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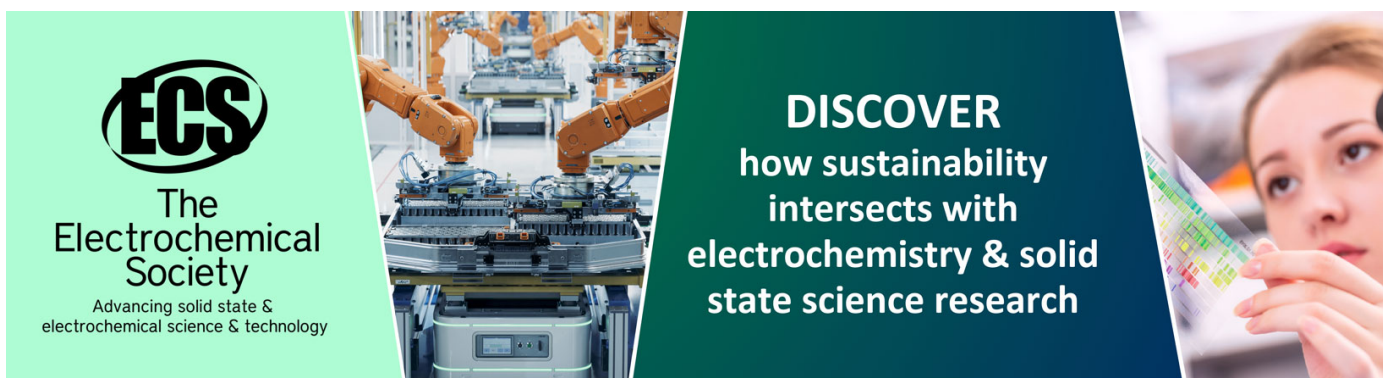
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Problems of the health status of children and atmospheric air of Gorno-Altai under the conditions of increasing transport load

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Abstract. The article contains a theoretical study of the problem of the children's health status and atmospheric air under conditions of increasing traffic load. The children's body is highly sensitive to the effects of unfavorable environmental factors, susceptible to the pathogenic effects of even subthreshold concentrations of harmful substances, which makes it possible to consider it as a kind of indicator of the state of the environment. The deterioration of the environmental state of the air of Gorno-Altai is associated with an increasing traffic load, solid fuel stationary sources, and transboundary pollution coming from the neighboring regions, as well as the location of the city in a mountain valley with poor natural weathering of the air basin. A comprehensive analysis of the health status of the child population in the region (depending on the degree of air pollution) is also conducted.

1. Introduction

The ecological state of atmospheric air is one of the main problems of environmental health [1]. The state of the air environment depends on many factors, including the transport, industrial, demographic and radiation load, terrain features, etc. [2]. The main sources of pollutant emissions into the air are the solid fuel heating systems and vehicles. If pollution from the first type of sources is seasonal, then emissions from the second type are observed on a year-round basis. In conditions of unfavorable ecological environment, deterioration of health and an increase in deviations in the physical development of children is noted [3-8]. The high sensitivity of the child's body to the effects of adverse environmental factors makes it possible to consider it as a kind of indicator of the state of the environment in the context of increasing environmental threat [8].

The purpose of the theoretical study is to substantiate the relevance of the problem on the ecological state of atmospheric air in Gorno-Altai, the need for zoning residential areas of Gorno-Altai depending on the degree of air pollution and the health status of the child population.

2. Atmospheric Air Pollution Caused by Road Emissions

The increase in emissions of pollutants occurs due to the use of automotive fuel vehicles that do not meet the requirements of environmental class K₄ and K₅ on the content of pollutants; to the growth in the number of urban vehicles operating in dense urban areas; to the use of coal and firewood as a fuel



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by heat supply sources located in the Asian part of Russia (mainly in the Siberian Federal District); to adverse meteorological conditions for dispersion of impurities in the atmosphere [1].

