The amount of heat to heat the biomass to the fermentation temperature, MJ/day	8036
Energy consumption for mechanical mixing, MJ/day	640
The amount of thermal energy discharged with biogas, MJ/day	4671
The amount of thermal energy removed with the effluent, MJ/day	7244
Heat loss through the wall, MJ/day	903
Heat loss through the floor, MJ/day	2958
Heat loss through the dome, MJ/day	452
The total amount of heat energy supplied to the methane tank, MJ/day	24904
Volume of methane in the biogas of aftertreatment odors, m3/day	3360
Calorific value of biogas after purification energy, MJ/day	133728
Energy efficiency, MJ/day	118225

Considering the coverage of heat losses, about 120000 MJ/day of thermal energy are obtained.

3.3. Economic efficiency

Table 4

Economic parameters and economic efficiency

Indicator, unit of measurement	Value
Recouped investments, rubles	1675396
Material costs, rubles/year	70000000
Make-up water costs, rub./year	1949577,5
Electricity costs, rubles/year	513350
Depreciation expenses, rubles/year	100523,76
Wage costs for workers, rubles/year	1078380,3
Workshop costs, rubles/year	1401894,4
General operating expenses, rubles/year	1500874,5
The amount of annual costs, rubles/year	76523119
Annual profit, rubles/year	85680000
Net annual profit, rubles/year	9135400
Payback period, years	0,18

The net annual profit is more than 9000000 rubles/year. The investment will pay off in 2 months.

4. CONCLUSIONS

The following conclusions were dawn:

1. When comparing technologies for the disposal of wet MSW components, the technology of anaerobic digestion turned out to be the most environmentally friendly and economically efficient.

2. The energy efficiency of the improved anaerobic digestion technology has been calculated. It turned out that the amount of heat from biogas combustion exceeds the amount of heat supplied to the digester. It follows that it is possible to generate energy from the biogas produced with this improvement.

3. The economic efficiency of the improved anaerobic digestion technology was calculated. We conclude from this that the introduction of improved anaerobic digestion technology is economically beneficial.

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UTILIZATION OF THE ORGANIC FRACTION OF MSW USING A COMBINED PYROLYSIS AND ANAEROBIC DIGESTION TECHNOLOGY

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Abstract: Nowadays, about 90 percent of the total amount of waste in Russia is buried in landfills. Landfills have a negative impact on the environment and human health. So, the purpose of this work was to develop a new scheme for utilizing the organic fraction of MSW using the technologies of pyrolysis and anaerobic digestion.

Keywords: Pyrolysis, anaerobic digestion, utilization of organic fraction, hydroseparation, vortex layer apparatus, drying cabinet, incineration furnace

1. INTRODUCTION

The most common method of municipal solid waste neutralization is their burial at MSW landfills. Every year in Russia, about 90% of the total mass of waste is buried, including the organic fraction of MSW [1–2].

However, landfill disposal has significant drawbacks:

- contamination of groundwater with toxic substances
- contamination of the soil with toxic substances because of rotting waste.

The relevance of this work is due to the need to find alternative ways to neutralize MSW in terms of the underdevelopment of waste processing and disposal in Russia.

The purpose of this work was to develop a new technology for utilizing the organic fraction of MSW.

The tasks of the work were:

- To study pyrolysis and anaerobic digestion technologies
- Conduct a scientific experiment: "Investigation of the solubility of organic substances in the process of hydroseparation"
- Calculate the economic costs.

2. METHODOLOGY

In Russia, the most common method of MSW disposal is their burial at MSW landfills but this method is not environmentally friendly.

So, a new waste management scheme using pyrolysis and anaerobic digestion was proposed (Fig. 1, Fig. 2). To simulate the processes taking place during this action, the experiment “Investigation of the solubility of organic substances in the process of hydroseparation” was conducted [3–4].

The methodology of this experiment is described below:

1. Compound feed of the K-65 brand is measured in an amount of 150 g. Mix the feed with crushed toilet paper (1 roll). Add 5 liters of water, mix, wait 10 minutes until it is infused.

2. In the resulting mixture, we measure the initial temperature and pH. T= 14°C at 0 min, ph = 6.7

3. Next, we pass the resulting substrate through the vortex layer apparatus, after 5,10,15 minutes we measure the temperature and ph.

4. Next, we put the samples in a centrifuge for 10 minutes at 1800 rpm. We weigh the resulting fugate formed at 0,5,10,15 minutes.

5. We send the resulting fugate and sediment to the drying cabinet at a temperature of 100° C.

6. Day 2 of the experiment. We take the fugate and sediment out of the drying cabinet, weigh it and send everything to the muffle furnace at a temperature of 600° C, where burning will take about 8 hours.

7. Day 3 of the experiment. We weigh the resulting substrate.

3. RESULTS

During the scientific experiment, the following data were obtained:

In the samples taken after passing the vortex layer apparatus, reductions were noted after the combustion:

- Concentration of organic substances decreased on average from 51.054 g/liter to 4.664 g/liter
- Organic matter content decreased on average from 83% to 75%
- Ash content decreased on average from 0.178 g to 0.024 g.
- The content of organic substances decreased on average from 0.896 g to 0.073 g.

In the samples of the fugate, a decrease was noted:

- Concentrations of OV g/l decreased from 3.004 g/liter to 2.875 g/liter
- The content of OV, % decreased from 82.914% to 72%.

In the sediment samples, we observed:

- an increase in the concentration of OV from 106,559 to 128.77 g/l

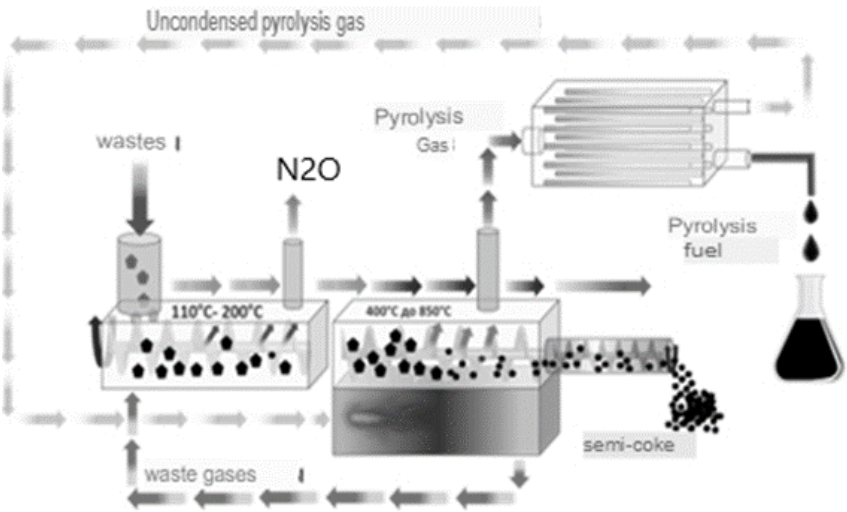

Fig. 1. Pyrolysis Scheme

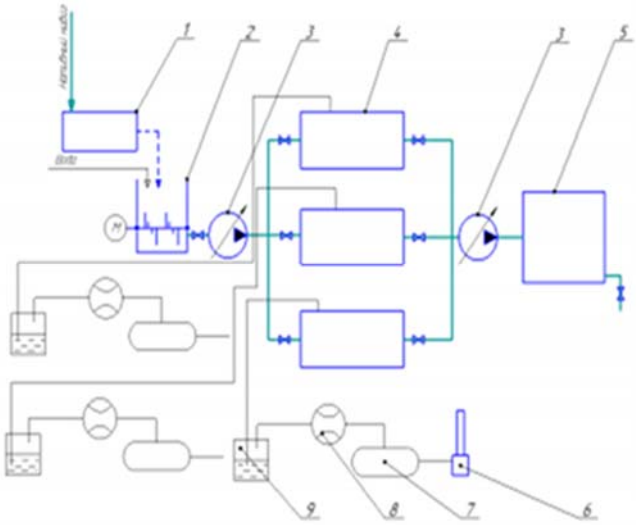

Fig. 2. Scheme of anaerobic digestion

• reduction of the content of OV, % from 92,878 to 87,696%
• increase in ash content from 0.075 g to 0.113 g.
• reduction of the content of OV in the sample, g. from 0.9 to 0.453 g.

As a result of calculating the economic costs of the enterprise, the costs amounted to about 39 million rubles/year.

The payback period of the (10 months) was analyzed and the enterprise annual profit was set at about 51 million rubles/year [5–6].

4. CONCLUSIONS

In the course of the work, the existing technologies for the utilization of the organic fraction of MSW by pyrolysis and anaerobic digestion were considered.

According to the results of the experiment "Investigation of the solubility of organic substances in the process of hydroseparation", the situations of mixing the organic fraction in the vortex layer apparatus, as well as the combustion of the organic fraction in a pyrolysis furnace were simulated.

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USE OF MICROBIOLOGICAL CULTURES TO ACCELERATE AEROBIC OXIDATION OF BIO-ORGANIC WASTE AND ELIMINATE FOUL SMELLS: CASE STUDY OF TROUT FARMS IN KARELIA

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Abstract: In this work, the study of the effectiveness of the experimental biopreparation Likvidator 2 on the bio-organic waste of fish farms and on the chemical composition of compounds released during the biodegradation of waste was carried out. Samples of volatile organic compounds (VOC) released during the decomposition of fish waste from OOO VICTAN trout farm were taken using the method of sample aspiration on sorption tubes and liquid extraction; a method of thermal desorption of VOC samples adsorbed on a layer of a stationary carrier was developed and applied; the composition of VOC desorption products and extracts was studied by gas-chromatography-mass spectrometry with electron ionization. The regularities of changes in the composition of VOC, emitted during biodegradation of fish waste, including the addition of the experimental biopreparation and the effectiveness of its use were assessed.

Key words: Likvidator 2, chemical composition, fish waste, gas-chromatography-mass spectrometry, biodegradation of fish waste.

1. INTRODUCTION

The growth of fish processing is accompanied by an increase in the number of secondary products of cutting and waste products, the

mass of which can reach 70% of the mass of fish undergoing industrial processing [1]. It is noteworthy that the output of fish products, which involves the most rational use of hydrobionts and products of their dressing, requires not only the introduction of new technological schemes of production and high-tech equipment, but also the observance of rules of transportation, storage, preparation of food fish products, etc. Therefore, the task of the fish industry includes both obtaining high-quality raw materials and fish products and preserving them without losses [2].

The decomposition of fish waste produces a large number of foul-smelling organic compounds. Unpleasant smells have a negative impact on the mental and physical state of people [3]. Therefore, there is an urgent need to develop a method to accelerate the biodegradation of waste from fish trout farms and reduce the intensity of unpleasant smells which made the research undertaken relevant.

The purpose of our work was to study the effect of the experimental biopreparation LIKVIDATOR-2 in the treatment of bioorganic waste of fish farms and to clarify the mechanisms of their action. To do this, the following tasks were solved in the work:

1. To collect samples of volatile organic compounds (VOCs) emitted during the decomposition of fish waste from the trout farm of OOO VICTAN, using the method of sample aspiration on sorption tubes;
2. To develop and apply the technique for thermal desorption of concentrated VOCs and their further analysis by gas chromategraphy/ mass spectrometry;
3. To study the composition of VOCs desorption products and extracts by gas chromatography-mass spectrometry with electron ionization;
4. To investigate changes in the composition of VOCs in presence of experimental bio additive and evaluate the efficiency of its use.

2. METHODOLOGY

The identification of volatile compounds (VOCs) aspirated and concentrated on sorption tubes was carried out by their thermal desorption followed by vapor separation by means of gas chromatography with cryomodulation and mass spectrometric detection.

3. RESULTS

In the process of our study, such substances as squalene and DETA could not be formed because of trout decomposition. We suppose that squalene originated from tissues of animals and plants used for fish feeding, whereas DETA is widely used as pesticide [4]. The analysis showed that the initial content of DETA in the sample was 33.1%; after 6 hours, the content of DETA in the sample decreased and reached 0% and after another 6 hours, it was again fixed at 5.4%, which was considered as a measurement error. Thus, we can assume that the experimental biopreparation accelerates the decomposition of such a hazardous waste component as pesticides.

Biphenyl is a toxic compound and a strong allergen. The biphenyl found in the selected samples may have resulted from biochemical processes of bacteria activity. The analysis showed that in the control sample the biphenyl content was 0.6%, after 6 hours it reached 1.5% and after 12 hours it dropped to 0%. These figures indicate insignificant formation of biphenyl in natural conditions of biomass decomposition. When biopreparation was added, the proportion of biphenyl component increased sharply after 6 hours and then decreased to almost zero. Phenol — as you known, under anaerobic conditions, the end products of decomposition are products of amino acid breakdown and decarboxylation with formation of foul-smelling substances, including phenol. Phenol was detected in all samples.

In the control sample, the phenol content was very low at all stages — less than 1%. In the experimental sample at the beginning of the experiment phenol was not detected (0%), then the share of the phenol component increased sharply after 6 hours and was 9.9%, and after 12 hours again dropped to 1.4%. Since phenol, according to literary sources, is a product of the decomposition of amino acids, it is likely that the action of the biopreparation significantly accelerated the decomposition process at the first stage and led to the formation of phenol and cresol, which was once fixed in the same sample. Limonene, a colorless liquid aliphatic hydrocarbon, is a component in citrus peel oil and has a specific citrus smell. According to the scientists, limonene is formed when untreated mixed food waste decomposes [5]. It is likely that limonene was present in the samples because it was a product of the decomposition of algae and other plant residues. In the control sample, the concentration of limonene changed insignificantly, and when the

biopreparation was added after 6 hours there was a sharp increase to 8.1%, and after 12 hours there was a decrease to 1.1%. In the experimental sample, the share of limonene component was lower than in the control sample.

Our results allow us to suppose that "LIKVIDATOR-2" can also be used for treating the wastes containing pesticides.

4. CONCLUSIONS

To sum up, the addition of the experimental biopreparation LIKVIDATOR-2 leads to rapid increasing content of biodegradation products. This fact clearly shows that the bio additive enhances biodegradation of the wastes.

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ALTERNATIVES TO INORGANIC NITROGEN FERTILIZERS: MYTH OR SOLUTION FOR ORGANIC FARMING

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Abstract: Organic farming is very popular nowadays.

Its main condition is to maintain soil fertility by applying only organic fertilizers. Considering the disadvantages of the production of nitrogen fertilizers, it is necessary to find alternative sources of nitrogen fertilizers.

Key words: environmental monitoring, organic fertilizers, organic farming, nitrogen, organic nitrogen fertilizers, siderates, compost, manure

1. INTRODUCTION

Organic farming and animal husbandry are very popular these days. The initial stages of its formation are hidden in the old methods of farming that were used in the pre-industrial era.

In organic farming, it is customary to purposefully minimize the use of synthetic drugs or exclude them altogether. They are replaced with organic fertilizers; crop rotations and special methods of soil treatment are used.

The main condition of organic farming is to maintain soil fertility by applying only organic fertilizers. An important problem of organic farming is the enrichment of soil with nitrogen.

Nitrogen is one of the main vital components for plants. With a lack of nitrogen, the yield decreases, because the photosynthesis process is disrupted.

The main source of nitrogen in modern agriculture is mineral inorganic nitrogen fertilizers. But their production increases with the increase in the cost of energy carriers, which is why the cost of fertilizers themselves increases, so their use becomes unprofitable.

In addition to economic inefficiency in the production of nitrogen fertilizers, the environment is polluted.

Given the disadvantages of nitrogen fertilizer production and the need for organic farming to use organic fertilizers, it is necessary to find alternative sources of nitrogen fertilizers.

2. METHODOLOGY

Such research methods as classification, analogy, modeling, comparison and literature analysis were used in the work. Based on the results obtained, some conclusions were drawn.

3. RESULTS

3.1. Mineral nitrogen fertilizers

In the XX century, there were forecasts that the world's population would die of hunger, which created a demand for synthetic and inexpensive nitrogen compounds in large quantities, because nitrogen does not accumulate in the soil due to a number of reasons.

Nitrogen fertilizers are very effective, they provide a significant increase in yield. Nitrogen fertilizers also increase the taste qualities of products, accelerate plant growth, increase the absorption of micro- and macroelements of plants from the soil, have a positive effect on the composition of the soil [2].

But nitrogen fertilizers also have their drawbacks:

• If the plants are oversaturated with nitrogen (fat), then the growth goes into the foliage, and there are few or no fruits at all. The taste qualities of the fruit also deteriorate.

• Due to the excess of nitrogen fertilizers, plants are more often exposed to diseases and are affected by pests.

• Nitrogen saturation also affects the keeping quality of plants, even in a mild winter, the fruits will freeze, and some of the plants will rot.

• Nitrates accumulate in fruits. If the plant lacks light or a large dose of nitrogen has been introduced, then the reproductive organs of plants will begin to accumulate nitrates harmful to humans (nitrogen affects the central nervous system and dissolves in adipose tissue, causing intoxication of the body) [3].

All the disadvantages of nitrogen inorganic fertilizers are associated with their improper use. With proper application, nitrogen fertilizers will bring maximum benefit.

3.2. Organic nitrogen fertilizers

Promising from the point of view of preserving and increasing soil fertility is the use of organic, bio-organic and mineral fertilizers, which do not have a negative impact, but only a positive one.

3.2.1. Siderates

Siderates (green fertilizers) are plants that are grown for their subsequent embedding in the soil in order to improve its structure, enrich it with nitrogen and suppress the growth of weeds.

The roots of siderative crops also perform a transport function, delivering nutrients from deeper layers of the soil to the top, closer to the roots of useful plants, between which the "siderate" grows. It is believed that about four hundred crops can act as a green fertilizer [6].

3.2.2. Compost

Composting is a microbiological process of decomposition of plant residues and synthesis of new organic compounds from them, similar to soil humus [5].

Layers of carbon and nitrogen materials are placed in a compost container and thoroughly watered. Nitrogen-rich materials are grass clippings, kitchen waste and coffee or tea grounds [1].

3.2.3. Manure

Manure is a fertilizer of natural origin, consisting of the excrement of farm animals. Proponents of mineral supplements often say that it is ineffective, its composition is not balanced, it is inconvenient to work with and, in the end, it smells bad [6].

But at the same time, manure has an advantage, the biomass of manure eventually turns into humus, creating an upper humus horizon.

3.3. Comparison of the effectiveness of fertilizers

To determine the effectiveness of organic nitrogen fertilizers, studies conducted in Russia and Egypt were taken, which implies different types of soils and climatic conditions, and which are based on different cultures.

Research of the National Research Center of the Department of Vegetables (Dokki, Cairo, Egypt) study was conducted in Benha, Egypt to assess the effect of mineral and organic fertilizers (chicken manure) on the growth and productivity of pumpkin [7].

During the harvest, the length, diameter and weight of the fruits were recorded, as well as the total weight of the fruits at each experimental site and the total yield was taken into account.

Table 1

The effect of nitrogen organic and mineral fertilizers on the yield and quality of pumpkin in the 2014s and 2015s [7]

Fertilizer	Length (cm)	diameter (cm)	Weight (g)	Final yield (t)
2014				
Mineral fertilizers	14,75	3,72	131,77	8,11
Chicken droppings	14,51	3,49	131,42	7,93
2015				
Mineral fertilizers	14,43	3,46	133,68	8,10
Chicken droppings	14,14	3,21	133,26	7,88

The data presented in Table 1 showed that the highest total yield and fruit quality was observed when using nitrogen mineral fertilizers, and the lowest values of total yield and fruit quality were revealed when using organic nitrogen fertilizers. These results were maintained in both experimental seasons.

4. CONCLUSIONS

Thus, it can be concluded that mineral (inorganic) fertilizers are very effective. But mineral fertilizers can harm not only the plant itself and the environment, but also a person, having a negative effect on the central nervous system and dissolving in adipose tissue, causing intoxication of the body. But all the disadvantages of mineral fertilizers are associated with their incorrect application, with proper application of fertilizers, only positive effects will be observed.

The optimal alternatives to mineral fertilizers — siderates, compost and manure were identified, and the effectiveness of mineral and organic fertilizers was compared.

As a result of the analysis of the study, it was found that manure fertilization has a positive effect on crops, but in comparison with mineral fertilizers, the yield increase is less, in the case of pumpkin harvest, by 2 times. From which it can be concluded that it is completely impossible to replace mineral fertilizers with organic ones. The best fertilizer option is their joint application. With this fertilizer, the yield and quality of products increases, as well as the profit from the sale of products.

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ELECTROCHEMICAL TECHNOLOGIES FOR WASTEWATER TREATMENT

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Abstract: The purpose of this work is to study the existing electrochemical wastewater treatment methods. To achieve this goal, it is necessary to determine in which cases electrochemical methods of wastewater treatment are most often used; to study the principle of operation of various electrochemical wastewater treatment devices; to identify the advantages and disadvantages of such electrochemical methods as electrodialysis, electrocoagulation, galvanocoagulation, electrochemical oxidation and reduction of wastewater components. As a result of the study, a comparative analysis of the methods of electrochemical wastewater treatment was carried out, which helps to choose the right method depending on the types of pollutants.

Key words: wastewater treatment, electrochemical methods, water recycling

1. INTRODUCTION

In modern world, such spheres as industry, agriculture, municipal production, etc. are very developed. At the same time, water consumption is increasing, and, consequently, the amount of wastewater is increasing. For the safe disposal of water or reuse for both industrial and domestic purposes, there is a need to treat wastewater to standard requirements. Depending on the sphere in which the water was used, the composition and concentration of impurities polluting it differ. Based on the indicators of the quality and quantity of water pollution, the most optimal method of purification is selected. Among the various methods, preference is given to the most efficient and cheap with low energy intensity, for which available substances are used [1,6].

Electrochemical technologies are widely used when traditional methods of mechanical, biological, and physicochemical water treatment are not effective enough or cannot be used, for example, due to a shortage of production areas, the complexity of the delivery and use of reagents, or for other reasons [4].

2. METHODOLOGY

To compare the electrochemical technologies of wastewater treatment, experiments were carried out, including electrochemical reactions in special devices — electrolyzers. These devices are divided into different types, depending on what process takes place in them. Cases have been identified where electrochemical technologies are most often used for cleaning, they are usually used in cases where other methods cannot achieve a sufficiently high degree of purification, or, if necessary, ensure environmental safety and minimize the number of hazardous emissions into the environment [3].

Owing to a comparative analysis of such indicators as installation parameters, water costs, the use of additional reagents, water treatment, the degree of purification and the resulting waste, the advantages, and disadvantages of such electrochemical methods as electrodialysis, electrocoagulation, galvanocoagulation, electrochemical oxidation and recovery of wastewater components were identified [5].

3. RESULTS

Electrochemical methods make it possible to effectively clean wastewater contaminated with oils, fats, proteins, petroleum products,

Table 1

Comparison of electrochemical wastewater treatment technologies

Criteria \ Method	Electrodialysis	Electrocoagulation	Galvanocoagulation	Electrochemical oxidation and reduction
Installation parameters	Easy operation of the equipment. They have no moving parts, which increases the reliability of installations and their service life.	Simple operation of the equipment, frequent replacement of electrodes due to deep passivation.	Simple operation of the equipment. Surface passivation of the electrodes is mechanically eliminated during the operation of the installation.	Simple operation of the equipment and the small areas occupied by it. Anodes made of scarce material.
Water consumption	In the process, the minimum amount of water is lost, multiple repetition of cleaning cycles is possible.	In the process, a sufficiently large amount of water is lost, it is impossible to return water to the recycling cycle.	In the process, a sufficiently large amount of water is lost, a large amount goes into the sediment.	In the process, the minimum amount of water is lost, multiple repetition of cleaning cycles is possible.
Additional reagents	Not needed.	Additional cleaning is needed if necessary.	Iron waste is used as a reagent, which reduces operating costs.	Insignificant consumption of reagents.
Water treatment	Purification from suspended and colloidal particles, removal of hardness salts.	Dilution of wastewater to a total concentration of heavy metal ions of 100 mg/l.	Practically not required.	Practically not required.
Degree of purification	Up to 100%	80–95 %	80–95 %	80–99 %
Wastes	Practically absent.	Heavy metal sludge, extraction is impossible due to the high iron content.	A large volume of wet sediment and the complexity of its dehydration.	The absence of sludge, the possibility of extracting metals from concentrated effluents.

surfactants, pesticides, heavy metal salts and other toxic substances. To achieve the best cleaning, it is important to choose the optimal method. For this purpose, the table "Comparison of electrochemical wastewater treatment technologies" was compiled [2]. This table shows the results of the study of each method according to such criteria as installation parameters, water costs, the use of additional reagents, water treatment, the degree of purification and the resulting waste.

4. CONCLUSIONS

Electrochemical wastewater treatment technologies have many advantages. The cleaning devices are compact, occupy a small area and are easy to operate. The significant disadvantages of the method today are the large consumption of electricity, which leads to large monetary costs. Usually, processes using electric current are used in cases where other methods cannot achieve a sufficiently high degree of purification, or, if necessary, ensure environmental safety and minimize the number of hazardous emissions into the environment. However, to achieve the best results in wastewater treatment, it is important to apply the most effective method for each specific situation, consider the specifics of each method and the experience of its application.

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WASTE-TO-ENERGY: HOW ENERGY IS PRODUCED FROM MUNICIPAL SOLID WASTE

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Abstract: Environmental, climate and energy issues are becoming more and more prominent in global society. This article aims to show methods, benefits and advantages of municipal solid waste disposal.

Key words: municipal solid waste, thermal treatment, anaerobic digestion, energy, disposal.

1. INTRODUCTION

The importance of innovation and the use of alternative or unconventional energy sources has become decisive for the existence of the future in a growing world, where conventional energy sources are rapidly moving towards extinction and are also contributing to global problems such as the greenhouse effect and global warming.

Waste-to-energy is the production of energy in the form of heat or electricity from waste through primary treatment of waste or recycling of waste into a fuel source. One of the basic principles behind a new generation incinerator is environmental friendliness and safety. Using evolving technologies, these various processes focus on the reduction and recycling of waste while attempting to generate energy from it. All this will lead to a reduction in waste disposal, thus avoiding the environmental damage caused by landfills and dumps [5].

The specificity of MSW is its complex morphological composition, including inorganic and organic components. They are divided into fractions consisting mainly of renewable raw materials (paper, wood, food waste) and fossil fuels (plastics, polyethylene and other synthetic materials). Thus, only a fraction of the energy derived from waste can be considered renewable.

2. METHODOLOGY

The article is based on a critical content analysis of energy generation methods from municipal solid waste. In 2020, 73 239 GWh of energy was produced globally from municipal solid waste (Fig. 1).

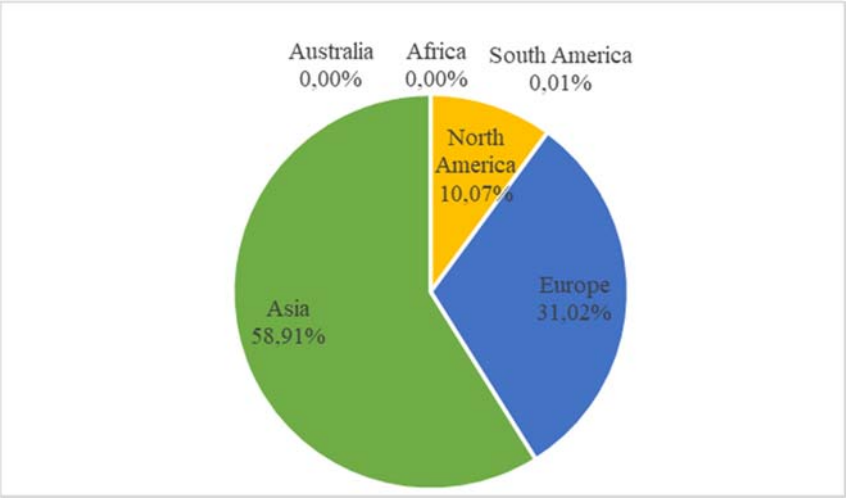

Figure 1. Renewable municipal solid waste production in the world in 2020, GWh

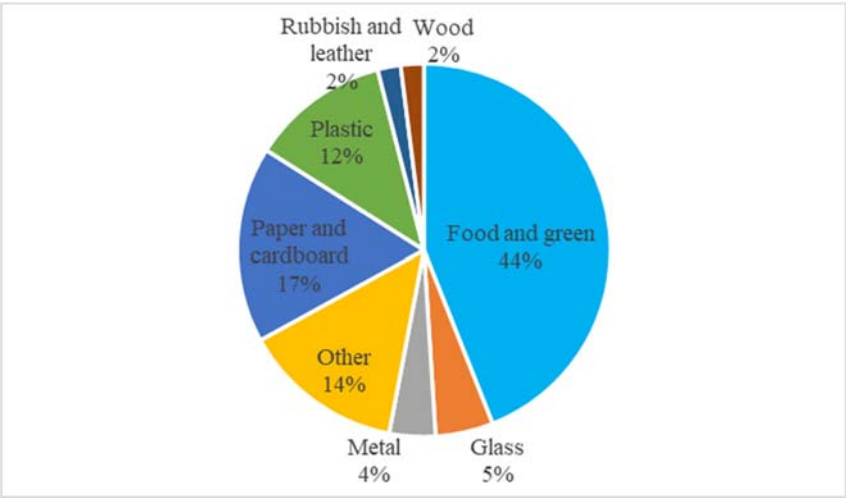

Figure 2. Composition of Municipal Solid Waste

Improving waste-to-energy conversion at existing facilities and developing technology for next generation facilities are important to local authorities around the world as they seek more cost-effective solutions for waste management. Initially, municipal solid waste is a complex mix of food waste, glass, metals, wood waste, paper and plastic, etc (Fig. 2).

Thermochemical (incineration, gasification, pyrolysis) and biochemical (anaerobic digestion) are two existing types of municipal solid waste-to-energy facilities. Both require pre-separation of recyclables to achieve optimum resource recovery and can produce electricity, heat or both.

These methods, combined with recycling and the use of alternative energy, will displace some of the fuel and resource consumption that pollutes the environment.

3. RESULTS

Thermal treatment is any waste treatment technology that involves high temperatures in the processing of raw materials. Waste is incinerated using combustible materials when they reach a given ignition temperature in contact with oxygen due to an oxidation reaction. Thermal energy is released during the combustion process. The excess heat from waste incineration is used to generate electricity and heat. Waste-to-energy plants can achieve an efficiency of up to 80% and electricity generation efficiency of up to 20%. This method can release fine particles, heavy metals, trace amounts of dioxins and acid gases [7].

Anaerobic digestion is a way of decomposing organics in an oxygen-free environment to produce biogas. The anaerobic digestion process produces biogas consisting of methane, carbon dioxide and other gases. This biogas can be used directly as electricity or heat, or upgraded to biomethane as natural gas. Anaerobic digestion is considered to be the most promising method for processing organic waste. It produces biogas with minimal impact on the environment [1].

4. CONCLUSIONS

Municipal solid waste has many unique and complex characteristics and is often a disposal problem for municipalities and other relevant

organisations. The technology to generate electricity from municipal solid waste must be more cost competitive with other electricity generation options in the market [4].

Waste-to-energy has significant potential to reduce greenhouse gas emissions. This approach therefore not only addresses the increasing problems of waste management in an environmentally sound manner, but also generates energy from essentially renewable sources and reduces greenhouse gas emissions, all of which are aimed at developing a low-carbon economy in the world [6].

Thermal treatment is a profitable method of recycling waste in the context of the continuous growth of production and the rapid expansion of cities around the world. Incineration significantly reduces the mass and volume of solid waste, resulting in a reduced need for landfill. After the thermal treatment of waste, slag and ash are left behind. These elements are in higher hazard classes [7].

Anaerobic digestion technology combats biological soil contamination and odours, and results in fertilizer and, as a consequence, less pollution [1].

The production of energy from solid materials, such as paper, wood or plastics, is feasible using thermo-chemical methods. Materials with a higher moisture content, e.g. food or vegetable waste, are not suitable for incineration. Biochemical methods, i.e. digestion in special digesters or directly in landfills, are more suitable for them.

Recycling a variety of waste products is preferable to landfill. Waste can be sent for recycling to make new products - or it can become an energy source. Waste-to-Energy is a form of energy recovery. The energy it generates, however, is much more expensive than conventional energy — you need to invest a lot of money in equipment and safe technology.

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MUNICIPAL SEWAGE SLUDGE AS A SECONDARY MATERIAL RESOURCE — WITH ESTIMATES OF POTENTIALLY USEFUL PRODUCTS AND SERVICES USING SLUDGE

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Abstract: This article presents the results of a study of urban wastewater sludge as a secondary material resource — with estimates of potentially useful products and services using sludge

Key words: Sewage sludge, microorganisms, secondary material resource, biofuel

1. INTRODUCTION

Urban sewage sludge is a complex multicomponent system that consists of mineral and organic parts containing various pathogenic microorganisms, helminth eggs, petroleum products and toxic compounds, including heavy metal ions, for example, cobalt, cadmium, copper, chromium, nickel, lead, zinc, and others. [1]

With complete biological purification, large volumes of sludge are formed, which then accumulate on silt sites. For example, in Moscow alone, more than nine million tons of municipal sewage sludge is formed every year, and throughout Russia this number exceeds 38 thousand million m^3. [2]

Sewage sludge has a negative impact on the environment, it occupies large territories, pollutes soils and groundwater with toxic components that are part of this sludge.

2. METHODOLOGY

Various methods were used in the study: study of scientific electronic and printed materials and the generalization of the received information.

3. RESULTS

As a result of anthropogenic activity, a large amount of urban sewage sludge is formed, which, when accumulated at treatment plants, is the source of pollution of the natural environment and its components. Every year, almost 40 thousand million m^3 of urban sewage sludge accumulates in Russia, a huge part of which is buried in landfills. However, despite the negative impact of sludge on the environment, it can be reduced with proper use of urban sewage sludge and will allow to get economic benefits [3].

For sewage treatment, methods are used that allow the separation of incoming effluents into clean sewage and sewage sludge [4].

One of the ways to use the urban sewage sludge, that is currently very promising, is the production of second generation biofuels. This technology is in high demand, because in order to significantly increase the volume of biofuels from crops, such as cereals or sugar cane, it is necessary to occupy a vast territory. In countries with a small area, these territories can only be freed by deforestation, because of which the landscape will suffer and the amount of carbon dioxide in the air will increase, which will negatively affect the environment. Also, during the production of biofuels from crops, nitrogen oxide is emitted as a result of the use of nitrogenous fertilizers in the cultivation of rapeseed [5].

These studies forced scientists to think about searching alternative sources of biofuels that have less harm to the environment. One of which was urban sewage sludge. The use of biogas obtained as a result of aerobic or anaerobic digestion is a fairly relevant method of using urban sewage sludge as a fuel resource. For example, China, because of this technology, provides almost 1.5 billion m^3 of biogas, which is used to generate electricity. In Europe and Australia, the amount of biogas received is 200 m3/day. Another example of the use of this technology

is Denmark, where about 20 factories for the biogas production from sewage sludge have been built. The advantage of this technology is that it can be considered self-contained and this allows to reduce emissions and economic costs [5].

Another use case of urban sewage sludge is to use it as a fertilizer in agriculture. This technology is well studied and is already being used in Canada, France and the UK. In Europe, more than 30% of urban sewage sludge is used as fertilizer, and only 10% in Russia. The reason for this is the difficulty of their removal from sludge maps and the imperfection of the mechanisms that remove this sludge, as well as the complexity and cost of getting rid of sewage sludge from chemical pollutants, heavy metals and pathogenic microorganisms [6].

