EasyChair Preprint

№ 3701

Analysis of Urban Environmental Factors as Potential Sources of Emergencies, Saint Petersburg

Irina Russkova, Alexandr Tumanov, Viktor Monashkov, Olga Konstantinova and Ksenia Velmozhina

June 29, 2020

Analysis of urban environmental factors as potential sources of emergencies, Saint Petersburg

I G Russkova[1], A U Tumanov[1], V V Monashkov[1], O E Konstantinova[1], K A Velmozhina[1]

[1] Higher School of Technospheric Safety, Peter the Great St. Petersburg Polytechnic University, Polytechnic Str., 29, St. Petersburg, 195220, Russia

E-mail: russkova_ig@spbstu.ru

Abstract. In this work, materials on hazardous production facilities of St. Petersburg are studied in detail and presented. Factors of the urban environment, which can affect the emergency situation in the city, are also considered. These factors include noise, vibration, electromagnetic and radiation, air pollution, forest, water and land resources of the city. Measures to reduce the negative impact of each of the above factors are proposed. A map of hazardous areas in St. Petersburg has also been developed, marking all hazardous industrial facilities and drawing the damage radium from potentially hazardous facilities in case of an accident.

Keywords: emergency, electromagnetic field, potentially dangerous production facility, complex of protective structures, safety, radiation hazardous substances, factors of the urban environment.

1. Introduction

Everyone in the modern society is subjected to different kinds of risks and threats. These are natural disasters, industrial accidents, catastrophes at hazardous production facilities, etc. People living in industrialized cities are subjected to these dangers more often. The actuality of this work is defined by the fact that urban environment has a lot of threats. For a town like Saint-Petersburg with population of 5 392 992 people (according to data of 2020) [1], this problem has special meaning. In the Northern Capital of Russia there are more than 100 facilities which are assigned to a particular hazard class. For example, there are about 20 explosive facilities and about 20 chemically hazardous objects [2], 14 large enterprises using radioactive substances (and about 10 smaller enterprises and organizations) in the city [3, 56-57].

We can find works that study factors of urban environment and improvement of workplaces at production facilities in modern scientific literature [4-8]. Research like this is being made in many other regions and countries in order to reduce the risks of citizens living there. For example, residents of the Cheboksary region made a research of geotechnical and hydrogeological conditions of the territory for transport construction [7]. The study of the given problem helped us to make a conclusion that the stability of the chosen places is insufficient. This conclusion and proposed solutions of identified problem show us that these studies must be carried out at the beginning of any building, since certain places do not always satisfy the construction conditions according to their geological data. In another region there was a research of noise loads in order to organize noise elimination work

[8]. In one of the articles there was given a particular research of the impact of the anthropogenic negative factors on small enclosed spaces [9]. The systematic analysis and assessment of territories, their zoning according to the main indicators of technosphere safety is important task and obligatory component for designing plans of development of the city, particularly in the analysis of future zones of growth and building of urban reconstruction territories.
Besides, environmental impact of the urban environment is also studied in scientific literature [10-14]. For instance, in one of the scientific works the impact of urban fires on the ecology and quality of life in cities are studied [10]. Other researches of water resources were conducted in the mining region of Mexico [11]. The results of these researches let us to minimize negative impact of industry on the environment.
Researches, who study emergencies at the production facilities [15-20], conclude that even though these accidents do not take place often, they still bring huge economic and social damage to the city. Study of these catastrophes should be the most important while ensuring the safety of the city. There are also different methods for ensuring labor safety at various production facilities in these articles [19, 20].
In this way, the environmental impact on urban buildings and importance of studying geological data and other environmental aspects for comfort living of citizens in industrialized cities is considered as significant in the world.
In this way, the aim of the conducted research was to create a unified map of St. Petersburg indicating the factors of the urban environment which have an impact on hazardous production facilities of the city. The methods, which are used for creation of this project, can be also used for making similar maps of other industrialized cities in order to create optimal working conditions at hazardous production facilities. Besides, there are some more factors, which affect the safety of living in certain areas of the metropolis, but they did not become a part of this research. For instance, the presence of faults in the Earth's crust, and, as a result, the release of radon to the surface.

