Sustainable development and social and environmental risks of industrial regions of Siberia

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Abstract. The high investment potential of the regions of Siberia is substantially leveled by the low infrastructural potential and the high level of investment risks, primarily social and environmental risks. Consequently, the fundamental basis for ensuring their sustainable development and increasing investment attractiveness is the optimization of social and environmental risks. And the main indicators of their sustainable development are the indicators characterizing the environmental safety and social and environmental risks of the population. To assess the socio-environmental risks of harm to the health of the population of the region, taking into account its specific features, we propose to use data mining methods and neural network models, along with classical methods.

1. Introduction
The main task of modern society is to ensure sustainable development in order to create favorable conditions for economic growth and improve the quality of life of the population. However, the Russian Federation is a very heterogeneous spatially distributed system of national and territorial entities. This peculiarity necessitates a differentiated approach to the selection of the main indicators of sustainable development of territories and regions, taking into account the specifics of their socio-economic development and the characteristics of regional programs and development strategies.

Among the eight federal districts, the Siberian Federal District takes the 2nd place in terms of the territory, 3rd in terms of the population, 5th in the fixed assets, 2nd in mining, 3rd in the production of energy resources. The Siberian Federal District provides more than 10% of the total gross product, but it occupies the last places in many social indicators, quality of life, and the human development index.

The imbalance between the economic and social development of the Siberian regions significantly reduces their investment attractiveness and poses a serious threat to sustainable socio-economic development.

To solve the problem of equalizing the economic and social development and investment attractiveness of the regions, the most critical components of their investment potential and investment risk must be identified.

2. Materials and Methods
According to the international rating agency “RAEX-Expert RA”, the ranks of investment potential and risk regions of the Siberian Federal District are significantly different (Tables 1 and 2) [1]. By the difference of ranks, the regions can be divided into three groups conditionally (Table 2):
• Regions where the investment potential roughly corresponds to the level of risks – Novosibirsk and Omsk regions, Altai region, and the Republics of Tyva and Altai;
• Regions with an investment potential rating being significantly lower than the investment risk rating. At the same time, in the Tomsk region, the average rating of the investment potential is combined with a high rating of investment risks; and in the Republic of Khakassia, both indicators are quite low;
• Regions with an investment potential rating being significantly higher than the investment risk rating. At the same time, in the Krasnoyarsk region, the Kemerovo and Irkutsk regions, a high rating of the investment potential is combined with a low rating of investment risks, and in the Republic of Buryatia and the Transbaikal region, both indicators are quite low.

This classification allows one to identify both the most attractive and the most problematic regions [2]. In addition, the classification should be taken into account when developing regional development plans and determining the main indicators of their sustainable development.

For example, we consider it obvious that a natural way to increase the investment attractiveness of the industrial regions of the Siberian Federal District — the Krasnoyarsk region, the Kemerovo and Irkutsk regions — is to reduce investment risks. Analysis of the components of investment risk shows that the most critical for these regions are the social and environmental risks (Table 2) [2].

Consequently, the fundamental basis for ensuring the sustainable socio-economic development and increasing the investment attractiveness of industrial regions of Siberia is to reduce social and environmental risks. And, accordingly, the indicators characterizing the socio-environmental risks of the population are considered the main indicators of their sustainable development [2-4].

