ARCTIC MEDICINE

E.V.Vorontsova, A.L.Vorontsov

ENVIRONMENTAL STATE AND HUMAN HEALTH IN THE ARCTIC ZONE: MEDICAL AND SOCIO-LEGAL ASPECT

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The authors investigate the environmental impact of the Arctic zone of the Russian Federation on human health. Noting the importance of the Arctic region for our country, the authors draw attention to the huge role of human capital in the processes of its further development. In their opinion, it is the “human factor” that is the main factor determining the possibility of implementing projects for the development of the Arctic zone. In turn, the quality of human capital in the extreme conditions of the North determined primarily by the state of health. This actualizes the need to study the adverse factors affecting the human body in the Arctic. The aim of the work was to analyze environmental problems in the Arctic zone of the Russian Federation and their impact on the health of the population living in this region. The analysis of these problems carried out by the authors not only from biomedical positions, but also from the positions of legal support of environmental protection as a condition for reducing risks to human health. The main research methods were the methods of statistical and logical analysis, the system-functional method, the comparative method, the generalization method. Results. In the course of the study, the authors identified the main factors of the negative impact of the environment of the Arctic zone on human health, having a natural and anthropogenic character. According to the authors, the main natural factorsare cold, increased electromagnetic activity and radiation, low absolute humidity of the air, frequent fluctuations in atmospheric pressure, unusual photoperiodism. The authors attributed the anthropogenic factors to pollution of surface and groundwater, as well as the soil cover with oil products; air pollution by emissions of mining, mining and metallurgical and metallurgical enterprises; radionuclides of technogenic origin. The paper describes the consequences of the impact of these environmental factors in the Arctic zone on human health. According to the results of the study, conclusions was drawn about the immanent nature of environmental risks, and, accordingly, risks to public health during intensive industrial development of the Arctic zone. The natural and climatic conditions of the Polar region objectively increase the harmful effects on human health of the effects of anthropogenic pressure on the environment. In order to prevent and minimize the risks of human health violations in the Arctic zone and environmental protection, it is necessary to amend a number of legislative acts of the Russian Federation, as well as to adopt a comprehensive Federal law "On the Arctic zone of the Russian Federation", which should be based on a unified concept of legal regulation, taking into account the climatic, environmental, medical and biological specifics of the Arctic.

Keywords: the Arctic, the Arctic zone of the Russian Federation, the Arctic region, natural factors of negative impact on health, negative environmental factors of anthropogenic origin, risks of impairment of health, environment, legislation, “Arctic synergy”, diseases, health protection.

In international law, the Arctic is usually understood as a part of the Earth's spheroid, whose center is the North Pole and the marginal boundary is the Arctic Circle (parallel 66 ° 33' north latitude)[13]. The Arctic region connects together two continents - Eurasia and North America, within its borders there are five states - Russia, Norway, Denmark, the USA and Canada, each of which has an exclusive economic zone and a continental shelf in the Arctic Ocean [3]. According to the Fundamentals of the State Policy of the Russian Federation in the Arctic for the period up to 2020 and beyond, the Arctic zone of the Russian Federation is understood as part of the Arctic which includes all or part of the territory of the Sakha Republic (Yakutia), Murmansk and Arkhangelsk Regions, Krasnoyarsk Territory, Nenets, Yamalo-Nenets and the Chukotka Autonomous Districts, as well as the lands and islands adjacent to these territories, internal sea waters, the territorial sea, the exclusive economic zone and the continental lf the Russian Federation, within which Russia has sovereign rights and jurisdiction in accordance with international law. This territory is the largest source and strategic reserve of mineral and energy resources of Russia. It produces 100% of domestic diamonds, 98% of platinum, 97.5% of gas, 75% of oil, 95% of nickel and cobalt [22, p.50-51]. The Arctic zone can rightly be called the source of raw materials for the development of the domestic economy. In addition, the Russian Arctic zone has a powerful logistical potential - in conditions of climatic warming, the Northern Sea Route we are reviving is able to reverse the existing global logistics schemes. Thus, the importance of the Arctic for our country cannot be overestimated.

Realization of the Arctic potential requires the involvement of human resources. This is also required by defense projects, since our competitors in the Arctic region are increasing their military presence and are seeking to question the sovereign rights of the Russian Federation to the natural resources belonging to it.