The most valuable organic-mineral fertilizer is activated silt, as it contains many trace elements, nitrogen and phosphorus, which are necessary for the proper growth of crops. The technology for the safe use of this sludge lies in the fact that it is firstly dehydrated, then dried. The smell is removed, and only then it becomes ready for use. After all these stages, urban sewage sludge is purified from dangerous microorganisms and helminth eggs, heavy metals and other toxic substances. Its humidity is approximately 40%, the sludge can be transported. It is not decaying and is easily applied to the soil as an agricultural fertilizer [6].

In order to increase the efficiency of using urban sewage sludge, it can be used together with sludge of the sewage treatment facilities or as an additive in power plants to generate more electricity [7].

In order to evaluate the most promising and useful products and services using urban sewage sludge, a comparative analysis of the considered technologies was conducted. For the analysis, the criteria presented in table № 1 were proposed. The assessment was conducted on a point scale, where 1 is the most positive effect or benefit, 0 is a negative impact or no benefit.

After table analysis, we can conclude that the production of biofuels accounts for 9 points, and the use as fertilizer in agriculture accounts for 7 points.

This assessment shows that the production of biofuel from urban sewage sludge is the most profitable and promising option out of the two considered. Obtaining biofuel is an economically profitable technology, since urban sewage sludge can be used as an alternative source for generating electricity and heat, and as a result, it will increase energy

efficiency and the security of the city's economy. Another advantage of this technology is that biogas production has less impact on the environment and its components, since less nitrogen and sulfur oxides, suspended particles and other chemicals are emitted when biogas is burned. It is also a plus that this technology requires less costs for sludge treatment [8].

Table 1

Criteria for a comparative analysis of the use of sewage sludge as a biofuel and the use as a fertilizer

Criteria/Technology for the use of sewage sludge	**Obtaining biofuel**	**Application as a fertilizer**
Usage frequency of the method	0	1
Prospects for development	1	0
Environmental Criteria		
Air pollution	0 *(because in the alternative version, emissions into the atmospheric air are less)*	1
Water pollution	1	0
Soil pollution	1	0
Contamination by pathogenic microorganisms	1	0
Pollution from chemicals and heavy metals	1	0
Hazard to human health	1	1
Fire risk	0	1
Decreased volumes of landfilled sludge	1	1
Economic Criteria		
Transportation costs	1	1
Capital expenditures	0	1
Obtaining economic benefits	1	0

The use of sludge for fuel production reduces the amount of sewage sludge buried in landfills. However, the positive aspects of using sewage sludge as a fertilizer in agriculture cannot be excluded, since this technology also has advantages. For example, its advantage over biofuel technology is that it is better understood and applied more frequently. Also, this technology pollutes the atmospheric air less, and it allows, like the previous technology, to preserve vast areas of land and prevent the disposal of sludge at the landfill. But there is a risk of contamination of fertile soils in case of insufficient treatment of the formed sludge.

4. CONCLUSIONS

The use of urban sewage sludge is a promising direction that is very profitable to develop in the modern world to obtain economic benefits and improve the state of the environment by reducing the negative impact on the soil, atmosphere and hydrosphere, as well as reducing the amount of landfilled sludge.

According to the results of a comparative analysis, obtaining biofuel from urban sewage sludge is more rational than using this material as an agricultural fertilizer.

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ANALYSIS OF WASTEWATER TREATMENT TECHNOLOGIES FOR PETROLEUM PRODUCTS

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Abstract: In this article, we reveal the problem of treating wastewater contaminated by petroleum products. We also give information on determining factors when choosing wastewater treatment technology. The article provides a comparative table on wastewater treatment methods and details aspects of technology and implementation of such wastewater treatment methods as adsorption and aerobic digestion.

Key words: wastewater treatment, aerobic fermentation, sedimentation, flotation, coalescence, adsorption.

1. INTRODUCTION

One of the most significant contaminants in water resources are oil and oil products. Organic substances, widely used in the electroplating industry, pose a serious hazard. These are primarily surfactants (surfactants) and aromatic hydrocarbons.

Pollutants contained in industrial storm water (oil products, suspended solids, heavy metals, etc.) are in the form of coarse suspensions and emulsions, in a colloidal and dissolved state [8].

Several types of sources have been identified that release wastewater with maximum concentrations of petroleum products:

- machine-building enterprises
- car service enterprises, car repair plants
- plants to produce reinforced concrete items
- petroleum product processing plants

- crude oil delivery units
- plants to produce chemical products
- railway car repair plants [4].

According to laboratory measurements, the concentration of oil and petroleum products in the wastewater of these enterprises may exceed the maximum allowable concentration (MAC) hundreds of times.

Considering that the oil refining industry is rather water-intensive, water use and sewerage systems in this industry are constantly being improved to reduce water consumption and water disposal as much as possible. By now in our country and abroad recycling water supply of some refineries reaches 99.3–99.8%, specific water consumption rate is reduced to 0.3–0.2 m3/t, refineries are put into operation without wastewater discharge into water bodies.

However, despite the development and use of waste-free technology at oil refineries, modernization of oil production facilities, improvement of storage and transportation of oil products, in general the level of pollution of water bodies and soils by oil products remains rather high [7].

Preventing the discharge of oil products with wastewater is a rather complicated engineering and scientific task. On the one hand, it is caused by a great variety of chemical compounds, united by the general concept of 'oil products', as well as the presence of a mass of accompanying contaminants in the effluent. On the other hand, companies that produce oily wastewater usually have rudimentary treatment facilities, and sometimes none at all.

2. METHODOLOGY

When selecting a particular wastewater treatment technology, the determining factors are the flow rate, the initial concentration of petroleum products and associated contaminants, the requirements for the quality of treated water for all standardized contaminants. It should be noted that the methods of oily wastewater treatment and their efficiency largely depend on the methods of wastewater transportation from the place of formation to the site of treatment facilities, because changes occur in the water, significantly worsening and complicating the treatment processes. The significance of this issue is discussed in the paper, and in this review, we present technical solutions for the treatment of wastewater that has passed through the conveyor stage [2, 13].

Thus, depending on the requirements for the quality of treated water, as well as several technical and economic indicators, the technological scheme of treatment is chosen, the basis of which is mechanical treatment. In this case, depending on the specific conditions, gravity devices of various designs are used, and to increase the effect of treatment can be carried out pre-treatment or post-treatment of wastewater.

In addition to sedimentation with or without the use of chemicals (coagulants, flocculants, flocculant combinations) the cleaning technology can include filtration, flotation, sorption, centrifugation, chlorination or ozonation. A summary of oily wastewater treatment methods is given in table 1 [5].

Table 1

Classification of oily water treatment methods and the efficiency achieved [5]

Wastewater treatment methods	Permissible initial concentration of petroleum products in effluent, mg/l	Achievable depth of treatment	Note
Mechanical (sedimentation)	More than 1000	40–100	Does not clean emulsified products
Physico-chemical:			
flotation	200	20–60	Degree of purification depends on flotation
coalescence	100	10–15	Partially cleans emulsified products
adsorption	100	1–3	Cleans emulsified products (after pre-treatment)
chemical	50	1–10	Can be combined with filtration or sedimentation
Biochemical (aerobic fermentation)	100	1–10	Must be pre-deposited, cleans emulsified products

2. RESULTS

We compare the technologies that guarantee the deepest treatment of water. To these we refer to the physical-chemical adsorption method and the biochemical method [1].

2.1. The adsorption

Widespread reagent methods in the treatment of oily wastewater include adsorption. Adsorption is virtually the only method that allows wastewater to be treated to any desired level without introducing any secondary contaminants into the water.

The apparatus design of sorption treatment is generally accepted in chemical technology - pressure filters with a dense layer of granulated active carbons, preceded by mechanical filters. Two-stage filtration is used for deep purification of wastewater containing emulsified and dissolved oil products (purification up to 0.1–2 mg/l) [9].

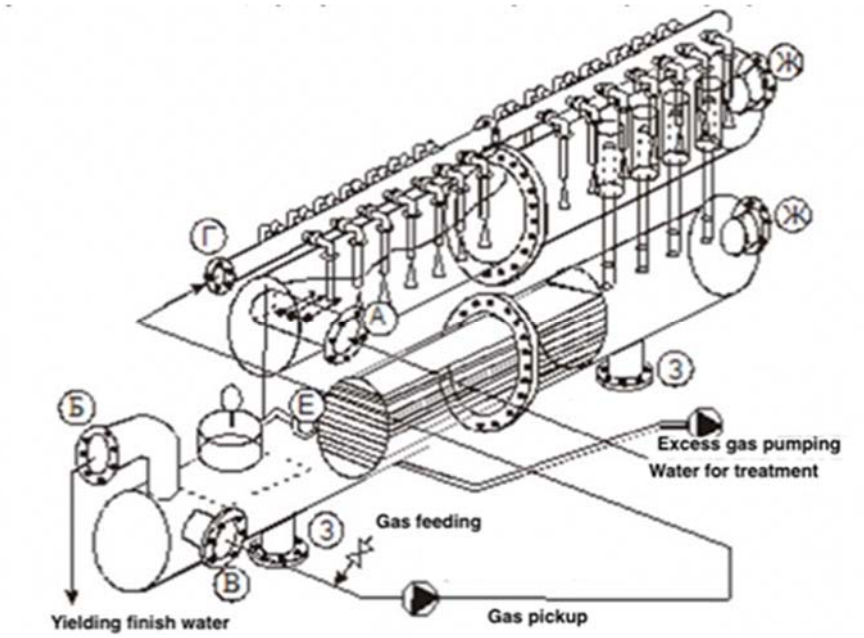

Figure 1. Wastewater treatment plant [6]

Adsorption processes are successfully used for the treatment of oily wastewater (OWW) at large plants. For example, in Tatneft for OWW treatment of emulsified oil and mechanical impurities the WWTA-type apparatuses (wastewater treatment apparatuses) (Fig. 1),

which consist of mass-exchange and gas-distributing sections, were developed. The initial WWTA is fed to the mass-exchange section of the apparatus. Along the length of the section there are cylindrical tubes with profiled nozzles, through which purified water flows out at high speed and gas saturation takes place. Part of the tubes communicate with the gas space of the mass exchange section, which leads to gas ejection into the water phase and the creation of intensive mixing of treated water. In this process the oil droplets, the smallest gas bubbles and mechanical impurities wetted by the oil interact to form flotation complexes, which are then removed in the gas exchange section from the flow. As a result of adsorption of surfactants on bubbles in the upper part of mass-exchange section of the apparatus an oil-foam layer is formed and a continuous process of mass transfer of mechanical impurities from the aqueous medium to the oil-foam layer takes place. Due to the high viscosity of the foam structure the frothy oil layer can retain mechanical impurities in concentrations several orders of magnitude higher than their concentration in the water. The frothy oil with high content of mechanical impurities is removed from the mass exchange section [6].

2.2. Biochemical treatment

Wastewater containing 15–25 mg/l of petroleum products after mechanical and physical-chemical treatment is sent for biochemical treatment consisting in the oxidation of organic pollutants by micro-organisms before discharge into the water [4].

The criterion for the degree of suitability of the biochemical oxidation method for decontamination of organic pollutants in wastewater is the biochemical index, defined as the ratio of total biochemical oxygen demand (BOD) to chemical oxygen demand (COD).

Biofilters and aeration tanks are most used for the treatment of oily wastewater. A biofilter is a rectangular or circular tank usually made of reinforced concrete (brick) with a double bottom. On the upper perforated bottom there is a filtering load made of durable chemically resistant materials: slag, granite crushed stone, coke, expanded clay, etc. The bottom solid bottom is used to collect water, which has passed through the filtering bed [11].

In the process of pollution oxidation new film is formed and the old one dies off, which is torn off the surface of the loading by the

moving water and is taken out of the biofilter. For its retention after the biofilter a sedimentation tank is installed.

Aerotanks are based on the activity of microorganisms living in natural water bodies, i.e. activated sludge (AI). Aerotanks are subdivided into aeration tanks with and without regeneration of activated sludge, mixing tanks, displacer tanks and settling tanks. Depending on the aeration devices there are aeration tanks with mechanical, pneumatic and pneumo-mechanical aeration [10].

The most widespread for treatment of small amounts of wastewater (12–700 m^3/day) are compact series plants of BIO (with biofilters) and CH (with aeration tanks) types. According to, for wastewater treatment combined installations which function as an aerotank and secondary settling tank, aerial accelerators, oxidizers, reactivators, and others, in which in different combinations processes of bio-coagulation, sedimentation, clarification in the suspended layer of sludge and aerobic bio-chemical oxidation are combined. Common to all types of combined works is the significant reduction of production area because of the creation of more favorable living conditions for activated sludge microorganisms.

Such combined works are successfully developed on the base of ВНИИ ВОДГЕО (fig. 2). This plant, named 'Oxitenk', uses pure or industrial oxygen, which improves the activated sludge activity and intensifies the oxidation processes. Because of this, the oxidizers have a volume that is about 50–70% smaller than conventional aeration tanks used to treat the same wastewater [3].

3. CONCLUSIONS

The need to improve the use of water resources in the country requires a dramatic increase in the volume of recycled water supply, as well as the treatment of wastewater to levels of impurities that allow it to be discharged into water bodies. In this connection, the purification of industrial wastewater from oil and petroleum products acquires great importance.

Along with large water-intensive oil refineries and petrochemical plants, machine-building and other enterprises generating quite a huge flow of oily wastewater, but at the same time more covered by recycled water supply, there are numerous small enterprises such as car repair

plants, car service centers, oil depots and others, the treatment of oily wastewater which is a pressing problem.

Industrial wastewater treatment is complex and time-consuming, despite the availability of a variety of effective methods. Some traditional mechanical, physical-chemical, and biochemical methods of oily wastewater treatment are presented in the review, and examples of specific wastewater treatment technologies are given.

But it should be noted that there are no universal purification schemes. As experience shows, when designing specific treatment technologies certain and specific indicators must be considered. Alongside these, territorial, often financial, and operational possibilities are considered.

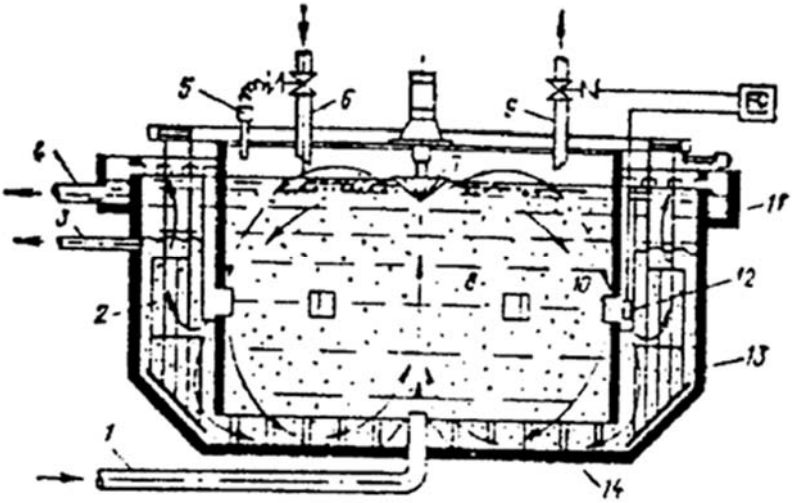

Figure 2. Oxitenk. *1* — influent piping;
2 — sedimentation zone (sludge separator); *3* — Sludge level regulator;
4 — treated water pipeline; *5* — pressure sensor; *6* — oxygen supply pipe;
7 — turbine aerator; *8* — aeration zone (reactor); *9* — exhaust gas pipe;
10 — window with nozzle; *11* — water tray; *12* — dissolved oxygen sensor;
13 — mixer; *14* — slot for return sludge [3]

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METHANE EXTRACTION FROM WASTE DISPOSAL FACILITIES BIOGAS BY GAS HYDRATE METHOD

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Abstract: The disposal of municipal solid waste in landfills leads to the formation of landfill gas, which has a high greenhouse activity as it consists mainly of methane and carbon dioxide. Existing landfill gas disposal methods are not always environmentally friendly, so it became necessary to develop alternative disposal methods. The use of gas hydrates will make it possible to extract methane from landfill gas and use it as a raw material in various fields. This article examines the influence of technological parameters, such as gas supply mode, reactor pressure and cooling rate, on the methane content in the obtained methane hydrates.

Key words: municipal solid waste, landfill gas, gas hydrates, energy resource, clathrates, methane.

INTRODUCTION

Every year a huge amount of municipal solid waste (MSW) enters the biosphere, and the main method of disposal of which in Russia is their burial in waste disposal facilities (WDF) [1]. Under such conditions, the organic part of the waste is biodegraded, and contributes to the formation of biogas, which has toxic properties and a negative impact on the environment [2].

According to statistical studies, the most common in Russia but non-environmentally friendly method of landfill gas disposal is incineration in high-temperature flares [3, 4]. Therefore, the development of valorization methods for biogas utilization is relevant. One of these methods can be gas hydrates.

The purpose of the work is to assess the possibility of using methane gas hydrates for the disposal of landfill gas generated at waste disposal facilities (WDF)

METHODOLOGY

Landfill gas can be considered as an alternative energy source, so it must be properly disposed of. There are several options for landfill gas utilization around the world — flaring, direct combustion and gas enrichment for use in general gas systems and gas hydrate technology can become an alternative disposal method [2].

Gas hydrates or clathrates are complex crystalline compounds that consist of water and gas molecules held together by hydrogen bonds. External, gas hydrates are similar to opaque ice. One hydrate volume can contain 160–180 volumes of gas [1, 3].

In general, the process of hydrate formation can be represented as a graph (fig. 1), which shows the stages of hydrate formation depending on the time of the experiment [2].

In this work, we studied the influence of the gas supply regime, the pressure in the reactor, and the cooling rate of the reaction medium on the methane content in the obtained hydrates.

Methane was fed into a reactor with a magnetic stirrer, into which an aqueous solution of a surfactant — sodium dodecyl sulfate ($NaC_{12}H_{25}SO_4$), was placed until the solution was completely frozen. Cooling was carried out using a cryostat (fig. 2).

RESULTS

We studied two methods for obtaining methane hydrates at different technological parameters. In one case, hydrate formation occurred at a constant gas pressure, in other case, gas was injected into the reactor once.

A comparison of the efficiency of these gas supply modes showed that the mass fraction of methane, while maintaining a given pressure value, is almost two times higher than the mass fraction of gas in the hydrate formed at a constant *volume (w = 9,8% (for p = const); w = 4,9% (for V = const))*

During the experiment, it was found that the maximum content of methane in the hydrate (mass fraction 10%) is achieved at optimum pressure of about 3.2 MPa (fig. 3).

We also studied the effect of the cooling rate of the reaction medium on the stability of the formed hydrate. It was found that the maximum content of methane is achieved at a cooling rate of 1.0°C /hour, but such a hydrate decomposed instantly. The most stable hydrate was obtained at a cooling rate of 10°C/ hour, but the methane content was lower (fig. 4).

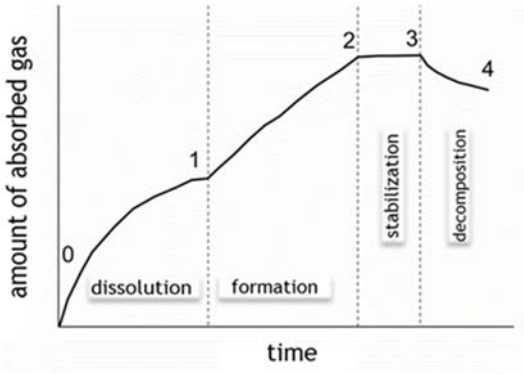

Figure 1. The stages of hydrate formation depending on the time of the experiment.

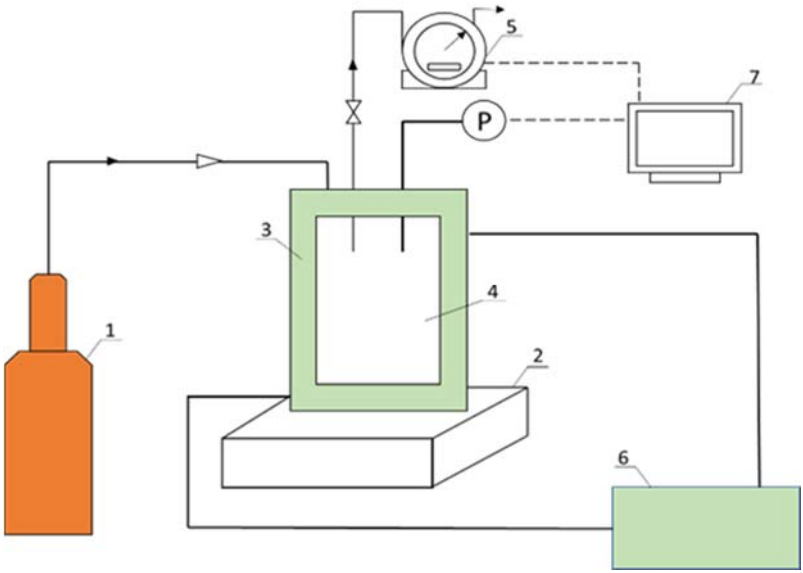

Figure 2. Scheme of installation of the reactor-tank for the formation of hydrates. *1* — gas cylinder, *2* — magnetic stirrer, *3* — cooling jacket, *4* — internal volume of the reactor, *5* — gas flow meter, *6* — cryostat, *7* — computer

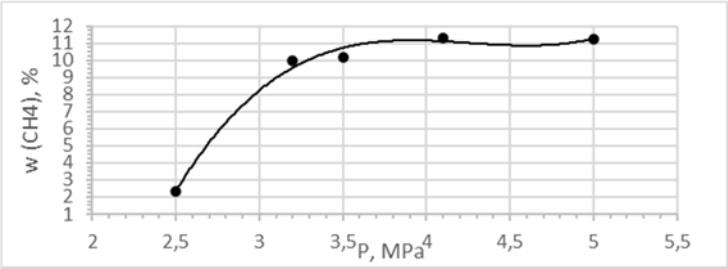

Figure 3. Dependence of the gas content in methane hydrate on the pressure in the reactor.

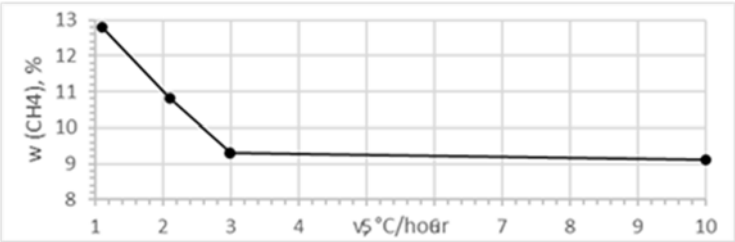

Figure 4. Gas content in methane hydrate depending on the cooling rate

CONCLUSION

The analysis of the literature data on the main properties of gas hydrates, as well as the processes of formation of landfill gas in the thickness of the landfill body and the prospects of its use as an energy resource led to the following conclusions:

1. The advantages of the gas hydrate technology are the high efficiency and environmental friendliness of the process, moderate thermobaric conditions of transportation and storage, and reduction of the risk of accidents.

2. The technology of transporting gas in the form of hydrates, in addition to a number of advantages, has a significant drawback — the low profitability of gas hydrate projects, which limits its use on an industrial scale.

3. Gas hydrate transportation can only be used for relatively small volumes of gas and over short distances, since the economic efficiency of the technology decreases significantly with increasing distance.

4. It was found that the optimal pressure for the process of hydrate formation is 3.2 MPa. At a lower pressure, the efficiency of the process is reduced by 4 times, and a higher pressure is not economically justified.

5. It has been established that the rate of cooling of the reaction medium affects the stability of the hydrate and the content of methane in it. Thus, the higher the cooling rate, the more stable the hydrate and the lower the gas concentration. The most stable product was obtained by rapid freezing at 10.0 °C/h, but the gas content in it is relatively low and amounts to 10% by weight.

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SOLVING THE PROBLEM OF INTRODUCING HYDROGEN ENERGY INTO THE ECONOMY

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Abstract: In this work, MOF-Cu-BTC was obtained by the solvothermal synthesis method, which is a potential H_2 sorbent for the accumulation of

hydrogen. Analysis of the porous structure by low-temperature nitrogen adsorption at 77k showed that this sample is a mesoporous structure of cylindrical pores with a micropore content, up to 2 nm in size. The introduction of MOF-Cu-BTC into the economy will contribute to the development of hydrogen energy.

Key words: alternative energy sources, hydrogen energy, hydrogen storage, organometallic frame compounds

1. INTRODUCTION

Hydrogen is the most promising source of energy in the global fight against climate change and decarbonization of the economy. In the coming years, a sharp increase in demand for hydrogen in final energy consumption is predicted due to cheaper production and the emergence of new industries [1].

Coal processing accounts for 18% of hydrogen production, 4% is provided by green hydrogen and 78% by processing natural gas and oil. Fossil fuel-based production methods generate 830 million tons of CO2 emissions each year, which is equal to the emissions of the UK and Indonesia combined. Nevertheless, hydrogen is a cleaner alternative to traditional fuel.

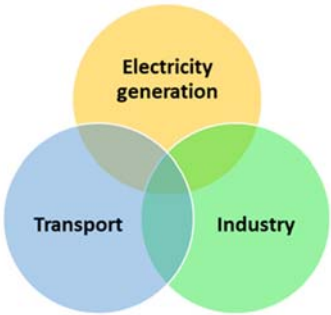

Figure 1. Sources of emissions that have an impact on the environment

Hydrogen can be used in all three areas (fig.1). When used in fuel cells, hydrogen energy leaves minimal losses, and after use as a by-product, only water remains, from which hydrogen can be extracted again [2].

2. METHODOLOGY

The solution to one of the problems of introducing hydrogen energy is the development of new highly efficient hydrogen storage systems [3].

Organometallic skeleton compounds are promising sorbents for hydrogen accumulation.

In the work, an organometallic MOF-Cu-BTC frame structure was synthesized, an H_3BTC suspension weighing 1.0113 g was dissolved in 6 ml of H_2O and 6 ml of C_2H_5OH. Then a suspension of $Cu(NO_3)_2*3H_2O$ weighing 2.0790 g was dissolved in 6 ml of H_2O and 6 ml of ethyl alcohol. As a result of the synthesis, a powder of blue color was obtained (Fig. 2)

Figure 2. MOF-Cu-BTC

3. RESULTS

Hydrogen adsorption was studied by thermoprogrammed desorption, a Crystal 2000M chromatograph equipped with a flame ionization detector and a thermal conductivity detector was used for analysis. Quantitative ratios and were determined using the standard Chromatech Analyst 1.21 program.

Table 1

Physico-chemical parameters MOF- Cu-BTC

Adsorbent	*T*,°C	W_0, см^3/г	E_0, кДж/моль	x_0, нм	*a0, ммоль/г*	$S_{БЭТ}$, м^2/г
MOF-Cu-BTC	180	0,28	40,6	0,30	8,02	650

4.CONCLUSIONS

This fine-pored sorbent with a narrow pore size distribution can be a potential sorbent for the separate purification of H_2 from the air. Having a molecule size of 0.3 nm, this adsorbate has a high affinity for the MOF-Cu-BTS sorbent with an adsorption work of 13.4 kJ/mol (Table 1). The physicochemical parameters of the H_2 molecule and the pores are predominantly cylindrical in shape with the most likely pore size distribution x0 = 0.30 nm orientates the H2 molecule in such a way that this the sorbate is separated from the components of the air mixture, being based on this type of adsorbent. Thus, the introduction of the obtained sample into the economy can contribute to the development of alternative energy sources.

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FEATURES OF WASTEWATER COMPOSITION IN THE BEER INDUSTRY

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Abstract: Industrial wastewater can lead to severe environmental pollution. The brewing industry produces large quantities of wastewater. This

study considers the main sources and wastewater indicators and their significance.

Key words: beer industry, COD, BOD, suspended solids, ammonia nitrogen

INTRODUCTION

In most countries, the food industry is a key industry. Poor treatment and improper disposal at wastewater treatment plants (WWTP) can lead to severe pollution of the environment, as well as contamination of water bodies, which can later become unfit for use[1].

Currently, a significant amount of food industry waste is produced, one of these industries is the brewing industry. During the complex and multistage technological process of beer production wastewater with different compositions is formed. Wastewater is formed not only during the production process, but also during the equipment washing, production operation and domestic premises (sanitary and shower rooms of domestic premises, canteen).

In this article we will look at the wastewater composition of enterprises in the brewing industry.

METHODOLOGY

Beer is one of the most complex fermented beverages in the world. Its production uses a wide range of ingredients, which creates a complex technological process of product production and wastewater processing.

The production process consists of several steps (Fig. 1) [2].

The main raw materials for beer production are malt, hops, water, and yeast [3].

Considering the industry as a whole, we can note that the main sources of wastewater generation are:

– Boiling workshop;
– Chemical water treatment plant;
– Fermentation room;
– Malt House;
– Bottling line;
– Syrup-boiling unit;
– Malting Branch;
– Dining Room;
– Sanitary units and shower rooms of the household premises [2].

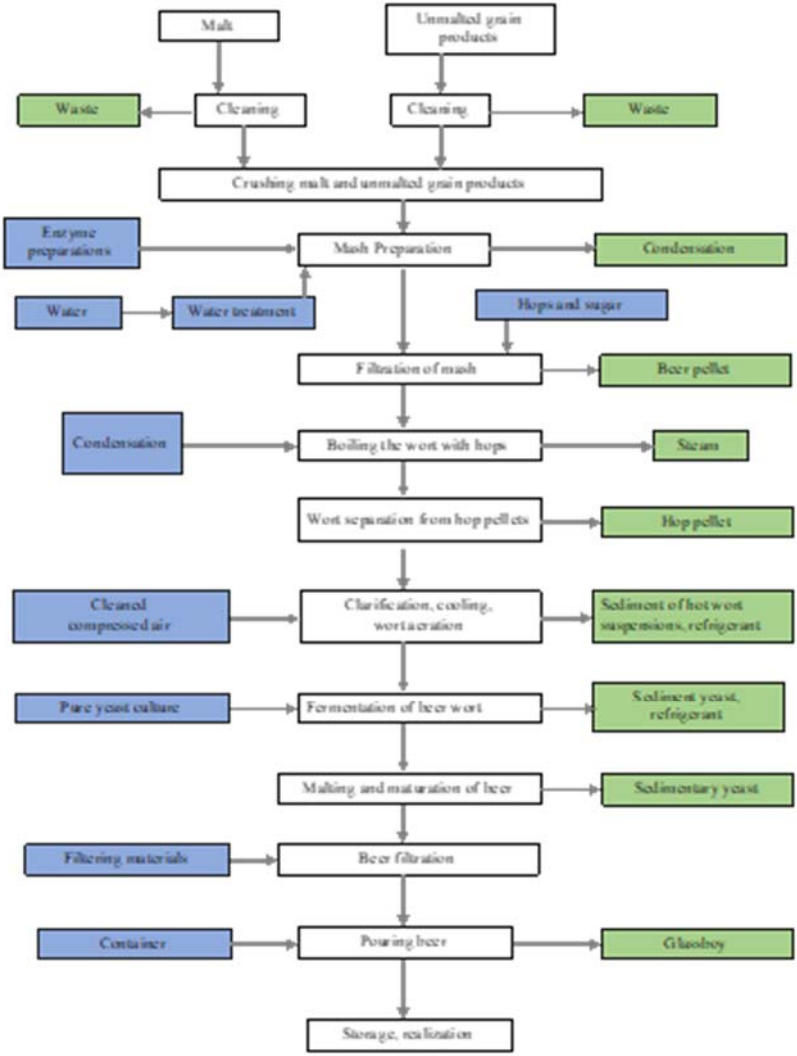

Figure 1. Block diagram of brewing production [2]

Since brewing belongs to the periodic production, it is characterized by the fact that the amount of wastewater and its composition is not always constant but fluctuates [4].

Let's consider indicators of wastewater contamination of various enterprises of the brewing industry in table 1.

Table 1

Indicators of wastewater composition [5, 6]

Indicator/ factory number	Value of the indicator	
	1	2
COD	1 400-5 500 mg/l	5 000–5 200 mg/l
BOD_5	700–2 800 mg/l	no data
Suspended solids	320–2 600 mg/l	650–1000 mg/l
Ammonia nitrogen	3–80 mg/l	10–90 mg/l

RESULTS

Based on the values of pollution indicators of two different wastewater treatment plants of brewery industry can be concluded that the content of organic pollutants in the wastewater of the industry leads to high rates of chemical oxygen demand (COD to 5 000 mg/L on average) and the biological oxygen demand (BOD_5 to 2.8–3 thousand mg / l on average). These values are so different from different methods of washing raw materials, hydrotransportation. The value of BOD_5 must be monitored, because it increases in contaminated water and it is important for the subsequent biological treatment. Number of suspended solids may reach up to 1,800–2,500 mg/l on average. Suspended solids mainly include beer pellets or particles from grain processing. The amount depends on the way the yeast is processed, the way the raw material is processed. It also depends on the stage of the technological process. Nitrogen in wastewater comes from organic proteins and yeast in the effluent, with a small portion coming from ammonia and nitrates.

It is important to note that there is not the same composition of effluents from different breweries with different methods of brewing, which means that the amounts of major pollutants are in varying ranges of values.

CONCLUSIONS

Brewing beer is one of the most complex technological processes in the food industry. During this production process numerous wastewaters with fluctuating compositions are generated, the sources of which are various production units. From the processes of washing, soaking, germination of grain, processing of hops, filtering of wort,

processing of yeast produce the most polluted wastewater about 30% of the total wastewater. These waters have a large amount of contamination by suspended solids. Also, wastewater from beer production is caused by the content of ammonium nitrogen and high indicators of COD, BOD_5.

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THE EVALUATION OF THE EFFICIENCY OF TROUT FARMS BIOLOGICAL WASTE UTILIZATION BY ANAEROBIC DIGESTION IN HARSH CLIMATIC CONDITIONS (CASE OF TROUT FARMS IN KARELIA)

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Abstract: The fishing industry in the Karelian Republic faces several challenges, including harsh climate, lack of access to electricity, a ban on the disposal of production waste, fines for emissions into the air when they are

burned. A solution for fish farming can be methane digestion in a biogas plant. With the proper organization of the technological process, the management will be able to achieve several goals at once: disposal of accumulated waste in an environmentally friendly way, eliminating the negative impact on the environment; production of additional energy — biogas, which can be converted into electricity or heat; the formation of an organic fertilizer that will be in demand due to the number of the components and the absence of a pathogenic environment.

Key words: methane digestion, biogas, organic fertilizers, anaerobic digestion, biofertilizer, fermented substrate.

1. INTRODUCTION

There is a general trend in the world of a lack of energy and raw materials, which has affected the development of alternative ways to replenish them. One of the solutions is the production of biogas from bioorganic waste, including waste from fish production. According to statistics, 9% more volumes of fish have been processed recently, therefore there is a significant potential for obtaining alternative energy and organic fertilizers.

2. METHODOLOGY

The object of the study is the waste generated on the stages of the technological chain of fish farming at the trout farm of Victan LLC. The subject of the study is the efficiency of utilization of bioorganic waste from trout farms by the method of anaerobic digestion.The schematic diagram of the organization of trout breeding shows that the main problem of cage culture is the generation of waste during cleaning, consisting of silt and waste products of fish.