2. Methods

The main task of the research was to find urban factors of Saint-Petersburg, which can have not only passive negative effect, but also can become the reason of accidents and catastrophes at production facilities.
After analyzing the scientific literature on a given problem, a detailed description of the impact of all identified factors of the urban environment, both on the citizens and on hazardous industries, was made [7]. A map of Saint-Petersburg indicating all hazardous production facilities was also proposed. Besides, the map shows the radius of damage from potentially dangerous objects in the case of an accident.
Empirical methods were fundamental in this research. Tracking such urban factors like electromagnetic radiation, city noise, city radiation background, etc., was made for studying the environment of the city. Monitoring of individual parameters such as atmospheric gas and water composition in rivers was made as well [7]. For example, noise maps created for St. Petersburg were needed to analyze noise level in the urban areas (Figure 1) [21].

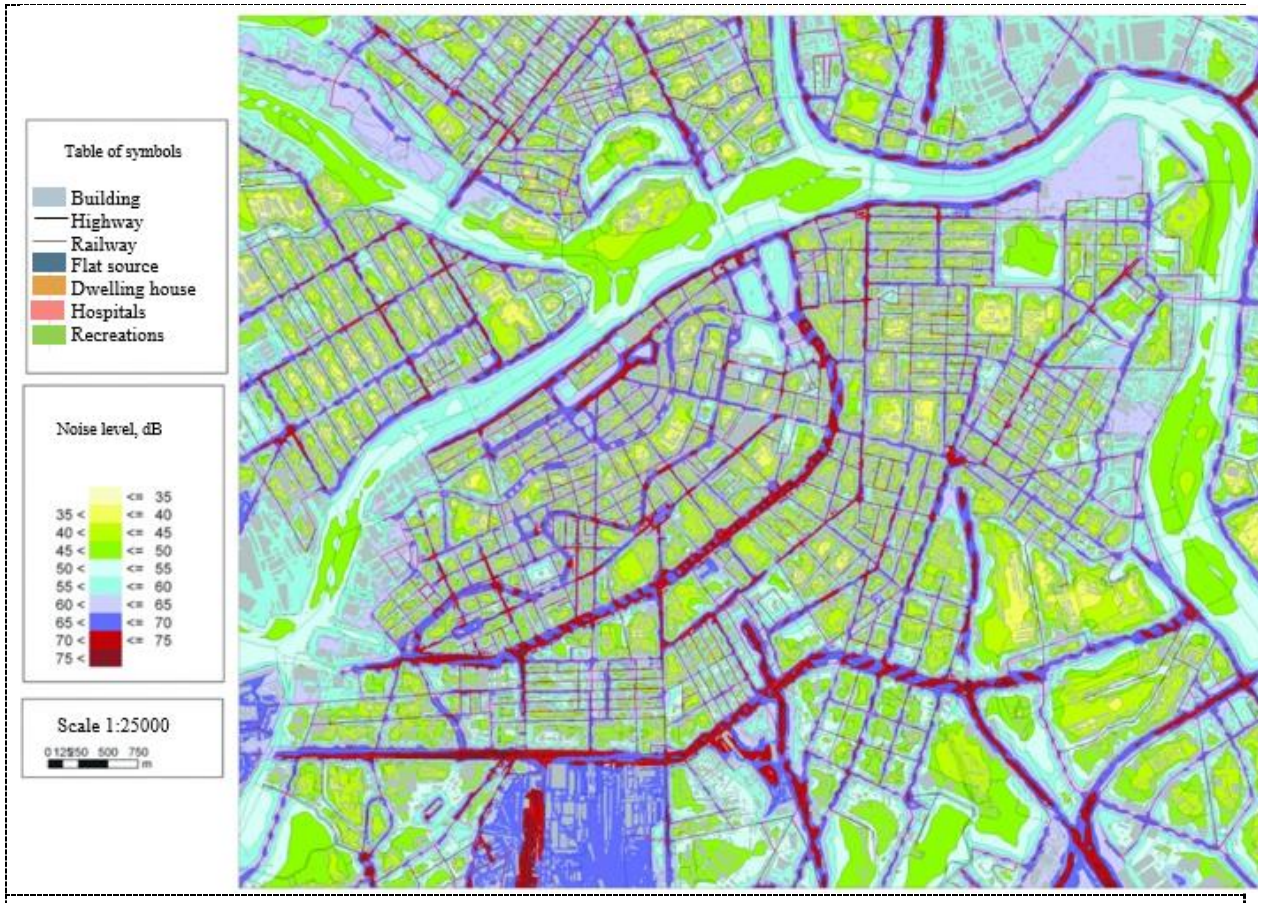

Figure 1. Acoustic map of Saint-Petersburg, Source: https://www.fontanka.ru/2017/10/30/108/?mobile=false

Saint-Petersburg is one of the 5 noisiest cities in the world. Noise figure in the metropolis is 60 decibels on the average, which exceeds the normalized figure [22, 12]. On a noise map, sound intensity levels have a specific color. In some cases, it is necessary to clearly distinguish between objects, so that is why only the dividing line indicating these levels is used for designation of the limits of the same noise level. In this way, it is possible to use the noise map for determination of the exact noise level at any point in the entire study area at any time.

The generalization and comparison of the facts presented in the publications of scientists helped us to formulate the exact scientific problem and hypothesis, taken as the basis of this research.

3. Results

Based on the data obtained as a result of monitoring various factors of the urban environment, urban environment factors, that can affect the number of emergencies at hazardous production facilities, were identified. For each of the factors a brief description, which indicates the influence of the factors both on the citizens and the production facilities of the city, was made. The methods of reduction of the negative impact of all identified factors of the urban environment were given.

Besides, the enterprises of St. Petersburg, that could become sources of emergency situations, were considered. Chemically hazardous objects (Figure 2), radiation hazardous facilities, explosive and fire hazardous objects, seaport and railway junction sorting stations, solid waste and hazardous waste landfills, airports were investigated separately.

