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Anthropogenic risks of industrial areas

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Anthropogenic risks of industrial areas

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Abstract. In the work we analyze the safety of an industrial region using a risk-based approach. Used methods for assessing overt and covert types of emergency situations. There were presented quantitative risk indicators on the territory of the Krasnoyarsk region with the subsequent assessment of the security of the region. The evaluations showed that hidden or potential health risks to the population of the cities of the Krasnoyarsk region are significantly higher than the risks realized.

1. Introduction

The implementation of an integrated approach to achieving regional development safety is determined by the solution of a number of scientific and organizational tasks. The tasks of developing directions for the sustainable development of municipalities, regions and the country based on risk management become relevant [1]. Technological systems, processes, territories are subject to influence of characteristic types of risk which need to be identified purposefully and also to take the measures to protect and mitigate the consequences in case of danger.

Krasnoyarsk region is one of the largest industrial regions of the Russian Federation, where more than 700 potentially dangerous objects with functionally complex and highly hazardous production systems [2, 3], characterized as obvious threats to life and health of the population (risks of accidents and catastrophes) and hidden threats (environmental pollution). Explicit emergencies have an immediate effect (human injury and mortality), hidden ones can appear after many years (the consequences of the soil, water, and air pollution). Basic risks at emergency of natural and anthropogenic character for the industrial region will be individual and population risks.

This work analyzes the methods and results of the assessment of natural and technogenic risks on the example of the Krasnoyarsk region.

2. Territorial technogenic risks

Basic risks at emergency of natural and anthropogenic character for the industrial region will be individual and collective risks. Individual risk of a man-made emergency is associated with the activity of the certain person or if he is exposed to risk as a part of society (accommodation in ecologically adverse regions, near sources of the increased danger) and is applied to establishment of qualitative value for the purpose of management of administrative territories [4].

Calculations of the risk of a technogenic emergency situation are based on statistical data [5], presented in the state reports of the EMERCOM of Russia. For the Krasnoyarsk region, individual risk does not exceed the acceptable risk level ($R < 10^{-5}$) (figure 1).



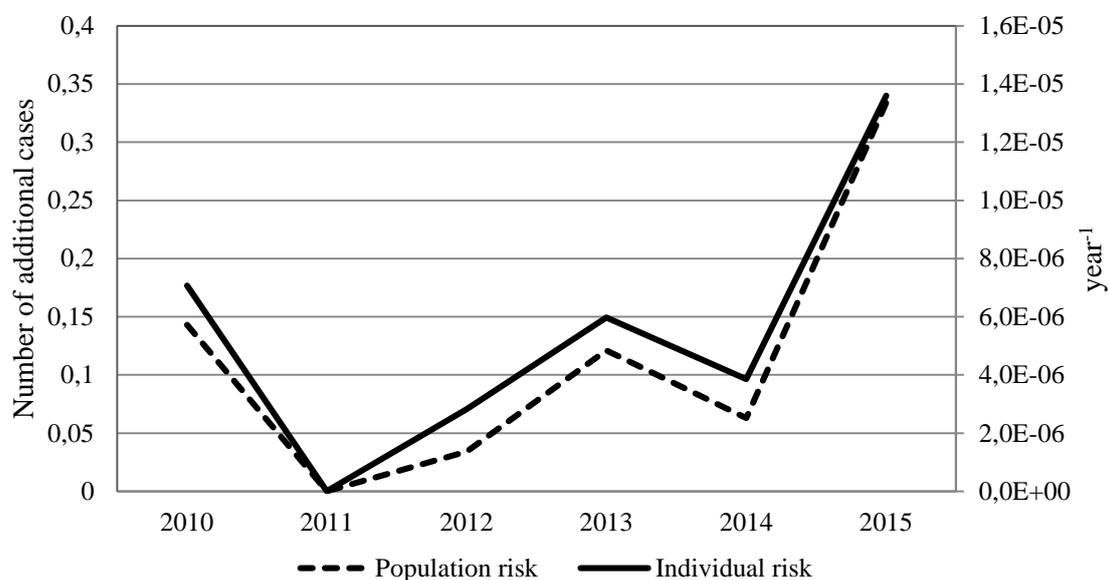


Figure 1. Dynamics of individual and technogenic risks caused by technogenic emergencies in Krasnoyarsk territory.

By the end of the analyzed period, the individual and population risks of an anthropogenic emergency are increasing, which is caused by a large number of the road accidents and air transport accidents in the region.

3. Health risks caused by environmental pollution

Air pollution is one of the causes of population's morbidity and mortality, more than 80% of the urban population are exposed to polluted air.