The main components that pollute the air are the fine particulate matter (PM), soot, NO, SO₂, CO, CH, formaldehyde, benzo (a) pyrene, heavy metals. The spectrum of pollutants is very wide, for many of them the norm limits are not defined. For example, in emissions from the road transport, specialists from the Research Institute of Human Ecology and Environmental Hygiene have identified 175 chemicals, 71% of which are not standardized [9]. Despite measures to reduce toxic substances in the exhaust of internal combustion engines due to new fuel standards, the motor transport is one of the leading factors of air pollution [10].

The atmospheric air pollution of cities occurs not only with exhaust gases, but also with wear and tear products of the road and automobile complex (RAC) (tire and roadbed wear). In the formed dust, more than 140 chemical compounds hazardous to health are contained, including polyaromatic hydrocarbons, volatile carcinogens [11]. The diesel engine exhaust is more toxic than gasoline and replacing fuel with ethanol or other types of energy source not only does not give the expected result but aggravates the unfavorable ecological condition of atmospheric air [12]. The use of alternative fuels reduces CO₂ emissions, but it significantly increases PM₁₀ and PM_{2.5} emissions [12]. Thus, the motor transport remains one of the leading factors of air pollution, attempts to reduce the content of toxic substances in the exhaust of internal combustion engines do not bring the desired result.

3. Children's Health Exposed to Air Pollutants

According to many authors, the deterioration of children's health and the inconsistency of physical development with age norms are the direct result of the negative impact of environmental factors [3-8]. The children's body is highly sensitive to the effects of adverse environmental factors, is susceptible to the pathogenic effects of even subthreshold concentrations of harmful substances. This allows us to consider the physical development and state of health of children as an indicator of the ecological status of the environment, especially in conditions of increasing environmental threat both in Russia as a whole and in its individual areas [8].

From the period of childhood, the human body is exposed to aerotechnogenic load, reducing the compensatory capabilities. Respiratory organs are most at risk of developing both chronic and acute adverse effects in the population due to suspended substances and NO₂, exposure to formaldehyde [12, 13]. Studies conducted in industrial cities of Siberia have shown that an increase in the incidence of allergic rhinitis and bronchial asthma among children amounts to 28-36%, and more than 30% of those examined have sensitization to this chemical [14]. It has been established that the risk of immunity disorders in children living in industrial cities of the Siberian region is due to the presence of formaldehyde in air [4]. Anthropogenic chemical factors that pollute the air have an ability to reduce the activity of local mechanisms of anti-infective resistance of the upper respiratory tract [3], [5], [6].

Any PM has an ability to adsorb toxic substances that also enter the body's internal environment [11], [12]. A direct relationship is found between the concentration of fine particles (PM₁₀ and PM_{2.5}) in the air and mortality and morbidity rates. A chronic exposure to PM exacerbates the risk of developing cardiorespiratory diseases [1]. Indicators of medical and demographic losses directly depend on the level of air pollution from PM [2], which trigger pathogenic vascular mechanisms, activate inflammation in the airways and lungs [14]. Studies have shown that the RAC products and exhaust gases determine from 58 to 81% of the diseases of children living in the zone of intensive traffic flow. In particular, the RAC products provoke from 16 to 23% of cases from all diseases, including from 8 to 12% with heavy metal compounds [15].

4. Ecological Condition of the Air in the Conditions of Increasing Transport Load

The Republic of Altai is a recreational and agricultural region, with small industrial enterprises. Air pollution in the region is mainly due to emissions from road transport, boilers, and heating stoves [16-18]. The territory of the city of Gorno-Altai is located in the northern part of the Altai mountain region, mainly in the valley-like expansion of the valley of the Maima River. The terrain varies in the

range of 250-820 m, with the average height of 400-450 m. In geomorphological terms, the area is located in the foothill and low-mountain zones of Gorny Altai [19].

It is known that the purification of the atmosphere from pollutants is due to meso-and macroscale processes, such as turbulent exchange, a height of the air mixing layer, a wind regime, etc. Repeatability and power of inversions are associated with large-scale atmospheric processes. The highest level of impurity concentration in the atmosphere is noted in slow-moving anticyclones and ridges, on the western periphery of the anticyclone or ridge, with advection of heat in a slow-moving cyclone of small area, in which one and also air mass circulates [2].

