PAPER • OPEN ACCESS

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

View the article online for updates and enhancements.

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

E Sugak [1*]

[1] Reshetnev Siberian State University of Science and Technology, 31 prospect behalf of the newspaper "Krasnoyarsky Rabochiy", Krasnoyarsk 660037 Russia

E-mail: sugak@mail.ru

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.

			Ranks of components of investment potential								
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	Ranks of investment risk components						Difference of ranks of potential and risk
			Social	Economic	Financial	Criminal	Ecological	Managerial	
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 has 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	Ranks of the components			
			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].

References

[1]   Expert RA 2016 *Rating of investment attractiveness of the regions in 2015* Available at: http://www.raexpert.ru (Accessed 04 02 2019)

[2]   Sugak E V 2017 Investment attractiveness and social and environmental risks of the Krasnoyarsk region *Nauka Krasnoyarya* **6**(4-2) pp 146-151

[3]   Sugak E V 2014 Modern methods of environmental risk assessment *European Social Science Journal* **5**(44) pp 427-433

[4]   Udartseva O V 2009 Environmental safety as a criterion for sustainable development of Western Siberia *Vestnik of RUDN* **4** pp 93-96

[5]   Tsalikov R Kh, Akimov V A, and Kozlov K A 2009 *Assessment of Russia's natural, man-mad,e and environmental safety* (Moscow, Russia: FGU VNII GOCHS (FTS))

[6]   Karanina E V, and Vershinina N A 2016 Ecological risks of Russian regions *Vestnik of Moscow University of Finance and Law* **2** pp 21-38

[7]   Belskaya E N, Sugak E V, and Brazgovka O V 2016 Calculation and prediction of the individual death risk of the population of an industrial region *Safety in the Technosphere* **5**(4) pp 18-22

[8]   Onishchenko G G, Zaitseva N V, May I V *et al* 2014 *Health risk analysis in the strategy of state socio-economic development* (Perm, Russia: Publishing House of the Perm National Research Polytechnic University)

[9]   Sugak E V, Okladnikova E N, and Kuznetsov E V 2008 Computational and informational technologies for analysis and assessment of social and ecological risks *Ecology and Industry of Russia* **8** pp 24-29

[10]   Sugak E V, Kuznetsov E V, and Nazarov A G 2009 Information technologies for assessing environmental safety *Mining Information and Analytical Bulletin (Scientific and Technical Journal)* **18**(12) pp 39-45

[11]   Potylitsyna E N, Lipinskiy L V, and Sugak E V 2013 Use of artificial neural networks to solve applied environmental problems *Modern Problems of Science and Education* **4** pp 51-58