In the Krasnoyarsk region there are 26 stationary monitoring posts for the level of air pollution from the state observation network and 6 posts of the regional network [6]. The assessment of carcinogenic and non-carcinogenic health risks to the population of urbanized territories from inhalation exposure was carried out according to observations on the state regional monitoring networks.

The calculation of an individual carcinogenic risk is carried out using data on the magnitude of the exposure and the values of the carcinogenic potential factors (tilt factor, unit risk). As a rule, for cancerogenic chemicals the additional probability of cancer development in an individual throughout life is estimated taking into account an average daily dose during life [7]. As an additional characteristic of risk, the value of annual population risk is often used - the estimated number of additional cases of an oncological disease in the course of a year. The assessment of the total carcinogenic risk from inhalation exposure was performed for formaldehyde, benzopyrene, benzene and ethylbenzene (figure 2).

The dynamics of individual carcinogenic risk in Krasnoyarsk do not have an obvious trend. During this period, the minimum value of carcinogenic risk is observed in 2004, the maximum - in 2012.

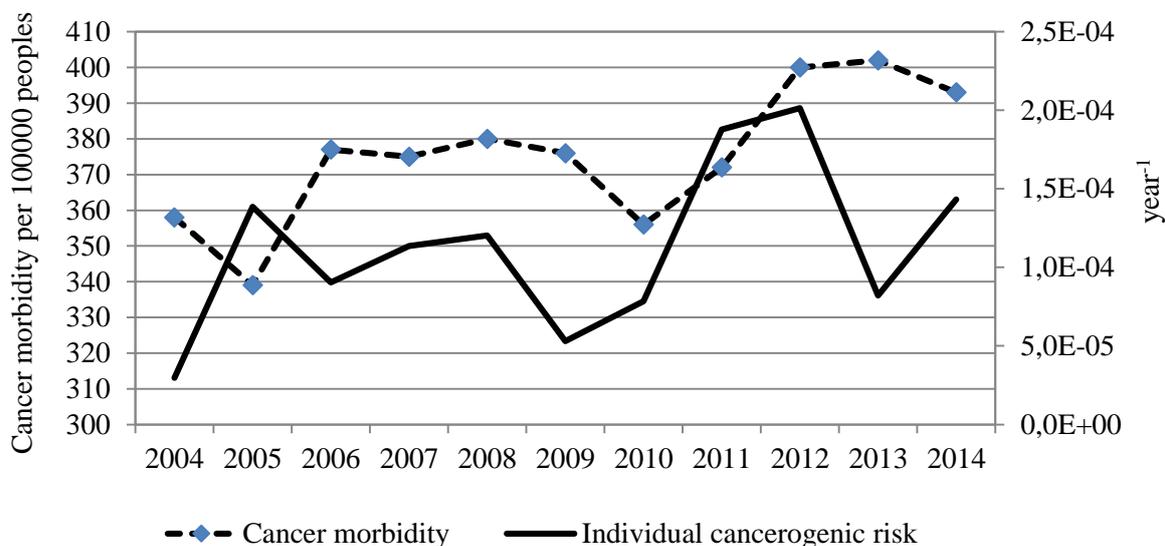


Figure 2. Dynamics of individual cancerogenic risk and cancer morbidity (calculated one hundred millions) for Krasnoyarsk city.

Analysis of incidence rates of malignant neoplasms is not consistent with the calculated levels of carcinogenic risks (figure 2) [8]. One of the reasons for such discrepancies is that the official method for calculating carcinogenic risks does not take into account a number of important indicators affecting actual incidence rates, such as the age structure of the population. At the same time, air pollution is just one of the factors influencing the human cancerogenic disease of a large industrial center. For a more complete assessment of the calculated carcinogenic risks, it is necessary to take into account, for example, such types of effects on public health as pollution of drinking water, a set of lifestyle factors, incl. smoking, etc. Comparison of the incidence of malignant neoplasms with estimated levels of risk for other cities of the Krasnoyarsk region is not possible due to the low population size in these cities.