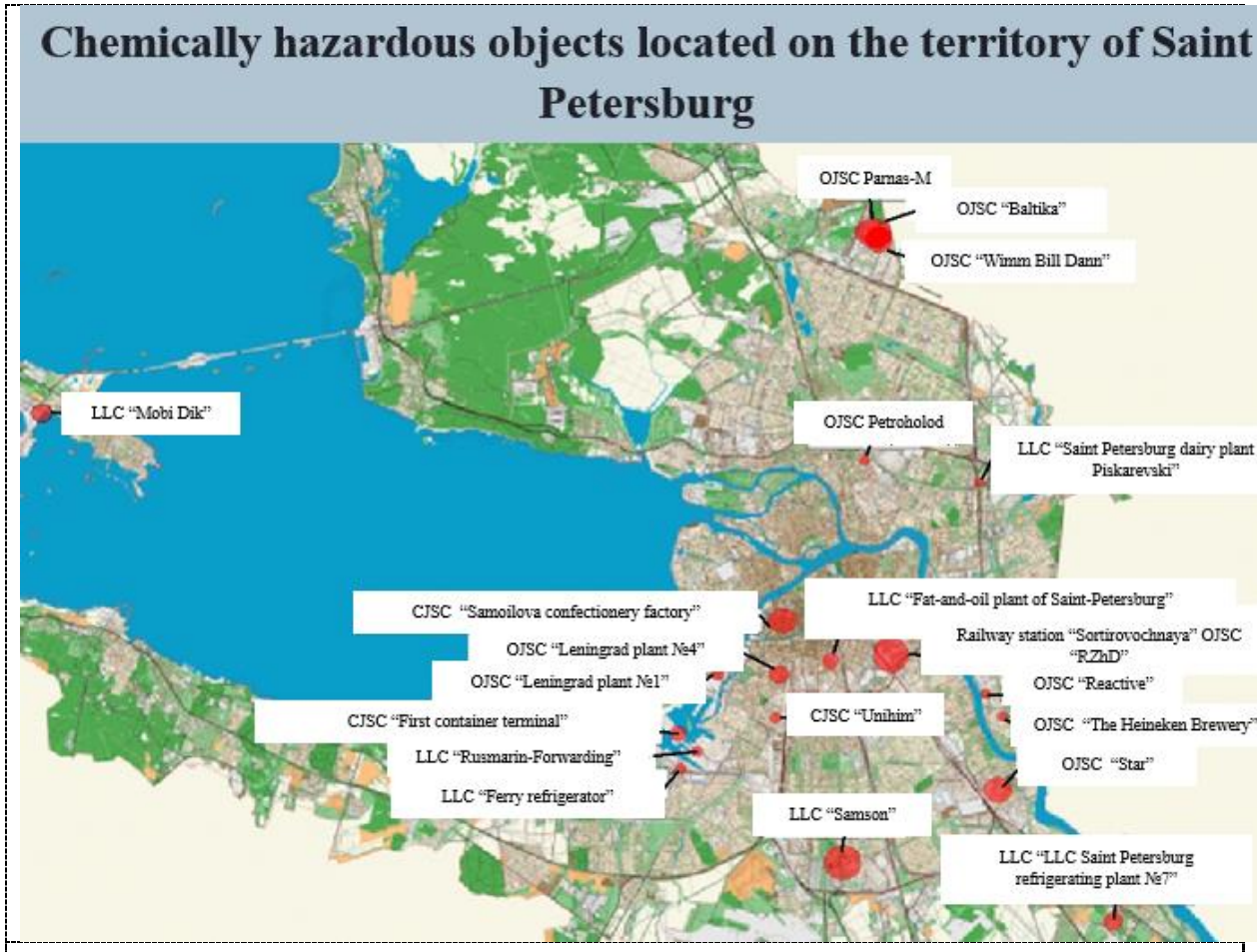

Figure 2. Chemically hazardous objects, Source: https://infourok.ru/chs-prirodnogo-i-tehnogennogo-haraktera-prisuschie-spb-1379643.html

The daytime, the average wind speed in the city (2.6 m/s) and the average cloud cover were chosen for calculation of possible accidents at radiation hazardous facilities. The share of the release of radioactive substances was 10%. To display on the map, the maximum area affected by radiation was applied, within which it is necessary to limit the stay of people.

Approximate trade turnover for Saint-Petersburg's seaport was compiled and is shown in table 1. In the seaport of the city there is a movement of oil products, metals, coal, ore, chemical cargo and other hazardous materials [23, 64-65].

Table 1. Trade turnover of the seaport

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Millions tons	58,0	60,0	57,8	58,0	61,2	51,5	48,6	53,6	59,3	59,9

Besides, the measures to improve the quality of the urban environment and prevention of accidents at production facilities were recommended. As the main aspects for the prevention of technological emergencies are considered:

- The upgrading of technical equipment.
- Increasing the number and improving the quality of instruments for identifying and monitoring hazardous and harmful factors.
- Increasing of technological reliability of all industrial safety systems.

- Increasing the level of literacy and responsibility of specialists working in hazardous objects.
- Reducing the use of hazardous substances and technologies.
- Creation of the necessary number of local warning systems for accidents at potentially dangerous facilities.

As a result of the work, a map of the main especially dangerous objects of St. Petersburg was created. This interactive map can be found on the Yandex.Maps. All of the especially dangerous objects of the Northern Capital of Russia are indicated (Figure 3), as well as the affected areas with the highest degree of risk in case of emergencies at especially dangerous sites.