The main features of the considered fisheries are:

1. Cold climate;
2. The period of operation of the enterprise is from May to November;
3. Production is performed in isolation, so there is no access to the power grid, it operates on diesel fuel;

1. Mandatory cleaning of cages with side waste in the form of silt (sapropel) and fish waste products;
2. On the territory of the republic there is a ban on the placement of this type of waste, therefore, production resorts to burning waste in cremators, which entails emissions into the atmosphere and fines for violating the maximum allowable emissions.

A solution could be the use of methane digestion of bioorganic waste in a digester with the formation of pure biogas and biofertilizers.

3.RESULTS

As mentioned earlier, the farm currently resorts to waste incineration in cremators without flue gas treatment. Here you can see the list of side pollutants during the operation of the plant: fly ash; N0x; carbon; sulfur dioxide; carbon monoxide; diphosphorus pentoxide; fluorine gaseous compounds; mixture of saturated hydrocarbons; PAH; phenols; formaldehyde; organic acids; mercaptans; furans; alkanes; dioxins.

With a production development, the emission values will only increase, which will entail the imposition of larger fines on the enterprise.

Table 1

Calculations for biogas output

Carcasses of fish (trout)	
Digester volume, V_{mt} m3	2,105
Maximum possible ash-free fermentation, R_{lim} %	13,12
Decay of the Ashless Substance, R_g %	9,89
Gas density, ρ kg/m3	1
Specific gas output, У m3/kg	0,099
Amount of loaded ashless substance, P_{oc} kg	11,88
Gas removal, $V_г$ m3/day	1,175
Lake sapropel (silt)	
Digester volume, V_{mt} m3	0,15
Maximum possible ash-free fermentation, R_{lim} %	20,472
Decay of the Ashless Substance, R_g %	17,242
Gas density, ρ kg/m3	1
Specific gas output, У m3/kg	0,172
Amount of loaded ashless substance, P_{oc} kg	0,591
Gas removal, $V_г$ m3/day	0,102

To solve this problem, a calculation was carried out for the commissioning of a biogas plant. For optimization, the following work parameters were selected:

- Fermentation mode — thermophilic (55°C).
- Loading dose — 19%.
- Fermentation period 14 days.

The estimated volume of gas per day with a given amount of waste, consisting of silt and dead fish carcasses, will be 1.3 m3, therefore the required volume of the digester should be at least 2.3 m3.

Considering the cost of delivery to the fish farm, the total cost of equipment for the autonomous operation of the installation will amount to 502 thousand 270 rubles.

Earlier it was said that there is no access to electricity networks at the production site, so diesel fuel is constantly purchased. For the operation of the installation, a generator operating on two types of gas, biogas, and liquefied gas, was considered. The purchase of liquefied gas is envisaged since with a given volume of waste, not enough gas is produced for autonomous operation.

According to calculations, the cost of liquefied gas for one cycle of operation of the installation will be 9 thousand 657 rubles.

Of course, with small volumes of fish waste in the conditions of this farm, one should not expect big profits due to the sale of biogas. However, some income may come from the sale of organic biofertilizer. Given that the bulk of the waste consists of fish carcasses, the fermented substrate will be rich in many micro and macro elements, which improves the quality of the fertilizer.

Table 2

Profit calculation for 1 period (14 days)

Fertilizer price, rub/t	6000
Fertilizer ratio of total biomass	0,85
Waste for 1 period, t	6
Profit from the sale of fertilizers, rub	30600
Net profit for the period, rub	20942,59469

Now, LLC “Victan” produces whole fish for sale in a larger volume. However, in the future, it is planned to introduce processing capacities. It means that the volume of waste will increase significantly, according to statistics, more than 50% of the fish becomes a by-product. Thus, the volume of gas produced will increase to 20.5 m3 per day.

One of the ways to intensify the fermentation process is to add activated sludge to the fermented substrate. Excess activated sludge is

formed in large volumes at the city treatment facilities, the nearest local treatment facilities are in 60 km from the trout farm. Transportation and placement of sludge in storage tanks for freezing during the winter period and subsequent thawing in May will destroy the structure of the bilipid layer of silt cell membranes and release proteases from lysosomes, which will subsequently accelerate the destruction of proteins, which are the main component of fish waste. The result of adding excess sludge will be an increase in biogas yield.

4. CONCLUSIONS

Waste from a trout farm is generated from the cleaning of fish cages and includes fish carcasses, fish by products and sludge (sapropel).

Currently, production uses incineration in cremators as a method of organic waste disposal. This method negatively affects the environment and can be replaced by anaerobic digestion.

The optimal conditions for the operation of a biogas plant with an increase in biogas yield and neutralization of digestate are thermophilic mode (55 ° C), pH 7, loading dose 19%, fermentation duration 14 days, mixing of the substrate 4 times a day. It can be considered promising to add activated sludge from wastewater treatment plants to the waste to increase the volume of biogas output.

The main components for the efficient operation of a biogas plant have been determined, the cost of their purchase will be about 503 thousand rubles.

To save costs, diesel fuel can be replaced by plant-generated biogas and liquefied gas; the profitability of the plant is achieved through the sale of biofertilizers from the digestate.

With a potential increase in the mass of fish processing, the volume of gas will increase to 20.5 m3 / day, therefore, profitability will increase.

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СОЗДАНИЕ ПОЛОВОЛОКОННЫХ ГАЗОРАЗДЕЛИТЕЛЬНЫХ МЕМБРАН ДЛЯ КОНДИЦИОНИРОВАНИЯ ПРИРОДНОГО ГАЗА

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CREATION OF HOLLOW FIBER GAS SEPARATION MEMBRANES FOR NATURAL GAS CONDITIONING

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Аннотация: По результатам работы выявлено, что разработанная композиционная половолоконная мембрана на основе полисульфона (ПСФ) и полидецилметилсилоксана (ПДецМС), а также газоразделительный модуль на её основе позволяют эффективно выделять низшие углеводороды (C_2–C_4) из смеси, моделирующей природный газ. Полученные мембранные модули могут быть масштабированы и использоваться в дальнейшем при подготовке природного газа к транспортировке по трубопроводу. Цель данной работы — создание половолоконных композиционных мембран и лабораторных газоразделительных модулей на их основе для высокоэффективного выделения низших углеводородов из их смесей с метаном.

Ключевые слова: мембранное газоразделение, композиционные мембраны, природный газ, половолоконные мембранные модули, полидецилметилсилоксан.

1. ВВЕДЕНИЕ

Мембранное газоразделение применяется для производства азота, кислорода, водорода, для удаления диоксида углерода из различных газовых смесей (например, из природного газа), осушки природного газа и др. В Российской Федерации отсутствует производство половолоконных мембран и газоразделительных модулей на их основе, нет опыта их расчета. В то же время, развитие отрасли мембранного газоразделения в России очень важно, в первую очередь потому, что наша страна является одним из крупнейших мировых лидеров и по запасам, и по добыче углеводородного сырья, в том числе природного и попутных газов, а также различных видов газовых конденсатов. Весьма актуальными являются процессы выделения конденсируемых углеводородов C_{3+} из природного газа, с получением метановой фракции и фракции C_{3+}. Общепринятая и хорошо отработанная во всем мире технология низкотемпературного разделения различных газовых смесей весьма дорогостояща как с точки зрения капитальных вложений, так и по эксплуатационным затратам. Существенный прорыв в этом направлении может дать разработка и применение газоразделительных мембран, селективных по углеводородам C_{3+}.

2. МЕТОДОЛОГИЯ

Нанесение тонкого полимерного слоя осуществлялось на внешнюю поверхность мембраны. Схема данной методики представлена на рисунке 1. В мембранный модуль с половолоконной подложкой из ПСФ помещался раствор из полидецилметилсилоксана [1] для

нанесения селективного слоя. Предварительно во внутренней полости половолоконной мембраны был создан вакуум 102 Па. Для лучшего нанесения и улавливания паров растворителя использовалась ловушка с жидким азотом. Половолоконная мембрана находилась в растворе для нанесения в течение 3 минут.

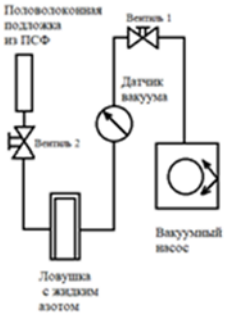

Рисунок 1. Схема методики нанесения тонкого слоя полидецилметилсилоксана на пористые половолоконные подложки из ПСФ

После этого в случае полидецилметилсилоксана половолоконная мембрана с нанесенным полимерным раствором помещалась в сушильный шкаф на 24 часа при 100°С, где растворитель испарялся, а также происходила сшивка. Такая сшивка приводит к тому, что тонкая пленка полимера фиксируется на пористой поверхности половолоконной подложки из ПСФ.

Исследование газотранспортных характеристик композиционных мембран при разделении многокомпонентной смеси углеводородов C_1–C_4 проводили на лабораторной установке [1]. При выборе концентраций компонентов модельной смеси ориентировались на состав природного газа.

3. РЕЗУЛЬТАТЫ

3.1. Получение половолоконной мембраны-подложки

Известно, что свойства ассиметричной половолоконной мембраны существенно зависит от состава формовочного раствора. Исходя из этого в данной работе было предложена модификация

формовочной композиции полимер-порообразователь-растворитель (ПСФ-ПЭГ-НМП) путем изменения концентрации порообразователя ПЭГ-400 в нем в диапазоне 10–30% мас. Газотранспортные свойства мембран-подложек определяли по паре газов CO_2 и He. Отношение проницаемостей индивидуальных газов (CO_2 и He), называемое идеальной селективностью, позволяет оценить характер течения газа через мембрану (по закону Кнудсена, Пуазёйля или смешанный характер) (данные измерений указаны в таблице 1). Из приведенных результатов можно сделать вывод, что приготовление формовочного раствора с концентрацией ПЭГ-400 30 % мас является предпочтительным, поскольку получаемые мембраны-подложки при сопоставимых значениях селективности обладают наивысшими значениями газопроницаемости по всем исследованным газам.

Таблица 1

Газотранспортные свойства половолоконных мембран-подложек из ПСФ в зависимости от концентрации ПЭГ-400 в формовочном растворе

Концентрация ПЭГ-400, %	Газопроницаемость, $м^3(н.у.)\cdot м^{-2}\cdot ч^{-1}\cdot бар^{-1}$		Идеальная селективность α
	He	CO_2	He/CO_2
10	84	27	3.1
20	101	36	2.8
30	166	55	3.0

3.2 Получение композиционной половолоконной мембраны и исследование её транспортных и разделительных свойств

В качестве полимерного материала для нанесения тонких селективных слоев был выбран полидецилметилсилоксан (ПДецМС), так как у него повышенная селективность по углеводородам C_{3+}. По разработанной методике была получена композиционная половолоконная мембрана.

4. ВЫВОДЫ

Разработана методика нанесения селективного слоя ПДецМС на поверхность половолоконных мембран-подложек. Показано, что для получения бездефектных композиционных мембран

с максимальной проницаемостью необходимо выдерживать мембрану-подложку в 5% мас. растворе ПДецМС в изооктане в течение 3 минут. Получена композиционная мембрана ПДецМС/ПСФ с тонким, бездефектным селективным слоем толщиной 5–6 мкм и проницаемостью по CO_2 — 0,72 $м^3$(н.у.)·$м^{-2}$·$ч^{-1}$·$бар^{-1}$.

Был создан 6-ти волоконный мембранный газоразделительный модуль на основе композиционных мембран ПДецМС/ПСФ с площадью поверхности мембран в модуле 80 $см^2$. Проницаемость CO_2 составила 3,0 $м^3$(н.у.) $м^{-2}ч^{-1}бар^{-1}$, селективность по паре газов CO_2/N_2 — 11,0, что свидетельствует о бездефектности данного модуля. Исследовано разделение модельной газовой смеси аналога природного газа и показано, что модуль ПДецМС/ПСФ демонстрирует хорошую разделительная способность по углеводородам C_{2+}: фактор разделения этан/метан — 2,9, пропан/метан — 6,2, н-бутан/метан — 12,5. Показано, что несмотря на значительную пластификацию материала мембраны в углеводородах C_{3+} продемонстрирована способность модуля к выделению метана из смеси с углеводородами C_{2+}.

БЛАГОДАРНОСТИ

Исследование выполнено в ИНХС РАН в рамках проекта РНФ 19-19-00647.

ЛИТЕРАТУРА

1. *Grushevenko E.A., BorisovA I.L., Knyazeva A., Volkov V.V., Volkov A.V.* Polyalkylmethylsiloxanes composite membranes for hydrocarbon/methane separation: Eight component mixed-gas permeation properties.

ENVIRONMENTAL ASSESSMENT OF DRINKING WATER TREATMENT PLANTS IN THE REPUBLIC OF ECUADOR

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Abstract: The objective of this study is to evaluate the environmental impacts of two small water treatment plants with water intake from surface water

sources with a high content of organic substances was evaluated. Open-LCA software is used for the LCA model and CML 2001 method is used to calculate the results in terms of global warming potential (GWP), acidification potential (AP), marine aquatic ecotoxicity potential (MAEP), terrestrial ecotoxicity potential (TETP), eutrophication potential (EP), human toxicity potential (HTP). The results are given per 1 m^3 of drinking water produced at a water treatment plant.

Key words: drinking water treatment, life cycle assessment, Republic of Ecuador.

INTRODUCTION

Various treatment processes can be applied to obtain water for consumption with various qualities. The source of water, such as groundwater, seawater, or surface freshwater shows different qualities; together with the adopted treatment methodology i.e., a sole desalination system or a treatment composed of coagulation flocculation followed by disinfection or thermal distillation; the source of energy; the required quality of water for distribution, etc. [1, 2]. All these parameters can be considered among the factors defining the environmental impacts of a water treatment scheme [3]. Thus, the complexity of water treatment systems makes it possible to apply broader methods of environmental assessment, such as life cycle analysis regulated by international standards ISO 14040 and 14044 [4, 5].

1. METHODOLOGY

The LCA study is carried out in four stages: determination of the purpose and scope of the study, inventory analysis, impact assessment and interpretation of the results.

1.1. Definition of the purpose and scope of the study

The purpose of this study is to assess the life cycle of 1 m^3 of drinking water produced by two water treatment plants located in Ecuador. The first water treatment plant is located in Latacunga, Cotopaxi province, and has a purification capacity of 0.035 m^3/s of water coming from the Retamales river. The second station is located in the canton of Pedro Vicente Maldonado, Pichincha province, and processes an average of 0.030 m^3/s of water from the Talala river.

The physical boundary of the two systems covers the following stages: coagulation-flocculation, precipitation, filtration, and disinfection.

There are also sub-stages included such as the supply of aluminum sulfate, chlorine gas, caustic soda and polyaluminium chloride (PAC).

1.2. Life cycle inventory analysis

At this stage, an inventory of the water treatment system was carried out, based not only on information about the electricity consumption and the amount of chemicals needed in the process of preparing drinking water, but also on the equivalent pollution factor. Both primary and secondary sources of information were used for this inventory. The primary source corresponded to the data provided by the technical staff of the studied water treatment plants. The secondary source corresponded to the Ecoinvent v3.1 database.

2. RESULTS

Table 1 presents the general results obtained by applying environmental impact indicators for the two studied water treatment plants.

Table 1

Results of the environmental impact assessments of two potable water treatment plants

Water treatment plant	GWP (Kg CO_2 eq)	AP (Kg SO_2 eq)	EP (Kg PO_4 eq)	HTP (Kg 1,4-DB eq)	TETP (Kg 1,4-DB eq)
Latacunga	4,40E-2	5,20E-4	9,26E-5	3,45E-2	1,50E-4
Pedro Vicente Maldonado	1,68E-2	1,40E-4	3,16E-5	1,26E-2	6,01E-5

Each process contributes to different impact categories. Figures 1 and 2 present the results of the characteristics of LCA processes, which show the proportion of each process in different categories of impact.

The exposure profile in the fig. 1 shows that approximately 96% of the total amount of HTP, AP and TETP is formed during the coagulation-flocculation process. About 98% of the total amount of MAEP is accounted for by the coagulation-flocculation process. The coagulation-flocculation process accounts for 94% of the total GWP.

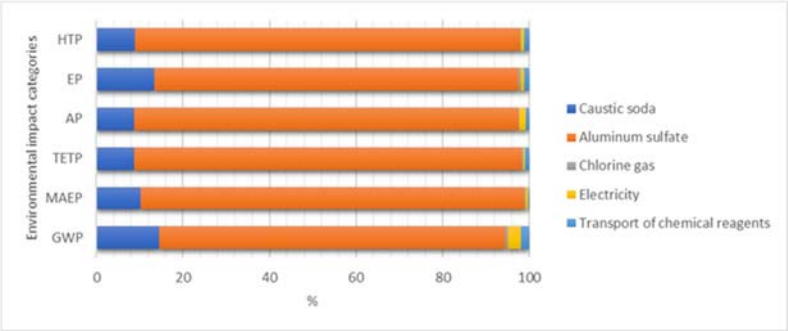

Figure 1. Contribution of caustic soda, aluminum sulfate, chlorine gas, electricity, and transport of chemical reagents to the environmental impact at the Latacunga water treatment plant

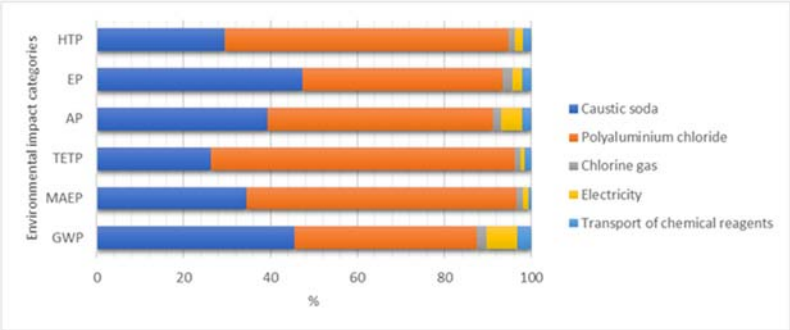

Figure 2. Contribution of caustic soda, polyaluminium chloride, chlorine gas, electricity, and transport of chemical reagents to the environmental impact at the Pedro Vicente Maldonado water treatment plant

According to the results of the fig. 2, at the water treatment plant in the canton of Pedro Vicente Maldonado, approximately 94% of the total amount of HTP is formed from PAC and caustic soda. About 93% of the total EP is accounted for by caustic soda and polyaluminium chloride. Also 91% of the AP is formed from polyaluminium chloride and caustic soda. About 96% of the total TETP is accounted for by polyaluminium chloride and caustic soda. Approximately 96% of all MAEP is formed during coagulation-flocculation. About 87% of the total GWP is accounted for by the coagulation-flocculation process.

3. CONCLUSIONS

This study applied a life cycle environmental assessment methodology to assess the environmental impact of two small drinking water treatment plants located in Ecuador, fed from surface waters with a high content of natural organics.

The results show that the greater environmental damage caused by water treatment plants is mainly explained by use of coagulants such as aluminum sulfate and polyaluminium chloride. At the Latacunga water treatment plant, aluminum sulfate has the largest impacts, while at the Pedro Vicente Maldonado water treatment plant, the contribution of polyaluminium chloride is 65%, 52%, 70% and 62% of the global warming potential, acidification potential, terrestrial ecotoxicity potential and marine aquatic ecotoxicity potential, respectively.

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BIOFUEL GENERATION

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Abstract: This article describes all five generations of biofuels, the principle of their synthesis and the biomass used. It also describes the popularity of using a particular method and provides a comparative analysis of all generations of biofuels

Key words: Fuel generation, biomass, algae, biobenzine, synthesis, renewable energy sources

1. INTRODUCTION

There is an acute problem of shortage of energy sources in the world. There are many needs, there are few resources. Also, a significant disadvantage of fossil fuels is the utilization of spent fuel. Thus, the question arises about the search for new alternative energy sources.

At the moment, the use of biofuels is very popular as an alternative energy source that is synthesized from biomass of plant or animal origin.

In Europe, there is a tendency to increase the use of biofuels for various needs. In Russia, in comparison with these countries, the introduction of biofuels is still of a project nature.

2. MATERIALS AND METHODS

Information on each type of biofuel was processed and analyzed in the form of a table of "disadvantages and advantages". After that, all generations were compared according to all of the above criteria.

The comparative method, as universally applied, is referred to as general scientific research methods. The essence of the comparison method is to compare data. This means that an analyst can take several values of one indicator or several values of absolute and relative indicators and compare them with each other.

In applied research, the comparative method is used as the main one in classification, typology, evaluation, generalization. It allows you to separate the common and distinctive features and properties of the studied objects and the processes of their development

3. RESULTS

3.1. First generation biofuels

Table 1

Advantages and disadvantages of first-generation biofuels

Advantages	Disadvantages
1. Maintaining the agricultural industry due to increased demand for some crops **2.** Ease of implementation in the techno-logical process, since there are already sites for growing crops.	**1.** Enjoys a slight advantage from fossil fuels, as large energy costs are being cut **2.** It affects the amount of food entering the market, since the raw materials for processing are agricultural crops

This biofuel was the first step towards energy independence and the rejection of fossil fuels as an energy source. Agricultural crops such as corn and beets were used as a resource for creating biofuels [1, 3].

Based on Table 1, we can say that this biofuel requires further development to improve efficiency and energy conservation.

3.2. Second-generation biofuels

For biofuels of the second generation, the raw materials are cellulose and lignin. In the process of processing, useful raw materials are extracted from this biomass, where useful sugars are blocked by lignin, hemicellulose and cellulose [2, 3, 4]

Table 2

Advantages and disadvantages of second-generation biofuels

Advantages	Disadvantages
1. Agricultural lands are not removed from the cycle of growing food crops. **2.** There are no costs for fertilizers and additional watering	**1.** Complexity of raw material processing (large technological process) **2.** Big expenses on expensive equipment and preparation of raw materials

This biofuel is used for internal combustion engines. For example, the American company Virent has developed, patented and has been producing bio-gasoline for several years, which [3].

3.3. Biofuel of the third generation

Algae is the raw material of biofuels of the third generation. They contain a large number of fatty oils, and the residue can also be fermented, fermented and used to produce alcohols and esters [3, 5].

Table 3

Advantages and disadvantages of third-generation biofuels

Advantages	Disadvantages
1. The algae harvest exceeds the crop yield 2. Do not occupy arable land 3. Do not require maintenance 4. Do not affect the cost of food	1. Algae strains are expensive to buy

The third generation of biofuels is considered promising, and it is promoted by many countries, investing heavily.

3.4. Biofuels of the fourth generation

The mechanism of the fourth generation of biofuels is based on the synthesis of hydrocarbons from carbon dioxide, water and sunlight with the help of microorganisms.

Table 4

Advantages and disadvantages of biofuels of the fourth generation

Advantages	Disadvantages
1. High efficiency of the process, according to preliminary estimates by 50–100 times. 2. Removes the stage of biomass processing	1. It is still under development

This generation of biofuels is very promising, it has similarities with the third generation. [2, 3].

3.5. Biofuels of the fifth generation

The fifth generation of biofuels is under development of the concept. Most of the funding comes from the US Department of Defense. [2, 3].

Thus, after analyzing each of the generations of biofuels, we can conclude that the third generation is the most in demand at the moment, since this is not only effective, but also already entered into production method of processing biomass into biofuels. The second generation of biofuels is significantly inferior to the third due to the exploitation of agricultural land and the required care of cultivated crops. The first generation could not prove itself due to low efficiency indicators and rising prices for food products of the population.

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IMPROVEMENT OF THE SYSTEM OF PURIFICATION OF GAS-AIR EMISSIONS DURING COAL TRANSSHIPMENT AT THE VANINO BULK TERMINAL OF JSC "DALTRANSUGOL" USING THE RESOURCE POTENTIAL OF CAPTURED WASTE

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Abstract: In the modern world, Russia is one of the leaders in the field of coal mining. Today, as a result of coal transshipment, one can face the problem of coal dust formation, the content of which in the atmosphere is at a critical level due to emissions at the enterprises. The main danger lies in the detrimental effect on the health of the working personnel, pollution of the environment, also the dust pollution affects the people living near the production facilities. Therefore, there is a question of developing the most effective way to clean the air from coal dust to reduce its content in the atmosphere and working area.

The system of purification of gas-air emissions during coal transshipment is chosen as an object of research in this work. The main purpose of this work is to find the most effective method of air purification in the port area as a result of reducing emissions of particulate dust, as well as the use of the resource potential of explosive dust.

Key words: coal dust, the vehicle discharge workshop, the foam apparatus, coal transshipment, air purification.

1. INTRODUCTION

The relevance of this topic lies in the fact that dust has a negative impact not only on the environment, but also adversely affects the health of workers and the population of the residential zone. This raises the question of effective air purification from coal dust and reducing its concentration in the working area and atmosphere.

The purpose of the study is to develop effective measures to improve air quality in the territory of the seaport under study, which will reduce the emission of solid particles into the atmosphere, as well as to involve the captured dust back into production.

The objectives of the work are:

1) to analyze the existing methods of air purification from suspended solid particles of coal dust;

2) to choose the most optimal hardware design for additional air purification;

3) to assess the possibility of using briquetting technology for the disposal of collected dust fractions.

2. METHODOLOGY

In writing the article such methods of scientific research as a study of the scientific literature on the topic of work, regulatory framework, analytical and comparative methods were used.

3. RESULTS

The work considers Vanino Bulk Terminal, which is located in the Khabarovsk Region in the Muchke Bay of the Tatar Strait. It specializes in exporting Russian coal to different countries. The port is one of the dustiest places in this region. In the seaport, where loading and unloading operations take place, the most polluted place is the car dumper workshop [1].

3.1. Air cleaning in the vehicle discharge workshop

The vehicle discharge workshop is designed for unloading coal from coaches to the conveyor. Rock dust emissions at this location account for about 70% of total dust emissions, averaging 4,000 tons per year. This workshop is the most dangerous for the health of workers, since it is the only place in the seaport that is located indoors, which prevents the natural ventilation of dust. In this workshop, a dust suppression system is used, which purifies the air by 75%. In order to increase the air purification rate of the working area and to bring the captured dust back into production, it is proposed to install an additional air purification system.

One of the most common methods of air purification is the method of dust suppression by irrigation with water. The cleaning efficiency is

70–80%. The minimum capture of particles is 5–10 micrometer. These factors suggest the importance of the integrated use of air purification [2].

3.2. The principle of complex cleaning

A comprehensive air purification of the working area was developed. The principle of complex cleaning is as follows: the main air purification, which is already functioning in the car dumper workshop, is carried out using a dust suppression system, where water particles with dust are lowered to the surface and loaded into the sump through a pipeline. Next, the liquid phase is sent to the treatment facilities, and the solid phase is briquetted. During complex cleaning, an additional dust collection system is installed to the main one. The fine dust particles are sent by the fan to the foam apparatus in which they are captured. Then the resulting coal-water mixture enters the sludge collector, where it is mixed with the liquid formed as a result of the basic air purification with nozzles. After settling, part of the liquid is taken for re-irrigation of the apparatus and nozzles, and the sludge is fed for drying. After that, binders are added to the mixture and briquetted with a roll press [3].

Under the action of the fans, dust gets into the foam apparatus. The principle of operation of the device is the following. The gas stream contaminated with dust enters the liquid in the form of bubbles, the liquid is evenly distributed in the apparatus on the plates. First, dust is deposited on the bottom surface of the plate, then dust is captured during the gas transition into the foam layer, in which gas bubbles are continuously formed, fused and destroyed and dust is further deposited into the foam layer. After that, the purified gas is released into the atmosphere [4].

After the foam apparatus, the coal-water suspension enters the sediment tank. A mixture of settled particles enters the briquetting apparatus. It was estimated that without complex cleaning, the device produces up to 14 tons of briquettes, but with complex cleaning, the press produces up to 18 tons of briquettes per day [5].

4. CONCLUSIONS

Based on the results of the work, the following conclusions were made:

1. Due to the high explosion of coal dust, wet cleaning methods are recommended to clean coal dust.

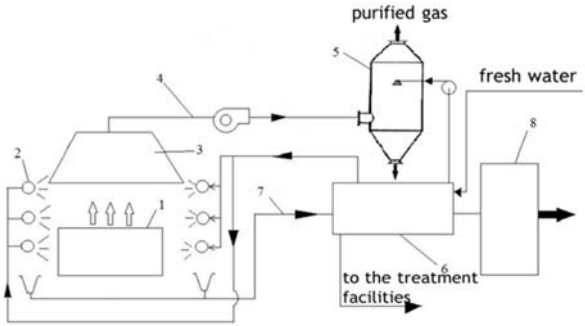

Figure 1. Complete air cleaning in the working area of the vehicle discharge workshop: *1* — discharge workshop, *2* — nozzles, *3* — hood riveted, *4* — dust pipeline, *5* — foam apparatus, *6* — sludge collector, *7* — pipeline substandard suspensions, *8* — roll press.

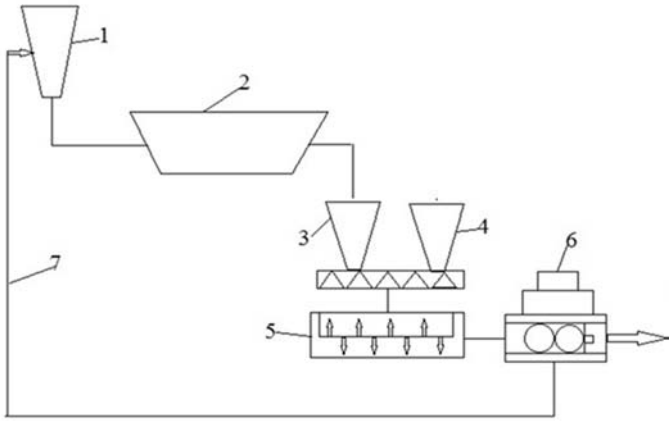

Figure 2. Coal dust briquetting pattern: *1* — charge hopper, *2* — dryer containing, *3* — dry bunker, *4* — binder with the binder, *5* — divider, *6* — press, *7* — mixing pipeline.

2. It was determined that the most optimal and energy-efficient wet cleaning machine is a foam apparatus.

3. In addition to the existing dust suppression system, the effective air purification of the working area should include the installation of a

fan and a foam apparatus, and there should also be a closed water-sludge system that will allow water to be reused, and this, in turn, is the rational use of water resources.

4. The integrated system allows increasing the air purification of the working area up to 99%, as well as to enhance the productivity of briquettes by 1,460 tons per year.

5. It is possible to reuse 438 tons of dust, thus ensuring resource saving.

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EFFECT OF FAT ON THE SELECTION OF WASTEWATER TREATMENT TECHNOLOGY FOR MEAT PROCESSING INDUSTRY

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Abstract: This article deals with the effect of the fats presence on the wastewater treatment from the meat processing industry. Methods for removing fats at wastewater

Key words: fats, meat processing, wastewater, grease trap, coagulation, dissolved air flotation, biological treatment

1. INTRODUCTION

Water is a widely used resource in most industries. The world's population is growing rapidly and with it the production volume, especially food production, is increasing. The food industry requires the use of large volumes of potable water, which then becomes contaminated and unfit for drinking and hazardous to the environment [1].

The wastewater treatment process from the food industry is quite complex. They are characterised by high levels of various organic pollutants, the qualitative and quantitative composition of which often fluctuates. Along with this, the treatment process is complicated by the presence of suspended solids, the presence of chemical disinfectants and detergents, as well as the irregularity of these effluents. Each branch of the food industry has its own priority pollutants. In this article, wastewater from the meat processing industry will be studied [1,7].

2. METHODOLOGY

The priority pollutants in wastewater from the meat processing industry are high levels of organic substances, which are introduced in large quantities by wastes such as fats and blood, which are discharged into the water during production processes.

In Table 1 presents average numerical values of fat, COD, BOD and suspended solids concentrations in wastewater from three meat processing enterprises and municipal wastewater. The table shows that the fat concentration in the wastewater from meat processing industry averaged 1,268 mg/l, which is 31.7 times higher than the value of the same indicator in domestic wastewater. It is also seen that concentrations of COD, BOD and suspended solids in wastewater from meat processing industry averaged respectively 1367 mg/l, 1700 mg/l and 1780 mg/l, which is respectively 5.5, 9.4 and 16.2 times higher than the concentration of the same indicators in domestic wastewater [2, 4, 5, 6].

Problems of wastewater treatment in meat processing industry arise due to the non-specific behaviour of fats under different conditions: sticking, colmatation of filter loading, slippage at elevated temperatures, at the same time fat-containing wastewater is a hotbed of bacteriological hazard, which requires the introduction of certain technological stages of

disinfection in the treatment process. Moreover, fats contain fatty acids, which react with metals, as a result of which there are special requirements for the structures involved in the treatment [3, 7].

Table 1

Average values of wastewater pollutants [2, 4, 5, 6]

Indicator	Concentration, mg/l			
	Enterprise 1	Enterprise 2	Enterprise 3	Municipal wastewater
Fats	1304	1300	1200	40
COD	1700	1600	1800	180
BOD	1391	1480	1230	250
Suspended solids	1740	1300	2300	110

The wastewater pollution depends on the type of raw materials, the assortment of products produced, the specificity of the pollution source — the workshop, the equipment and detergents used, and compliance with the technological regulations [1].

In Table 2 presents the main pollution sources in the meat processing plant. As can be seen from the Table 2, each of these workshops is a source of wastewater pollution by fats. The largest amount of fat comes from the slaughterhouse, as this is where the primary washing of carcasses and animal intestines takes place [1].

Table 2

The main sources of pollution [1]

Pollution source	Main pollutants
Slaughterhouse	Fat, sand, blood, fodder residues, caninga particles, hair and other
Meat processing plant	Fat, remains of raw materials (meat), sand
Sausage processing plant	Particles of fat, meat, blood, protein, small quantities of nitrite, nitrate and salt

3. RESULTS

In view of the above, each plant and/or individual plant has to be treated individually in an individual local treatment plant.

First of all, because of the property of fatty acids to react with metals, the wastewater must be neutralised. For pre-treatment, grease traps should be included in the scheme. A grease trap is a tank in which grease floats to the top during the passage of the liquid and is separated by means of vacuum units or pumps. In this case, it is important to choose the right temperature — not more than 40°C — and keep it in check, as the lower the wastewater temperature, the faster the fat solidifies and the faster the separation of liquids. After the pre-treatment stage at the grease trap the amount of solid and coarse fat particles is reduced by about 60% [3, 8].

Fats in wastewater can also be in an emulsified state. To remove these fats from wastewater mechanical treatment is not sufficient, so for their removal use physical and chemical treatment methods, such as coagulation, flocculation, dissolved air flotation, sorption, etc. The most effective technology is dissolved air flotation, which is used in combination with pre-coagulation. During coagulation the charges of the pollutant particles are neutralized, as a result of which the particles are no longer repelled from each other and are blended into larger compounds, most of which can be captured by water filters. The remaining contaminants are removed already in the flotator. In the treated water, reagent flocs are formed on which the smallest grease particles "stick". The flocs are brought to the surface by the dissolved air under pressure. Foam and flocs are removed from the surface by a scraper mechanism. This combination enables the water to be 98% grease-free, which complies with the regulations permitting discharge into the municipal sewer system [3].