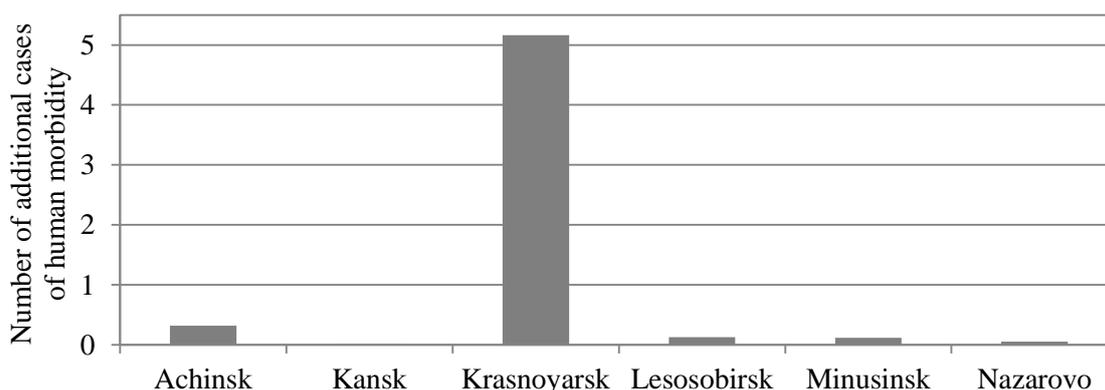


Figure 3. Population cancerogenic risks for cities in Krasnoyarsk region during 2014.

According to the results presented in figures 2 and 3, it can be concluded that Krasnoyarsk city is characterized by a high rate of both individual and population's total carcinogenic risks from exposure to air pollution. The minimum indicator is observed in Kansk.

Characterization of the risk of non-carcinogenic effects for individual substances is carried out on the basis of the calculation of the hazard coefficient taking into account the average annual concentration of the substance and its reference (safe) concentration [7]. When

analyzing non-carcinogenic risk, the following pollutants were considered to have an impact on the health of the population of cities in the Krasnoyarsk Territory: suspended substances, sulfur dioxide, carbon monoxide, nitrogen dioxide, nitrous oxide, phenol, hydrofluoride, formaldehyde, benzopyrene, benzene, ethylbenzene, xylene, toluene.

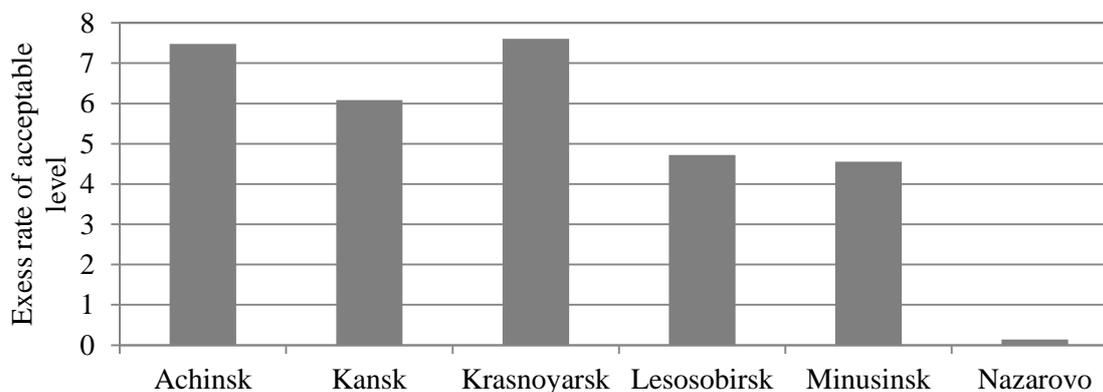


Figure 4. Summary noncancerogenic risks for cities in Krasnoyarsk region during 2014.

For the period of 2014, the highest indicators of non-carcinogenic risk are observed in Achinsk and Krasnoyarsk, Kansk is characterized by the lowest risk indicator (figure 4).

The evaluations showed that hidden or potential health risks to the population of the cities of the Krasnoyarsk region are significantly higher than the risks realized. In order to compare the risks of potential with the real impact on human health, a detailed analysis of morbidity and mortality rates is necessary simultaneously with the analysis of the obtained values of risks.

4. Conclusion

In the current unfavorable situation with air pollution in the Krasnoyarsk region, it is possible to increase the mortality rate of the population, the development of oncological diseases, diseases of the respiratory organs, the central nervous system, the cardiovascular system, the blood-forming organs, vision and the reproductive system.

The development of industrial regions should be carried out without prejudice to future generations. At the same time, risks to humans and the environment should be minimal. The presence of strategically important and potentially dangerous objects in the Krasnoyarsk region entails the risk of obvious and hidden emergencies. It should be borne in mind that the safety and security of objects of increased risk from emergency situations does not fully meet modern requirements. The non-zero concept of risk reflects the fact that it is impossible to completely prevent and eliminate the occurrence of man-made accidents, natural disasters and the other emergencies, it is only possible to reduce their number, to reduce the damage from their consequences by monitoring and analyzing development risks. To assess the integrated security of territorial entities, great attention should be paid to the development and use of criteria and methods of risk analysis, since the methods currently in place do not allow to evaluate complex multifactor processes of risk formation.

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