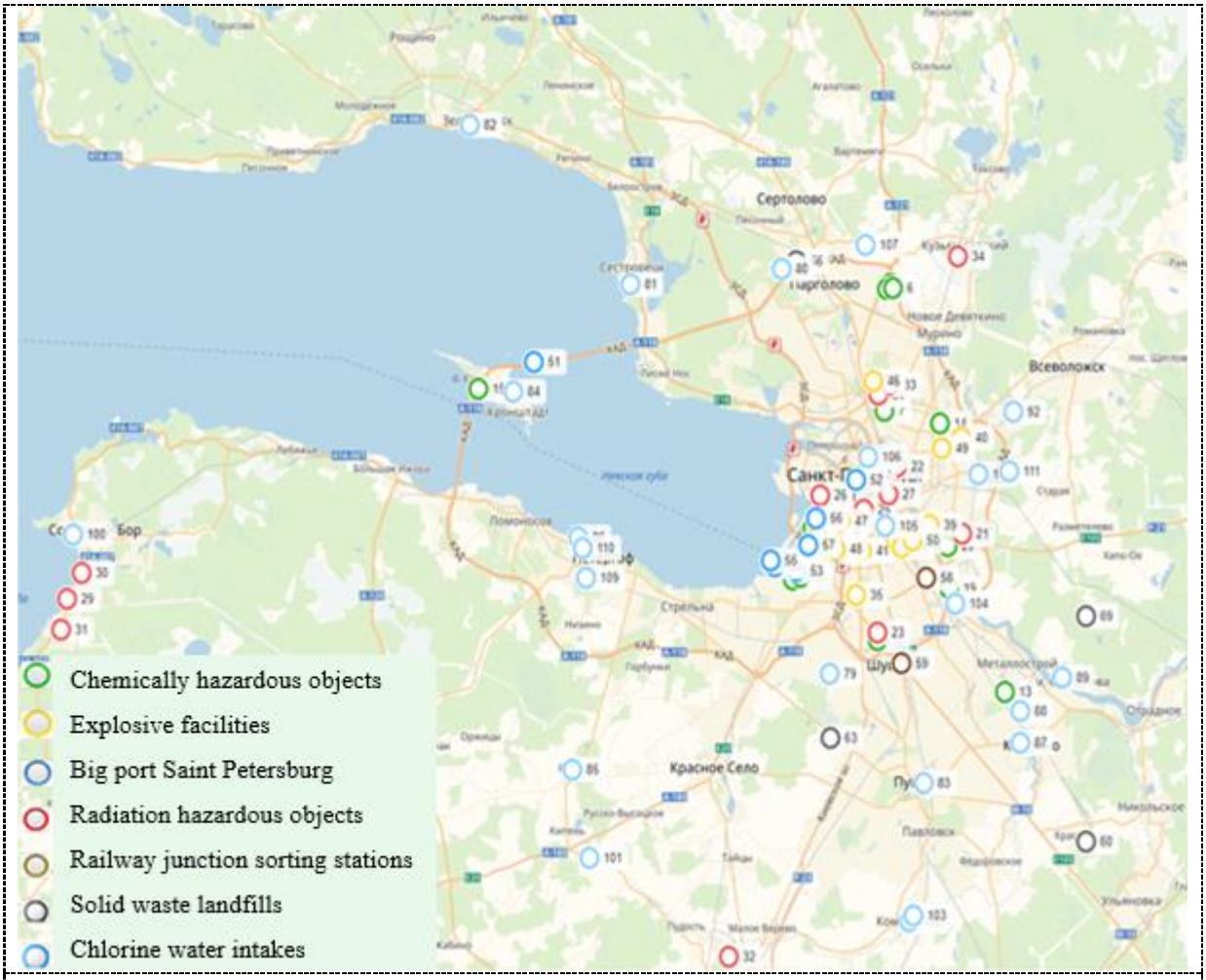

Figure 3. Map of the main especially dangerous objects of Saint-Petersburg

The interactive map is as follows (Figure 4).