Fat particles that are in the effluent in a fine, colloidal or dissolved state are better treated by biological treatment methods. These methods are based on the ability of microorganisms to use dissolved organic matter as a nutrient medium. Their advantage is that they do not produce hazardous secondary wastes, which need to be disposed of. Activated sludge completely break down organic substances — including fats — into gaseous substances and water. This completes the natural cycle. Thus, organic pollutants are not concentrated into new substances and do not change their form. The efficiency of the biological treatment process lies in the fact that the main active part, the activated sludge, can be produced and recycled. The activated sludge has a high tendency to form flakes. The flakes represent dead parts of organisms,

sorbed molecules of organic substances and living microorganisms. The sludge in the form of flakes can be easily settled and separated from the treated water. The activated sludge with adsorbed impurities is regenerated for reuse or disposal. After biological treatment, the water is disinfected and discharged into a natural water body. Efficiency of biological purification for fats is over 99%, for COD — up to 78%, for BOD decrease — 73–79% and for suspended solids removal — up to 98% [3].

Thus, a complete wastewater treatment process of meat processing plant, which contains fat in solid and coarse dispersed state, in emulsified state and in fine dispersed, colloidal or dissolved state should include the stages presented in the scheme below in Figure 1.

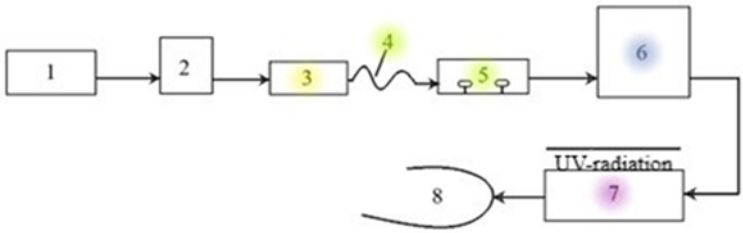

Figure 1. Scheme of fat-containing wastewater treatment:
1 — aredder, *2* — grid, *3* — grease trap, *4* — coagulation,
5 — dissolved air flotation, *6* — biological treatment tank,
7 — disinfection, *8* — water body

First, the wastewater enters the averaging unit, this is necessary to ensure the stabilisation of the incoming flow. This is followed by a coarse mechanical treatment stage using a grid, where large organic and mineral impurities are extracted from the water. The effluent then enters the grease trap where solid and coarse fat particles are extracted. This is followed by coagulation and dissolved air flotation to remove emulsified fat from the wastewater. The water then enters a tank designed for biological treatment, which removes fats in a fine, colloidal or dissolved state. As a result, over 99% of fats of various states are removed from the water. The final stage of treatment is the disinfection of wastewater under ultraviolet rays.

4. CONCLUSIONS

The wastewater treatment from a meat processing plant is a complex process for a number of reasons. The main difficulty is the presence of fat in these wastewaters. Fats can be in several different states: solid and coarse, emulsified as well as fine, colloidal and dissolved. For each of these states there are fundamentally different technologies for wastewater treatment. In this article the methods of treatment of wastewater containing fat in each of the presented states have been considered, and the scheme of treatment of wastewater including fat in all states has been proposed.

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THE IMPACT OF THE OIL REFINING INDUSTRY ON THE ENVIRONMENT

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Abstract: The article presents the results of the assessment of carbon and toxic footprint of the life cycle of various types of energy carriers of modern vehicles. The stages of the life cycle of energy carriers along the entire technological chain from the extraction of raw materials to the production of commercial products were determined. A comparative analysis of the full life cycles of various energy carriers in the motor transport sector was carried out. The absolute and specific emissions of CO2 and pollutants in the life cycle chain of motor transport energy carriers per kilometer were calculated. The study reveals the environmental benefits of using gas as a transport fuel.

Key words: oil refining, alternative fuels, gas motor fuel, full life cycle, toxic footprint.

INTRODUCTION

The largest enterprises of the energy complex that have a negative impact on the environment include oil refineries that provide the export market with a wide range of primary and secondary petroleum products. The problem of the activities of such enterprises is associated with their significant potential of a technogenic nature, which has an increased level of environmental danger. Given the deterioration of the socio-economic conditions of people's lives, the problem of improving the state of the environment is becoming especially urgent. Unfortunately, approaches aimed at reducing the amount of pollution are often carried out by reducing the level of production.

It should be noted that the fuel and energy complex accounts for more than 40% of the total pollution among all sectors of the economy. At the same time, the oil refining industry is one of the most dangerous sectors of the economy. This has a negative impact on the natural environment, disrupting its regenerative potential.

METHODOLOGY

To ensure maximum recovery in the process and prevent large discharges of cleaning fluids into the drainage system of oily wastewater, a sufficient storage capacity for cleaning fluids is needed.

In order to prevent the ingress of contaminated water into the soil and groundwater, waterproof tanks are needed for the storage of wastewater and hazardous materials.

If the installation contains aggressive and acidic wastewater from demineralized water treatment, they must be eliminated before being discharged into the wastewater treatment system.

Sludge treatment may include application to the soil (bioremediation) or solvent extraction followed by burning of the residue and/or use in asphalt or cement kilns, if possible. In some cases, the residue must be stabilized before removal to reduce the leachability of toxic metals. In the absence of treatment, hazardous sludge from oil refineries must be disposed of to a safe landfill in accordance with the hazardous waste management procedure.

RESULTS

The verification and classification of technological waste into non-hazardous and hazardous is carried out either in accordance with local legislation or according to internationally recognized approaches.

Pollution can be controlled and prevented by introducing a variety of technological processes and monitoring the natural environment with international, national, industrial labeling.

Emergency liquid releases can be controlled through periodic inspections and maintenance of storage and transportation systems, including pump packaging, valves and other potential leakage points, as well as the implementation of spill control plans.

CONCLUSIONS

The main problems of environmental protection activities at the enterprises of the oil refining industry are: emissions into the environment, treatment and pumping of operational waste water, handling of hazardous materials, noise from the working blowing.

Also, for the implementation of this activity, huge injections of funds are needed for the modernization of equipment and environmental audit at the enterprises themselves.

It is necessary to introduce various technological processes and environmental monitoring with industrial, national and international labeling helps to prevent and control pollution.

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CONSIDERATION OF SOLAR ACTIVITY BY DETERMINING PARAMETERS OF THE GENERATION SYSTEM BASED ON RES

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Abstract: Renewable energy is widely used to provide electricity to consumers isolated from the centralized power supply. When introducing a new renewable energy sources unit into the existing power system, it is necessary to determine its optimal parameters and the equipment co-located with it, including the energy storage system. The article presents the specifics of taking into account the criterion of solar activity when determining the optimal parameters of a new generation system based on renewable energy sources.

Key words: renewable energy sources, energy storage system, optimization problem, daily load schedule, daily generation schedule, analysis, optimal parameters.

1. INTRODUCTION

A promising area of application of units based on renewable energy sources (RES) are individual power consumers isolated from the

centralized power supply system (operating in isolated or autonomous mode).

There are three ways to provide them with electricity:

- firstly, by creating a technical possibility and direct connection to the main power system (grid connection);
- secondly, by installation of local generation — diesel generator;
- finally, by installation of local generation — RES unit and associated equipment, including energy storage system (ESS).

The need for joint installation of RES unit and ESS is due to the inconstancy of electricity generation by RES units due to natural reasons (dependence on changes in weather conditions during the day and the seasons of the year).

Of the three options listed above, the most promising is to provide electricity to consumers isolated from the centralized power supply – by installation of local generation (joint installation of RES unit and ESS). Providing a grid connection is usually very expensive. The installation of local generation — diesel generator, is also expensive, especially for consumers located in remote areas, as well as environmentally unfriendly.

When introducing RES unit into the existing power system, it is necessary to determine its optimal parameters and mode of operation, taking into account the impact on the mode parameters of the power system [1].

2. METHODOLOGY

In order to assess the impact of RES unit on the mode parameters of the power system, a software product based on a proprietary optimization algorithm is used. Mathematical calculations of the algorithm are based on the iteration method of calculating power flows and losses through the communication lines (the program realization of the algorithm is made in JavaScript language and represents an independent software product, the certificate of registration of the program for the computer № 2022611224 from 21.01.2022 was received). The study was conducted on the example of a test scheme — 15 bus IEEE.

3. RESULTS

Hereinafter, we will refer to solar panels as RES unit. Let’s show how important it is to take into account the real value of the criterion of solar activity for a particular area when solving the optimization problem

of determining the optimal parameters of jointly installed RES unit and ESS. Optimal parameters of RES unit itself were determined by the authors earlier in [2] using the proprietary optimization algorithm: installation location — node 3, power of the unit — 718 kW.

Since the investigated scheme is a test one, there is no information about the geographical location of this energy district and the nature of the load located in the nodes. Assume that the selected RES unit operates according to a typical (idealized) schedule of solar panel generation, typical for the summer season [3] and a typical daily load schedule for the case of generalized load. The resulting graphs are shown in Figure 1.

After which a real schedule of solar panel generation was plotted according to the data obtained from an autonomous solar power plant located at the Grozny carbon test site (Figure 1). Comparison and analysis of the resulting graphs indicate that the available excess solar panel output for the real daily schedule is less than for the idealized one by about 20%.

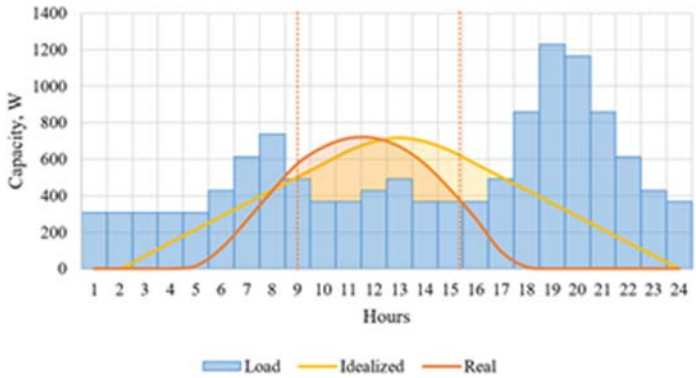

Figure 1. Daily schedules of solar panel output (idealized and real) and daily load schedule

4. CONCLUSIONS

Thus, we can conclude that when solving the optimization problem of choosing the optimal parameters and mode of operation of RES unit and ESS it is necessary to take into account the criterion of solar activity by the value of appropriate correction factors for the correctness of

calculating the value of available excess generation capacity of RES unit and, respectively, the assumed capacity of ESS.

ACKNOWLEDGEMENTS

This work was performed as part of TPU's Priority 2030 Strategic Academic Leadership Program (Priority-2030-NIP/EB-022-1308-2021).

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ENERGIE VON FESTEN BRENNSTOFFEN. PROBLEME UND ENTWICKLUNGSPERSPEKTIVEN

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Inhaltsangabe: Die Zunahme der Bevölkerung führt zum höheren Energieverbrauch. Da die fossilen Energiebrennstoffen beschränkt sind und dabei negative Auswirkungen auf die Umwelt haben, ist es nötig möglichst schnell das Problem zu lösen.

Stichworte: nachhaltige Entwicklung, BIP, echter Fortschrittsindex, fester Brennstoff

1. METHODEN

Bei der Erforschung wurden die Daten analysiert und verglichen.

2. EINLEITUNG

Die Untersuchung dieses Themas ist sehr relevant, da mit steigendem Energieverbrauch die Energieressourcen erschöpft sind, sich

negative Auswirkungen auf den Zustand der Umwelt und ihrer Komponenten ergeben und soziale und geopolitische Bedrohungen auftreten. Zum Beispiel hat sich der Energieverbrauch seit Beginn des 20. Jahrhunderts um das 15-fache erhöht, da er in allen menschlichen Aktivitäten verwendet wird.

1. Fester Brennstoff

Betrachten wir verschiedene Arten von festen Brennstoffen:

1. Steinkohle. Steinkohle besteht aus vielen chemischen Elementen, so wie Kohlenstoff, Wasserstoff, Schwefel, flüchtige Substanzen usw., die mineralische Verunreinigungen enthalten. Einige Substanzen, die Steinkohle enthält, sind sehr giftig. Die Verarbeitung von Kohle durch Vergasung ist die effizienteste Art der alternativen Verarbeitung von Steinkohle. Als Ergebnis dieses Prozesses werden Wasserstoff und Kohlenmonoxid gelehrt, nach katalytischen Reaktionen tritt die Bildung von flüssigem Brennstoff auf. Mit industriellen Verfahren können verschiedene Chemikalien wie Zink, Blei, Vanadium, Schwefel oder Germanium aus Steinkohle gewonnen werden. Auch in einigen Betrieben werden Abfälle aus der Verarbeitung oder Gewinnung von Steinkohle verwendet, ein Beispiel ist die Herstellung von Keramik oder Baustoffen. Daher kann man daraus schließen, dass Steinkohle als fester Brennstoff in vielen Bereichen des menschlichen Lebens verwendet wird.

2. Braunkohle. Als Ergebnis der Destillation wird aus dieser Art von festem Brennstoff ein flüssiger Kohlenwasserstoffbrennstoff hergestellt. Auch Ruß kann aus dem Rest der Destillation gewonnen werden. Zum Beispiel gibt es derzeit einen Mangel an metallurgischen Brennstoffen und Koks-Produkten, und gerade die Verarbeitung von Braunkohle kann dazu beitragen, die Situation zu verbessern. Diese Verarbeitung ist wirtschaftlich vorteilhaft, weil der Gewinn aus der Produktion die Kosten für Braunkohle übersteigt.

3. Torf. Diese Art von brennbarem Festbrennstoff wird als Ergebnis von Ansammlungen der Moosresten gebildet, die sich in Sümpfen unvollständig zersetzen. Torf enthält in seiner Zusammensetzung mindestens 50% organische Verbindungen. Torf hat als fester Brennstoff mehrere Nachteile, zum Beispiel aufgrund seines hohen Feuchtigkeitsgehalts ist es schwer zu verbrennen und zeichnet sich auch

durch einen niedrigen Heizwert aus. Die Vorteile der Verwendung von Torf als Brennstoff sind ein kleiner Ascherückstand, die umweltfreundliche Verbrennung, denn der Schwefelanteil darin zu niedrig ist.

4. Brikettbrennstoff. Diese Art von Festbrennstoff wird durch Sintern von Kohle- oder Torfpartikeln unter Druck und hoher Temperatur gewonnen. Zahnspangen sind Torf- und brauneckig. Torfbrikett wird aus rohem Torf hergestellt, zu dem Bindemittel hinzugefügt werden, dann getrocknet und unter hohem Druck verarbeitet werden.

5. Koks ist ein fester Rückstand, der durch die Destillation von Stein- und Braunkohle gewonnen wird, es gibt keinen Sauerstoffzugang. Diese Art von festem Brennstoff gibt es in verschiedenen Arten: Kohle-Koks und Gaskoks. Nicht so oft, aber immer noch verwendet, brennbarer Schiefer, Bitumen und Bituminosand.

3. ERGEBNISSE

Probleme der Festbrennstoffenergie. Bei der Erforschung kamen folgende Probleme zur Licht. Ein Problem ist die Erschöpfung von Energie und Elektrizität, da sie nicht erneuerbare natürliche Ressourcen sind und ungleich auf dem Planeten verteilt sind.

Bereiche, die das Problem der Festbrennstoffenergie betreffen:

• Wirtschaftliche

Es wurde schon oben erwähnt, dass diese Ressourcen erschöpft sind und sehr ungleichmäßig auf dem Planeten verteilt sind. Um diese Situation zu verbessern, ist es notwendig, die Energieeffizienz zu erhöhen und Technologien zur Gewinnung von Energie aus erneuerbaren natürlichen Ressourcen zu entwickeln.

• Politische

• Soziale

Auch die ungleichmäßige Verteilung fester Ressourcen beeinflusst politische Beziehungen, es gibt oft Versuche, Energieressourcen gewaltsam zu übertragen. Länder mit hohen Energieressourcen leiden ebenfalls darunter, denn wenn sie nur auf Kosten der natürlichen Miete leben, wird dies große negative Auswirkungen haben.

• Ökologische

Mehr als 50% der Treibhausgase werden jedes Jahr aus Energieanlagen in die Atmosphäre ausgestoßen. Es gibt auch eine Kontamination der Lithosphäre, Beispiele dazu sind Goldschäfte, die Schwermetalle enthalten können. Die Hydrosphäre wird auch

kontaminiert, wenn beispielsweise warmes Wasser in Gewässer abgegeben wird, tritt eine Störung des Sauerstoffgleichgewichts auf und das Wasserobjekt wird mit Algen überwuchert. Treibhausgasemissionen wirken sich negativ auf das Klima aus, weil die Lufttemperatur ansteigt.

Daher kann man schließen, dass die Festbrennstoffenergie eine große Anzahl von Problemen hat und sich höchst negativ auf die natürliche Umwelt und alle Komponenten auswirkt.

Perspektiven für die Entwicklung von Festbrennstoffenergie

Die Entwicklung der Kohleenergie hat durchaus gute Aussichten, weil es derzeit eine große Anzahl von Kohlevorräten gibt. Aber heutzutage können sogar die besten verfügbaren Technologien diese Art von Kraftstoff jedoch nicht umweltfreundlich machen. Derzeit haben etwa 30 Länder einen schrittweisen Verzicht auf die Verwendung von Kohle in der Energiewirtschaft unterzeichnet, um den Zustand der Umwelt zu verbessern. Die meisten Prognosen gehen davon aus, dass die Erzeugung von Energie aus Kohle in der Welt in naher Zukunft deutlich zurückgehen wird, aber die Kosten für Kohle werden weiterhin unter den Kosten für Gasstrom liegen, so dass die Entwicklungsländer weiterhin ihre Kohleauslastung erhöhen werden.

4. SCHLUSSFOLGERUNGEN

Der Energieverbrauch steigt jährlich an, da er in allen menschlichen Aktivitäten verwendet wird. Zu den wichtigsten Energiequellen gehören feste Brennstoffe, fossile Brennstoffe, Kernenergie und erneuerbare natürliche Ressourcen. Der größte Teil der Energie wird jedoch mit festem Brennstoff erzeugt. Energie auf festen Brennstoffen wirkt sich negativ auf den Zustand der Umwelt aus. Es gibt auch negative Auswirkungen auf Lebewesen. Auch fester Brennstoff ist die Ursache vieler politischer Konflikte. Die Entwicklung von Festbrennstoffenergie hat nicht die besten Zukunftsaussichten, da die Entwicklung von Energie aus erneuerbaren Energien eine umweltfreundlichere und kostengünstigere Option sein wird. Da feste Brennstoffe jedoch ein bisschen billiger als Rohstoffe sind und in vielen Ländern verwendet werden, müssen derzeit die besten verfügbaren Technologien entwickelt werden,

um die negativen Auswirkungen der Festbrennstoffenergie auf die Umwelt und die Gesundheit von Lebewesen zu reduzieren.

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DIE AUSWIRKUNG VON PLASTIKVERPACKUNGEN AUF DIE QUALITÄT VON ARZNEIMITTELN

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Inhaltsangabe: Der Artikel befasst sich mit Aspekten der Verwendung von Kunststoffverpackungen für Arzneimittel in der Russischen Föderation. Besondere Aufmerksamkeit wird der Frage der Sicherheit für die menschliche Gesundheit bei der Verwendung verschiedener polymerer Materialien und Methoden zur Bestimmung des Auftretens geschenkt.

Stichwörter: verpackungsmaterial, arzneimittel, polymeres material

1. EINFÜHRUNG

Die pharmazeutische Industrie ist einer der wichtigsten Produktionsbereiche für das Leben der Gesellschaft. Jedes Jahr werden viele Arten von Arzneimitteln hergestellt, die sich nicht nur in ihrer biochemischen Zusammensetzung und ihren Eigenschaften, sondern auch in ihrer Form unterscheiden. Um diese Eigenschaften und die höchste Qualität des Arzneimittels zu erhalten, gelten in vielen Ländern besondere Anforderungen an die Primär- und Sekundärverpackungen, in denen sich das Arzneimittel befindet.

Für die Zulassung eines Arzneimittels zum Verkehr in der Russischen Föderation ist zunächst eine spezielle Expertise erforderlich, dass mehrere Parameter des Arzneimittels bewertet, wie z.B.: die verwendeten Wirk- und Hilfsstoffe, die bei der Herstellung verwendeten Verpackungsmaterialien, die physikalischen und chemischen Eigenschaften der Substanzen, die technologischen Bedingungen des Arzneimittels (Druck, Feuchtigkeit, Stabilität der Formulierung und Freisetzung des Wirkstoffs), usw. [1]. Bis vor kurzem bezog sich dieses Fachwissen jedoch nur auf den Hauptwirkstoff des Arzneimittels und nicht auf die Qualität der Hilfsstoffe und die Verpackung des Endprodukts selbst.

In der Europäischen Union ist es gemäß den Leitlinien für die Erstellung des Registrierungsdossiers eines Arzneimittels erforderlich, bei der Registrierung Informationen über die Untersuchung der Wahl des polymeren Verpackungsmaterials sowie über seine verschiedenen physikalischen Eigenschaften (Licht- und Feuchtigkeitsbeständigkeit, Sorption der Substanz durch das Verpackungsmaterial und seine Verträglichkeit mit dem Arzneimittel) anzugeben. In der Russischen Föderation unterscheiden sich die Anforderungen an die Spezifizierung und Prüfung von Kunststoffverpackungsmaterial für Arzneimittel derzeit nicht allzu sehr von den Anforderungen der Europäischen Union und zwingen den Hersteller, Informationen über die Bestandteile der Verpackungen und Verschlüsse sowie Nachweise über deren Eignung, Sicherheit und Stabilität anzugeben [1].

Besondere Aufmerksamkeit wird den Präparaten geschenkt, die durch Inhalation oder parenteral verabreicht werden und in flüssiger Form vorliegen, da diese Formen von Arzneimitteln den höchsten Feuchtigkeitsgrad aufweisen und daher am stärksten verschiedenen Wechselwirkungen und chemischen Reaktionen ausgesetzt sind, auch mit dem Verpackungsmaterial, in dem das Fertigarzneimittel gelagert wird. Zu den Auswirkungen zwischen der Verpackung und dem Arzneimittel gehören die Auslaugung von Chemikalien aus der Verpackung und ihren Bestandteilen, die Absorption und Adsorption von Bestandteilen durch Verpackungsmaterialien, chemische Wechselwirkungen, die Zersetzung des Verpackungsbehälters bei Kontakt mit der Substanz usw.

Dennoch bleibt die Frage nach den Auswirkungen von Kunststoffverpackungen auf Arzneimittel und das Qualitätsmanagement nicht nur

der Wirk- und Hilfsstoffe, sondern auch der Verpackungsbehälter und Verschlüsse selbst offen.

2. METHODOLOGIE

Der im Staatlichen Arzneibuch der Russischen Föderation veröffentlichte allgemeine Arzneibuchartikel OFS.1.4.2.0006.15 „Unsichtbare mechanische Einschlüsse in Darreichungsformen zur parenteralen Anwendung“ beschreibt Methoden zur Bestimmung von mikroskopisch kleinen (Größe kleiner als 100 µm) unlöslichen Partikeln in festen und flüssigen Darreichungsformen zur parenteralen Anwendung. Diese Methoden dienen unter anderem dazu, das Vorhandensein von Partikeln in der Kunststoffprimärverpackung, in der sich das Arzneimittel befindet, festzustellen. Für Darreichungsformen, die durch Inhalation verabreicht werden, gibt es derzeit keinen allgemeinen Arzneibuchartikel in der Ausgabe XIV von 2018.

In dem Artikel werden drei Analysemethoden für 10 µm- und 25 µm-Partikel vorgeschlagen, darunter die fotometrische Zählmethode, die Methode der elektrosensiblen Zone und die Elektroskopiemethode. Die Wahl der Methode hängt von der Form ab, in der das Arzneimittel vorliegt. Die zähl-photometrische Methode ist nicht für trübe Darreichungsformen oder Formen geeignet, die beim Durchlaufen der Messzelle Luft- oder Gasblasen bilden. In einem solchen Fall wird die Mikroskopiemethode angewandt. Die Methode der elektrosensitiven Zone ist nur für Emulsionen geeignet, nachdem die Zubereitung mit einem Lösungsmittel verdünnt wird, das auf der Grundlage der gesetzlichen Vorschriften ausgewählt werden muss. Die einzige Einschränkung bei allen drei Methoden ist die hohe Viskosität des Prüfpräparats, daher muss für die Prüfung eine Verdünnung mit dem vorschriftsmäßig gewählten Lösungsmittel vorgenommen werden [2].

3.ERGEBNISSE

Es ist bemerkenswert, dass das staatliche Arzneibuch 2018 mit OFS.1.1.0025.18 „Verpackung, Etikettierung und Transport von Arzneimitteln“ einen ausführlichen Artikel enthält, in dem grundlegende Begriffe und Definitionen zur Verpackung und ihrer Klassifizierung festgelegt sind. In früheren Ausgaben gab es einen Artikel, in dem lediglich die grundlegenden Sicherheits- und Stabilitätsanforderungen an Verpackungsmaterial ohne weitere Erläuterungen erwähnt wurden.

Zum ersten Mal wird offiziell zwischen den Begriffen Primärverpackung (Innenverpackung) und Sekundärverpackung (Außenverpackung) unterschieden. Die Primärverpackung muss in direktem Kontakt mit dem Arzneimittel stehen und es vor Umwelteinflüssen schützen und kann auch als System für den einmaligen Transport des Arzneimittels (Dosierhilfe oder Aerosol) dienen[3]. Auch die Arten und Formen von Verpackungen werden beschrieben, einschließlich der Materialien, die für die Verpackung verwendet werden können. Die polymere Zusammensetzung von Verpackungen ist in der pharmazeutischen Industrie weit verbreitet und kann in Ampullen, Zylindern, Flaschen, Spritzen, Behältern, Beuteln, Fläschchen usw. vorkommen.

Die als Primärverpackung verwendeten Materialien sollten in Übereinstimmung mit den GMP-Vorschriften freigegeben werden und dürfen nicht zu einem Verlust des Arzneimittels durch Diffusion, Absorption oder Adsorption führen[3].

Polymere Werkstoffe dürfen nur aus bestimmten, vom russischen Gesundheitsministerium zugelassenen Materialien bestehen, insbesondere Polypropylen, Hoch- und Niederdruckpolyethylen sowie Polyvinylchlorid, Polystyrol und Polyethylenterephthalat. Das Verpackungsmaterial kann verschiedene Zusatzstoffe in Form von Stabilisatoren, Weichmachern, Farbstoffen usw. enthalten, die neben dem Basispolymer an das Arzneimittel abgegeben werden und mit diesem reagieren können.

Kunststoffverpackungen haben einige Vorteile gegenüber Glasverpackungen, da sie flexibel und leicht sind und nur schwer zerbrechlich sind. Es ist jedoch zu beachten, dass solche Verpackungen halbdurchlässig sind, was das Risiko des Eindringens von Feuchtigkeit, Licht und Luft in das Arzneimittel erhöht und daher anfälliger für Abbau und Freisetzung von Mikroplastik in das Arzneimittel ist.

4. SCHLUSSFOLGERUNGEN

Derzeit werden der Qualität und Sicherheit der bei der Herstellung von Arzneimitteln verwendeten polymeren Werkstoffe besondere Aufmerksamkeit gewidmet, da sie in direktem und unmittelbarem Kontakt miteinander stehen, was bedeutet, dass eine unzureichende Kontrolle dazu führen kann, dass gefährliche Chemikalien in das Arzneimittel und den menschlichen Körper gelangen. Das russische

Kontrollsystem ähnelt den Kontrollmethoden in der Europäischen Union, ist aber nicht so streng in seinen Anforderungen an die Prüfung der Sicherheit, Stabilität und Wirksamkeit von Verpackungsmaterialien.

In der Russischen Föderation gibt es Methoden zur Bestimmung verschiedener unlöslicher Verunreinigungen in parenteral verabreichten Arzneimitteln, aber Arzneimittel, die auf anderen Wegen in dem Körper gelangen, insbesondere inhalativ verabreichte Produkte, werden aufgrund ihrer Anfälligkeit für verschiedene Umweltfaktoren übersehen. Es ist wichtig, darauf hinzuweisen, dass alle Verpackungsmaterialien in Übereinstimmung mit den gesetzlichen Vorschriften ausgewählt werden, die eine Liste der in der pharmazeutischen Industrie zugelassenen Polymermaterialien enthalten, aber das Problem der Freisetzung verschiedener chemischer Verbindungen wie Phthalate, Phenole, Chlorwasserstoff, einschließlich Mikroplastik, deren Auswirkungen auf den menschlichen Körper nicht vollständig erforscht sind.

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GREEN BUILDING

JUSTIFICATION FOR CERTIFICATION OF BUILDING MATERIALS. ASSESSMENT OF VOC CONTENT IN VARIOUS BUILDING MATERIALS

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Abstract: The article focuses on the need for certification of the use of building materials for room design and engineering design in general. Numerous types of building materials have been evaluated for their emissions of highly volatile organic compounds, which are a risk factor for human health.

Key words: certification, volatile organic compounds, risk factor, VOC emission, indoor air quality.

1. INTRODUCTION

Certification of building material plays an important role in the maintenance of both human health and environment. Passing the procedure of certification of building materials proves compliance of building materials with the norms, which are approved by the legislative state organizations, in certain documents.

The purpose of this paper is to review recent research into one certification system to define limitations and assessment of the use of volatile organic compounds in the production of materials.

This paper investigates the importance of environmental certification of building materials to define the safest product for our housing and work.

Environmental certification is carried out in order to ensure the environmentally safe implementation of economic and other activities on the territory of the Russian Federation. Therefore, this procedure is

designed to protect the consumer from dangerous products, provide reliable, objective and accurate information about their quality and environmental safety, freeing the buyer from the need to carry out a complex and time-consuming procedure of evaluation of the goods. Environmental certification addresses a number of critical challenges in managing natural resources, protecting the environment and human health from the harmful effects of potentially hazardous products or services.

In 2010, the National Bureau of Environmental Standards and Ratings (NBESR) and Russia's leading environmental auditor, the EcoStandard Group, developed a new standard for environmentally friendly building and finishing materials, the EcoMaterial standard. It was created in accordance with the legislative framework of the Russian Federation, taking into account the recommendations of the World Health Organization, US GBC (US Green Building Council), the requirements of international regulations REACH and CLP, complies with ISO 14000 environmental management standards and regional European methods, taking into account the legal and market characteristics of Russia.

It is within the framework of EcoMaterial that the building materials, the VOC content in them will be considered.

2. METHODOLOGY

Case studies have been long established in various scientific magazines and books to present detailed analysis of EcoMaterial 2.0 certification method.

The study uses qualitative analysis in order to gain insights into description of details of construction of building materials. The initial sample consisted of 6 different kinds of building and finishing materials, all of whom belonged to Russian production.

The present paper covers emissions of VOCs from gypsum boards, tile adhesive, linoleum, mineral wool, plastic windows and putty.

The methodological basis of the work was the study of various building materials in the climatic chamber according to the GOST standard. [3]

The climatic chamber that was used in the study is CM 1040-120 CF (TBxC) in which certain conditions were maintained, namely: the air temperature was 20 C, the air humidity was 50 ± 3% and the saturation was 1m2/m3, and the size of the samples were 0.4 ± 0.02 m2, and the

concentration of substances itself was determined by VOC emission using a gas chromatograph.

The VOC concentration in the chamber is obtained by analyzing air samples taken from the chamber exhaust. After the system reaches an apparent equilibrium (the concentration at the chamber exhaust does not increase any more), the dynamic desorption period starts whereby the VOC supply is stopped while the chamber is continuously flushed out by the clean air.

The data was plotted and compared to one another. The process was repeated several times in order to remove mistakes and inaccuracy.

During the analytical work, an analysis of regulatory documents was carried out (Sanitary rules and norms of SanPiN 1.2.3685-21 "Hygienic standards and requirements for ensuring the safety and (or) harmlessness of environmental factors for humans", GOST 17177-94, GOST R ISO 16000-5-2009 and GOST R ISO 16000-9-2009).

3. RESULTS

The samples of building materials were tested for the content of 39 volatile organic substances, it turned out that of the 39 studied VOC indicators, 10 belonged to the 2nd hazard class, 19 indicators — to the 3rd, and the remaining 10 — to the 4th. Moreover, at least 7 VOC indicators belong to the class of carcinogenic.

The most striking result to emerge from the data is that in the samples studied by the author, there was really no excess of air pollutants.

Presented data of concertation of VOC is shown taking into account the error.

It should be noted that most of the VOC content in the samples was clearly less than the area of determination of the gas chromatograph in the climate chamber (>0.0005 mg/m3 or >0.1 mg/m3 for ammonia and >0.003 mg/m3 for formaldehyde).

The VOC content in the samples in the study does not exceed 0.3 mg/m3 and is within the limits of the maximum permissible concentrations of substances in the air.

Research has shown that pollutants from floors, ceilings and walls have a negative impact on IAQ in buildings. Numerous building materials emit VOCs.

Overall, these results indicate that there are more opportunities to work further in this topic. Further studies, which take these variables into account, will need to be undertaken.

4. CONCLUSIONS

The main goal of the current study was to determine the importance of controlling the emission of hazardous pollutants into the indoor air from building materials.

The results of this investigation show that that all tested samples do not exceed the maximum single maximum permissible concentrations of substances established by GOST. However, this only shows the responsibility of the manufacturer of materials, since environmental certification is a voluntary event and officially confirms or not the environmental friendliness of the product life cycle

More research is needed to better understand when implementation ends and work on the disadvantages of every certification system reported.

In conclusion, certification in construction materials is an important procedure that every manufacturer of construction products should go through, since only certified products can be adequately represented on the market and gain consumer knowledge.

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LEGAL AND ECONOMIC FRAMEWORK FOR ENVIRONMENTAL MANAGEMENT

ECONOMIC LIMITATION MITIGATING CLIMATE CHANGE

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Abstract: The impact of climate change reduces the possibility of controlling the greenhouse effect. Policymakers, agents and environmental activists promoted the science ideology of carbon capture for the general public. Economic limitation mitigating climate change can hamper or influence systematic management resources including modern information technologies and techniques that would help solve the climate change issues. This article aims at explaining possible economic limitations mitigating climate change in various areas of the world. Carbon capture has newly surfaced in reports educating the public on agricultural practices that have a potential to support and improve CO_2 problems and combat the greenhouse effect. Nevertheless, science ideology of carbon capture is yet to be properly developed and carefully analyzed, and there are many uncertainties as to how farmers, stakeholders, companies, and governments can carry out the practices described in carbon capture without so much complications. Significantly it is important to understand the economic importance of such practices.

Key words: economic limitation, climate change, ecology, carbon farming

1. INTRODUCTION

Climate change has been causing devastating effects. The worsening condition of the natural environment is viewed as a significant risk to

human safety. This risk relates to intensifying exposure to communicable and contagious diseases, lack of clean potable water, food shortage, and natural disasters. Change in the natural habitat brings about the negative effect on human health as natural existing microorganisms responsible for specific functions in the ecosystem perish causing instability in the environment. Since the early 20th century changes have been observed in the Earth's climate which are largely driven by anthropogenic activities increasing heat-trapping greenhouse gas levels in the Earth's atmosphere, raising the Earth's temperature.