The circumstances noted above increase the importance of human capital. In turn, the quality of human capital is largely (and in the first place in the extreme conditions of the North) determined by the state of health. Hence, when planning and implementing plans for the development of the Arctic, it is extremely important to take into account a wide range of adverse factors affecting the human body. This actualizes the study of biomedical problems of the development of the Arctic zone in a wide range of scientific fields, including in the aspect of environmental protection and its legal support as directly related to human health.

The **purpose** of this work was to analyze environmental problems in the Arctic zone of the Russian Federation and their impact on the health of the population living in this region.

Based on the results of the analysis, the authors will propose legal measures to reduce risks to human health in the Arctic region (in the regions of the Far North).

Materials and methods of the research. The research process was based on the principles of scientific knowledge and objectivity of the knowledge gained. The material for the analysis undertaken was the results of previously conducted research in the field of human physiology and hygiene in the Far North, identifying the main risk factors for health problems

VORONTSOVA Elena Vladimirovna, PhD, associate Professor of Department of financial law, constitutional, civil and administrative proceedings, South-West state University, 305040, Kursk, street 50 let Oktyabrya, 94, e-mail: proskyrinae@mail.ru; **VORONTSOV Andrey Leonidovich**, PhD, associate Professor, associate Professor of Department of administrative and labor law South-West state University, 305040, Kursk, street 50 let Oktyabrya, 94, e-mail: vorontsov.a.l@mail.ru.

in these areas, as well as materials from other biomedical research. In addition, data obtained from environmental monitoring in specific regions of the Arctic zone, as well as data from integrated geo-environmental studies were used. In addition, the content of the program strategic documents of the Russian state in the field of development and development of the Arctic zone, as well as the content of environmental legislation were analyzed. A specific methodology comprised a complex of general scientific and private scientific methods, among which the main ones were the method of statistical and logical analysis, the system-functional method, the comparative method, the generalization method.

Results and discussion.

1. The impact of environmental factors on the human body in the Arctic. The natural and climatic environment of the Arctic zone is characterized by an abundance of factors that have a negative impact on the health of the population living here. First of all, such factors should include cold, by which many researchers tend to understand the entire set of cooling meteorological conditions — low air temperatures, a long period of standing snow, strong winds, lack of solar insolation [18, p.5].

Cold affects the heat transfer and human performance. Labor load in cold conditions requires large physiological costs. Coefficient of performance (COP) of physical work in the open air in the conditions of the Extreme North is approximately 15–25% lower than in middle latitudes [12]. At the same time, there is an increased risk of chronic exposure to the cold factor in the Arctic zone for many workers.

The respiratory system, which is most vulnerable, as it cannot be completely protected from external conditions, is exposed to cold most often.The cold factor also contributes to the fact that the respiratory tract and respiratory membranes have the largest environmental contact surface among all tissues of the body, the area of which is approximately 50 times the surface of the body [20]. According to medical research, the local exposure to cold air on the mucous membrane of the upper respiratory tract, trachea and bronchial tree causes a significant loss of heat and moisture, which are used to warm and moisten the inhaled air. Negative temperature values of inhaled air require significant functional stress from the respiratory system and, in general, create an extremely aggressive environment for the respiratory system. In addition, the increase in pulmonary ventilation caused by cold exacerbates the harmful effects on the body of chemicals. It should be added that the super cooled organism more sensitive to industrial poisons.

In addition to the respiratory system, the primary objects of cold exposure in the Arctic zone are open areas of the face and head (most often the nose and ears), as well as the hands and feet. Blood supply in these parts of the body is peripheral and therefore and they are more prone to frostbite. In addition, the narrowing of peripheral blood vessels under the influence of cold strengthens the central circulation and provokes an increase in blood pressure.Even cooling the forehead and head can increase blood pressure and heart rate. Joints also suffer in this situation: under the influence of cold, they lose mobility due to an increase in the viscosity of synovial fluid [12]. It should be added that the effect of the cold factor in the Arctic is enhanced by the high speed of air movement (i.e. strong wind).