### Table 1. Investment potential of the regions of the Siberian Federal District.

| Place (SFD) | Rank (RF) | Region              | Labor | Consumer | Industrial | Financial | Institutional | Innovative | Infrastructure | Natural Resource | Tourist |
|-------------|-----------|---------------------|-------|----------|------------|-----------|---------------|------------|----------------|-----------------|---------|
| 1           | 7         | Krasnoyarsk region  | 14    | 14       | 15         | 11        | 13            | 16         | 78             | 1               | 9       |
| 2           | 15        | Novosibirsk region  | 13    | 16       | 20         | 17        | 9             | 6          | 49             | 40              | 32      |
| 3           | 16        | Kemerovo region     | 17    | 18       | 16         | 19        | 26            | 37         | 53             | 4               | 36      |
| 4           | 18        | Irkutsk region      | 20    | 23       | 18         | 15        | 20            | 20         | 74             | 7               | 13      |
| 5           | 26        | Altai region        | 24    | 24       | 33         | 28        | 30            | 13         | 44             | 23              | 25      |
| 6           | 30        | Omsk region         | 26    | 21       | 17         | 24        | 21            | 27         | 60             | 43              | 64      |
| 7           | 48        | Tomsk region        | 37    | 60       | 44         | 50        | 45            | 10         | 82             | 37              | 79      |
| 8           | 53        | Republic of Buryatia| 55    | 58       | 65         | 59        | 65            | 63         | 79             | 10              | 15      |
| 9           | 54        | Transbaikal region  | 64    | 52       | 64         | 57        | 62            | 74         | 70             | 9               | 43      |
| 10          | 77        | Republic of Khakassia| 75    | 74       | 67         | 73        | 70            | 81         | 67             | 32              | 78      |
| 11          | 82        | Tyva Republic       | 80    | 80       | 83         | 80        | 82            | 78         | 84             | 31              | 72      |
| 12          | 83        | Altai Republic      | 82    | 82       | 84         | 83        | 81            | 83         | 81             | 60              | 50      |
Table 2. Investment risks of the regions of the Siberian Federal District.

| Place (SFD) | Rank (RF) | Region                        | Social | Economic | Financial | Criminal | Ecological | Managerial | Difference of ranks of potential and risk |
|-------------|-----------|-------------------------------|--------|----------|-----------|----------|------------|------------|----------------------------------------|
| 1           | 19        | Novosibirsk region            | 44     | 13       | 9         | 39       | 41         | 50         | -4                                    |
| 2           | 28        | Tomsk region                  | 64     | 35       | 19        | 27       | 58         | 12         | +20                                   |
| 3           | 29        | Omsk region                   | 42     | 8        | 21        | 73       | 56         | 59         | +1                                    |
| 4           | 32        | Altai region                  | 55     | 40       | 23        | 31       | 42         | 58         | -6                                    |
| 5           | 43        | Krasnoyarsk region            | 57     | 21       | 28        | 44       | 78         | 43         | -36                                   |
| 6           | 52        | Irkutsk region                | 68     | 26       | 17        | 59       | 72         | 61         | -34                                   |
| 7           | 56        | Kemerovo region               | 33     | 66       | 54        | 33       | 73         | 32         | -40                                   |
| 8           | 64        | Republic of Khakassia         | 60     | 60       | 61        | 48       | 52         | 55         | +13                                   |
| 9           | 68        | Republic of Buryatia          | 75     | 19       | 75        | 69       | 67         | 45         | -15                                   |
| 10          | 74        | Transbaikal region            | 71     | 70       | 73        | 80       | 75         | 53         | -20                                   |
| 11          | 77        | Altai Republic                | 78     | 73       | 81        | 41       | 57         | 10         | +6                                    |
| 12          | 85        | Tyva Republic                 | 85     | 48       | 83        | 64       | 62         | 78         | -3                                    |

Features of the ecological situation in Siberia due to the nature of the environmental impact of industry, transport, utilities, and agriculture [5]. The change in the natural environment has led to the emergence of a number of environmental problems in the region. It has also caused deterioration of living conditions an increase in the number of diseases of the population and an increase in social tension. The main factors determining the degree of environmental hazard in the regions of the Siberian Federal District are the metallurgical industry, oil production and refining, the coal mining and gas industry, engineering and electric power industry [5]. Therefore, for industrial regions of Siberia, the main problem is air pollution (Table 3) [6].