Natural processes also contribute to climate change, including internal variability. To bring the average earth's surface temperature back to normal, science driven ideological method such as carbon capture has been suggested and is being implemented. One of the various options of carbon capture is carbon farming. Carbon farming can be practised individually or jointly. Decreasing the level of soil degradation through a method called no-till cultivation lowers carbon emission from the soil into the atmosphere. Creating environmental standards that encourage genuine and existential changes in carbon ought to obtain financial supports.

Practising shifting cultivation, soil mulching, planting legumes, and cover crops allow to keep more carbon in the soil, nurture and support soil microorganisms that are important in carbon storage and protect the topsoil from heat and erosion. Carbon is stored in soil due to the process called soil carbon sequestration. Plant materials decompose due to activity of soil microorganisms and create soil carbon-based matter which traps and sequesters CO2 from the environment. High levels of carbon-based matter indicate a nutritious soil, adequately meaning the soil can store a large amount of carbon. This nutritious soil is rich and loamy compared to sandy or lose soil. Bush burning, erosion, land clearing and deforestation for mining, construction projects and agricultural purposes deprive soil of carbon-based matter, consequently bringing about more CO2 release into the atmosphere.

Carbon dioxide capture and storage deals with fossil fuels loopholes by reducing CO2 emissions to near zero. It can produce power when needed. Global costs of CO2 extraction may be difficult for individuals to grasp. CO2 cost of extraction per person for national emissions, based on the lower limit of Keith is estimated to cost $123//tCO2 [1]. The current annual cost to extract all of the annual emissions is of the order of $1,000 per person per year in developed

countries and the cost is twice regarding developing countries, about $600/person/year on global average.

2. ECONOMIC IMPORTANCE OF CARBON

Researchers have discovered that chemically converting CO2 into fuel or other products or practising carbon farming might influence greenhouse gas emissions. The economic value of lowering CO2 emissions can be beneficial for further existence of life. The Environmental Protection Agency has projected the value of climate pollution mitigation efforts from three recent vehicle rulemakings at between $78 billion and $1.2 trillion [2]. The social cost of carbon is a measure of the economic harm from those effects, expressed as the dollar value of the total damage from emitting one ton of carbon dioxide into the atmosphere.

The current central estimate of the social cost of carbon is over $50 per ton in today's dollars. While this is the most robust and credible figure available, it does not yet include all of the widely recognized and accepted scientific and economic effects of climate change [2]. Carbon-rich soil encourages cultivation by improving soil health and increasing crop yields. Crop yields aid us to understand food security and also explains why cost of farm products is higher one year and then lower the following year. Farming practice covers over half of the Earth's surface and somewhat affects one-third of global greenhouse gas emissions.

3. ECONOMIC LIMITATION OF CARBON CAPTURE AND MITIGATING CLIMATE CHANGE

There are practical and functional difficulties such as how to classify and compare the measure of emission reduction. Analyzing different economic limitations of greenhouse gas capture and storage, it is very important to compare the measure of how many emission cutbacks can be reached and the cost for such. For example, transforming CO2 into other carbon compounds such as methane or ethanol, to be used as fuel, or ethylene for polymers, has methods to achieve such transformations including photochemical, electrochemical, thermo-catalytic or photothermal processes. These processes have limitations such as low efficiency. For instance, very high temperature is needed for the thermal process, and not very high-value chemical products are indeed produced, this affects the photo process.

The global voluntary carbon market is predicted to be valued at more than $50 billion by 2030 [3]. At a cost of $400–$500 million per unit, commercial technology can capture carbon at roughly $58.30 per metric ton of CO2, according to the DOE analysis [4]. Expertise is required and going with the ideology that the problem of climate change can be solved with only renewable energy is practically not feasible. Lack of qualified human resources in the field of research on climate change is a substantial hindrance. All major projects including the Kemper project are connected with the problems of cost, knowledge, expertise needed to achieve the goal including the resources for further scientific research. No doubt, the use of fossil fuel is far much cheaper than the cost of the research work, technology involved in reducing greenhouse gases. Regarding the economy of most developing countries and developed countries, it is impossible to invest in the technologies and science of carbon capture.

4. CONCLUSION

Ecological changes that precisely influence the state of human health and environment include the rise in temperature. Environmental degradation caused by anthropogenic activities is the main reason natural environment is compromised in some way, bringing about a reduction in biological diversity and the general health of the environment at large. Carbon capture promises to help combat climate change but has limitations. Carbon capture and storage (CCS) facilities sometimes break down, the dysfunctional compressor motors force the facilities to shut down for several months. Carbon capture and storage is too expensive and doesn't capture 1 million tons of CO2 annually as seen in the case of facility attached to the Boundary Dam Power Station, near Estevan, Canada. The level of the climate change challenge is so large, we need as many options as possible, including renewable energy, nuclear and carbon capture. Carbon capture is generally too expensive and developing various options of low-carbon energy ought to be a better approach to climate change.

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ENVIRONMENTAL AND LEGAL LIABILITY IN THE FIELD OF RADIOACTIVE WASTE MANAGEMENT IN RUSSIAN FEDERATION AND ABROAD

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Abstract: The article presents the results of a comparison of environmental and legal liability in the field of radioactive waste management in the French Republic, the Russian Federation and the Republic of Korea. In addition, based on the experience of foreign countries, recommendations are given in order to improve the efficiency of responsibility in this area in Russia.

Key words: ecological and legal liability, radioactive waste, radioactive waste management, environmental code, criminal code, code of administrative offenses.

1. INTRODUCTION

Climate change was named "the defining issue of our time" by the UN. And because of the target of declining amount of CO_2 in the atmosphere and reaching "zero" point by 2050 we can expect a steep rise in nuclear energy numbers. This in turn leads to increase in radioactive

waste volume and, possibly, in violation rate in the field of radioactive waste management.

2. METODOLOGY

In this work, analysis, comparison and structuring of the assessment materials of the legislative framework of three countries were carried out: France (environmental code), Russia (Criminal code and Administrative Code), Korea (Radioactive waste management law No. 15082).

3.RESULTS

Under environmental liability, we will consider legal liability for offenses related to non-compliance with the legislation in the field of environmental protection.

After a detailed analysis of the regulatory documents, a comparative characteristic was carried out. Firstly, the most obvious difference is in the papers that establish liability. In Russia, this is the criminal code and the code of administrative offenses. In France, the basis for the application of liability is the Environmental Code, in the Republic of Korea — the Law on the Management of Radioactive Waste № 15082. In Russia, responsibility is spelled out in four articles. It would be vised to mention here that article 247 of Criminal Code "Violation of the rules for handling environmentally hazardous substances and waste" includes not only radioactive waste, but also bacteriologically and chemically hazardous waste [3].

Secondly, in these foreign countries, there is no differentiation of responsibility by subject: individuals, legal entities, officials bear equal responsibility for crimes, when in Russia this division is described.

In addition, the Environmental code of France is not anthropocentric, it does not contain indications of harm to human life and health, when the laws of the Russian Federation and the Republic of Korea clearly prescribe these circumstances as aggravating. It is noteworthy that France does not distinguish between the crimes. The fine in the French Republic for these acts is 68 times higher than in Russia and 5.3 times higher than in South Korea [4, 5]. It is noteworthy that in general, the legislation of Korea prescribes more stringent measures for violation of the legislation in the field of radioactive waste management. It becomes obvious that in Russia fine system is mild.

Based on the analysis the following proposals were developed in order to improve the efficiency of the application of responsibility in the field of radioactive waste management in our country.

In our opinion, the best option would be the creation of an environmental code, which will be the main document regulating environmental activities in the Russian Federation. The French Republic created its Code through incorporation. This scenario is also acceptable for Russia.

The system for identifying causal relationships, especially in the field of offenses related to radioactive waste, is not that straightforward. And therefore, in our opinion, many cases are not fully disclosed, and liability is charged only in the form of fines (Fig. 1).

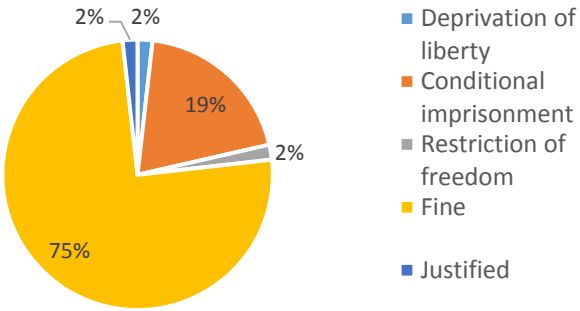

Figure1. Responsibility for violation of Article 247 of the Criminal Code of the Russian Federation 2016–2020

Multifractality of the natural environment components isn't the only problem. We also face the issue that lies in the lack of knowledge in the bodies considering these acts. That is why the creation of competent narrowly focused bodies that deal only with the disclosure of cases related to violation of legislation in the field of environmental management is important.

It is also a big omission that there is no separate fund that would receive funds for environmental protection and would specialize in its restoration. Paragraph 22 of Article 46 of the Budget Code of the Russian Federation establishes that payments for claims for damages are transferred to the budgets of the governing bodies at the place where the

damages are recovered [1]. However, this is not enough since the funds may not be spent on the restoration of the environment.

Also, based on the experience of South Korea, it is necessary to single out liability for violations in the field of radioactive waste management in a separate article of the law. Unfortunately, our legislation does not make such distinctions. Firstly, it will provide an opportunity to change or even reorient sanctions for violation of radioactive waste management. Secondly, the ability to clearly trace the statistics.

4. CONCLUSIONS

The legal basis for the application of environmental liability in France are the provisions of the Environmental Code. In Russia, all offenses in this area are enshrined in three articles of the Criminal Code (Articles 236, 237 and 247) and one article in Code of Administrative Offenses (Article 8.2.2.) [2,3]. In the Republic of Korea, this is the Law on the Management of Radioactive Waste № 15082.

The main differences in the legal regulation of the application of liability in the management of radioactive waste in the three countries were identified, at first, in branches of law. In Russia, this issue is referred to the field of criminal and administrative law, while in France and the Republic of Korea it is a branch of environmental law.

Secondly, in the differentiation and severity of punishments. Thus, in the considered foreign countries, individuals, legal entities and officials bear equal responsibility, while in Russia the amount of punishment for all subjects is different.

And finally, in the approach to considering the target object of protection. Unlike the legislation of the Russian Federation and the Republic of Korea, the Environmental Code of France is not anthropocentric.

The following proposals for increasing the effectiveness of the application of responsibility in the field of radioactive waste management in Russia can be mentioned: creation of the environmental code of the Russian Federation; allocation of responsibility for violations in the field of radioactive waste management into separate articles; establishment of law enforcement bodies specializing in environmental and legal liability; creation of a state structure responsible for restoring the state of the environment.

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LEGAL ISSUES OF COMBATING UNAUTHORIZED DUMPS: CASE-STUDY OF THE KOSINO-UKHTOMSKY DISTRICT OF MOSCOW

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Abstract: Unauthorized dumps of production and consumption waste pose a particular threat to the environment. Citizens can help to combat them. The article tells people how to distinguish an unauthorized dump from an authorized landfill and gives a frame of measures that need to be taken for legal counteraction to illegal dumps.

Key words: Unauthorized dumps, landfills, legal counteraction, a citizen's scheme of action.

1. INTRODUCTION

One of the most pressing environmental problems is the accumulation of various types of waste in authorized and unauthorized locations. Unauthorized dumps of production and consumption waste pose a particular threat to the environment.

With the growth of production, the amount of waste increases and it is necessary to organize landfills, so that waste does not cause more harm, but also landfills not in specially designated areas, which are called unauthorized landfills. Also, development and growth of cities inevitably leads to increase in quantity of different wastes, and this inevitably leads to increase in landfills and also leads to formation of unauthorized landfills in urban areas. The relevance of the topic is that unauthorized dumpsites are being generated in increasing numbers every year and knowing how to deal with them, under the current legal framework, is essential [1–2].

The purpose of the work is to develop a system of legal counter-action to unauthorized dumps by citizens.

The work included the following tasks:

1. Analysis of the legal framework in the field of waste management.

2. Investigation of an unauthorized dump by the example of the Kosino-Ukhtomsky District in Moscow in autumn 2021 (Fig. 1).

3. Analysis of legal actions of citizens to stop illegal dumping.

Figure 1. Unauthorized landfill in Kosino-Ukhtomsky District of Moscow in autumn 2021 (marked in red)

2. METHODOLOGY

The unauthorized dumpsite we investigated is located in the Kosino-Ukhtomsky District and has an area of 44000 square metres. The

land on which this unauthorized landfill is located is classified as inhabited land.

Saltykovsky Woodland Park and Kosinsky Natural-Historical Park are located in the vicinity of the unauthorized dump site. The parks are rich in flora and fauna. There are also numerous lakes and rivers in the surrounding area.

The unauthorized dump site poses a risk of contamination of the surrounding unique territories and poses a danger to human life, as there are many residential areas close to the dump [3].

The unauthorized dump in the Kosino-Ukhtomsky District of Moscow was set up in autumn 2021 in an area not designated for this purpose.

For the first time, attention to this unauthorized dump was drawn on November 10 by Kosino-Ukhtomsky environmental activist, who managed to get behind the fenced area and fix the fact of dump formation, rubbish delivery to the area, called the police to register the violation of the current legislation in the field of waste management.

When the police arrived, they were not given any permits for waste management activities. Eventually, the police officers demanded that the operation be suspended, but a few days after the police stopped the work, the unauthorized dump resumed operation.

In large numbers, residents of the district began to write complaints to the state authorities, such as the prosecutor’s office, Rospotrebnadzor, and the Moscow mayor's website. Also, citizens and activists spread information about the unauthorized dump in social media and various online resources.

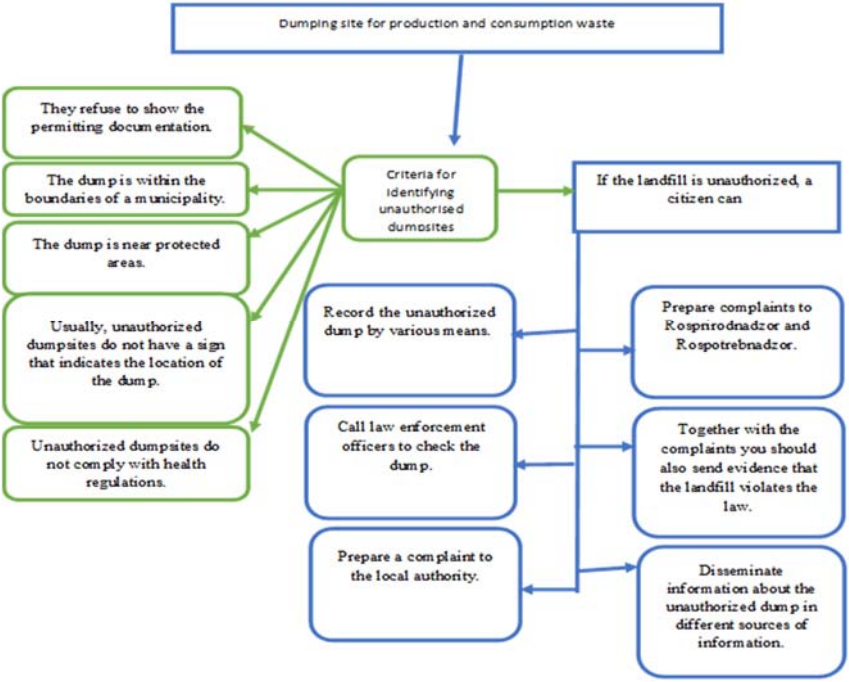
In mid-November, thanks to the activity of the residents and a deputy, the mass media and law enforcement agencies turned their attention to the dump.

On November 28, the prosecutor’s office came to the place of the unauthorized dump and started inspecting it. As a result of the inspection, the prosecutor’s office found multiple violations, such as the lack of a license, a sanitary protection zone, drainage, and wastewater treatment facilities. Eventually, the prosecutor’s office stopped the work of this unauthorized dump, and the facility was sealed.

In March 2022, they began removing rubbish from the dump to begin work on eliminating this unauthorized dump.

Table 1

A citizen's scheme of action when an unauthorized dump is discovered



3. RESULTS

Based on the case of unauthorized dumping in the Kosino-Ukhtomsky district, it is possible to draw up a scheme of citizens' actions when an unauthorized dump is detected.

When detecting a place of waste accumulation, a citizen should distinguish an unauthorized dump from an authorized one. Five criteria can be defined for this [4]:

1. They refuse to show the permitting documentation.
2. The dump is within the boundaries of a municipality.
3. The dump is near protected areas.
4. Usually, unauthorized dumpsites do not have a sign that indicates the location of the dump.
5. Unauthorized dumpsites do not comply with health regulations.

If the landfill is unauthorized, a citizen can:

- Call law enforcement officers to check the dump.
- Record the unauthorized dump by various means.
- Prepare a complaint to the local authority.
- Prepare complaints to Rosprirodnadzor and Rospotrebnadzor.
- Together with the complaints you should also send evidence that the landfill violates the law.
- Disseminate information about the unauthorized dump in different sources of information.

4. CONCLUSIONS

Thus, the legal framework in the field of handling unauthorized dumps was considered; the case of counteracting unauthorized dumping in the Kosino-Ukhtomsky District of Moscow was studied; legal actions of citizens to stop the work of illegal dumps were analyzed; a system of legal counteraction of citizens to unauthorized dumps was worked out [5].

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ELIMINATION OF ACCUMULATED ENVIRONMENTAL DAMAGE

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Abstract: Objects of accumulated environmental damage are land plots that have been contaminated with production and consumption waste, abandoned real estate, liquid, radioactive or other harmful substances, or disturbed due to mining or irrational land use. The purpose of this work is to study the basic principles of organizing the elimination of accumulated environmental damage on the example of the Krasny Bor landfill, as well as to formulate recommendations for improving the legislation.

Key words: accumulated environmental damage, landfill, legal regulation, environmental expertise.

1. INTRODUCTION

Objects of accumulated environmental damage are land plots that have been contaminated with production and consumption waste, abandoned real estate, liquid, radioactive or other harmful substances, or disturbed due to mining or irrational land use.

The main causes of accumulating environmental damage (AED) are the following:

– accelerated socio-economic development
– intensive extraction of natural resources
– a large concentration of industrial production
– a high degree of wear and tear of equipment and facilities.

AED objects negatively affect all components of the environment: soil, water, air. These objects contain harmful substances that are unsafe for human life and health.

Thus, we need some methods for eliminating accumulated environmental damage to reduce the negative impact on the environment and restore disturbed natural ecological systems [1–2].

2. METHODOLOGY

In our work, we studied the norms of federal legislation, other regulatory legal acts controlling relations in the field of elimination of accumulated environmental damage. We also analyzed foreign experience in the field of legal regulation of accumulated environmental damage elimination [3].

The work on the elimination of an accumulated environmental damage object was analyzed by the example of the "Krasny Bor" landfill.

3. RESULTS

3.1. Objects of Accumulated Environmental Damage

The very definition of "accumulated environmental damage" is not yet legally recognized. However, it is possible to characterize AED objects as land plots of all types and categories that have been contaminated with production and consumption waste, abandoned real estate objects, liquid, radioactive or other harmful substances, or disrupted due to mining or irrational land use. As a result, they can no longer be used and pose a threat to human life [4].

Figure 1. Objects of accumulated environmental damage in the Russian Federation

At present, 340 AED objects have been identified in the Russian Federation (Fig. 1). According to the estimates of the Ministry of Natural Resources of Russia, they occupy an area of 77.6 thousand hectares. The main problems of the current legislation in the field of the elimination of accumulated environmental damage objects are its fragmentary development and incomplete coverage of legal problems. The key problems associated with AED objects are:

– refusal of subjects from obligations

– insufficient financial guarantees for obligations to compensate for environmental damage and

– elimination of accumulated environmental damage objects [5].

3.2. The example of the "Krasny Bor" landfill

The Krasny Bor landfill can serve as an example of a dangerous object of accumulated environmental damage. It is located 6 km from Kolpino. Over 50 years of operation, about 2 million tons of waste and 3 million tons of secondarily contaminated soils have been disposed of there (Fig. 2).

The elimination of the landfill is planned to be carried out in several stages:

– Preparatory stage. Covering open maps.

– The main stage. Constructing an anti-filtration curtain along the landfill perimeter. Also, building infrastructure for the neutralization of liquid waste maps.

– The final stage. Recultivation of closed landfill maps [6].

Figure 2. The layout of "Krasny Bor" polygon

3.3. Proposals for improving legislation

1. For a more effective solution to the problems of negative environmental impact (NEI) it is necessary to explain the signs of objects more clearly. To this end, it is proposed to supplement Article 80.1 of the Federal Law "On Environmental Protection".

2. Another problem is that the project documentation for the elimination of NEI facilities is not included in the list of objects of environmental expertise. It is proposed to amend the Federal Law "On Environmental Expertise".

3. For a prompt elimination of NEI facilities, it is necessary for legal entities and individuals to be interested in eliminating the negative impact on the environment. It can be motivated by providing preferential conditions for the use of land plots and other natural resources.

4. CONCLUSIONS

1. Analysis of some examples of regional regulation of AED facilities has shown that accumulated environmental damage slows down the development of regions, reduces their investment attractiveness.

2. The foreign experience in terms of legal relations in the field of elimination of AED was analyzed. The research revealed common features in approaches to the legal regulation of relations in the field of AED elimination.

4. The analysis of the regulatory and legal bases for the implementation of AED elimination was carried out and some proposals were developed to improve the legislative framework, which should contribute to the reasonable and effective state support for the projects of AED elimination.

5. By the example of the Krasny Bor Landfill, a program for the elimination of an AED facility was assessed.

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INTERNATIONAL PRACTICES OF LEGAL REGULATION OF THE EXTENDED PRODUCERS RESPONSIBILITY (EPR) IN THE FIELD OF WASTE MANAGEMENT

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Abstract: This work is a comprehensive comparative assessment of the legal regulation of Extended Producer Responsibility (EPR) application in the field of waste management in Russia and abroad. The research introduced a general analysis of the legal regulations of EPR in Russia, Sweden and Canada as well as the comparative analysis of the advantages and disadvantages of their legal regulations. Moreover, special proposals were formed to improve the effectiveness of legal regulation of EPR mechanism in the Russian Federation based on its current shortcomings.

Key words: wastes, management, producer, importers, manufactures, environment, packaging, recycling, zero waste, legal regulation, Extended Producer Responsibility (EPR)

1. INTRODUCTION

Every year the modern society produces more and more waste, therefore the problem of regulation in the field of the waste treatment becomes more relevant than ever before. With the increase in the number of industries and industrialization, this problem will get worse and worse. In this regard, it is necessary to find and develop more modern and environmentally friendly ways to solve this problem. One of the ways to regulate is the legislative methods of controlling the amount of recycled goods and packaging in production facilities. This direction began to develop in 1974 [4], and the country that became the founder of the concept of extended producer responsibility is Sweden. In this case, the EPR should be understood as a mechanism of economic regulation, in which manufacturers and importers are obliged to recycle goods and packaging produced or brought into the territory of the country, after the loss of consumer properties [6].

2. METHODOLOGY

The purpose of the work is to carry out a comprehensive comparative assessment of the legal regulation of the application of EPR in the field of waste management in Russia and foreign countries. Proceeding from the goal, the following tasks were formulated and set:

1. To give a general characteristic of the state of legal regulation of EPR in Russia.
2. To analyze the international experience of EPR application (on the example of Canada and Sweden).
3. To identify the main advantages and disadvantages of the current EPR system in Russia in comparison with other countries.
4. To use the foreign experience so as to develop suggestions for increasing the effectiveness of the legal regulation of EPR in the Russian Federation.

As objects of research the systems of extended producer responsibility were chosen in three countries: Russia, Sweden and Canada.

Sweden is the founder of the EPR concept. Today it produces about 500 kg of waste per person per year [1], and more than 50% of waste is sent for recycling. This is all made possible by the introduction of closed-loop mechanisms, the EPR concept for producers and importers, and Sweden's commitment to zero-discharge technologies [5].

Canada ranks first in terms of the amount of waste produced, the concept of EPR was introduced relatively recently in 2009. Canada

produces 1 billion 325 million metric tons of waste per year, which is about 36 tons per person [6]. About 20% of the waste is recycled, but that doesn't mean that all the rest is landfilled. The rest of the waste is exported, which is why Canada is in the top 5 most environmentally friendly countries in the world.

Over the past 15 years, the Russian Federation has seen an increase in population [2]. Every year about 70 million tons of solid municipal waste is generated on the territory of the country, and this figure is increasing by 3% every year, so the implemented concept of EPR in 2015 can unload landfills, and also encourage producers and the population to recycle different kinds of waste [3].

It should be noted that the basic provisions of the EPR concept in Russia are: the responsibility of producers and importers of goods to recycle those goods they have produced and the packaging they have used when putting goods on the market; their responsibility to meet the established standards for waste recycling; the payment of an environmental fee if waste is not recycled [1]. Distinctive features of the Canadian EPR system from the Russian one: a clear distinction between such concepts as “waste” and “environmental fee”; responsibility for recycling activities lies only with the producers of goods and packaging; waste collection by the population on a voluntary basis (all without exception); implementation of the “pay as you throw” method for various waste (medical, electronics, old cars, etc.) [2]. A distinctive feature of the EPR concept in Sweden as the founding country of this mechanism is that the state is partially responsible for the implementation of the EPR mechanism (for transportation, collection and disposal) [6], while the manufacturer is responsible for the disposal and recycling of products not covered by the implementation of the concept [8].

We conducted a general analysis-characteristics of the legal regulation of EPR in the above countries. It turned out that the youngest and insufficiently mature concept of implementation was the system of EPR in the Russian Federation [5]. At the same time as the main disadvantages of the EPR system in Russia in comparison with Canada and Sweden can be called the following: the priority of fines from the supervisory authorities; the governments of Sweden and Canada are trying to solve the problems of recycling, dealing with the stage of the problem of recycling activities, not prioritizing the imposition of fines; also the lack of economic incentives for manufacturers and importers to implement recycling activities in a legal way and in full. The lack of

communication between the business community and the government on the issue of waste disposal in Russia is a significant disadvantage of the system in the RF in comparison with Canada and Sweden. In these countries, production is built in such a way so as to minimize the amount of waste produced and there is a transition to a closed cycle of production. In our country there is an acute problem of lack of technology and equipment for the disposal of various types of waste, while in Sweden and Canada the equipment for the disposal of various types of waste has been used for several decades and the results show the successful functioning of the implemented technologies. Sweden is the undisputed leader in this matter, since it accounts for only 0.7% of waste disposal The Swedes do not focus only on recycling. According to their policy, the first step in the waste management hierarchy is waste prevention [4].

3. CONCLUSIONS

As a result of the analysis it was found out that at the legislative level the EPR mechanism is established and functions at a proper level only in Sweden and Canada, in this connection the mechanism in the Russian Federation should be adjusted to the regulatory framework, taking into account the features, established in the legislative and executive authorities [6].

On the basis of the analysis the following improvements can be suggested:

1. Tax benefits Introduction.
2. Abolition of VAT on goods created from recycled products and waste.
3. Granting subsidized loans at minimal interest rates to industries and enterprises so as to facilitate the implementation of the EPR concept.
4. Creation of hubs to offload the waste management system.
5. Introduction of the system of waste redemption of from the population, for example, through the installation of collection points for a particular producer or association of producers, or special machines (for glass, plastic, etc.) [7].

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REPARATION OF ENVIRONMENTAL DAMAGE

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Abstract: Currently, the importance of environmental problems not only does not lose its relevance but is constantly increasing. Of particular importance are studies aimed at identifying, studying and expanding understanding of the modern approach to compensation for environmental damage. This article is devoted to the study of theory and legislation in this area. The study proposes to

identify possible actions that lead to negative consequences for the environment, as well as ways to compensate for them. The results of this investigation show: despite the fact that the legislation in this area is at a fairly high level of development, it is not without imperfections, which creates problems related to the possibilities of its effective application.

Key words: environmental damage, environmental pollution, environmental insurance, accumulated environmental damage, recultivation, compensation, legal regulation.

1. INTRODUCTION

The problem of compensation for environmental harm in environmental and legal science is given a lot of attention. However, in the theory of environmental law and environmental doctrine, there is no unified methodological approach to understanding the essence and specifics of this harm, as well as a unified approach to its measurement and evaluation.

The purpose of this article is to review recent research in the theory and law of environmental damage compensation. This article investigates the importance of improving legislation in the field of compensation for environmental damage.

This article investigates the importance of an accurate approach to compensate for environmental harm.

The relevance of the work, first of all, is due to the increased interest in environmental problems in the modern world and no less increased interest in one of the ways to solve them — development of a comprehension of legal ways to compensate for environmental damage.

Legislation continues to develop, establishing difficult and sometimes unexpected solutions, which forces us to turn to its analysis and understanding in order to contribute to the effective protection of rights and interests in maintaining favorable natural conditions [2].

The harm caused to the natural environment, and the harm caused by the adverse impact of this environment itself, is ecological by nature. Environmental harm is a negative change in the environment, as a result of its pollution, resulting in the degradation of natural ecological systems and the depletion of natural resources [1].

Since the natural environment around us is endless in its manifestations, the manifestations of environmental harm are also endless in their types and varieties. They can be expressed in the depletion of natural resources, and in their degradation, and in violation of eco-links

between natural objects, and in violation of the species ratio of natural elements of the environment. At the same time, with all the infinite variety of manifestations of types of environmental harm, they can be classified according to certain elements of similarity and varieties.

From the standpoint of the state of environmental and legal regulation, the following types of environmental harm can be distinguished [4].

1. Natural resource environmental damage, in which damage is done to natural objects, primarily their economically significant part. Because of this, legally significant signs of environmental damage caused to each of these objects are provided for in special natural resource laws — codes (Land, Water, Forest), in federal laws on subsoil, on wildlife, on the protection of atmospheric air.

2. Humanitarian environmental harm — a kind of environmental harm, expressed in causing it to a person who is the main object of environmental protection, since it is for him that all environmental activities are carried out.

3. Property environmental damage is distinguished by the fact that the affected objects have, generally, inorganic character: for example, hydraulic structures affected by floods; mining equipment damaged by an accident in mines, etc.

2. METHODOLOGY

The study uses analysis in order to gain insights into description of legal regulation of issues of compensation for environmental damage. This study is exploratory and interpretative in nature. The methodological basis of the work was the study of various studies on this topic.

There is a large volume of published research works describing the role of legal regulation of compensation issues for environmental damage.

Russian civil and environmental legislation enshrined the principle of compensation for environmental damage in full. This means that the victim must receive full compensation. The obligation to compensate for the damage lies with the tortfeasor. However, different persons and the state may participate in such compensation in different cases [3].

The decision on the choice of the method of compensation for harm is made by the court. Environmental legislation does not provide for the priority of real compensation for harm, which reduces the importance of the institution of compensation for harm in maintaining and preserving

favorable natural conditions. The essence of the problem lies in the fact that in many cases the tortfeasor is objectively unable to restore the disturbed natural conditions — to clean the water body from pollutants, plant the destroyed forest, restore the fish population [3].

Monetary compensation for environmental damage caused by damage or destruction of natural objects is calculated based on the losses incurred, i.e. the actual costs of restoring the disturbed state of the environment, as well as the lost profit, which refers to lost income that the victim could have received under normal environmental conditions if his right had not been violated. Determination of the monetary amount of the harm caused is one of the complex elements of the compensation procedure. The difficulty lies in the fact that natural objects do not have a pre-fixed price. Therefore, various methods are used to determine the harm caused and the amount of its compensation. Losses and lost profits are calculated using established methods and rates for determining damage, including using a cadastral valuation of natural resources, as well as by calculating the cost of restoration work [5].

3. CONCLUSIONS

The purpose of the current study was to determine the importance of improving legislation in the field of compensation for environmental damage.

The most obvious finding to emerge from this study is that compensation for environmental damage is an important tool for environmental protection. It is able not only to ensure a fair distribution of costs associated with maintaining favorable natural conditions, but also to stimulate environmentally correct behavior, influencing the economic interests of users of natural resources.

It was also shown that although the legislation in this area is at a fairly high level of development, it is not without shortcomings, which creates problems related to the possibilities of its effective application. Among them are the contradictory definition of the rights and obligations of state environmental management bodies to file claims for compen-sation for harm, the questionable effectiveness of the procedure for using funds received by the state in the form of compensation for causing environmental damage, technical difficulties associated with establishing a causal relationship between the offense and the consequences.

These findings enhance our understanding of some of the problems in the field of legal regulation of environmental damages. Solving these problems requires bringing the legislation into proper condition, as well as organizing practical actions for its implementation. It should also be specially noted that increasing the effectiveness of the institution of civil liability for environmental offenses depends not only on improving legislation, improving the activities of the judiciary, but also on the readiness of society to counteract environmental offenses, including using, where necessary, the mechanism of compensation for harm.

This research has thrown up several questions in need of further investigation. A natural progression of this work is to analyze proposals for improving the current legislation on compensation for environmental damage, including through the use of instruments of environmental insurance, the formation of the land registry (territories), subject to reclamation by type and directions to repair the damage, the empowerment of environmental organizations.

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PROBLEMS OF IMPLEMENTATION OF EXTENDED PRODUCER RESPONSIBILITY IN RUSSIA

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Abstract: After years of application, the existing system of extended producer responsibility has not created a significant economic incentive for the development of the waste management industry. A number of strictly Russian difficulties of this process have been identified. The paper considers the problems of implementing extended producer responsibility in Russian Federation.

Key words: waste management, extended producer responsibility, environmental fee.

1. INTRODUCTION

Consumerism and growing consumer expectations for choice and speedy fulfillment have accelerated the rise in trash. This has led the world's governments to consider new ways to regulate the treatment of end-of-life products and packaging of products. At this point it is important to look at the data. According to the Ministry of Nature Resources and the Environment of the Russian Federation, about 70 million tons of production and consumption waste is generated in Russia annually. Only 5–7% of waste is sent for recycling, the rest is stored or buried [1]. The growing area of landfills poses risks to public health and environmental safety.

In 2017–2018, the waste crisis exacerbated social tensions. In early 2019, large-scale protests took place in 30 regions of Russia. In the Moscow region alone, about 36,000 people took part in protests related to solid waste issue. Concerned about this, the Russian government began to reform the waste management system [2].

2. METHODOLOGY

In general, Extended Producer Responsibility (EPR) makes producers financially and/or physically responsible for disposing of end-of-life products and packaging of end-of-life products [3]. Organisation for Economic Co-operation and Development has given a good definition for this mechanism, but the experience of EPR application in

Russia differs significantly from foreign practice. Due to its institutional and historical characteristics, the Russian model of the EPR has its own characteristics and problems that are unique to it.

Therefore, the aim of this paper is to analyze the problems faced by producers in Russia.

Firstly, I considered the history of the trash problems. Next, I studied the regulatory-legal acts and by-laws of the Russian Federation, which regulate the waste management. Finally, the next step was a review of the systematic literature, which also helped to identify the main approaches of specialists to understanding the legislative language. Analysis of the specialized literature allowed to assess the current situation of EPR application and problems of EPR implementation in Russia, as well as to draw appropriate conclusions by analyzing the impact of economic instruments and regulation.

3. RESULTS

In 2014, a mechanism of extended producer responsibility was introduced in Russia. The government passed a bill under which manufacturers and importers of goods and packaging must ensure compliance with established standards for the disposal of waste from goods and packaging of goods that have lost their consumer properties (recycling standards) [4].