Another natural factor in the Arctic zone of the Russian Federation, which has a negative impact on human health, is increased electromagnetic activity and radiation. The first adverse phenomenon is due to the strong variability of the natural physical environment and is associated with the structural features of the Earth's magnetosphere in the Polar Regions. In these areas, the fluctuations of the variable geomagnetic field and the intensity of cosmic solar rays at the surface of the planet are most pronounced. This leads to the so-called geomagnetic storms, which affect the functional state of the human body [6, p. 44-52]. During this period, the number of hypertensive crises, strokes, myocardial infarction increases, the course of some mental diseases worsens, etc. Causing geomagnetic storms, solar activity also affects the radon content in the atmospheric air of the Arctic zone, thereby increasing the dose of ionizing radiation. For example, a study conducted in the Murmansk region (Apatity) showed that the average dose from natural sources of ionizing radiation due to atmospheric air is 12.5 times higher than the average in Russia [7, p. 93-111].

A characteristic natural factor of the Arctic that has a negative impact on human health is low humidity (especially on frosty days). This reduces the oxygen utilization factor in the lungs [8, p. 213-217]. In dry air the lungs hard to lose moisture. This leads to disruption of gas exchange in the alveoli and the formation of hypoxemia in the northerners (low oxygen content in the blood). In addition, the dry air of the Arctic region contributes to the loss of moisture in the skin and mucous membranes, which leads to a decrease in their protective functions. It should be noted that low air humidity is a constant environmental factor for residents of the Arctic and is typical not only for open areas of the territory, but also for residential and industrial premises, which in turn requires the moistening of air in these premises during the winter period and the development of individual means protection of the respiratory system to work in the cold 11 [8, p.213-217].

The Arctic zone is also characterized by frequent daily fluctuations in atmospheric pressure, and very significant ones. This fact also leads to serious risks of health disorders of the population.

A feature of the Arctic region is an unusual photoperiodism: polar night and polar day. Both natural phenomena affect the state of the human body, in particular, the development of aging, age-related pathology and neoplasm[9].

In general, it should be concluded that the human in the Arctic zone is a restructuring of all types of metabolism and hormonal regulation. The body of the inhabitants of the Arctic is functioning more intensively, in connection with which the physiological reserves are gradually depleted. In the Far North, morbidity and mortality rates of the population are increasedcompared with central Russia [17]. More often, there are diseases of the cardiovascular system and respiratory organs, musculoskeletal and nervous systems, digestive organs, damage to teeth and bone tissue. There is a reduction in the reproductive period and the acceleration of age-related changes in other physiological functions. In our opinion, this is due to negative natural-climatic and anthropogenic factors that give rise to the effect of "Arctic synergy"in their combined effect on the human body. This effect increases the harmful effects of each adverse environmental factor in the Arctic zone. All this leads to significant labor losses, early disability and reduced life expectancy [16, p. 33-40].

Unfortunately, it is impossible to eliminate the adverse effects of natural and climatic factors of the Arctic. At the same time, the interests of public health require the adoption of state measures aimed at reducing the harmful effects of such exposure. It seems to us that in this case it is necessary to focus on preventive measures and the development of new personal protective equipment. Note that this, among other things, is prompted by Russian legislation [2; 1], as well as documents adopted by the World Health Organization (WHO) [24] and the Arctic Council.

2. Human health and human impact on the environment. In addition to natural factors, technogenic pollution has a significant impact on human health in the Arctic zone of the Russian Federation (as well as in the entire Arctic).

The intensity and scale of the current anthropogenic impact on the environment is already incommensurable with the ability of the Arctic ecosystem to natural self-purification.The assimilation potential of the ecosystem has been exhausted at the present stage and the situation is close to critical. The Arctic ecosystem is under stress[4, p.85]. In this regard, the environmental problems of the Arctic attract the attention of both the Arctic states and the states located outside its territory [10, p.133].

Wherein the possibility of eliminating the consequences of emergency situations in Arctic is complicated by the conditions of the polar night, numerous storms with high waves, thick fog, multi-meter ice and the possibility of collision with icebergs [14, p.159].

Our country, as a state with a third part of its territory in the Far North, is aware of its responsibility for the preservation of the environment of the Arctic region and notes this in the fundamental strategic documents.The key document in this sense is the “Fundamentals of the state policy of the Russian Federation in the Arctic for the period up to 2020 and further perspective”. One of Russia's main national interestsin this document is saving unique ecological systems of the Arctic. The next most important document regarding the Arctic is the “Strategy for the Development of the Arctic Zone of the Russian Federation and Ensuring National Security until 2020”, which specified the planned results of environmental protection in stages: the first stage of the implementation of the Strategy should ensure the development of a unified national monitoring system the state and pollution of the environment of the Arctic zone, synchronized with similar international systems; at the second stage - the reduction and prevention of the negative impact on the environment of the Arctic zone.