The concentration of harmful impurities increases with fogs and haze, which accumulate substances of high toxicity. Fast moving cyclones, strong frontal winds and intense rainfall contribute to the dispersion of harmful impurities. Purification of the atmosphere occurs during the invasion of air masses from the Arctic, carrying clean air.

To characterize the degree of purification of the Gorno-Altai air basin from certain pollutants, we used a meteorological indicator of atmospheric self-purification (K_M) [21]:

$$K_M = (P_{SR} + P_T) / (P_O + P_B),$$

where P_{SR} – a wind speed repeatability 0 - m / s; P_T – a repeatability of days with fog, %; P_O – a repeatability of days with precipitation > 0.5 mm, %; P_B – a wind speed repeatability > 6 m / s.

When K_M is less than one, the processes of self-purification prevail over the processes that contribute to the accumulation of impurities. When K_M is more than one, the processes of accumulation of impurities predominate over the processes of self-purification.

It was established that in the valley of the Maima River (where Gorno-Altai is located), the meteorological indicator of self-purification of the atmosphere was 1.8 for the winter period, 1.2 for the spring, 1.5 for the summer, and 2.1 for the autumn periods. Consequently, processes that contribute to the accumulation of impurities in the atmosphere prevail throughout the year. This is due to the peculiarities of the relief, the valley-shaped expansion of the valley and slight elevation changes with a significant frequency of anticyclonic weather.

According to the calculation results for 2016, the volume of gross emissions of pollutants from various sources into the atmospheric air was: 33.6 thousand tons/year throughout the republic; 8.3 thousand tons/year on the territory of Gorno-Altai, of which 49% are due to road transport and 51% because of fuel and energy enterprises [18]. Despite the city's gasification and reduction of emissions from coal-fired boilers, the total amount of pollutants remains the same. According to the authors of [17], within the city's territory, emissions from solid-fuel heating systems are preserved, as evidenced by the content of pollutants in bioindicators. According to other sources [18], the volume of emissions remains at the same level due to a significant increase in motor transport and unresolved problems in expanding the network of the city's highway, which is currently extremely limited and overloaded with transport. If the task of reducing emissions from coal-fired boilers is solved by switching to gas heating systems, the problems of air pollution due to emissions from motor vehicles remain relevant. During the period from 2013 to 2016, the volume of vehicle emissions increased by 45-50% in Gorno-Altai (by 8-10% per year) [18].

According to the literature, the transboundary transfer of air polluting substances is carried out from the territories adjacent to the republic (Altai region, Kazakhstan) [16]. As a result, in the context of low industrial and demographic (63214 people) loads, the unfavorable ecological situation is developing due to the state of atmospheric air. Thus, the deterioration of the ecological state of the air environment of Gorno-Altai is associated with an increasing transport load, operating solid stationary sources, and transboundary transport of pollutants from neighboring regions.

Our assessment of the physical development of the 8-years-old children in Gorno-Altai shows that 52% of children have lung capacity indicators below the age norm and 48% of children have hand strength values below the age norm. More than that, 22% of children are obese, according to the Quetelet index; 54% of children have an atypical type of reaction of the cardiovascular system to the standard physical activity, a decremental nature of the recovery of heart rate, indicating a low

efficiency of the circulatory system [22]. In general, almost half of the children surveyed have physical impairments. According to the authors [3-8], the discrepancy between the physical development of children and age norms often manifests itself in unfavorable environmental conditions.

A comprehensive analysis of the state of health of the population as a whole and of the child population in particular in this region, depending on the degree of air pollution, was not carried out. To actualize the problem, measures are necessary to rank the residential area depending on the degree of air pollution. And also, the analysis of the health status of children, as the most vulnerable part of the population, is necessary, taking into account the environmental situation.

5. Conclusion

Currently, the main sources polluting the atmospheric air in the city of Gorno-Altai are motor vehicles and heat power facilities. At the same time, the specificity of atmospheric processes and features of the relief of the territory do not contribute to the active self-purification of the atmosphere. The medico-demographic situation of the child population directly depends on the level of air pollution. Therefore, measures to actualize the problem of air pollution are essential for improving the environmental situation in residential areas and preserving the health of the younger generation.

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