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Ecological Balance of Territory: Key Factors and the Regulation Mechanism

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In the article the allocation of contaminants emission in Federal Districts of the Russian Federation is shown. Also the detailed description of contaminants emission in the regions of the Siberian Federal District was done. The structure of contaminants in the largest industrial centers of Krasnoyarsk region had been analyzed. Groups of factors affecting the ecological situation on territories are revealed. The mechanism allowing to regulate rates of economic growth taking into account ecological restrictions is suggested.

Keywords: Economic growth, environmental economics, enterprises, contaminants emission, ecological restrictions, the sustainable development conception.

Statement of Problem

Nowadays economic systems have reached such level of development when the quality of growth takes a particular importance, reducing the role of the rates of economic growth. In other words, the high rate of economic growth is considered as an instrument of achievement of a comprehensible living standard, and the purpose of such economic system is the quality of inhabitancy of the individual. The situation is that the basic limiting factor of economic development is the ecological balance of territory, therefore, the greatest possible rate of economic growth will be far from the optimum, most probably. In this connection it is necessary to define such rate of economic system development, which will lead to sustainable development, instead of short-term favorable results.

It is obvious that sources of economic growth are social and economic systems of the lowest level – enterprises. On the other hand, the enterprises come out as the basic stationary sources of contaminants emission. Considering such double role of the enterprises in economic development, it is necessary to point out the ecological consequences of industrial production (In the given research only atmosphere pollution is considered), how emission of contaminants are allocated and what can be the mechanism of economic growth optimization subject to ecological restrictions.

The most polluted Federal District of Russia in view of the total emissions from stationary sources are the Siberian (Table 1, Fig. 1; in 2008 the total contaminants emission in atmosphere comprised 8 537,6 thousand tons) and the Ural Federal Districts (7 320,0 thousand tons in 2008).

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Table 1. The basic indicators of environmental damage of the Russian Federation in 2007-2008 [1]

Indicator	Year	The Russian Federation	including Federal Districts						
			Central	Northwestern	South	Volga	Ural	Siberian	Far Eastern
Contaminants emission from transport , thousand tons	2007	16 214,2	4 316,3	1 535,0	2 481,4	3 347,5	1 359,0	2 368,6	806,4
	2008	17 344,0	4 755,0	1 599,7	2 647,2	3 424,0	1 520,9	2 571,3	826,0
Contaminants emission from stationary sources , thousand tons	2007	20 636,9	1 588,2	2 319,0	875,3	2 876,8	6 326,1	5 801,7	849,9
	2008	20 103,3	1 587,9	2 226,2	860,0	2 822,0	5 799,2	5 966,3	841,8
inclusive of:									
solid substance	2007	2 743,4	223,3	289,4	88,7	214,2	840,4	794,9	292,7
	2008	2 704,2	211,6	268,8	96,2	189,3	817,4	833,9	287,0
liquid and gaseous substances	2007	17 893,5	1 364,9	2 029,6	786,6	2 662,6	5 485,7	5 006,8	557,3
	2008	17 399,1	1 376,3	1 957,4	763,8	2 632,7	4 981,8	5 132,4	554,8
sulfur dioxide	2007	4 573,1	166,9	560,1	125,9	420,2	550,3	2 562,0	187,8
	2008	4 534,1	154,4	548,4	137,3	371,0	553,7	2 593,2	176,1
carbon oxide	2007	6 448,4	588,3	751,1	287,7	849,6	2 671,0	1 072,6	228,2
	2008	6 091,5	572,4	706,4	253,7	764,7	2 495,9	1 063,5	234,8
nitrogen oxides	2007	1 732,8	281,3	170,1	119,2	282,8	428,0	350,8	100,7
	2008	1 816,6	278,9	166,1	121,9	298,6	446,5	396,6	108,0
hydrocarbons (including volatile dangerous compound)	2007	4 901,0	293,9	528,5	241,8	1 066	1 780,8	962,5	27,4
	2008	4 749,5	342,9	518,8	240,4	1 169,9	1 430,6	1 021,2	25,8
Collected and rendered harmless, %	2007	74,8	76,7	74,1	75,6	67,3	70,0	79,0	83,3
	2008	75,0	74,8	73,7	75,0	66,2	69,9	79,7	83,5

The reasons are clear. The largest industrials concerning following kinds of economic activities are situated within these districts: «Processing manufactures» (regarding subsection «Metallurgical manufacture and manufacture of ready metal products»), «Mining operations» and «Manufacture and distribution of the electric power, gas and water» which traditionally are the leaders of anthropogenous influence on the environment.

Krasnoyarsk region is the leader of the contribution (34 %) in the total emission of pollutants in atmosphere from stationary

sources and transport in the Siberian Federal District.

As we noticed above, the enterprises are the main pollutants of the whole environment. At the same time, following the sustainable development conception, regions and local authorities come out as the exclusive centers of decision-making on directions and rates of economic development, so they urged to provide reproduction of qualitative resources [3]. Territorial unit is considered as the individual inhabitancy, hence, it is necessary to regulate activity of all participants of economic system so that the territory could become