In practice, it is difficult to determine the exact number of entities that must dispose of their waste. According to expert estimates, over 160 thousand organizations in the Russian Federation produce and import goods. Rosprirodnadzor, which supervises the fulfillment of the obligation to comply with recycling norms, does not have primary information on the sale of goods. Therefore, many organizations find themselves off the books. According to the All-Russian public organization “Business Russia”, the number of business entities that use packaging can reach 4 million business entities [5]. The results point to an interesting statistic. It turns out that almost 98% of the number of obligated entities do not fulfill the obligation to dispose of their goods and packaging.

According to Federal Law No. 89 [6] producers and importers may choose how to fulfill their waste management responsibilities (Fig 1).

The manufacturer can organize the collection, sorting-transportation, recycling, and disposal of its used goods (option 1). But most often, the

producer makes an agreement and pays to outsource waste management to a third-party organization (option 2). In this way, the producer of the commodity relieves himself of the obligation to ensure the disposal of waste in the agreed amount. If the producer does not have the ability to arrange for recycling or disposal, he pays the environmental fee (option 3). However, in reality, the conditions for the full implementation of the EPR are practically non-existent for a number of reasons.

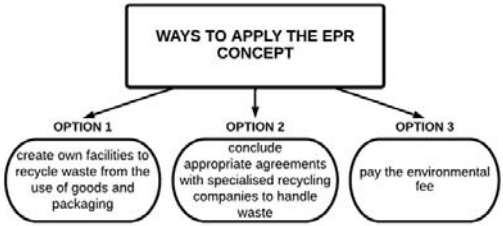

Figure 1. Tools for applying the EPR model

It is extremely disadvantageous for manufacturers to use option 1 and invest in infrastructure to recycle their used goods and packaging. Already at the stage of waste collection and sorting, there is confusion as to where the goods and packaging for which they are responsible begin and end. In addition, setting up a recycling facility requires a significant financial investment in unprofitable assets, which is not good for business. Therefore, manufacturers are looking for alternative ways to fulfill their responsibilities.

However, an analysis of the relevant literature revealed a number of facts of evasion of manufacturers and importers of goods and packaging from obligations under EPR by entering into fictitious contracts with industrial companies (option 2) for the disposal of waste. This leads to non-compliance with recycling standards, and insufficient efficiency of administration leads to low collection of the environmental fee [7].

According to the legislator's idea, the rates of the environmental fee (payment for failure to meet the recycling rate) should be of such a size as to encourage manufacturers to implement EPR on their own. However, the rates of the environmental fee are not high enough to encourage Russian manufacturers to create their own system of waste collection and recycling.

The situation is aggravated by the fact that recycling rates (the share of goods or packaging subject to mandatory recycling) are not high enough and average 15% [8], which also prevents the creation of an effective collection and recycling infrastructure. In addition, some types of packaging popular in the Russia are still not included in the list of goods subject to mandatory recycling, which means that neither environmental collection rates nor recycling norms are established for them. For example, multilayer packaging made of polyethylene terephthalate and various laminated paper cups. This creates a situation where packaging, which accounts for up to 50% of trash, often ends up in landfills, and the recycling capacity of waste processing plants is underutilized.

Nevertheless, a simultaneous increase in recycling rates and environmental levy rates does not seem adequate. An increase in the "price" for recycling goods and packaging can seriously affect the cost of production, which will ultimately affect the price of the consumer basket. The use of economic mechanisms to regulate extended producer responsibility will lose its meaning after reaching a certain maximum that consumers of goods and packaging can afford.

Thus, the implementation of extended producer responsibility in the Russian Federation turns out to be extremely ineffective.

4. CONCLUSIONS

The analysis of the Russian EPR system revealed some problems that hinder the effective functioning of the model. To date, no system for evaluating the effectiveness of the current extended producer responsibility model has been implemented, and there is a lack of proper administration and control over the fulfillment of obligations by the subjects.

The most important reasons are also the mismatch between recycling standards, the rate of environmental fees and the real costs of enterprises for separate waste collection. Low recycling standards and low rates of environmental fees do not encourage producers to develop the creation of waste recycling facilities.

At the same time, an increase in taxes and fees for the development of these purposes may cause a negative effect on the part of citizens. Consequently, the economic incentives for the introduction of EPR are not attractive enough to force manufacturers to switch to recycling of their goods and packaging. This demonstrates the ineffectiveness of the existing model of extend producer responsibility in Russia.

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MODELING OF THE SOCIO-ECOLOGICAL AND ECONOMIC SYSTEM OF THE CITY FOR THE DEVELOPMENT OF A SUSTAINABLE DEVELOPMENT STRATEGY

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Abstract: The article demonstrates the methodology of studying the model of the socio-ecological-economic system of the city and drawing conclusions

about the strategy of sustainable development based on it on the example of the city of Norilsk.

Key words: sustainable development of the city, sustainability, strategic planning, indicators of sustainable development, cognitive modeling, oriented graph.

1. INTRODUCTION

At the beginning of the XIX century, active modern urbanization began. The growth of cities contributes to the aggravation of environmental, economic and social problems. Urban areas located in the Arctic zone are particularly susceptible to anthropogenic impact. A sustainable development strategy is necessary for the effective solution of problems and the stable development of the city. A systematic approach is needed to create it. One of the effective ways to implement it is cognitive modeling. It allows you to predict the development and choose the most effective solutions for managing the socio-ecological and economic system.

For the sustainable development of the territory, it is necessary to develop a strategy taking into account the specifics of a particular city. In the course of strategic planning, goals and objectives are formed, activities are selected and a mechanism for their implementation is developed [1].

The creation of a sustainable development strategy is particularly relevant for single-industry towns of the Far North. Currently, interest in the northern territories of the country has grown. This is due to the expansion of the mining complex, the growth of industry, and the aggravation of environmental problems. The largest industrial city in the Far North is Norilsk [4].

2. METHODOLOGY

Indicators and their systems are needed to assess the sustainability of a city's development. The existing criteria systems can serve as a support for the development of a unique system of indicators for a particular city. When selecting sustainable development indicators for Norilsk, we used the most complete system of indicators – the basic set of indicators proposed by the UN Commission, consisting of 132 indicators [3]. During the selection of indicators, we took into account the regional characteristics of the city and the applicability of indicators to the assessment of urban areas.

At the same time, as a reference information, we used the strategy of socio-economic development of the municipality, which contains the results of the analysis of the current state and possible directions of development of the city [5]. In the concept of the Norilsk development strategy, the following priority goals can be identified: modernization of industrial enterprises, reduction of negative impact on the environment, creation of high-quality transport and social infrastructure, improvement of the quality of life of the population. However, nothing can be said about the comparative importance of these goals and the impact of their achievement on the sustainable development of the city.

To determine the strategy of sustainable development of Norilsk, cognitive modeling of the socio-ecological and economic system of the city was carried out. For this purpose, an oriented graph was created, the vertices of which are previously selected indicators of sustainable development. The digraph arcs show direct connections between the indicators. The signs show what effect the indicators have on each other. To study the quantitative characteristics of the model, statistical data on indicators for the period 2010–2021 were considered. To confirm the connection between the vertices, a correlation analysis of the data was carried out using the Spearman correlation coefficient. Next, the weights of the arcs were determined: part by direct calculation, part by regression analysis, and the rest by expert analysis.

To predict the development of indicators, we conducted a study of the digraph reaction to perturbations using the methodology of the group led by V.I. Gorelov [2].

3. RESULTS

During the calculation, we obtained the values of the system weights of the indicators (Table 1). They allow us to determine the level of stability of the system, its proximity to the crisis and development priorities.

The turnover of industrial production has the greatest influence in the system. For further sustainable development of the city, it is necessary to increase investment attractiveness, increase the turnover of industrial production, develop not only the mining sector of the economy, but also the manufacturing industry.

Also, the priority of development is to increase the overall VMP, which can be achieved not only through the development of industry, but also through the development of the service sector, including tourism.

Table 1

System weights of indicators of socio-ecological and economic system of Norilsk

Indicator	System weight
Population size	3,2613
Birth rate	1,0185
Migration growth	0,9135
Life expectancy	0,9642
Morbidity	–0,8620
Standard of living	3,2318
Unemployment rate	0,4320
Average salary	3,4200
Secondary and higher professional education	1,3423
Length of highways	1,2914
Municipal budget	1,2165
GNP per capita	5,8013
Trade turnover	3,0084
Industrial production turnover	7,3683
Tourism turnover	0,9974
Share of green spaces	0,9999
Atmospheric air quality	–1,1232
Emissions into the atmosphere	–1,9878
Energy consumption	–1,2457
Water consumption	–0,8117
Water quality	–0,9999
Environmental protection costs	0,5039
Generated Solid municipal waste	–0,4941
Share of disposed municipal solid waste	1,0024
Construction	0,1772
Number of people in dilapidated housing	–0,6369

An important indicator of the system is the population. One of the main problems of Norilsk is the decline of the population. To increase the attractiveness of the city, it is necessary to improve the urban environment, reduce emissions and discharges from industrial enterprises, and increase the standard of living of the population.

Emissions of pollutants into the atmospheric air have the greatest negative impact on the system. For the sustainable development of the city, it is necessary to reduce emissions of pollutants by upgrading outdated equipment, installing equipment for cleaning emissions.

The systemic crisis of Norilsk, expressed in the negative impact of the low unemployment rate on the socio-ecological and economic system of Norilsk, is revealed. For the sustainable development of the city, it is necessary to increase competitiveness to attract qualified specialists, increase the level of education of the population.

The identified priorities correspond to the goals of the existing socio-economic development strategy. However, the strategy of sustainable development of the city is somewhat broader. It takes into account not only social and economic aspects of development, but also environmental ones.

4. CONCLUSIONS

On the example of the city of Norilsk, the methodology of studying the model and drawing conclusions about the strategy of sustainable development based on it was demonstrated, however, due to incomplete initial information about the state and dynamics of the indicators of Norilsk, it is impossible to use the findings as a guide to action. More in-depth research and reliable statistical data are needed for high accuracy of forecasting and effective management of the system.

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ACTUAL PROBLEMS OF LEGAL REGULATION OF ENVIRONMENTAL AUDIT

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Abstract: The article deals with the legal regulation of the impact of enterprises on the environment through ecological audits. This practice is voluntary, so there are problems in the legal regulation.

Key words: ecological audit, Federal Law, incentives, environment.

1. INTRODUCTION

Currently, in all countries of the world the most important task is to ensure environmental safety, so the implementation of various kinds of control (primarily state) in this area is mandatory. In this connection the author has analyzed the composition of bodies of control, supervision, and audit measures in the field of ecological safety in RF.

The relevance of ecological audit at the Russian enterprises has economic, ecological, and social aspects. Three groups of factors compel the enterprise to decide about the environmental audit. Ecological, economic, and social reasons are often interconnected. Thus, environmental degradation leads to the degradation of the natural world, the destruction of ecosystems and the emergence of social problems of national health, the deterioration of the environmental quality of life, at the same time being a loss to the economy, as the enterprise incurs losses, paying for the emissions of harmful substances and environmental damage caused to the environment. The emergence of global environmental problems, such as pollution of air, water, soil, depletion of natural resources, can lead to the degradation of human civilization.

In accordance with Article 1 of the Federal Law “On environmental protection”, environmental audit is understood as an independent, comprehensive, documented assessment of compliance by a legal entity or an individual entrepreneur with requirements, including norms and regulatory documents, federal norms, and rules in the field of environmental protection, requirements of international standards and preparation of recommendations on improvement of such activities [1]. Based on this definition, the main purpose of the environmental audit is

to bring the activities of the enterprise in accordance with the requirements of legislation and environmental standards, development of recommendations for the optimization of the policy in the field of environmental management.

2. METHODOLOGY

Having analyzed textbooks and normative-legal acts, the basic information on the topic of the article was highlighted. The necessity of introducing environmental audit in the economic activities of enterprises is emphasized in the Fundamentals of State Policy in the field of environmental development of the Russian Federation until 2030, where it is presented as one of the leading mechanisms for implementing state policy in the field of ecology, environmental protection, and natural resource management [2]. Despite the importance that the environmental audit can have on ensuring a more rational use of natural resources, its legal framework is currently fragmented and limited. So, the current norms concerning environmental auditing are contained only in the mentioned Article 1 of the Federal Law "About Environmental Protection" [1] and in the Decree of the President of the Russian Federation "About the Classifier of Legal Acts", where it is assigned number 110.010.100 and where it refers to the types of auditing activities [3]. The order of conducting and mandatory nature of the environmental audit is not stipulated by the legislation on auditing activities, first by the Federal Law "On auditing activities" with the same name (hereinafter — Federal Law "On auditing activities").

3. RESULTS

3.1. Problems of legal regulation of eco-audit

The Federal Law "On auditing activities" is designed to regulate public relations connected with audits of financial (accounting) statements, although from its name it follows that it contains the norms of auditing activities in general. Application of the Federal Law "On Auditing Activity" to the relations connected with environmental audit does not seem possible, because it implies checking not only financial records of the enterprise, but also its production activity [4]. The question of the parameters, according to which the procedure of the ecological audit will be carried out, is not clear, because the norms about

environmental protection are located not only in the federal laws, but also in numerous departmental regulations. The international requirements for environmental safety and environmental protection — international standards ISO 14000 are also basic for the environmental audit [5].

All the above makes obvious the need for legal regulation of the environmental audit and the development of unified standards for its implementation.

3.2. Incentives for eco-audits

Incentives for introducing eco-audits into the economic activity of enterprises are supposed to be in the following variants. The first of them is the method of encouraging the voluntary regular application of the environmental audit. Thus, L.V. Chkhutiashvili's proposals seem expedient; she believes that a positive audit opinion can be used to postpone a planned audit by the state environmental oversight bodies for a three-year period; provision of an eco-auditor's opinion can serve as a basis for simplified determination of the norms of permissible environmental impact [6]. We see such a measure as effective for establishing tax exemptions for certain categories of taxes, for example, the tax on property of organizations.

The second method could be the establishment of cases of mandatory environmental audits. T Mandatory environmental audit is carried out in cases, directly established by normative legal acts of the Russian Federation in relation, as a rule, to ecologically dangerous enterprises and types of activity at [7]:

– privatization and bankruptcy of legal entities and citizens engaged in entrepreneurial activities, if their activities are environmentally particularly hazardous, including enterprises operating in the fields of nuclear energy and resource extraction;

– ecological insurance for the purpose of determining the rate or amount of insurance payments and (or) compensations;

– crediting of legal entities and citizens engaged in entrepreneurial activities by state banks;

– assessment of activities on liquidation of ecological consequences of accidents and natural disasters;

– decision-making by government agencies on renewal of licenses issued to legal entities and citizens-entrepreneurs engaged in operating environmentally hazardous facilities;

– performance of international obligations of the Russian Federation in the area of natural resources use and environmental protection;

– in other cases stipulated by regulatory acts.

Benefits for the state at development of toolkit of ecological audit are unconditional and give an opportunity [8]:

– obtaining independent information about the environmental characteristics of the enterprise's activities;

– reducing the load on the state budget at the expense of a considerable reduction in the number of controllers;

– improvement of quality of management of functions of environmental protection.

4. CONCLUSIONS

In our opinion, to improve the legal regulation of eco-auditing, it is the most expedient to revise the Federal Law "On Auditing Activities" and to allocate in it a general part containing the basic prescriptions for all types of auditing activities, as well as special parts concerning financial and ecological auditing.

In addition to revising the law, entrepreneurs must be encouraged, because it is companies that play the key role in affecting nature. It is for them that laws governing the relationship between human activities and the environment are created. Active application of ecological audit will promote realization of the rights of citizens to favorable environment, its protection from negative impact and more effective compensation of damage, caused to the environment by the activity of certain enterprises.

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BILDUNG DER BIOKAPITALQUOTE IM RAHMEN NACHHALTIGER ENTWICKLUNGSPROGRAMME IN RUSSLAND

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Inhaltsangabe: Der Artikel bietet eine knappe Beschreibung des Prozesses zur Bildung eines umfassenden Indikators (Genuine Progress Index), wonach Parallelen zwischen der Bildung des Diskurses über nachhaltige Entwicklung in Russland und der Notwendigkeit gezogen wurden, das umfassende Bewertungssystem für alle Kategorien der Nachhaltigkeit zu modernisieren Entwicklungsziele.

Stichworte: nachhaltige Entwicklung, BIP, echter Fortschrittsindex

1. EINFÜHRUNG

Das Thema Biodergation als globales komplexes Phänomen, bei dem die Zunahme der anthropogenen Auswirkungen auf die Umwelt eine Schlüsselrolle spielte, wurde erstmals 1972 im Bericht des Club of Rome „Die Grenzen des Wachstums“ angesprochen. Unter den Annahmen über die Ursachen und Gesetzmäßigkeiten der auf der Erde ablaufenden Prozesse im Bereich des Klimawandels wurde erstmals vermutet, dass das lineare Wachstum des Rohenergiesektors die Veränderung des Umweltzustandes beeinflusst. Gleichzeitig wurde das Problem immer weniger institutionalisiert, so dass Versuche, eine ausgewogene und wirksame globale Strategie zu entwickeln, zur Bildung des Konzepts der nachhaltigen Entwicklung führten, unter dessen Einfluss Disziplinen wie „Ökopolitik“ und „Green Economy“ oder „Umweltökonomie“ entstanden.

In den Folgejahren wurden sie parallel zu Umweltthemen zunehmend in Verbindung mit anderen Faktoren, wie zum Beispiel dem Bevölkerungswachstum und dem erhöhten Druck auf die Energiekomplexe der Welt, betrachtet und führten mit der umfassenden Entwicklung des Energiesektors zu einer quantitativen Erhöhung der Produktionsemissionen. 1983 wurde bei der Weltkommission für Umwelt und Entwicklung (Brundtlandt-Kommission) das Konzept der „nachhaltigen Entwicklung“ in den öffentlichen Diskurs eingeführt und implizierte einen Weg der wirtschaftlichen Entwicklung, bei dem die menschlichen Bedürfnisse befriedigt werden, ohne die Interessen künftiger Generationen zu unterdrücken.

Die Konferenz über Umwelt und Entwicklung 1992 in Rio de Janeiro markierte den Beginn einer aktiven Phase der Klimapolitik, deren Ausmaß weiter an Fahrt gewann, was sich im Kyoto-Protokoll 1997 und im Kopenhagener Abkommen 2009 niederschlug. Bis September 2015 wurden schließlich 17 Ziele für nachhaltige Entwicklung fertiggestellt und offiziell vorgestellt, die von der Pariser Klimakon-ferenz im November unterstützt wurden, wo die SDGs zum ersten internationalen Abkommen dieser Art zur Eindämmung des Klima-wandels führten.

Somit kann man derzeit mit Sicherheit sagen, dass sich die Entwicklung des Diskurses der „Nachhaltigen Entwicklung“ in einen Trend der sogenannten „Energiewende“ wandelt. Die Grundlage der aktuellen Energiewende liegt in der Bildung eines stabilen Verständnisses, dass die Befriedigung menschlicher Bedürfnisse ohne Schädigung des Ökosystems erfolgen muss. Durch den technologischen Fortschritt hat sich das Wirtschaftswachstum nach vielen Jahrzehnten des kontinuierlichen Anstiegs des Energieverbrauchs endgültig von der Dynamik des Energieverbrauchs gelöst. Die Mengen des Primärenergieverbrauchs haben sich in vielen Regionen (EU, USA, China) stabilisiert, in einigen Ländern (Großbritannien, Deutschland, Japan) begannen sie sogar mit steigendem BIP zu sinken.

Allerdings bleibt die Frage der direkten Interdependenz und Koordination von Programmen im Bereich der nachhaltigen Entwicklung derzeit offen. Angesichts der Verfügbarkeit einer Reihe von Indikatoren zur Bewertung jedes Themas aus der Liste der SDGs finden diese derzeit vor allem in der Praxis des strategischen Managements in privaten Unternehmen breite Anwendung, während sie in der Praxis des staatlichen und kommunalen Managements vor Ort breite Anwendung

finden der nachhaltigen Entwicklung wurden die ersten konkreten Schritte erst im Jahr 2020 eingeleitet. Gleichzeitig sind das BIP und seine Anpassung nach wie vor die wichtigsten makroökonomischen Indikatoren, auf deren Grundlage Entscheidungen getroffen werden.

2. METHODOLOGIE

Als Grundlage für die Bildung eines solchen BioCapital-Indikators kann der Indikator echten Fortschritts (GPI) [*Pearce D.W., Atkinson G.D.* Capital theory and the measurement of sustainable development: An indicator of "weak" sustainability // Ecological Economics. 1993. Vol. 8. P. 103–108.], der an folgenden Stellen anpasst:

1. Wenn im BIP die Kosten für die Beseitigung der Folgen von Umweltkatastrophen aufsummiert werden, werden diese Kosten im GPI abgezogen

2. Im BIP wird der Faktor der Erschöpfung nicht erneuerbarer natürlicher Ressourcen vernachlässigt und im GPI als Kostenfaktor positioniert.

3. Der GPI umfasst soziale Kosten, die im BIP vernachlässigt werden (im BIP führt der Kampf gegen soziale Geschwüre der Gesellschaft zu einem Anstieg des BIP): die Kosten der Kriminalität, die Kosten der Scheidung, die Kosten der Arbeitslosigkeit, die Kosten für Freiwilligenarbeit, die Kosten von Verkehrsunfällen usw.

Es lohnt sich auch, das hinzuzufügen Der GPI basierte auf dem Index of Sustainable Economic Welfare (ISEW) [Daly H. E., Cobb J. B. For the Common Good: Redirecting the Economy Toward Community, the Environment, and a Sustainable Future. – Beacon Press, 1989. – 534 p.], dessen Essenz darin besteht, die Abschreibung des Sozial- und Naturkapitals von den privaten Konsumausgaben so zu subtrahieren, dass die intertemporale Veränderung des Index einen echten Anstieg (oder Rückgang) der nationalen Wohlfahrt.

3. ERGEBNISSE

Bemerkenswert ist, dass das Dekret „Über die Genehmigung der Grundlagen der Staatspolitik im Bereich der strategischen Planung" vom 8. November 2021 das bereits bestehende Bundesgesetz Nr. 172-FZ vom 28. Juni 2014 ändert, was die Bereitschaft demonstriert des Staatsapparates, um die Methodik der strategischen Planung zu verbessern. Dies

ermöglicht es, die gemäß der Verordnung der Regierung der Russischen Föderation vom 11. November 2010 N 1950-r durchgeführten Programme sowie die neuen Programme, die durch die Regierungsverordnung Nr. 2816-r. festgelegt wurden, untereinander zu koordinieren vom 6. Oktober 2021.

Vorrangige Aufgabe für die strategische Planung von Projekten mit Bezug zu nachhaltigen Entwicklungszielen ist dabei die Bildung eines universellen Indikators, der den Zusammenhang von wirtschaftlicher Entwicklung, Technik, Energiewende, Gesundheitszustand der Bevölkerung, Natur Umwelt und die Noosphäre als Ganzes.

Der GPI-Indikator wird traditionell auf der Grundlage von 26 Indikatoren [*Talberth J., Cobb C. W., Slattery N.* The Genuine Progress Indicator 2006 : A Tool for Sustainable Development. — Oakland, CA : Redefining Progress, 2007. 33 p. — https://sustainable-economy.org/wp-content/uploads/GPI-2006-Final.pdf] gebildet, und die Vollständigkeit, Zusammensetzung der Daten und die Qualität der Erhebung statistischer Informationen sind in den verschiedenen Ländern unterschiedlich. Und da es keine einheitliche, universelle Methodik gibt, die es leicht macht, Schätzungen für beliebige Messobjekte (Länder, Regionen, Gemeinden) zu erhalten, erfordert jeder Koeffizient eine eigene Anpassung unter Berücksichtigung der Besonderheiten der statistischen Rechnungslegung, Forschungsergebnisse für einzelne Komponenten . Da es keine Studien über den Zustand der Regionen mit GPI gibt, erfordert ihre Umsetzung nicht nur die Erhebung der erforderlichen Daten, sondern auch eine umfassende Entwicklung und Begründung der Methodik zur Berechnung solcher Schätzungen.

4. SCHLUSSFOLGERUNGEN

Dieser Ansatz wird den dynamischen Bereich von GPI-Schätzungen ergänzen. Es wird vorgeschlagen, eine Software zu entwickeln, um die weitere Arbeit an der regelmäßigen Aktualisierung der GPI-Schätzungen zu unterstützen. Dieses Softwareprodukt wird die weitere Arbeit mit der Verwendung von GPI erheblich erleichtern, eine vollständige Visualisierung der erzielten Ergebnisse und die Möglichkeit zur Integration in das System der staatlichen Statistik bieten.

Es erscheint daher sinnvoll, in den SUP und UVP Verwaltungssystemen nicht weiter neue Haufen und Verzweigungen zu schaffen, sondern auf der Basis der bestehenden Infrastruktur in der Praxis damit

zu beginnen, die Ziele einer nachhaltigen Entwicklung zu verbinden, indem die wechselseitigen Korrelationen der Dynamiken gesellschaftlicher Wirtschaftsprozesse und die Umweltsituation sowie entsprechende Ländervergleiche durchzuführen.

Basierend auf der Analyse können Empfehlungen für die Verfolgung der Politik der nachhaltigen Entwicklung auf nationaler Ebene formuliert werden. Im Rahmen dieses Systems wird vorgeschlagen, den Zustand der Regionen, in denen das Wohlergehen, der Index der menschlichen Entwicklung und die Gesundheitsindikatoren der Bevölkerung in Verbindung mit Indikatoren des natürlichen Wohlergehens berücksichtigt werden, umfassend zu bewerten.

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METHODOLOGY FOR DEVELOPING AND CREATING ECOLOGICAL TRAILS

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Abstract: Ecological trails enable the involvement of the public in active environmental activities, promote environmental education of citizens, and have a favorable impact on the ecological state of the environment by minimizing the anthropogenic impact on the territory, which is relevant in conditions of high level of anthropogenic impact on the territory of the Russian Federation. This article discusses the methodology of development and creation of ecological

trails through a literature review of various relevant works. This study revealed a general approach to the design of hiking ecological trails. The criteria of attractiveness, accessibility and informational content and the importance of the biological, ecological-geographical, and historical significance of the trails were considered. Also, the components of the trail passport were listed.

Key words: ecological trail, environmental education, anthropogenic influence, tourism

1. INTRODUCTION

The relevance of the topic is explained by the fact that the environmental situation in the Russian Federation is characterized by a high level of anthropogenic impact on the natural environment and significant environmental consequences of past economic activities. The increase in the volume of tourist flows, in turn, leads to the need for rational environmental management and regulation of anthropogenic pressure on natural areas, especially near large industrial cities. The preservation of nature largely depends on an environmentally responsible outlook and ecological culture of a person. One of the most promising types of environmental education and upbringing is the organization of ecological trails.

2. METHODOLOGY

Systematic literature reviews (SLRs) are a scientific method to identify and summarize literature to address clearly defined research questions intended to reduce bias. The systematic search for and evaluation of data and materials is more precise than the traditional literature reviews and can lead to a high level of credibility regarding the proposed conclusion. Although the efforts were guided to eliminate bias from SLRs, it is not possible due to the involvement of different factors in a level of subjectivity. In SLRs, the methodology is explicitly expressed, allowing others to evaluate the author's assumptions, evidence, procedures, and conclusions. Some practical models guided this SLR research to assess the validity of findings and formulate discussion and decisions.

3. RESULTS

Before proceeding with the creation of a system of eco-trails in the reserve, it is necessary to study not only the natural conditions and remarkable objects, but also the type of existing recreational use (periods

of the most active visits, types of activities for vacationers, etc.). The length, purpose, and choice of the type of ecological path that is most suitable for given conditions will largely depend on this.

In Russia, there is still no standard for designing ecological walking routes, but you can rely on GOST R 50681–2010 “Tourism Services”. Designing tourism services”, which clearly articulates the stages of designing tourist trips. [7]

Having studied the literature on this topic, we can say that several authors offer a general methodology for designing an ecological trail. Many works describe the technique of Dashkova E.V. [1]

The first stage in the development of an ecological trail should be a sketch of an approximate route indicating natural objects that may become objects of tourist interest. Since ecological trails are mainly laid in specially protected areas, it is necessary to assess the load on this area, considering the timing of the tourist season, categories of tourists, types of tourist and recreational activities on the route, as well as the planned number of visitors. The length, purpose, and principle of building an ecological trail largely depend on this. Then you should draw up a preliminary scheme of the ecological trail. Consider the projects of the necessary equipment (paths, stairs, etc.) for this route, choose the design style of the ecological trail. It depends on local conditions. [1]

Under any circumstances, criteria such as attractiveness, content and accessibility remain unchanged.

The attractiveness of the ecological trail lies in the beauty of the landscape, the uniqueness of natural objects and their diversity (variety of tree species, outcrop of rocks, the presence of waterfalls, springs and lakes). In addition, for each ecological trail, you can choose an individual art style, which is used when creating bridges, crossings, parking lots, information stands, etc. [6]

The ecotrail should not be monotonous. When choosing a route and landscaping, it is necessary to alternate open and closed spaces. Characteristic landscapes should be replaced by ecotones, that is, transitional strips, such as a forest clearing, lake shore, terraced cliff, etc.

When choosing the most attractive ecological walking route for visitors, it is necessary to comply with environmental requirements. The route should be planned in such a way as to bypass, if possible, places where rare species of plants and animals listed in the Red Book of Russia or in the corresponding region are found. [1]

Despite the desire of the organizers of the ecological trail to acquaint visitors with rare plants and animals of the region, one should not forget that this can provoke poaching. There are many other ways to introduce people to species listed in the Red Book — not in their natural environment, but in the vicinity.

Accessibility for visitors is one of the main requirements when designing a trail, which largely determines the choice of route. It is necessary that the beginning of the ecological trail be relatively close to the entrance to the corresponding park or reserve, and that good access roads lead to it. This requirement is related to information perception schemes: visitors should not feel any physical or psychological fatigue before the first step on the ecological path. [1]

The route of the ecological trail itself should not be very difficult to pass (too steep slopes, long transitions between stops, prolonged exposure to the sun — all this is undesirable). As a result, excessive physical activity can significantly reduce a person's pleasure. It also does not contribute to the memorization of new information.

Informativeness, that is, the ability to satisfy the cognitive needs of people in geography, biology, ecology, and other scientific disciplines, is the main difference between the ecological trail and the usual tourist route. Most of the existing hiking trails are clearly biological in nature. However, it is equally important to create trails that also reveal the ecological, geographical, historical aspects and nature of human interaction with nature. [1]

In addition to the history of the guidebook, information stands and booklets with texts, photographs and cartographic material can play an important educational role.

When choosing the route of an ecological trail, it is necessary to consider all the features of the landscape: not only its geographical and ecological cognitive potential, but also the general impression that it makes on the visitor. Therefore, when choosing viewing points, attention is paid to what a person perceives with his senses: landscape forms, colors and their seasonal changes, smells, sounds (the sound of falling water, the sound of a spring, birdsong, etc.). [4]

When choosing the route of an ecological trail, contrast and rhythm are of great importance. The first of them is perfectly manifested in the southern mountains, where at a short distance (less than a day's journey) one can observe a rapid change of landscapes from deserts to a high-

altitude strip with snow fields and glaciers. In the conditions of the Moscow metropolis, the contrast is manifested in a sharp change in practically untouched natural areas with several species of flora and fauna, more typical for nature reserves, on the one hand, and in areas completely changed by people, on the other. Rhythm is characteristic of almost all landscapes and manifests itself in the alternation of elevations and depressions of the relief, steppe slopes and swampy basins, closed forests, and open meadows, etc. Both properties — both contrast and rhythm — objectively exist in nature, but their perception and therefore, the ecological educational value can be greatly improved by the intelligent choice of the ecological path. [3]

Thus, the main principles for designing ecological walking routes are as follows:

– minimal damage to natural, cultural, and historical monuments around the ecological trail.

– high information content.

– the attractiveness of the surrounding landscapes.

– accessibility of the ecological trail for different categories of participants. [1]

After we have determined the route scheme of the upcoming ecological trail, conducted a survey of the area, and selected interesting sightseeing objects, we can begin to develop it.

To create a project for a specific ecological trail, you must:

1) develop a comprehensive project of an ecological trail.

2) determine the necessary equipment for the ecological trail (viewing platforms, stairs, information boards).

3) prepare resource support for the ecological trail (development of a package of technological documentation for excursions, preparation of maps with excursion objects, development of guidebooks for individual tourists, placement of information stands throughout the ecological trail). [2]

To prepare excursions along the route of the ecological trail, excursion development technology is used, which includes choosing a topic, defining goals and objectives, choosing objects to display along the route, collecting information about exhibits, preparing a control text that completes the “Guide’s Portfolio”, determining the demonstration methodology and storytelling, determining the technique of conducting excursions and creating technological documentation. [5]

The General Plan of the integrated project of the ecological trail includes the following activities [1]:

1) the concept of an ecological trail (a brief description of the route line, goals, objectives, target groups of visitors, main topics of information saturation, length, mode of movement, average duration of a visit, seasonality, visiting rules).

2) assessment of the current state of the route.

3) working draft of the arrangement of the route:

– topographic plan of the area (M 1:2000 and smaller), including the route of the trail.

– trail master plan (M 1:1000 or 1:500).

– indicating the location of recreation areas, viewpoints, information stands, with diagrams of the structure of the roadway, a plan for sanitary and recreational activities. Part of the information can be placed on separate drawings.

– fragments of individual sections of the trail on a larger scale (1:200, 1:100).

– plan for the placement of small architectural forms (if any).

– layout of stairs, viewing platforms, etc.

– list and sketches of information stands.

– drawings of stands designs.

4) information materials for the organization of environmental education along the route of the ecological trail.

5) cost estimate for the arrangement of the route and the publication of information materials. Further, the drafted project is transferred to the direct executors for the development of the ecological trail. The project of the ecological trail is developed considering the main criteria presented in the table [1]:

Table 1

Criteria for choosing an ecological trail

Attractiveness criteria	Availability Criteria
— The beauty of the landscape — Each path should be different from the others — The trail should not be monotonous	— The location of the trail is relatively close to settlement and transport accessibility — The route of the trail should not represent danger or difficulty

As a result of the work, a passport for the ecological path is drawn up, which contains the following provisions:

1) location of the ecological trail.
2) the importance of the ecological path.
3) direction of the route of the ecological trail (landmarks, distances).
4) necessary activities.
5) studied natural objects.
6) responsible for the protection of the ecological trail.
7) time of creation of the ecological path. [1]

4. CONCLUSIONS

The development of ecological trails is carried out based on a systematic approach, which allows considering both the natural and cultural and historical features of the area, and the specifics of the recreational use of a certain territory and planning environmental education activities in specially protected areas in the most rational way.

