Environmental Risk as an Indicator of Sustainable Development of Industrial Regions of Russia

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Abstract. Analysis of the components of investment potential and investment risk in industrial regions of Russia shows that the most critical for most of them are environmental risks. Therefore, the necessary condition for increasing investment attractiveness and ensuring sustainable development of these regions is the optimization of environmental risks, and the main indicators of their sustainable development can be considered indicators that characterize the environmental safety and environmental risks of the population. However, currently there are no methods for quantitative and statistically reliable assessment of technogenic environmental risks of causing harm to the health of the population of a particular region, taking into account factors specific to this region. To assess and forecast environmental risks, it is proposed to use methods and models of data mining, which use data from long-term observations of the state of the environment and statistical data on the health of the population of these regions.

1. Introduction
Currently, Russia faces the challenge of adapting the Sustainable Development Goals (SDGs) for the period up to 2030, adopted at the UN General Assembly summit on September 25, 2015, and integrating them into the strategic planning system, into existing and planned government programs [1]. A more specific task is the adaptation of global indicators of sustainable development at the national and regional levels.

However, the scale, regional diversity and other features of Russia require more active, in comparison with global practice, the government's activities to eliminate disproportions in economic development, address specific regional problems, and create conditions for sustainable development of regions [2]. Differentiation of regions and disproportion in the development of productive forces, focus on the mining and primary processing of natural resources, often imperfect technologies used predetermine the need for a differentiated regional investment, social and environmental policy and an individual system of goals and indicators of sustainable development [3].

2. Research materials and methods
It is possible to solve the problems of sustainable development and create favorable conditions for intensifying economic growth and improving the quality of life of the population by attracting investment in infrastructure and the real sector of the economy. The volume and growth rates of investments are indicators of investment attractiveness and indicators of sustainable development of
regions. However, the Russian Federation is a heterogeneous spatially distributed system of national and territorial entities, which necessitates a differentiated approach to the analysis of the socio-economic situation and the choice of indicators of sustainable development for specific regions, taking into account the specifics of their socio-economic development and the characteristics of regional programs and development strategies [3, 4].

The main factors determining the investment attractiveness of the regions are investment potential and investment risk. At the same time, labor, consumer, industrial, financial, institutional, innovation, infrastructural, natural resource and tourism potentials are taken into account as the components of the investment potential, and the components of the investment risk are social, economic, financial, criminal, environmental and management risks [5].

The classification of regions according to the ranks of potential and risk and their ratio allows identifying the most attractive and most problematic regions. In addition, it can be taken into account when developing plans for the development of regions and determining the main indicators of sustainable development of the region. Analysis of the components of investment potential and investment risk allows us to identify the main indicators of sustainable development of a particular region or group of regions, which must be taken into account when developing plans and programs for socio-economic development [6-8]. Russian regions are divided into four main groups [9, 10]: financial and economic centers, export-oriented regions, industrial regions, and agricultural and industrial regions. The industrial regions of Russia differ significantly from each other both in terms of the main indicators of socio-economic development, and in terms of the values of the human development index and its components - average per capita income, life expectancy and educational level [11, 12]. However, at the same time, the average values of the income index (0.885) and the longevity index (0.761) in these regions are significantly lower than the values for Russia as a whole (0.921 and 0.781) [13].

Analysis of investment potential and investment risk components can help identify critical indicators of sustainable development of a particular region or group of regions that need to be taken into account when developing plans and programs for socio-economic development. Industrial regions of Russia, on average, belong to regions with a relatively high investment potential (32.3), a relatively low investment risk (34.7) and average investment attractiveness (Figure 1) [13]. However, a wide range of ratings of both investment potential (from 5 to 77) and investment risk (from 2 to 72), suggests an individual approach to the development of programs for the socio-economic development of these regions and the range of indicators of sustainable development [13]. However, a common problem for most industrial regions of Russia is the low indicators of natural resource (average value 40.1) and infrastructural (39.6) potentials, which is significantly lower than the average values of the other components [13].

A natural and logical way to increase investment attractiveness and a condition for sustainable development of regions is to reduce, first of all, investment risk and its components. For industrial regions of Russia, the average values of the ranks of investment risk components are: social risk-35.4, economic risk-39.9, financial risk-33.5, criminal risk – 39.7, environmental risk – 45.1, and management risk – 40.1 [13]. Thus, the analysis of the investment risk components of the industrial regions of Russia shows that the most critical for most of these regions is environmental risk. Consequently, the fundamental basis for increasing investment attractiveness and ensuring sustainable development of industrial regions of Russia as a whole is the optimization of environmental risks and the main indicators of their sustainable development specific to these regions can be considered, in particular, indicators characterizing environmental safety and environmental risks.

The core of the concept of environmental safety is the theory of environmental risk, which is determined by harmful effects on the health of the population [14]. Risk is one of the most important categories that reflect the degree of danger of situations in which there are potential factors that can adversely affect people, society and nature [14]. In the system of social and hygienic monitoring environmental risk is considered a potential hazard to the health of an individual, a group of people, a part of the population or the population of the region as a whole, arising or expected due to the
unfavorable effect of certain environmental factors [14]. Recommendations of the World Health Organization (WHO) define risk as “the expected frequency of adverse effects arising from a given exposure to a pollutant” [15].