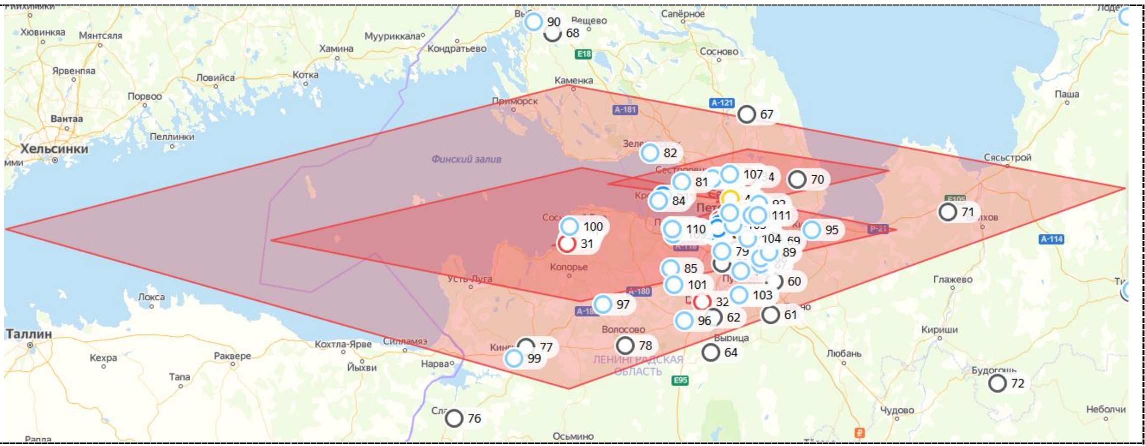

Figure 4. Map of dangerous objects of Saint-Petersburg

The most polluted for living and located in the maximum risk zone in case of emergency areas were also found. These are: Admiralteysky, Vasileostrovsky, Central and Kirovsky districts of the city.

4. Discussion

The results obtained in this work can be useful in creating a general plan for the development of the city.

In the future, it is possible to continue the study based on the results. It is planned to take into account the influence of faults in the Earth's crust at hazardous production facilities and further calculation of the depths of the affected areas in case of possible accidents. The obtained results will be added to the existing interactive map.

5. Conclusion

During the study, factors of the urban environment that could become a source of emergency situations at production facilities were identified and characterized. Besides, calculations of the depths of the affected areas during accidents at hazardous industries were made. Based on the data obtained, two maps were compiled: a map of especially dangerous enterprises of Saint-Petersburg and an interactive map with the indicated radius of damage from potentially dangerous objects in the case of an accident.

References

[1] Naselenie Sankt-Peterburga po rajonam. Available at: https://www.sites.google.com/site/ruregdatav1/naselenie-sankt-peterburga-po-rajonam (accesed 20.04.2020).

[2] Opasnye i osobo opasnye ob"ekty leningradskogo regiona. Available at: http://www.eco.nw.ru/lib/data/04/13/011304.htm (accesed 08.04.2020).

[3] Statisticheskie dannye MCHS Rossii. Available at: http://www.mchs.gov.ru/activities/stats (accesed 08.04.2020).

[4] Dement'Eva M and Dement'Eva A 2018 *Cartographic modeling for monitoring the technical condition of urban development objects* vol 170 (MATEC Web of Conferences)

[5] Sidyakin P A and Khorzova L I 2018 *Integrated assessment of ecological state of municipal economy objects in towns of caucasus mineral waters region* vol 451, ed O A Bykadorova (Conference Series: Materials Science and Engineering)

[6] Pineo H and Zimmermann N 2020 *Integrating health into the complex urban planning policy and decision-making context: A systems thinking analysis* vol 6, ed M Davies (Palgrave Communications)