Note that other Arctic states - the United States, Canada, Norway, Denmark also pay serious attention to environmental protection and environmental safety in the Arctic, but at the level of strategic planning, our country regulates these issues in more detail.

The above cannot be attributed to the current Russian legislation in the field of environmental protection. Neither the Federal Law “On Environmental Protection”, nor the Federal Law “On Specially Protected Natural Territories”, nor other federal laws and other regulatory legal acts in this area take into account the natural and climatic specifics of the Arctic zone. After all, it causes need of establishment of special (issued author) environmental protection requirements when carrying out economic and other activities in a given region. However, the Russian legislator in these matters is limited to existing legal approaches, i.e. legal tools used in the Arctic are almost the same as those used in mid-latitudes. For example, despite the fact that the Strategy for the Development of the Arctic Zone provides for the need to increase the responsibility of nature utilization enterprises operating in the Arctic, neither the Criminal Code of the Russian Federation nor the Russian Federation Code on Administrative Offenses still does not contain special rules governing liability for environmental pollution in the Arctic zone.

The special vulnerability of the Arctic ecosystem urgently requires the mandatory state environmental review when planning all types of economic activities without exception (issued by the author.). However, the current Federal Law "On Ecological Expertise" allows not to do this, allowing the possibility of carrying out certain types of economic activity without an expert examination. Of course, this lack of regulation creates the risk of irreversible environmental damage to the environment of the Arctic region, as well as harm to the health of the population living there.

In addition to the federal laws mentioned by us, adjustments require other regulations that play a huge role in the industrial development of the Arctic: the law of Russian Federation "On Subsoil", the Federal Law "On the Continental Shelf of the RF" and a number of others. A more radical and more acceptable option would be the adoption of a comprehensive Federal Law “On the Arctic zone of the Russian Federation”, which would be based on a single concept of legal regulation, taking into account the specific climatic, ethnic, cultural and medical biological features of the Arctic region and providing special approach to the use and protection of the environment as an environment that forms human health.

A powerful factor in the pollution of the Arctic is oil pollution in the basin of the Arctic Ocean. Most of the rivers of the Urals and Siberia flow into the Arctic seas, carrying oil emissions into them that have fallen into the rivers thousands of kilometers from the ocean coast. The scale of such pollution is several hundred thousand tons of petroleum products per year [19, p.118]. As a result, the concentration of pollutants in the Russian part of the Arctic Ocean is several times higher than normal. As a result - accumulation in the Arctic food chains - fish, terrestrial and especially marine mammals - persistent toxic substances (PTS). Many representatives of the Arctic fauna are traditional food sources for the indigenous peoples of the North, and this pathway for PTS in the human body remains one of the main risks to human health in the Arctic zone.

The main way of getting oil and oil products into the environment of the Arctic region of the Russian Federation is oil spills. However, relatively small accidents on oil pipelines occur with enviable regularity in Russia. At the same time, the cumulative amount of spilled oil is simply shocking - more than 5 million tons of oil annually (this figure was cited by an employee of the Department of American Studies at St. Petersburg State University - N. A. Chenskikh, after comparing the published data on the volumes of oil produced and mining and transportation in Russia). For comparison, this is more than the volume of oil spilled as a result of the disaster in the Gulf of Mexico in 2010, which led to environmental consequences of a global scale. According to experts, hundreds of drilling sites and pipelines cross the migration routes of wild animals and the routes of domestic deer migrations, having had a negative impact to date on more than 40% of the areas of reindeer pastures and hunting grounds [15, p.48]. In addition to damage to the environment, this circumstance creates real risks to human health, taking into account the food chain of indigenous peoples of the North that we noted earlier.