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OVERVIEW OF THE MAIN TRENDS IN THE ECONOMIC ASSESSMENT OF ECOSYSTEM SERVICES

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Abstract: The concept of ecosystem services, first proposed in the report "On the assessment of Ecosystems at the turn of the Millennium" in 1999, plays an important role in the idea of a Green Economy that is developing today. The main purpose of the ecosystem services concept is to draw decision makers' attention to the problem of ecosystem degradation and the need for rational use of the benefits and benefits received by society from them. As a result, it is the cost and economic assessment of ecosystem services that plays an important role as the closest and most understandable way for decision makers to show the benefits of ecosystems and the risks of their degradation. In this article, an overview of current trends in the economic assessment of ecosystem services was conducted, a classification of ES and economic methods was provided, and an analysis of the most relevant economic methods for assessing ES was carried out on the example of climate and water management services. The current methods of cost estimation of ES today are the methods of prevented costs, replacement cost, conditional assessment, cost of travel, direct payment for ecosystem services, transfer of benefits and factor income. The choice of method depends on the service or services being evaluated, as well as the quantity and quality of input data. The variety of modern methods of economic assessment of ecosystem services is determined both by the presence of a formed market for the service under study and the structure of this market, and by the actual ability to evaluate the service using economic methods.

Key words: sustainable development, ecosystem services, green economy, carbon sequestration, carbon neutrality.

1. INTRODUCTION

In the XXI century, the world community has faced the need for a structural transformation of the economic and social sphere of society in order to avoid further escalation of economic, social, environmental, and, consequently, political tensions. The Sustainable Development Goals reflect the need to restructure the global economy towards a transition to more efficient use of natural resources and reducing the burden on ecosystems, preserving and multiplying natural capital, as well as to planned and socially-oriented economic growth [10].

The central element of sustainable development is the concept of a Green Economy as an economy focused on improving human and social well-being while reducing risks to the environment. The main aspects of Green Economy are the circular economy and the concept of ecosystem services [1].

The purpose of ecosystem services assessment is to draw the attention of decision–makers (business and government representatives) to the need to take into account the state of natural capital for sustainable and long-term economic growth. Therefore, the main emphasis in research on ecosystem services is on economic methods of evaluating services [9].

Despite the great attention to the concept of green economy and ecosystem services in particular, this area is well researched mainly in developed countries, while in developing countries there is a lack of both works on the assessment of ecosystem services as well as the impact of scientific developments in this area on decision makers when planning economic development [18].

This article examines current trends in the field of economic assessment of ecosystem services, primarily such services as climate regulation through the assessment of carbon accumulation and sequestration, ecosystem regulation of the water.

2. OVERVIEW OF MODERN TRENDS IN THE ECONOMIC ASSESSMENT OF ECOSYSTEM SERVICES

2.1. Modern classifications of ecosystem services

The concept of ecosystem services was first announced in the report “On the assessment of Ecosystems at the turn of the millennium”

in 1999. According to this report, ecosystem services are divided into the following categories:

1. Supporting services;
2. Provisioning services;
3. Regulating services;
4. Cultural services [10].

In 2011, the European Commission created Mapping and Assessment of Ecosystems and their Services or MAES initiative that uses the Common International Classification of Ecosystem Services or CICES. CICES divide ecosystem services on:

1. Provisioning services;
2. Regulating services;
3. Cultural services [19].

One of the latest works in the field of identification of ecosystem services was the work of Brown, Bergstrom & Loomis (2007), in which they identified ecosystem goods and ecosystem services.

In this study, ecosystem services included:

1. Regulating services;
2. Cultural services;
3. Supporting services [8].

2.2. Overview of modern methods of economic assessment of ecosystem services

The methods of economic assessment of ecosystem services are based on the concepts of exchange value, market value and social value of ES. When services are sold directly in conventional markets, the price represents the exchange value. The market value of the service is easy to assess, since there are transactions by which it can be measured. While exchange value requires markets or observable transactions, the public value of services is much broader and difficult to measure [13] [19].

Costanza et al. (2002) identified six main methods of economic evaluation of EC, when market estimates do not reflect the public value properly:

1. Prevented/Avoided costs (AC);
2. Replacement cost (RC);
3. Factor income (FI);
4. Cost of travel (TC);
5. Hedonistic Pricing (HP);

6. Conditional assessment (CV) [11].

Sannigrahi et al (2020) used the following economic assessment methods in their study of ecosystem services of mangrove forests:

1. Conditional assessment (CV);
2. Payment for Ecosystem Services (PES);
3. The cost of the trip (TC);
4. Cost of Damage (DC);
5. Benefit Transfer Method (BTM);
6. Statistical model of value transfer [17].

Several methods may need to be used together to evaluate a part of the EC. For example, the recreational value of an ecosystem will include not only the value resulting from visiting visitors (TC), but also increased revenues associated with the use of the territory (FI) [6] [7] [18].

3. MODERN METHODS OF ECONOMIC EVALUATION OF REGULATING SERVICES

3.1. Economic assessment of carbon storage

Indirect data are used to assess ecosystem functions for climate regulation and air quality. In modern scientific literature, a popular method of estimating the economic value of the total accumulation of organic carbon is the Marginal Abatement Cost of Carbon method, or MAC as the amount of carbon stock per hectare. It is an estimate of the costs of eliminating an additional unit of carbon emissions. The assessment of the cost of the service for the accumulation and retention of carbon by mangroves is calculated using the following formula [12]:

$$Vcs = TC*MAC*Am,$$

where Vcs is the cost of EU carbon storage, TC is the total carbon stock per hectare, MAC is the marginal cost of controlling emissions of one ton of carbon, and Am is the area of mangroves in hectares [14] [15].

3.2. Economic assessment of carbon sequestration

The sequestration assessment requires data that is not available for the study area, for example, the rate of carbon uptake. Based on this condition, Hernandez-Blanco et al. (2021) proposed calculating this ecosystem service using theoretical data, in particular, through the Social

Cost of Carbon (SCC), or the Marginal Cost of Damage. Toll (2011) describes SCC as damage that can be avoided by reducing emissions by one ton. Using this methodology, the economic assessment of carbon sequestration as an ecosystem service is carried out using the following equation [12]:

$$Vcseq = SR*SCC*3.67*Am,$$

where Vcseq is the cost of carbon sequestration services, SR is the absorption coefficient in tons of CO2eq per hectare per year, 3.67 is the conversion coefficient for obtaining CO2eq from C, Am is the area of mangroves in hectares, and SCC is the social cost of carbon [16] [20].

3.3. Economic assessment of water flow

Water flows can be affected by the accumulation of water by vegetation and in surface reservoirs, infiltration and retention in soil and seepage into underground reservoirs [8] [9].

Kasimov D.V. (2013) evaluated the water-regulating service of the Yasnaya Polyana Nature Reserve through the relationship between forest cover and the flow module on the territory. They estimated this indicator by the expression:

$$M = -1.02 + 0.068 \cdot L,$$

where M is the flow modulus from 1 km2 of the catchment area; L is the wooded area [2].

Lelkova and Pakina (2020) to assess the water-regulating service of mixed forests used the method of determining the increase in underground runoff proposed by Lebedev and Neklyudov (2012), according to which the average annual increase in underground runoff is represented as the difference between the actual runoff in a forested catchment area and theoretical underground runoff in a treeless area. The economic effect can be expressed as:

$$Ev = \Delta S*ti*di*r,$$

where ti is the duration of the i–th age group of years; di is the discount coefficient; r is the cost (water rent) of 1 m3 of water [3] [4].

The work of Morozova and Debelai (2022) included the calculation of the ability of the park territory to intercept water in the form of

precipitation, thereby purifying it to calculate the water-regulating function, preventing soil erosion and unloading the urban storm sewer.

$$Rv = (\Delta Sg*r) / Sl,$$

where Rv is an estimate of the cost of the water protection function of plantings ($);

ΔSg — the volume of water retained by plantings (m3);

r — the cost of 1 m3 of water for this economic zone ($/m3);

Sl — forest cover of the catchment area (%) [5].

4. CONCLUSIONS

This article analyzes the current trends in the economic assessment of ecosystem services. The main classifications of EC and widely used economic methods of their assessment were analyzed, after which a review of current methods of valuation of ecosystem services such as sequestration and carbon storage, regulation of the water cycle in nature by ecosystems and cultural services was conducted. As a result of the analysis, conclusions were drawn about modern scientific approaches to the assessment of ES at different levels, which methods are used, from which a variety of approaches to assessment is formed and which factors are limiting for the presented methods.

From the variety of economic methods used today to assess ecosystem services, it is possible to distinguish methods of prevented costs, replacement cost, conditional assessment, cost of travel, direct payment for ecosystem services, transfer of benefits and factor income. The choice of method depends on the service or services being evaluated, as well as the quantity and quality of input data.

The variety of modern methods of economic assessment of ecosystem services is caused by the following factors:

1) The presence of a formed market for the service under study and the structure of this market. The method of service valuation depends on this factor, since the market structure determines price for ES, as a result, it can be competitive or based on strictly fixed prices.

2) The ability to evaluate the service using economic methods. Part of ecosystem services, due to various limiting factors, for example, the difficulty of assessing a specific benefit to society, which is characteristic of supporting services, is poorly subject to economic evaluation. In this

case, researchers can rely on various non-economic and auxiliary assessment methods, for example, using surveys and working with focus groups, or based solely on indirect biophysical and biochemical data on the impact of certain natural processes (such as soil formation and nutrient cycling) on ecosystems and the services they provide.

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DECARBONIZATION AS A GLOBAL TREND TO COMBAT CLIMATE CHANGE

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Abstract: In order to curb the negative processes of anthropogenic activity. The transition to the high carbon standards established in In order to limit the negative effects of human activity, a transition to high carbon standards is required in many countries. Global greenhouse gas emissions trading

emissions trading is spurring the creation of carbon farms. Such farms are Carbon sequestration is an integral part of a new direction for the Russian Federation.

Key words: decarbonization, carbon balance, carbon farms, geographic information modeling, carbon sequestration, land allocation.

INTRODUCTION

The problem of carbon balance is very relevant for the Russian Federation. This is due to the fact that Russia has developed resource- and energy-intensive industries, thermal power and mechanical engineering, which strongly influence the violation of the carbon cycle. Due to the acceleration of the transition from an agrarian society to an industrial one, anthropogenic carbon dioxide has formed in the atmosphere as a result of the scientific and technological process and the rapid development of the energy industries. As a result, tangible changes were formed in the biosphere on Earth.

1. THE PROBLEM OF CARBON BALANCE IN OBSERVED CLIMATE CHANGE

The problem of carbon sequestration has a global scale and it is most obvious for large territories (individual countries, landscape zones, climate zones). It is necessary to understand that the problem affects not only large regions, but also much smaller territories — mesoregions. V.B. Sochava in his book noted that "we can think of the big substance cycle in the geographical environment as a hierarchy of subordinate to each other and as if nested in one another cycles...". [1].

Carbon cycles in smaller areas have not been considered in many studies. The analysis and research of large-scale phenomena and processes requires mandatory consideration of regional and local features. Kolomyts E.G. and Surova N.A. note that "...there are practically no forecasts of climatogenic dynamics of ecosystem parameters that carry out the biotic regulation of carbon dioxide content in the atmosphere and the entire carbon cycle...". [2].

1.1. Carbon Farms and Their Purpose

Creation of carbon farms is one of the approaches to optimize carbon sequestration by introducing methods that, increase the rate of

CO2 removal from the atmosphere and its accumulation in the organic matter of plants and/or soil on agricultural land. The main idea of carbon farming is that the main place in the ecosystem is the sun, namely solar energy, and carbon acts as a carrier of this energy in the agricultural landscape. Carbon farming is synonymous with the term "regenerative agriculture", when this term is clearly based on the understanding of the underlying system dynamics and positive feedback processes that actually make possible the "regenerative" trend of increasing soil fertility and land productivity [3].

Carbon farming is successful when carbon storage resulting from improved land management and improved conservation measures exceeds carbon loss.

1.2. The process of creating carbon farms

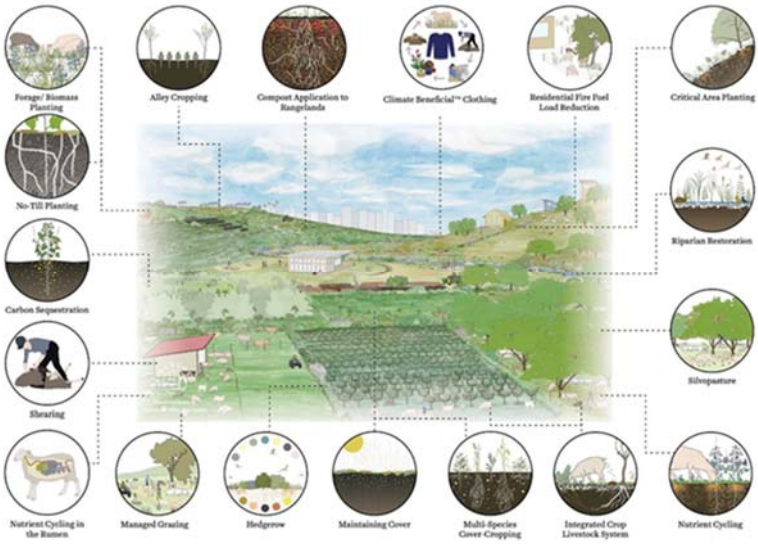

Figure 1. Carbon farm and the necessary factors for its realization [4].

Carbon-based farming practices are management practices that result in carbon sequestration and/or reduce greenhouse gas emissions. At least thirty-five of these practices are identified by the U.S. Natural Resources Conservation Service (NRCS) as conservation practices that

improve soil quality and sequester carbon while providing important co-benefits including: increased soil water retention capacity, hydrologic function, biodiversity and sustainability. Factors that are considered when establishing a carbon farm are shown in Figure 1.

Carbon farm planning emerged as an approach to optimizing carbon sequestration on farmland. Typically, a carbon farm planning team works with farmers or ranchers to assess all opportunities to reduce greenhouse gas emissions and carbon sequestration on their land. The process combines traditional whole-farm planning and resource assessment approaches with modern advances in climate science to develop a comprehensive farm plan focused on carbon sequestration.

Ultimately, the carbon farm planning process helps transform agricultural producers into carbon farmers, supporting their understanding of carbon as a powerful organizing principle for managing their land. In the carbon farm planning process, carbon farming experts work with producers to identify opportunities for carbon sequestration throughout their farming system.

2. CARBON AGRICULTURE — EXPERIENCE OF RUSSIA AND FOREIGN COUNTRIES

Currently, in the Russian Federation for mesoregions there are few studies taking into account the discussion of the carbon cycle, so there are no methodological guidelines for this kind of research.

The land sector is key to achieving a climate-neutral economy because it can capture CO2 from the atmosphere. However, in order to encourage the agriculture and forestry sectors to take action on climate change and contribute to the challenge of maintaining a carbon balance, direct incentives for climate-friendly practices need to be created, as there is currently no targeted policy tool to significantly incentivize increased carbon storage.

Carbon agriculture and carbon forestry are land management concepts that first emerged in the global context after the Kyoto Protocol (KP) came into force in 2004 [5]. Several countries and organizations, such as New Zealand and Verified Carbon Standard, have begun testing and exploring market-based schemes that offer incentives for land management organizations to manage carbon balances on farm or land.

In 2019, the Russian Federation joined the multilateral Paris Climate Agreement and made commitments to reduce greenhouse gas

emissions by 2030 by 25–30% from 1990 levels. But the Russian government, accepting the agreement, made a reservation that the reduction will take into account the maximum absorptive capacity of forests, thus leaving the possibility not to reduce emissions if the forests in the Russian Federation will take up sufficient amount of carbon dioxide [6].

CONCLUSION

Many climate change mitigation actions automatically provide co-benefits for the environment, but this cannot be assumed without careful analysis.

One example of a potentially negative impact is the potential for displacement of food production and disruption of food industries that can be associated with large-scale over-watering of highly productive drained peatlands. This also illustrates the need to manage, to the extent possible, the interaction of outcome-oriented farming schemes with other policy tools. With other policy tools.

In any case, the first phase of implementing carbon farms requires planning for optimal land use in terms of carbon sequestration. Implementing carbon farming practices is necessary to reduce the carbon footprint of agricultural products and so the land user can become a provider of carbon sequestration services. Land management plans and farming systems aimed specifically at this task should be developed. But at the moment such studies are practically absent both in Russia and abroad.

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COMPARISON OF ELECTRIC BUS AND TROLLEYBUS

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Abstract: The purpose of the article is to compare a trolleybus with an electric bus, because the trolleybus was removed in Moscow. Moreover, a table with information on the costs of different types of public transport is presented.

Keywords: trolleybus, electric bus, energy, city, ecology.

1. INTRODUCTION

The purpose of the article: to find out whether the trolleybus was reasonably removed from Moscow, and to understand whether the electric bus is paying off.

The Moscow authorities dealt with the trolleybus in a few years, burying the most extensive network in the world. They left the only route, which was called the museum route (now, due to the transfer of the contact network, it does not work) and about 5 km of wires on its route. And not so long ago, Moscow had the longest trolleybus network in the world, there were 1,250 km and over 80 routes. The former trolleybus lines are now served by diesel buses and electric buses.

Who was bothered by the trolleybus?

By the time of the total dismantling of the trolleybus, almost half of the contact network in the capital was worn out. They said it was a pity to spend 250 million rubles on repairs, and why — the contact network spoils the appearance of the city. We'd better buy electric buses. A batch of 300 pieces with a set of charging stations cost 32 billion rubles. [3] But the main claim to the trolleybus was the too high cost of

its maintenance and operation, which spoiled the economic indicator of costs per kilometer. No one has officially provided specific data. Although it was known that an electric bus is much more expensive than a trolleybus, twice as expensive as a tram and three times more expensive than a bus — one of its batteries costs almost like a bus.

Figure 1. Trolleybuses on Mosfilmovskaya Street.
A u t h o r : *Alexander Lezhenko*

2. METHODOLOGY

2.1. Controversial benefits

And yet the numbers can be found. In November, at the conference "Electric Vehicles 2021", an up-to-date calculation of the cost of the life cycle of buses, trolleybuses and electric buses was presented.

It may be concluded that the electric bus costs the city (and the citizens who fill the budget) more than any other type of ground transport. The benefits that it gives in this case are partly controversial. An electric bus is more maneuverable than a trolleybus, it is easier for it to bypass local congestion. But where does the congestion on the lanes allocated for public transport come from? Of course, if you suddenly want to change the route, you need to pull the wires. So what? The task is quite feasible — no more difficult than installing charging stations. [1] [2] [3].

Figure 2. Electric bus in the village “Northern”.
A u t h o r : *Alexander Lezhenko*

Table 1

Some economic parameters of land transport

	DT Bus	CNG Bus*	Trolleybus	Trolleybus withUAH*	Electric bus
Life cycle, years.	7	7	20	20	15
Vehicle price, thousand rubles.	13 100	18 600	22 000	28 000	36 800
Maintenance and repair, thousand rubles.	15 540	17 879	16 275	16 800	30 618
Fuel/electricity costs, thousand rubles	21 782	12 119	10 710	10 710	10 710
Price 1 km of run, rub.	62,3	64,5	60,4	60,9	86,5

* CNG — compressed natural gas. UAH — increased autonomous travel; compact traction battery allows the trolleybus to overcome part of the route without a contact network.

The electric bus has large downtime and idle mileage. From the final stops, you need to get to the charger and stand there. After almost every trip. It takes a lot of time, which it could spend more usefully. Thus, to maintain the same intervals on the route, more electric buses are required than trolleybuses or buses. Accordingly, there are more drivers. [3]

The electric bus is called the most modern in terms of the technologies used. But this is not quite true: the technology is about the same only the scale is different. And the picture is greatly spoiled by a diesel cabin stove. In the cold season, the electric bus palpably loses to the trolleybus in ecology. And to charge traction batteries, in any case, they will have to burn gas at 11 Moscow thermal power plants located within the city. [1] [3]

3. RESULTS

Educated people know that at low temperatures, chemical reactions slow down. Charging the battery takes much longer. So, the battery of the Nissan Leaf electric car at zero temperature takes 36% less energy than at 25° C — for the same time. [2]

Electric buses have the same thing. Therefore, in the cold, queues of dozens of cars accumulate at charging stations. The authorities stubbornly deny that this is due to winter, stating that the stations themselves are malfunctioning. But we see queues every winter in the same places. They also occur in the heat, but for other reasons — charging stations overheat.

There is another technological feature. In frosts, part of the energy is spent on heating the battery of the electric bus — it does not tolerate cold below +8° C, and in the heat — for cooling. Both options reduce the power reserve, which, with convenient weather, optimal driving modes and gentle loading, reaches 60–70 km. [2] [3]

4. CONCLUSIONS

General conclusion: the trolleybus was found to be ineffective unreasonably. Briefly, the authorities removed them in vain. Indirectly, this is confirmed by European countries. In large cities in France, Switzerland, the Czech Republic, Italy, where there are no harsh winters, a trolleybus network is being developed. And if Moscow really wanted to introduce electric buses, then it was not a trolleybus that should have been strangled. They could exist together.

Fortunately, Russia has remained the world leader in the production of trolleybuses. So, if they decide to revive the trolleybus in the capital, there is everything for this, including modern models. The leading trend is trolleybuses with dynamic charging and autonomous running. Almost like an electric bus, only cheaper. [1]

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LIFE CYCLE ASSESSMENT OF CARBON AND TOXIC FOOTPRINT OF ENERGY CARRIERS OF GAS, HYBRID AND ELECTRIC VEHICLES

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Abstract: The article presents the results of the assessment of carbon and toxic footprint of the life cycle of various types of energy carriers of modern vehicles. The stages of the life cycle of energy carriers along the entire technological chain from the extraction of raw materials to the production of commercial products were determined. A comparative analysis of the full life cycles of various energy carriers in the motor transport sector was carried out. The absolute and specific emissions of CO_2 and pollutants in the life cycle chain of motor transport energy carriers per kilometer were calculated. The study reveals the environmental benefits of using gas as a transport fuel.

Key words: road transport, alternative fuels, gas motor fuel, full life cycle, carbon footprint, toxic footprint.

INTRODUCTION

Road transport is one of the strongest environmental pollutants in most major cities.

For an objective assessment of the environmental efficiency of the life cycle of road transport energy carriers, the concepts of carbon footprint, which is defined as the ratio of greenhouse gas (GHG)

emissions to a ton of oil equivalent of produced raw materials (oil or gas), and toxic footprint — the total emissions of all pollutants, taking into account their toxicity, were used.

The carbon and toxic footprint are an indicator that characterizes the level of negative impact caused to the environment not only at the stage of vehicle operation, but also at other stages of the full life cycle (FLC) of energy carriers. Reducing the carbon and toxic footprint at each stage of the FLC of the energy carrier, from the receipt of raw materials to the stage of operation of the vehicle, becomes an important catalyst for the efficiency of the development of the transport sector.

1. METHODOLOGY

For the main stage of the research, the methodological approach for assessing the carbon and toxic footprint of road transport energy carriers, which consists in estimation of emissions of greenhouse gases and pollutants, respectively, generated in the chain of the FLC of energy carriers, is proposed.

Quantitative assessment of pollutants and GHG emissions from the use of various types of vehicle energy carriers was carried out using the GREET model, which allows estimating emissions over the FLC from the extraction of raw materials (fuel) to the car tank, from the use of fuel directly in the car engine, as well as through the cycle associated with the production of vehicles. This model is used as an assumption, since a large amount of data is required [5].

The main stages of assessing the carbon and toxic footprint are: determining the boundaries of the assessment of the life cycle of an energy carrier based on an inventory of the main production stages, detailing the stages of the production life cycle of an energy carrier, collecting and preparing initial data, conducting a quantitative assessment of absolute and specific GHG emissions of pollutants in the energy carrier life cycle chain.

All calculations were performed taking into account international documents and standards [1–4; 6,7].

2. RESULTS

The specific values of pollutants and GHG emissions have been calculated, the absolute values of pollutants and GHG emissions for each

stage of the life cycle of the compared energy carriers have been estimated in order to conduct a comparative analysis of the reduction in emissions during the transition of vehicles from traditional motor fuels (gasoline, diesel) to alternative energy sources (electric, hybrid, gas vehicles).

As a result of the calculations, it was revealed that electric vehicles have the lowest CO_2 emissions throughout their FLC and per kilometer, regardless of the method of electricity generation. Hydrogen fuel cell vehicles (hydrogen obtained by the electrolysis) are characterized by the highest amount of CO_2 emissions over their FLC.

The method of hydrogen production is an important factor in determining the burden on the environment. For example, if hydrogen is produced by the electrolysis, then the life cycle of such a vehicle has a carbon footprint more than twice as large compared to a hydrogen-powered vehicle when hydrogen is obtained by steam methane reforming (SMR). In the case of renewable energy, electrolysis will be energy competitive compared to hydrocarbon-based methods. The use of renewable energy will have a positive impact on all methods of hydrogen production.

The carbon footprint for hybrid electric vehicles with electricity generation in accordance with the energy balance of the Russian Federation exceeds the specified figure for electric vehicles and compressed natural gas (CNG) vehicles.

The data of the calculation of the toxic footprint showed a strong excess of the hydrogen FLC indicator in comparison with gas motor fuel.

The comparison of pollutant emissions from various types of energy resources, taking into account their FLC, shows that the use of gas motor fuel leads to the lowest emissions.

The comparison of data on the toxic and carbon footprint, depending on the types of energy carriers, showed that the toxic footprint of obtaining energy carriers differs several times.

For example, the toxic footprint of electric vehicles, under the condition of generating energy at thermal power plants (TPP) operating on energy resources in accordance with the energy balance of the Russian Federation, is slightly lower than the toxic footprint of the hydrogen energy carrier when energy is obtained by electrolysis, but many times higher than the indicators for vehicles running on CNG, hybrid vehicles, as well as the toxic footprint of hydrogen production by SMR. The toxic

footprint of the hydrogen energy carrier (when it is obtained by electrolysis) is higher than in the case of hydrogen production by the SMR method. And the figure for gas vehicles is several times lower than for hybrid cars.

Thus, the main results of the research should include a comparative assessment of environmental performance, efficiency and benefits of using gas motor fuel and alternative energy sources for road transport.

3. CONCLUSIONS

Road transport with internal combustion engines (ICE or IC engine) is the main source of emission of various exhaust gases and chemical compounds. In addition, the combustion of carbonaceous fuel (energy carrier) in vehicle engines results in GHG emissions.

Thus, switching from liquid fossil fuels to energy alternatives with lower carbon and toxic footprint, such as gas, electricity and hydrogen fuel cells, could be the main means of reducing CO_2 and pollutant emissions from motor vehicles. At the same time, the use of CNG vehicles is currently more environmentally efficient than even hybrid vehicles.

However, for an objective assessment of the negative impact of vehicles on the environment, it is necessary to take into account not only emissions of pollutants and GHGs during the operation of vehicles, but also emissions in the FLC of motor fuel from the extraction of raw materials to the use of the vehicle.

Thus, analyzing the actual annual amount of emissions of pollutants and CO_2 from vehicles in the Russian Federation using various types of energy carriers in the FLC, we can conclude that the transfer of the part of vehicles from traditional fuels (gasoline, diesel) to natural gas makes it possible to almost proportionally reduce exhaust gas emissions in CO_2 equivalent. Electric cars also have minimal emissions of pollutants and CO_2, however, the production of electric cars has not yet been put on stream in the Russian Federation, and their operation is complicated by an acute shortage of charging infrastructure.

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METHODOLOGY FOR CALCULATING UNCERTAINTY OF MEASUREMENT ON THE EXAMPLE OF AN ELECTRONIC TACHOMETER

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Abstract: This article presents the results of calculating uncertainty of measurement on the example of an electronic tachometer

Key words: metrological control, tachometer, uncertainty of measurement, verification procedure

1. INTRODUCTION

Under the conditions of accelerated scientific and technological development and the rapid growth of industrial production, metrological control of technological and measuring processes becomes an important argument in favor of ensuring the efficiency and safety of both production as a whole and its environmental component.

One of the most important devices in the control of industrial engines is a tachometer — a device for measuring the shaft speed (angular velocity). Tachometers can be used for various types of equipment in various settings such as conveyors, windmills, rotary feeders, shredders, dryers, cooling equipment, augers and elevators. The list of industries that use these devices includes power plants, processing plants, chemical plants, automotive plants, material handling, food/beverage plants, paper mills, and many more.

To ensure and confirm the suitability of tachometers in production, a verification operation is used — a set of operations performed in order to confirm the compliance of measuring instruments with metrological requirements. However, when developing a verification procedure for a given measuring instrument, it makes sense to calculate the uncertainty of its measurements.

2. METHODOLOGY

Uncertainty (of measurement) is a parameter associated with a measurement result that characterizes the spread of values that could reasonably be attributed to the measurement quantity. Uncertainty makes it possible to compare the results of different measurements of the same measured quantities with each other or with reference values [1].

There are 2 main types of uncertainty estimation:

• *Type A* — a method for estimating uncertainty by statistical analysis of a series of observations.

• *Type B* is a method for estimating uncertainty in a manner other than statistical analysis of a series of observations.

3. RESULTS

The measured quantity Y is not directly measurable, but depends on other variable quantities $X_1, X_2, \dots X_n$. These influencing quantities

act on it and convert its "true" value into the value indicated by the tachometer. Therefore, the measured value Y should be expressed through a functional dependence, which in general is formula (1):

$$Y = f(X_{ind}, X_1, X_2 \dots, X_N). \quad (1)$$

The Y value is the output value in the verification process and is defined as the error of the measuring instrument. The values X1, X2, X3, X4 and X5 are sources of uncertainty, since most of them are not constant and their values can be determined with different errors over time:

X1 — the value of the standard sample (tachometric installation UT-05-60);

X2 — air temperature;

X3 — relative humidity of the air;

X4 — atmospheric pressure;

X5 — power supply of verification tools from the AC mains with frequency.

In order to compose a system of equations, it is necessary to move from conditional equations to normal ones. We get a system of equations that needs to be solved to find the coefficients:

0,0103a+6,45b+20,15c+29,58d+14,57e=0,035;

6,45a+5040b+15892c+22911d+11258,7e =26,1;

20,15a+15892b+50399c+72548d+35636,1e =80,7;

29,58a+22911b+72548c+104669d+51416,2e =117,5;

14,57a+11258,7b+35636,1c+51416,2d+25260,88e =57,79.

Therefore: a=-0,965; b=0,0192; c=-0,0114; d=0,00354; e=0,00317.

For each quantity, an estimate and standard uncertainty must be determined. Each estimate of the input quantity Xi and its associated standard uncertainty u(Xj) is obtained from the probability distribution of the input quantity Xi.

Type B uncertainty assessment:

1. The error of the standard sample (tachometric installation):

$$U = \frac{0.05}{2\sqrt{3}} = 0.014\,.$$

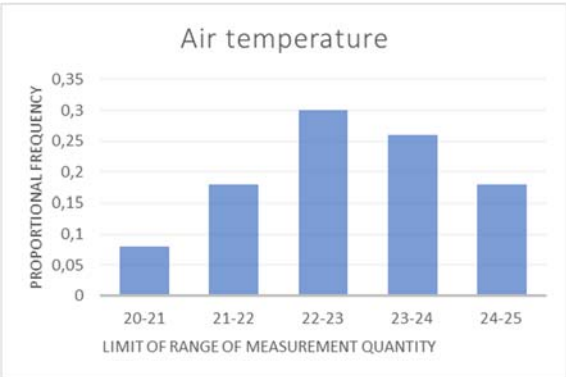
2. Power supply of verification tools from the AC mains with a frequency:

$$U = \frac{0,5}{2\sqrt{3}} = 0,144\,.$$

For factors assigned to type A (air temperature, relative air humidity, atmospheric pressure), it is necessary to conduct an experiment of multiple measurements in order to determine the type of distribution and calculate the RMS. To measure factors of type A, the following measuring instruments are used:

For type A factors, the following measuring instruments are used: a thermometer for the air temperature, a moisture meter for the relative humidity of the air, and a barometer for atmospheric pressure.

$$\bar{X} = 22,32°\text{C}\,;\ S = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{X})^2}{n(n-1)}} = 0,179°C\,;$$



Histogram 1. Fir temperature

Analyzing the above histogram, we can conclude that the histogram has a bell-shaped shape, similar to the normal distribution. It is asymmetric and has a scatter slightly larger than that of the normal distribution.

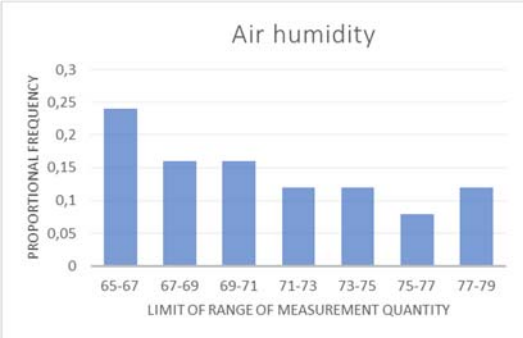
Similar measurements were made for relative air humidity and atmospheric pressure.

Results for air humidity:

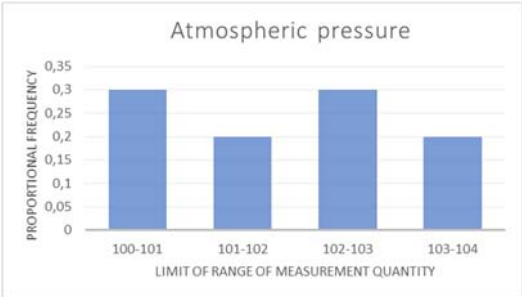
$$\bar{X} = 70{,}32\% \; ; \; S = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{X})^2}{n(n-1)}} = 0{,}598\% \; ;$$

Results for atmospheric pressure:

$$\bar{X} = 102{,}3 \text{ kPa} \; ; \; S = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{X})^2}{n(n-1)}} = 0{,}181 \; kPa \; ;$$



Histogram 2. Air humidity (left)



Histogram 3. Atmospheric pressure (right)

When analyzing the air humidity histogram, we can conclude that the histogram has a shape similar to a uniform distribution and is also asymmetric. When analyzing the atmospheric pressure histogram, we can conclude that the histogram has a shape similar to a uniform distribution, and is also asymmetric, with a spread within two values.

The concept of uncertainty refers to a “logical” correlation, not a mathematical one. To what extent the correlation effect should be taken into account depends on the specifics of the measurement, on knowledge about the measurement method and on the evaluation of the interdependencies of the input quantities.

Since the input quantities are independent of each other, we can say that there is no correlation.

An estimate of the output quantity Y, denoted y, is the result of measuring the quantity whose value is to be set when the measurement is taken. This estimate is obtained from the regression equation (model) by replacing the input values Xi with their estimates xi.

$$y = (-0{,}965) * 0{,}05 + 0{,}0192 * 22{,}32 + (-0{,}0114) * 70{,}32 + 0{,}00354 * 102{,}3 + 0{,}00317 * 3 = -0{,}0497\,.$$

We calculate the standard uncertainty of the output quantity, which is the standard deviation of the estimate of the input quantity or measurement result and characterizes the spread of values that can be reasonably attributed to the measured quantity Y.

$$\mathrm{U}_c(y) = \sqrt{0{,}000183 + 0{,}00000118 + 0{,}0000465 + 0{,}000000411 + 0.000000209} = 0{,}0156\,.$$

The expanded uncertainty U is obtained by multiplying the standard output uncertainty u(y) by the coverage factor k:

$$U = ku(y) = 2 \cdot 0{,}0156 = 0{,}0312\,.$$

In general, in practice, take k = 2 for an interval with a 95% confidence level or k = 3 for an interval with a 99% confidence level.

When specifying the expanded uncertainty, the result should be expressed as Y = y ± U.

$$Y = 0{,}2 \pm 0{,}0312\ rpm.$$

This means that the best estimate of the value attributed to the measurand Y is y, and that the interval from y — U to y + U contains, one would expect, most of the distribution of values that can reasonably be attributed to Y.