Figure 1. Distribution of Russian regions according to the rating of investment attractiveness - the sum of the ranks of investment potential and investment risk.

The problem of adequate assessment of environmental risk is closely related to many other environmental and economic problems – financing of environmental research and environmental activities, environmental insurance, and others [14]. In particular, the growth of Russia's raw material export economy, which is usually associated with an increase in environmental pollution and the deterioration of public health, limits the opportunities for human development. This, in turn, leads to a decrease in the quality of life and well – being of the population, in General-to an increase in morbidity and mortality, a decrease in life expectancy and, accordingly, the human development index. According to some estimates the economic costs for public health associated with air and water pollution are on average at least 4-6% of the gross domestic product (GDP), in industrial regions the damage can reach 8-10% [16].

The main factors determining the degree of environmental hazard in most industrial regions of Russia are the metallurgical industry, oil production and refining, coal and gas production, mechanical engineering and energy [17]. Accordingly, the main problem for most of these regions is air pollution [18]. Consequently, the fundamental basis for ensuring sustainable development and increasing the investment attractiveness of industrial regions of Russia is the optimization of environmental risks and the main indicators of their sustainable development can be considered, in particular, indicators characterizing environmental safety and environmental (socio-environmental) risks of the population, primarily from air pollution.

Analysis of the recommendations of WHO and International Bank for Reconstruction and Development (World Bank), as well as informative indicators of population health with the aim of assessing the relationship of health and environment, as well as the reliability of the methods used for the collection and processing of information, allows you to define a list of core indicators of population health - life expectancy, morbidity, mortality and indicators of physical development of children [19,20]. At the same time, one of the components of the total average risk (probability) of
human death during the year (year − 1), which is numerically equal to the inverse of the average life expectancy, can be taken as the main indicator of environmental risk [20].

3. Results and discussion
At present, there are practically no methods of quantitative statistically reliable assessment of environmental risks of harm to the health of the population of a particular region under the influence of environmental factors [20]. Existing methods, as a rule, are based on large-scale long-term and expensive medico-biological and epidemiological studies and do not take into account factors specific to a particular region - geographical and natural-climatic conditions, the level of industrial and socioeconomic development, features of the social structure and lifestyle of the population, the level of development of the health care system and other factors [20, 21]. Only a combination of classical methods of assessment and methods of data mining with the use of modern information technologies can make it possible to fully assess the influence of harmful environmental factors on the health of the population of the region - the dose-effect relationship [20-23].

When constructing the dose-effect relationship, it seems promising to use artificial neural networks, which allow the development of highly efficient computer models and systems for assessing, analyzing and predicting mortality, morbidity and life expectancy of the population when changing environmental factors [22-24]. Analysis of the simulation results shows that the neural network models built for specific industrial regions describe the initial data satisfactorily - the error for various indicators ranges from 0.4 to 4.7% (Figure 2) [24, 25].

Figure 2. Charts of changes in life expectancy of the population of Krasnoyarsk region in 1991-2016, based on statistics (1) and calculations (2).

The constructed models make it possible, using the available databases for monitoring emissions and concentrations of pollutants in the air and the health status of the population of the region, to automatically obtain dependencies reflecting the cause-and-effect relationships between indicators of environmental pollution and indicators of public health. Their application significantly speeds up the assessment and forecast of the development of the socio-ecological situation in the region as a result of
the technogenic impact on the environment and public health without large-scale clinical biomedical research. Interpretation of the results obtained makes it possible to assess the real or expected socio-economic efficiency of implemented or planned technical, technological, administrative and economic and management decisions in the industrial and socio-economic development of the region and environmental protection management, makes it possible to substantiate socio-economic development programs, develop regional environmental quality standards.

With the appearance of new data, the obtained models can be easily corrected by "learning" [20, 22-25]. With the appropriate “retraining” using adaptive technologies and algorithms and tuning, the model can be adapted to the conditions of another region of Russia, taking into account its specific features [25-27].

4. Conclusions

Thus, the analysis of the components of investment potential and investment risk shows that a common problem for most industrial regions of Russia is low indicators of natural resource and infrastructural potential, as well as social and environmental risks.

Accordingly, a natural and logical way to increase investment attractiveness and a condition for the sustainable development of regions is to reduce environmental (socio-environmental) risks, and the fundamental basis for ensuring sustainable development of these regions is the optimization of environmental risks, the main specific indicators of their sustainable development can be considered indicators characterizing environmental safety and social and environmental risks of the population.

To assess and predict environmental risks, it is proposed to use methods and models of data mining, for the construction of which data from long-term observations of the state of the environment and statistical data on the state of health of the population of these regions are used. Neural network models built for a specific industrial region satisfactorily describe the initial data allow determining the dose-effect relationships for individual components of the environment and make it possible to create an integrated quantitative statistically reliable methodology for intelligent analysis and forecasting of environmental risks for the population of a particular region using the available long-term monitoring databases emissions and concentrations of pollutants and health status of the population.

When new data becomes available, the obtained models can be easily corrected by “learning more”. With the appropriate "retraining" using adaptive technologies and algorithms and tuning, the model can be adapted to the conditions of any other region.

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