Oil pollution of water and soil cover are not the only negative environmental factors in the Arctic, which are of an anthropogenic character. In addition, the enormous risks of disruption to public health are created by the activities of mining enterprises, as well as enterprises of ferrous and non-ferrous metallurgy. In areas with developed industry concentrations of heavy metals, fluorides, sulfates, nitrogen compounds in surface and groundwater are often at the level of high and extremely high pollution. Serious anthropogenic impact on the atmosphere. If the total world industrial emissions of SO2 (sulfur dioxide, sulfur dioxide) is about 100 million tons per year, in Russia this figure is 9.2 million tons [23, pp.370-373]. At the same time, mining industry enterprises emit more than 3 million tons into the atmosphere annually [11, p.73-75]. The emissions of solid compounds, espe-

cially insoluble nickel, copper and cobalt compounds, carried out by enterprises in the north of the Krasnoyarsk Territory and the Kola Peninsula, are of great negative importance for human health in the Arctic zone. Emissions from ore-dressing enterprises largely determine the chemical composition of dust in the Arctic region. Thus, in the Western and Central Arctic, dust contains up to 25% Cu, 15% Ni, 11% S and 4% Co [5; 21, p. 369-374].

The impact of air pollution is most pronounced in the large industrial centers of the Arctic zone, especially in Norilsk, the coal-mining cities of the Komi Republic, and the industrial centers of the Kola Peninsula. This leads to pronounced changes in the immune, hormonal, cardiorespiratory, hematopoietic and other vital human systems (especially in children). In addition, the atmospheric air of a number of settlements, for example, the city of Monchegorsk (Murmansk region) and the city of Norilsk (Krasnoyarsk Territory), has an increased carcinogenic risk.

For the health of the Arctic population, a noticeable negative environmental factor of anthropogenic origin is exposure to radionuclides. It should be noted that for a long time, residents of the Arctic zone of the Russian Federation were subjected to chronic radiation by radionuclides formed in the atmosphere as a result of nuclear tests at arctic test sites. Falling out with precipitation, these radionuclides affected a huge area, causing significant harm to human health. The termination of nuclear tests reduced the value of radiation exposure as a risk of impairment of health in the Arctic region, but didn't completely eliminate it. Even now, residents of certain Arctic areas, especially the Murmansk region, are exposed to the potential danger of radiation contamination. This is facilitated by the presence of a large number of radiation sources of anthropogenic origin: nuclear reactors of operating and decommissioned submarines (NPS), radioactive waste storage facilities, infrastructure facilities of the icebreaking fleet of the Russian Federation.

Thus, negative environmental factors of anthropogenic origin continue to constitute a significant proportion of the risks to human health in the Arctic zone.

Conclusion. The study allowed the authors to draw the following conclusions:

- The Arctic zone of the Russian Federation is a unique natural resource, environmental and logistical resource not only of our country, but of the whole world. Industrial development of the Arctic zone acts as an objective need of the Russian Federation, as a condition for its successful economic development. At the same time, harsh climatic conditions create significant problems in the process of industrial and infrastructural development of the Arctic region, having a negative impact on human health. The consequences of anthropogenic pressure on the environment that have accumulated over many years have a huge negative impact on the health of the population of the Arctic;

- the main natural factors of negative impact on human health in the Arctic are the cold factor, increased electromagnetic activity, increased ionizing radiation, low absolute air humidity, frequent and abrupt changes in atmospheric pressure, and specific photoperiodism. These natural factors are immanent characteristics of the environment of the Arctic region and have a constant negative impact on human health;

- negative environmental factors of the Arctic zone, which are of anthropogenic origin, are pollution of surface and groundwater, as well as soil cover with oil products and waste from other industrial production; increased concentration of persistent toxic substances (PTS) in the atmospheric air of the industrial centers of the Arctic region, triggered by emissions of mining and ore-dressing complexes, as well as enterprises of ferrous and non-ferrous metallurgy; radionuclides accumulated in the environment of the Arctic zone as a result of past nuclear tests, as well as the potential danger from existing man-made sources of radiation. It should be noted that the negative impact of many of these factors on human health is increasing (the effect of "Arctic synergy") due to the influence of the natural climatic conditions of the North. In addition, environmental risks (due to the vulnerability of Arctic ecosystems) and, accordingly, risks to human health as a result of anthropogenic environmental impact, are also likely to be immanent;

- a significant contribution to reducing the harmful effects of anthropogenic pressures on the environment can be made by an effective mechanism of legal regulation of the relationship between man and nature, taking into account the specifics of the ecology of the Arctic region, in particular, its endemicity and vulnerability. According to the authors, it is necessary to adopt a comprehensive federal law "On the Arctic zone of the Russian Federation", providing a special legal regime for the use and protection of the environment of the Russian Arctic. In addition, it is necessary to include in the sectoral legislation the rules governing the legal status of natural and nature-resource objects in the Arctic.

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