4. CONCLUSIONS

Metrologists are not as far from ecology as it seems at first glance. After all ecology and environmental control cannot do without measuring instruments for various purposes. For example, one of the functions of metrological departments at enterprises is to ensure the correctness and efficiency of technological processes, which are closely related to industrial environmental control. Compliance with environmental legislation and the implementation of environmental protection measures is the main task of every person working in the industry.

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ACTUAL PROBLEMS OF MODERN EDUCATION

SELF-CONTROL AS A GUARANTEE OF TEENAGERS' SUCCESSFUL FOREIGN LANGUAGE LEARNING

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Abstract: The research is aimed at studying whether the characteristics of personality and temperament are related to self-control in the process of foreign language learning. The study has many uses in the field of education. The variety of methods for diagnosing the temperament type, self-organization and self-control level were used in this work (Eysenck personality inventory or EPI by G. Eysenck; questionnaire of self-organization of activity (based on TSQ) by E.Y. Mandrikova; questionnaire of volitional self-control (VSC) by A.G. Zverkov and E.V. Eidman). Methods of statistical data processing — correlation and factor analyses — allowed measuring how temperament, self-organization and assessment are interconnected with school performance in foreign language classes.

Key words: temperament, self-control, self-organization, self-discipline, foreign languages learning, progress, success of learning, academic score

1. INTRODUCTION

The term 'self-discipline' is generally understood to mean such as self-control, conscious discipline, self-organization, and an internal discipline. Books, blogs, videos, educational programmes are devoted to self-development. A person assembles his own soft-skills under the guidance of specialists. The first flexible skills that every individual seeks to achieve are effective time planning and self-organization.

Self-control is associated with biological abilities. Nonetheless, there is no certainty about whether self-control is a trait of temperament. Furthermore, the interaction of human character and its relationship with self-control has been little studied.

Therefore, we would like to answer the following research questions:

1. Are a person's temperament and self-control level connected to each other?

2. Are self-control and self-organization related to a teenager's secondary school foreign language progress and marks?

On receiving the empirical results of our pilot research, we can make a conclusion about the influence of temperament on the level of self-control and, accordingly, about the relationship between these two categories. Furthermore, we hypothesize that students with high levels of self-control also possess high academic results.

2. METHODOLOGY

A total of 70 teenagers in educational institutions of Moscow, Magnitogorsk, Taganrog (Russian Federation) and Almaty (the Republic of Kazakhstan) aged 12–15, were surveyed for this study.

The data were obtained using Eysenck personality inventory test or EPI by G. Eysenck, a questionnaire of self-organization of activity (based on Time Structure Questionnaire, TSQ) by E.Y. Mandrikova, a questionnaire of volitional self-control (VSC) by A.G. Zverkov and E.V. Eidman.

The EPI questionnaire consists of two scales: *extraversion-introversion* and *neuroticism-stability*. The 'lie score' measures how sincerely a person is trying to be in their answers. The test includes 57 questions. The questionnaire of self-organization of activity is the author's psychodiagnostic technique designed to evaluate the formation of tactical planning skills and strategic goal setting, features of structuring activities as well as self-organization. The analysis includes 25 questions. The VSC test is designed to determine the level of development of volitional self-regulation, understood as a measure of mastering one's own behaviour in various situations as well as the ability to consciously control one's actions, states and impulses. The survey includes 30 questions.

Statistical significance of the obtained research data was analyzed with the help of an advanced analytics software package — Statistica

10.0.1011. Inferential statistics including a Pearson product-moment correlation test and a factor analysis were used to examine the probable relationship between the variables of self-control, self-organization and the influence of temperament on the success of learning a foreign language (an average academic score).

3. RESULTS

The pie chart (Fig. 1.) illustrates the data about the amount of temperament among the questioned teenagers. The majority of respondents have the sanguine temperament (42%). Approximately one-thirds of the participants (30%) are cholerics. The proportions of phlegmatics are similar to melancholics (14%).

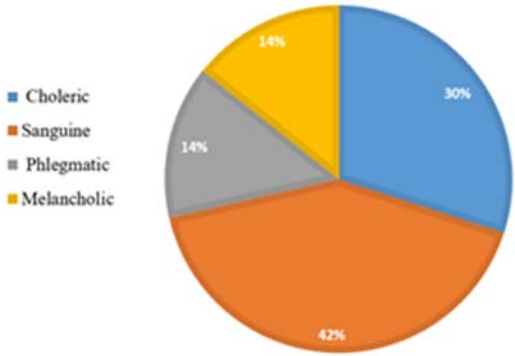

Figure 1. Division of the surveyed teens by temperament types

Our findings have demonstrated the presence of positive correlations between the character traits that make up a person's self-control and the ability to self-organize. For example, the relationship between self-organization and the ability to plan operates at a correlation level of 0,34. The situation is similar with such character traits as perseverance, purposefulness (the strength of correlations 0,42 and 0,47, respectively). Thereby, we can assume that the success of studies is determined by the ability to organize and control oneself.

When analyzing the influence of a person's ability to self-organize (that is, his or her self-control) on the level of school performance in a foreign language class, it is necessary to consider the factors that may

explain this correlation. For this purpose, we carried out the factor analysis (see table 2 below) that helped us identify two important reasons (factors) affecting the success of learning.

We named the factors according to the maximum weight of a significant variable (var 1, var 2 — 0, 94 (factor 1); var 4 — 0, 72, var 7 — 0,76, var 10 — 0, 82 (factor 2)). Therefore, the factors that explain the correlation between a person's self-control and the success of learning are the following ones: *moral and volitional qualities factor* (factor 1); *concentration and assiduity factor* (factor 2).

Table 2

Factors explaining the dependence on a person's self-control to the success of learning

Variable	Factor Loadings (Spreadsheet) Basic components, N=70 (Marked loadings are > ,700000)	
	Factor 1	Factor 2
Var1	0,949246	0,168981
Var2	0,941254	0,198364
Var3	0,883017	0,108751
Var4	0,394418	0,722350
Var5	0,456757	0,521314
Var6	0,807525	0,137480
Var7	-0,045335	0,761480
Var8	0,104591	0,566538
Var9	-0,175471	0,198093
Var10	0,533769	0,824325
Var11	-0,230389	0,258266
Var12	0,514843	0,159527
Var13	0,339138	0,016156
Var14	-0,839579	0,087614
Expl. Var	5,049779	2,611845
Prp Totl	0,360699	0,186560

Var 1 — index of volitional self-regulation; *Var 2* — persistence index; *Var 3* — composure index; *Var 4* — regularity; *Var 5* — purposefulness; *Var 6* — persistence; *Var 7* — fixation; *Var 8* — self-organization; *Var 9* — focus on the present; *Var 10* – general indicator of self-organization; *Var 11* — average academic score; *Var 12* — scale of sincerity; *Var 13* — extraversion/ introversion; *Var 14* – neuroticism

Our primary data showed that the correlation between the average score and self-control is low. We made the same conclusion based on the processed results of the tests: sanguine teenagers have a high level of

self-organization, but marks in a foreign language are below average. Consequently, the level of self-organization does not depend overwhelmingly on assessment and evaluation in a foreign language. At the same time, the moral and volitional qualities factor and the ability to concentrate affect academic success. In addition, factor 1 has inverse relationship to neuroticism. Consequently, choleric and melancholic people, who have neuroticism as a common characteristic, face the trouble with self-control (success in learning). Thereby, success in learning is a strong correlation between moral and volitional qualities factor (factor l), self-organization, and ability to concentrate on a task for a long period of time (factor 2).

Moreover, according to the correlation analysis, the relationship between the average score and self-control is weak. We made the same conclusion on the basis of the processed test results — sanguine teenagers have a high organization, but academic performance in a foreign language is below average.

4. CONCLUSIONS

Our research has led us to conclude that grades in a foreign language do not correspond to the level of self-organization. The reasons can be both neuroticism and external factors such as a school program, a teacher's attitude, family circumstances and other issues. Nonetheless, temperament and a person's level of self-control are related to each other. The lower the indicator of neuroticism, the stronger a person can control himself or herself (sanguine, phlegmatic) and therefore, the more successful he or she might be in their foreign language acquisition.

ACKNOWLEDGEMENTS

We gratefully acknowledge the help provided by a scientific advisor A.V. Guslyakova for constructive comments, her support, encouragement and patience.

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ECO-FRIENDLY PARENTING

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Abstract: Eco-friendly parenting is becoming more common these days. Observing the basic principles, you can raise a child in a healthier environment and help nature. Even switching to reusable diapers, you can reduce the mass of waste by 381 times.

Key words: eco-friendly parenting, conscious parenting, reusable diaper, eco-labeling.

1. INTRODUCTION

The study is devoted to the problem of eco-friendly parenting, which contributes to the creation of a healthy environment for the child and the introduction of useful eco-habits. The article will focus on how to raise a child without leaving behind a mountain of garbage.

Many people, hearing the phrase "eco-friendly parenting", imagine a terrifying picture: a family lives in a tree far from civilization and eats green grass. But this is not the case. People who embark on the path of conscious parenting raise their children in harmony with themselves and the world around them.

The relevance of the study is high, because the health and future of children are directly related to the quality of the environment. And the ecological situation is getting worse every year. Many families want to help the environment and at the same time reduce the harm to the child.

And the question arises: how to make both the baby and the environment feel good? This is the main purpose of the study.

Eco-friendly parenting is associated with several principles. Firstly, nothing unnecessary is bought; everything that can be used repeatedly. Before the birth of a child, you should not buy a lot of things on the advice of everyone. It is better to buy the most necessary things, and buy the rest as needed. Before going to the store, it is better to make a list. Another important problem is receiving gifts that are not really needed. Nowadays, many people make up a wishlist. Used things and toys can be given to relatives or friends who already have or will have children, or to poor families.

The second principle is the use of a reusable alternative from childhood. Basically, it concerns diapers. Disposable diapers are a big polluter of the planet [1]. Reusable ones can be used. Further calculations on their benefits will be given. This also applies to wet wipes. They can be replaced with water and a rag [2]. An irreplaceable thing will be a reusable bottle.

The third principle: everything natural is for children. It is applied to household chemicals, food, clothing, and toys. Brands with a good composition or with eco-labeling are preferred. There are sites where you can check the composition https://ecogolik.ru/. The compositions of eco-friendly household chemicals look as follows: surfactants of plant origin, natural preservatives and flavors, the absence of refined petroleum products, microplastics, phosphates, chlorine-containing components, ammonia [1]. When choosing a toy, focus on its smell — there should be no sharp smell of plastic and other active odors, flavors. Give preference in clothing to natural materials (cotton, linen, silk) [1]. Complementary foods can be prepared by yourself from fresh products [3]. Thus, waste in the form of glass jars, boxes, plastic spoons is not formed.

The fourth principle concerns the direct upbringing of children. To begin with, you need to start with yourself and be an example for the child. You can read special books, study nature, sort waste [2]. It is not necessary to do everything at once and a lot, the child should be interested.

In the following sections of the article, the benefits of eco-friendly parenting will be considered.

2. METHODOLOGY

Calculations were carried out on the basis of average statistical data. Calculations do not carry complete information. They are aimed at

an approximate understanding of the problem. The average statistical data on the number of diapers and cans of the mixture used were provided by a forum on which women share their experience.

2.1. Diapers

The number of children born in 2020 was used for the calculation because at the moment their average age is 2 years. Accordingly, the average number of diapers used for 2 years was calculated. It is difficult to assess the data more reliably, because each family uses a different number of diapers per day, different sizes and different costs. The different number of diapers per day needed as the child grows up was taken into account.

2.2. Complementary food

The number of children born in 2020 was used for calculation because at the moment their average age is 2 years. Accordingly, the average number of cans of the mixture used for 2 years was calculated. Only the average number of cans of the mixture used per month was taken into account. An important factor is that not all mothers feed mixtures immediately or use it at all until the age of 2. For this reason, the number of children was halved, which can be considered a gross mistake.

3. RESULTS

3.1. Diapers

To understand the results, I present some data:

- the number of children born in 2020 is — 1.4 million [4];
- the average weight of the used diaper is 0.4 kg;
- the average cost of a disposable diaper is 21 rubles;
- the average cost of a reusable diaper is 900 rubles.

The costs and volumes of the formation of diapers per child for 2 years are calculated (Fig. 1). It was taken into account that up to six months 10 diapers a day are spent, up to a year — 6 pieces, up to 2 years — 3 pieces. [5]

The previous data were multiplied by the number of children born in 2020 (Fig.2). The values are in the millions.

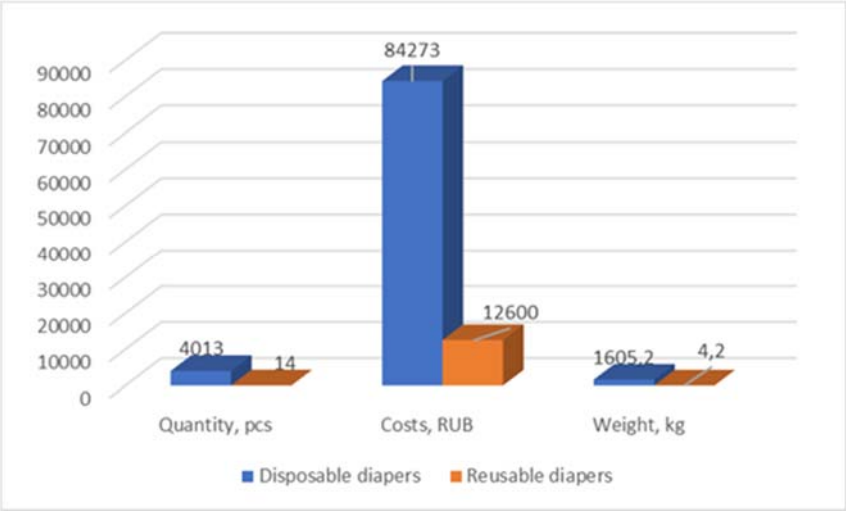

Figure 1. Comparison of disposable and reusable diapers per child for 2 years

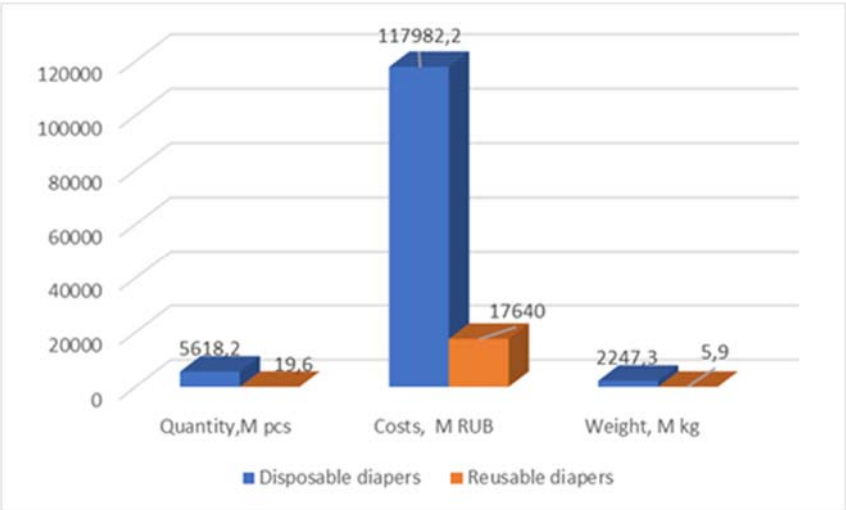

Figure 2. Comparison of disposable and reusable diapers per children born in 2020 for 2 years

3.2. Complementary food

Calculations show that on average 4 cans of the mixture are used per month [1]. Consequently, 96 cans are spent on a child for 2 years. A total of 67,200,000 cans and the same number of plastic lids and spoons are formed.

4. CONCLUSIONS

In this study, the goal was to show how eco-friendly parenting is possible and how it helps nature. The basic principles were considered, following which it is possible to minimize the impact on the environment.

The study showed how large the volume of formation of disposable diapers compared to reusable ones. A lot of cans of complementary foods are formed, which can be reduced using breastfeeding, if possible.

More research is needed that will clearly show the benefits of eco-friendly parenting and provide new alternatives.

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ANALYSIS OF GREENWASHING IN THE RUSSIAN MARKET

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Abstract: The article considers one of the urgent problems of environmental marketing — the use of greenwashing (green camouflage) by manufacturers of goods, presents examples of using the environmental theme in promoting their products to the market and manipulating consumer behavior by misleading the environmental properties of the product, discusses the experience and approaches of the People's Republic of China for the interest of manufacturers in the environmental certification of their products, recommendations are given to counter the misleading of consumers and improve the environmental awareness of the population.

Key words: eco marketing, greenwashing, eco labeling, eco certification, green certificate.

1. INTRODUCTION

For several decades, environmental problems have been among the most topical and topical topics of public life around the world. The media, various Internet resources, the scientific community, political and public figures pay close attention to them. Of course, with such a wide coverage, environmental issues are of interest to the widest sections of society today.

Recently, a steady trend has been noted in the consumer goods market: a product labeled "ecological" is in much greater demand among consumers than a similar product without an "eco" label, even if the price of the former is much higher. The consent of consumers to overpay for

"green" is also confirmed by the data of various studies on the change in the mentality of buyers. Thus, according to a survey conducted in 2018 by the independent company Nielsen, 73% of consumers support the idea of sustainability and are aware of the importance of preserving the environment. Consumers are willing to pay more for organic products (41%), for products that do not harm nature (38%) and for those that support social responsibility (30%) **[1]**.

Such behavior of consumers can be associated with modern vigorous activity around the world to preserve the environment from the negative impact of the activities of enterprises and the unreasonable consumption of resources.

The purpose of this article is to identify one of the problems of environmental marketing — greenwashing, as a way to manipulate consumer behavior, a comparative analysis and an attempt to classify examples of the use of environmental topics by manufacturing companies to promote goods on the consumer market, and to identify steps to counter this unethical method of promoting goods.

2. METHODOLOGY

The information base of the study was open information data and advertising materials in the media and the Internet, the websites of manufacturing companies. As part of achieving this goal, materials were collected containing information about the use of environmental topics by brands for positioning their products, the data obtained were evaluated and analyzed by comparison and comparison, patterns were identified in the data obtained, which were then classified into groups (methods). When performing the work, methods of analysis and synthesis, characteristic of interdisciplinary research, were applied, the balanced application of which made it possible to formulate recommendations for counteracting greenwashing in the Russian consumer market.

3. RESULTS

In Russia, in recent years, the level of environmental awareness of the population has also noticeably increased, and therefore, when buying goods, many people tend to follow rational and environmental consumption. In response to social demand and the growing popularity of sustainability, the concept of environmental marketing has emerged,

which is to meet the needs of consumers, taking into account the least negative impact on the environment, from the extraction of raw materials to the end of their life cycle. Environmental marketing, like any other business model, has a number of problems that need to be investigated and addressed. One of the most relevant and topical of them is "pseudo-green" marketing, when a company actively creates a "green" image for itself, but does not change the essence and technology of the business. Such manufacturers, unable to launch a truly sustainable product on the market, but wanting to get the full benefits of this positioning, often resort to unethical methods — greenwashing.

Greenwashing (from the English greenwashing — "green camouflage") is a negative consequence of the concept of environmental marketing: the activity of companies in positioning their goods or services as environmentally friendly, but in reality they are not.

Consider the main reasons for the use of green camouflage. Two aspects can be attributed here: the reason for brand owners to present their products as "green" and the reason for refusing to achieve environmental sustainability in a legal way.

The reasons for positioning your organization as "green" are quite obvious:

– the possibility of increasing the price of products (environmentally friendly raw materials and technologies that reduce emissions and discharges during production cost an order of magnitude more than conventional resources, so companies positioning their products as "green" include these costs in the final price of products. If the company does not change its activities to "green" and, accordingly, does not incur any costs, then the price increase generates a net profit);

– loyalty of consumers who traditionally prefer environmentally friendly goods, because due to the markedly increased environmental awareness of the population, most consumers prefer to choose brands that adhere to the same position.

The main reason for the unethical behavior of manufacturers is the complexity and high cost of changing production to a more environmentally friendly one, as well as obtaining official certification. Now there is the only Russian environmental certificate based on the international standard ISO 14024, recognized by the World Ecolabel Association (GEN) — Leaf of Life, which appeared on the initiative of the Ecological Union in 2001 in St. Petersburg [2].

Table 1

The main greenwashing methods used by manufacturers in the consumer market

Methods	Examples
Adding the words “eco”, “bio”, “organic” to the name.	Used in names (“BioBalance” — fermented milk products, “Organic kitchen” — cosmetics).
Part of the design (green colors, image of a leaf or sprout).	Dairy product manufacturer EkoNiva uses predominantly green colors in its design, which are associated with environmental friendliness and naturalness, although the company does not have regulatory documents on environmental friendliness. The Sloboda company placed a green leaflet with the inscription “live food” on the packages of dairy products, vegetable oil and sauces, which can be compared with the certificate “Leaf of Life”.
Activities aimed at the conser-vation of resources, protection of the environment.	The company collects old clothes for recycling, but it turned out that some clothes of acceptable quality were resold, and the rest was burned. It turns out that instead of saving resources, the company also spends additional energy (Swedish retailer H&M, represented on the Russian market) [3].
“Greening” the composition.	The Russian cosmetics company Natura Siberica is famous for its natural formulations, but many of these plants do not exist in nature. For example, wild black Sakhalin cedar (does not grow in the Sakhalin region), wild volcanic cloudberry and mountain Sakhalin burdock. In addition, the company was accused of cruelty to animals: one line used antlers — unossified deer antlers. Many animals cannot tolerate the painful procedure and die. [4].
Use of environmental certificates without validation or non-existent environmental labels.	In 2019, there was a situation that the brand of household chemicals placed on its products environmental labels — E and Ptitsa, which belong to the International Synergetic Environmental Fund (IEF) and do not comply with some environmental standard of the IEF, but with the Uniform sanitary-epidemiological and hygienic requirements to products subject to sanitary and epidemiological supervision. In Russia, any household chemicals must meet these requirements. Due to the loss of trust of most of its customers, the company received a real certificate — ICEA (Institute for Environmental Certification — the main Italian certifying organization) [5].
Plastic replacement.	Water of the Waterful brand is positioned as an eco-friendly product, as the manufacturer has replaced plastic with tetrapack. However, in this case, the replacement of plastic only aggravates the situation, since there are very few points for receiving tetrapacks for processing in Russia, and its processing requires even more energy.
Hiding part of the composition.	Companies write the good, harmless ingredients in normal type, and the bad ones at the end in small print, even though the rules require ingredients in a formula to be listed by their proportion in the product (“Synergetic” — household chemicals).

Consider what are the main methods used by companies to position their products as an environmental (*Table 1*).

Companies using greenwashing not only deliberately mislead customers, but also undermine the credibility of all eco-products, thereby reducing the demand for environmental products. To avoid this, the state should pay attention to this problem and take measures to solve it. One of such measures is the certification of products as ecological according to established standards.

On March 1, 2022, the Federal Law on Agricultural Products, Food and Industrial Products with Improved Characteristics came into force, which contains requirements for production, storage, transportation, as well as standards and procedures for obtaining a distinctive trademark — the Green Standard. The right holder of this mark is the Ministry of Agriculture of Russia, and the accredited standardization body is Roskachestvo.

Certification and obtaining the certificate itself is carried out on a voluntary basis. The data are entered into the Unified State Register of Producers of Agricultural Products, Food, Industrial and Other Products with Improved Characteristics, which is being formed from September 1, 2022. Thanks to this service, customers can independently verify the authenticity of the eco-label.

This measure is very much expected and necessary, but due to the short period of validity and the voluntary nature of the procedure, it is difficult to say how many manufacturers will want to receive it. However, it clearly demonstrates that the state is gradually beginning to regulate the market for environmentally friendly products and fight unscrupulous labeling. Now we are waiting for the appearance of certification and GOSTs in other — in addition to agricultural — industries.

Certification has spawned one of the most common ways to go green — getting a green certificate.

Now in Russia there are many non-governmental certifying organizations. For example, “Rosekoprodukt”, “International Ecological Fund” and others. In such systems, as a rule, there are no clear criteria by which a certificate is awarded, and the certification body itself (inspection organization) does not have the state accreditation required by law.

There are also those who issue certificates without any verification of goods at all, in fact selling them to anyone who wants them.

There are also those who issue certificates without any verification of goods at all, in fact selling them to anyone who wants them.

By purchasing such a certificate, the company gets the right to put on its product a kind of “green” marking with the symbols of this non-state certification body.

To combat this vicious phenomenon, Roskachestvo proposes to limit free labeling. Until now, they have not been regulated by law in any way, so manufacturers could use such designations, relying only on their good faith.

I believe that the time has come for the state to act more decisively. there is a need to completely ban the use of free eco-labels other than the state standard.

In this matter, it makes sense to refer to the international practice of combating “green camouflage”. For example, to study the experience of our eastern partner within the framework of an agreement on work on environmental certification of goods and services, signed in 2015 by the Russian Ecological Union with the Certification Center under the Ministry of the Environment of China.

As in most countries of the world, the procedure for obtaining an environmental certificate in China is voluntary, but the authorities of this country have found a way to encourage enterprises to switch to green production.

China's government procurement is required by law to include "green" goods. Moreover, some of them are strictly mandatory for certification (for example, textbooks for primary and secondary school students). As a result, nearly 4,000 organizations have already been accredited for the China Environmental Labeling (CEL) ecolabel. Every year, about three hundred more companies are added to them. In addition, support for the activities of enterprises that have received CEL is facilitated by favorable “green loans” provided by banks [6].

Russia's borrowing of these measures would motivate most companies to obtain Life Leaf or Green Standard certificates.

4. CONCLUSIONS

The most important thing today is to teach people to independently distinguish environmental goods from those masquerading as them. To do this, it would be advisable to create and implement a specialized computer program for checking environmentally friendly products, make

it popular and accessible to all segments of the population. It is necessary to cover this problem as widely as possible in the media, online resources, social networks, explain to children from an early age why organizations should switch to environmentally friendly production, what consumers can do in such a situation, and how to recognize brand fraud.

The first steps in this direction have already been taken. In particular, applications have been developed to help consumers verify the authenticity of the product certificate directly at the point of sale. An example is the Ecolabel Guide mobile app created in 2018 by the Ecological Union, the United Nations Environment Agency and the Nordic Ministry [7].

The introduction of regulation, standardization and controls on organic products are necessary measures to solve the problem, but they will not be useful if there is no incentive for companies to obtain this certification. Only a competent consumer who is aware of greenwashing methods, and therefore focused in his choice on truly environmentally friendly products, can really stimulate this transition.

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SYMBOLES MATHÉMATIQUES DANS LE DISCOURS MÉDIATIQUE MONDIAL MODERNE (À L'EXEMPLE DES MÉDIAS RUSSES, FRANÇAIS ET ANGLAIS)

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Annotation: L'objectif de l'étude est d'analyser le rôle des symboles mathématiques dans la construction du contenu informationnel du discours médiatique mondial basé sur les médias modernes en Russie, en France et dans le monde anglophone. Une analyse d'exemples pratiques extraits par la méthode d'échantillonnage continu des discours médiatiques russes, français et anglais a démontré la fonction clé du fonctionnement des symboles mathématiques dans les médias mondiaux de l'ère numérique moderne.

Mots clés: symboles mathématiques, discours médiatique mondial, médias en Russie, en France et dans le monde anglophone, savoir universel, valeurs, idéaux

1. INTRODUCTION

Les mathématiques sont une science universelle, sans laquelle l'humanité n'aurait pas atteint les sommets auxquels elle se trouve aujourd'hui, à l'ère actuelle du monde médiatique (numérique) et de l'intelligence artificielle. Ces deux derniers phénomènes rapprochent encore plus la connaissance mathématique et le symbolisme au public,

transformant la science mathématique en beaux «symboles intelligents et soignés». «Téléphone mobile, transmission radio ou sondes sur Mars… toutes ces inventions marchent grâce aux mathématiques. Tel est le postulat que tente de démontrer, avec un certain succès, ce documentaire ambitieusement titré Le Grand Mystère des mathématiques» [1].

Une telle magie des nombres est souvent devenue une «fascination» pour les chercheurs dans le domaine du journalisme et des disciplines scientifiques connexes, soulignant le rôle des mathématiques dans l'évolution de nouveaux médias et de la communication. Ainsi, par exemple, le chercheur Russe S.G. Korkonosenko souligne le rôle significatif du modèle mathématique qui représente l'une des premières tentatives du plan de diffusion de projets médiatiques à long terme qui affectent ... la sphère émotionnelle d'une personne [2, p. 159].

Compte tenu de la numérisation à grande échelle de la vie de la société moderne, le recours au symbolisme mathématique semble être un objet de recherche pertinent. En conséquence, dans le cadre de ce travail, l'objectif principal est à analyser le recours aux symboles mathématiques dans les discours médiatiques russes, français et anglais et à établir leurs caractéristiques fonctionnelles dans les contextes mentionnés ci-dessus. De plus, cette étude implique une analyse comparative afin d'identifier à la fois les similitudes et les différences de l'utilisation des symboles mathématiques dans l'espace des médias au-delà des zones linguistiques nationales indiquées.

Avant de passer à l'examen empirique direct des exemples du recours aux symboles mathématiques dans les masses médias russes, francophones et anglophones, nous attirons l'attention à la justification théorique de la pertinence du choix du sujet d'étude.

2. FONDEMENTS THÉORIQUES DE LA RECHERCHE ET EXPÉRIENCE EMPIRIQUE

La question de l'examen du rôle d'un symbole mathématique et de son application pratique dans les médias modernes est l'un des problèmes les plus intéressants dans la connaissance scientifique interdisciplinaire des sciences humaines russes et étrangères. D'après K.K. Martynenko, l'utilisation des codes mathématiques dans les masses médias s'explique par la compréhension axiologique de la culture elle-même par l'homme moderne qui, dans le processus de la révolution numérique de la réalité, a acquis le statut de «personne symbolique» (homosymbolicus) dans

l'univers symbolique d'Internet [3, pp. 309–310]. On ne peut qu'être d'accord et qu' à ajouter que l'homme symbolique et médiatique moderne, comme jamais auparavant, s'est rapproché de l'interprétation mathématique de la réalité au niveau de la vie quotidienne.

En science interdisciplinaire étrangère, la question de l'interaction du symbolisme mathématique et de l'espace médiatique est vue encore plus en détail, y compris le transfert d'une approche purement scientifique des mathématiques dans la société. C'est le 19ème siècle qui a vu les premières tentatives de transformer la connaissance mathématique et son symbolisme en quelque chose de populaire…, dans la soi-disant «compréhension publique de la science» [4].

«À la fin du XIXe siècle, il n'était pas rare que les grands mathématiciens de l'époque s'engagaient auprès du public. Felix Klein et Henri Poincaré ont écrit des livres populaires. David Hilbert a intervenu à la radio sur l'avenir des mathématiques» [5].

Il est à noter que, cet objectif a été atteint deux siècles plus tard, dans le premier quart du 21ème siècle, lorsque la révolution technologique a incité l'individu et la société numérique au symbolisme mathématique non seulement à des fins de recherches, mais également au niveau de la société moderne.

C'est ce que témoignent de nombreux exemples du fonctionnement de divers symboles mathématiques dans l'espace médiatique de la Russie, de la France et du monde anglophone. Citons des extraits des textes consacrés à l'interaction de l'homme moderne–médias-symboles mathématiques, qui permet de transformer l'individu en «alter ego» de la personnalité numérique du XXIe siècle.

L'exemple 1. «Les scientifiques ont développé des formules pour toutes les occasions. ***Les mathématiques*** contribueront-elles à rendre notre monde plus harmonieux?» [6].

«UNE CONVERSATION TÉLÉPHONIQUE IDÉALE

Un appel téléphonique à un ami ou à un parent devrait durer exactement ***9 minutes et 36 secondes***. Ces données ont été obtenues au cours d'une étude menée auprès de deux mille personnes ayant participé à une recherche visant à établir la durée idéale et les sujets de communication téléphonique.» [ibid.].

L'exemple 2. «Pour moi, ***les signes des mathématiques*** sont un ensemble de métaphores visuelles des manières de ressentir. **"±"** est un

signe signifiant qu'il existe deux possibilités différentes qui sont également valables — ***un symbole d;incertitude***. ***"∞" parle du combat*** que nous menons avec nous-mêmes pour essayer de comprendre de plus en plus. Et quand je conçois quelque chose, je dis que je dois d'abord aller au **"√",** la racine carrée du problème: le sentiment que j'ai atteint le cœur, à partir duquel je peux construire. Le but est toujours de transmettre une idée de la manière la plus nette possible. C'est pourquoi j'admire le symbole de Wallis. En introduisant ***le signe de l'infini***, il atteint l'objectif que doit viser tout bon design: ***l'élégance***» [7].

L'exemple 3. "L'art consiste à ne pas laisser la nature se dissoudre en moyens de production, en objets de consommation ou ***en symboles mathématiques***" [8].

L'exemple 4. «***Tout le monde parle maths! La réelle langue universelle*** qui nous a accompagnés depuis le début des temps dans notre quête du savoir: ***les mathématiques***» [9].

Les exemples ci-dessus plaident en faveur de l'importance des mathématiques et du symbole mathématique en tant qu'un des outils de construction du contenu informationnel des médias modernes. L'universalité de la connaissance mathématique s'étend également au caractère universel du symbolisme mathématique fonctionnant dans l'espace médiatique russe, français ou anglais.

3. CONCLUSION

En résumant tout ce qui précède, nous notons que le symbole mathématique est un élément de la culture humaine qui existe depuis plusieurs millénaires. Le développement rapide des technologies de l'information dans le premier quart du XXIe siècle a suscité un regard neuf sur le fonctionnement des symboles mathématiques dans la société. L'espace médiatique moderne, indépendamment de son appartenance nationale ou géographique, s'est tourné vers l'utilisation de la culture symbolique mathématique, dans le but de construire une compréhension plus simple de l'ordre numérique moderne bien complexe.

Le langage des nombres et des symbols du discours médiatique de la Russie, de la France et du monde anglophone est devenu un outil efficace des médias complétant le mot et lui attribuant des effets supplémentaires d'influence et de force, qui peuvent agir comme des «moteurs» caractéristiques de la transformation de l'âme humaine et de la vision du monde.

Ainsi, le symbolisme mathématique des médias russes, français et anglophones continue la politique évolutive des médias, cherche à unifier l'humanité par les connaissances, les valeurs et les idéaux universels, indépendamment des cadres nationaux, territoriaux ou raciaux.

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GREEN–2022

СТУДЕНЧЕСКИЕ ИССЛЕДОВАНИЯ В ОБЛАСТИ ЭКОЛОГИИ, ИНЖЕНЕРИИ И ПРИРОДЫ — 2022

В двух частях

ЧАСТЬ 1

Издание подготовлено в авторской редакции

Технический редактор *Н.А. Ясько*
Компьютерная верстка *Н.В. Маркеловой*
Дизайн обложки *М.В. Роговой*

Подписано в печать 01.12.2022 г. Формат 60×84/16. Печать офсетная.
Усл. печ. л. 28,13. Тираж 300 экз. Заказ 1609.

Российский университет дружбы народов
115419, ГСП-1, г. Москва, ул. Орджоникидзе, д. 3.

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