Table 3. Rating of regions in terms of pollution and environmental impacts.

| Place (SFD) | Rank (RF) | Region                  | Air pollution | Water pollution | Ecosystem disturbance | Ecosystem protection |
|-------------|-----------|-------------------------|---------------|------------------|-----------------------|---------------------|
| 1           | 3         | Tyva Republic           | 26            | 9                | 17                    | 20                  |
| 2           | 4         | The Republic of Buryatia| 24            | 18               | 22                    | 23                  |
| 3           | 5         | Irkutsk region          | 59            | 27               | 19                    | 58                  |
| 4           | 12        | The Republic of Khakassia| 70            | 7                | 36                    | 21                  |
| 5           | 24        | Krasnoyarsk region      | 88            | 28               | 25                    | 49                  |
| 6           | 29        | Transbaikal region      | 16            | 19               | 20                    | 75                  |
| 7           | 35        | Tomsk region            | 77            | 31               | 21                    | 70                  |
| 8           | 49        | Altai region            | 43            | 21               | 67                    | 68                  |
| 9           | 53        | Novosibirsk region      | 74            | 22               | 45                    | 52                  |
| 10          | 59        | Omsk region             | 71            | 36               | 54                    | 71                  |
| 11          | 63        | Kemerovo region         | 82            | 61               | 42                    | 9                   |
However, at present, there are practically no methods for quantitative, statistically reliable assessment of technogenic social and environmental risks of harm to the health of the population of a particular region [3, 7]. As a rule, existing methods are based on large-scale long-term and expensive biomedical and epidemiological studies. And these methods do not take into account the factors specific to a particular region — geographical and climatic conditions, the level of industrial and socio-economic development, the particular social structure and way of life of the population, the level of development of the health care system, and others [3, 8]. Only a combination of classical methods and methods of data mining can make it possible to fully assess the influence of harmful environmental factors on the health of the population of a region [3, 8-10].

The use of artificial neural networks (ANN) seems to be promising when building a “dose-effect” relationship. They allow the development of highly efficient computer systems for predicting and analyzing mortality and morbidity with changes in environmental factors [3, 9-11].

For the assessment of environmental risks, neural network models describing the influence of harmful factors on the health of the population of Krasnoyarsk and the Krasnoyarsk region are built [3, 7-10]. Concentrations and emissions of major pollutants into the atmosphere were used as indicators of the environmental state. Primary morbidity, mortality, and life expectancy data were used as the indicators of health [3, 9-11].

3. Results
Calculations show that the neural network models satisfactorily describe the initial data — the error for various indicators of public health ranged from 0.4 to 4.7% [3, 9-11]. The results obtained allow us to determine the dose-effect relationships for individual components of the environment. And it provides an opportunity to create a comprehensive quantitative, statistically reliable methodology for the intellectual analysis and forecasting of social and environmental risks of the population of a particular industrial region using the available databases for monitoring emissions and pollutant concentrations and the state of public health [3, 9-11].

When new data is available, the resulting models can be easily corrected by the “complementary training.” With appropriate “retraining” and customization, the models can be adapted to the conditions of any other industrial region of Russia, taking into account its specific features.

Interpretation of the obtained results will allow to assess the real or estimated socio-economic efficiency of implemented or planned technical, technological, administrative, and managerial decisions in the industrial and socio-economic development of an industrial region and an environmental management. Also, the interpretation of the results will make it possible to substantiate programs for the socio-economic development of the region, to develop regional standards for environmental quality.

4. Conclusion
Thus, the transition to the sustainable development of industrial regions of Siberia makes it necessary to include social and environmental factors in the system of basic socio-economic indicators of the region. This can be achieved through the development and adaptation of indicators of environmental safety at the national and regional levels. These indicators would reflect the influence of environmental factors on the health status of the population - social and environmental risks.

The currently existing traditional macroeconomic indicators that usually measure the success of the economic and social development of regions and the economic well-being of the population do not reflect the progress towards the achievement of sustainable development goals. This is due to the fact that the growth of these indicators can be based on man-made nature-intensive development. This creates prerequisites for a sharp deterioration in the economic and social indicators of the region in the future, in the event of depletion of natural resources and environmental pollution.

To assess and predict the social and environmental risks of the population of an industrial region, taking into account its specific features and the state of the environment, modern information
technologies and data mining methods should be used, along with classical methods [3, 10, 11].

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