[7] Nikonorova I V and Petrov N F 2019 *Sustainable use of natural resources in a hazardous landslide slopes of Cheboksary reservoir (river Volga)* vol 663, ed A E Gumenyuk and V N Ilyin (IOP Conference Series: Materials Science and Engineering)
[8] Sidyakin P and Belaya C 2019 *The impact of noise pollution on the ecological state of the territories of preschool institutions of the resort City of Pyatigorsk* vol 32, ed D Shchitov (Akustika) pp 100-104
[9] Sydyakin P A and Belaya E N 2019 *Impact of traffic flows on environmental situation in resort cities* vol 687, ed D V Shchitov (IOP Conference Series: Materials Science and Engineering)
[10] Radionova S G and Zhulina S A 2018 *On the methodological recommendations for classification of emergency events at hazardous production facilities of the oil and gas complex* vol 2018, ed T A Kuznetsova, I A Kruchinina, A I Grazhdankin and O V Kurpatov (Bezopasnost' Truda v Promyshlennosti) pp 22-30
[11] Grazhdankin A I and Pecherkin A S 2019 *On the background levels of emergency hazards at hazardous production facilities* vol 2019, ed E A Samuseva, N L Razumnyak and V I Sidorov (Bezopasnost' Truda v Promyshlennosti) pp 50-56
[12] Lisanov M V and Zhukov I S 2019 *Criteria for buildings and structures blast resistance at hazardous production facilities* vol 2019, ed R V Bazaliy (Bezopasnost' Truda v Promyshlennosti) pp 40-46
[13] Kurbangaleeva M H and Tazetdinov A S 2019 *Safety improving of cooling unit of is open tane - isoprene charge stock for production of isoprene rubber* vol 272 (IOP Conference Series: Earth and Environmental Science)
[14] Saltanaeva E A and Maister A V 2019 *Optimization of calculations of the effects of spill fires during accidents on linear equipment* vol 140 (E3S Web of Conferences)
[15] Kostyukov A V and Boychenko S N 2017 *Multi-method automated diagnostics of rotating machines* vol 1876, ed A V Shchelkanov and E A Burda (AIP Conference Proceedings)
[16] Liu J 2019 *Research on how to improve environmental protection during fire emergency rescue* vol 300 (IOP Conference Series: Earth and Environmental Science)
[17] Kurbanov A R and Liadova A V 2019 *Spatial inequality and health of russian population* vol 40, ed I A Vershinina (Espacios)
[18] Bozdogan Sert E and Turkmen M 2019 *Heavy metal accumulation in rosemary leaves and stems exposed to traffic-related pollution near Adana-Iskenderun Highway (Hatay, Turkey)* vol 191, ed M Cetin (Environmental Monitoring and Assessment)
[19] Malyukov V P and Fedin V D 2018 *Environment protection in oil production at the prirazlomnoe field on the Pechora sea shelf* vol 2018 (Mining Informational and Analytical Bulletin) pp 95- 101
[20] Mendezcarlo Silva V and Lizardi-Jiménez M A 2020 *Environmental problems and the state of compliance with the right to a healthy environment in a mining region of México* (International Journal of Chemical Reactor Engineering)
[21] Kakie rajony Peterburga tishe, a kakie shumnee? Kakoj shum dlya cheloveka samyj nepriyatnyj? CHto nado delat', chtoby shuma v gorode stalo men'she?. Available at: https://www.fontanka.ru/2017/10/30/108/?mobile=false (accesed 02.05.2020).
[22] Ekologiya i klimat goroda Sankt-Peterburga. Available at: https://betosteel.ru/ecology/sankt-peterburg-7.html#3 (accesed 28.05.2020).
[23] Osipov V.I. Megapolisy pod ugrozoj prirodnyh katastrof [Megacities under threat of natural disasters*], // *Vestnik Rossijskoj akademii nauk* [Bulletin of the Russian Academy of Sciences*], 2015, no. 9, pp. 28-45.
**Translated by author of the article.*