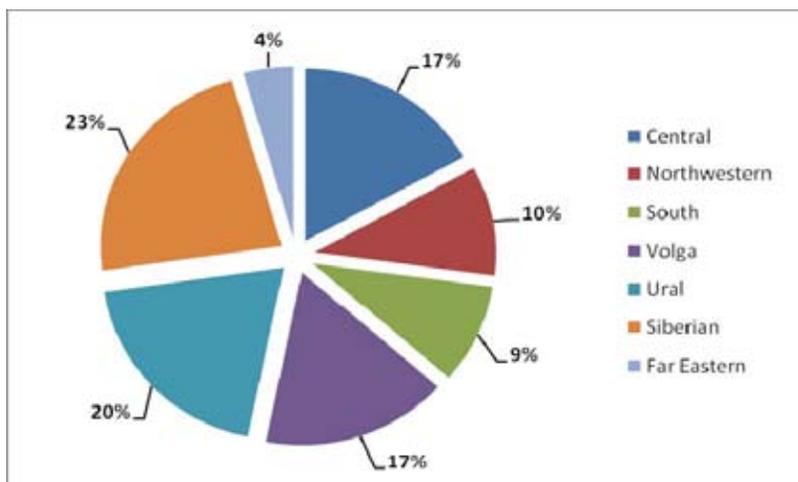


Fig. 1. The allocation of contaminants emission in Federal Districts of the Russian Federation (2008), %

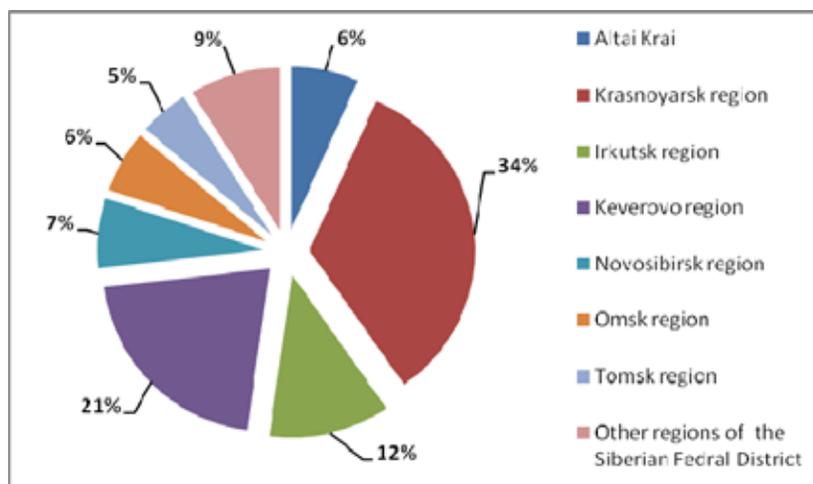


Fig. 2. The allocation of contaminants emission in regions of the Siberian Federal District (2008), %

attractive for the population. It means that local authorities should promote a sustainable development in long-term prospect by creation and development of a territory infrastructure, acceptance of measures on restriction of an ecological capacity and assimilative potential, and also by means of motivation of economic agents to innovative reproduction. Also the local authorities should develop the policies for increasing of competitiveness both separate kinds of production, and business as a whole. Thus, environmental problems are of a fundamental importance and should be considered not in the separate enterprise level, but in a complex – in

the context of ecological balance of territory maintenance.

From this point of view it is necessary to develop the mechanism which, on the one hand, will help to reveal group of factors influencing an ecological situation within territory, and, on the other hand, will provide a full framework for regulating the rates of economic growth subject to ecological restrictions. The majority of environmental problems of the “huge” Krasnoyarsk region are connected with the relatively small territories where industrial centers and zones of direct external influence are located. The largest thermal and hydroelectric

Table 2. Structure of emissions of the basic atmosphere contaminants from stationary sources in cities of Krasnoyarsk region in 2008 [2]

City	Emissions of the atmosphere contaminants (thousand tons)					Number of enterprises
	Solid substance	Sulfur dioxide	Carbon oxide	Nitrogen oxides	Volatile dangerous compound	
Achinsk	29,97	4,52	4,49	12,59	0,04	29
Krasnoyarsk	28,96	28,53	74,37	15,55	2,99	77
Kansk	2,40	1,17	2,03	0,47	0,06	17
Lesosibirsk	3,13	1,03	7,43	1,04	0,10	16
Minusinsk	0,43	1,66	1,26	1,52	0,03	25
Nazarovo	19,43	28,87	4,45	18,54	0,32	17
Overall in the basic industrial centers	84,32	65,78	94,03	49,71	3,54	181
Specific weight of emissions in basic industrial centers in the structure of total emissions of Krasnoyarsk region	55,76	57,50	68,96	69,22	22,12	31,9
For comparison:						
Polar Division of the Mining and Metallurgical Company «Norilsk nickel»	10,67	1 919,9	6,74	1,78	0,953	1

power stations in the Russian Federation, coal mines, aluminum production and gold mining are placed in Krasnoyarsk region. Many of regional industrial enterprises are city-forming. At the same time, excessive concentration of manufacture strengthens an urgency of environmental problems repeatedly.

Results

In the given research we will consider the cities of Krasnoyarsk region – Krasnoyarsk, Achinsk, Nazarovo, Kansk, Minusinsk, Lesosibirsk. The choice of the named cities is caused by the several reasons: first, they are the largest industrial centres in which the basic enterprises of main kinds of economic activities of Krasnoyarsk region are concentrated; secondly, on these territories the necessary calculation data on ecological situation is fully available. It is necessary to notice that the Norilsk city is not included in the presented list, though it is known that emissions of the enterprises of

Norilsk industrial region (NIR) traditionally make 70-75 % of total emissions of Krasnoyarsk region. One of the reasons of its exception is that the specified data characterizing ecological indicators NIR are «closed» since 2000 year and are not presented in appropriate statistical collections. Other reason consists in too high specific weight of emissions NIR in structure of total emissions in Krasnoyarsk region, therefore the NIR inclusion in the analysis would lead to level shift of distinctions in other industrial centres. Thus, emissions of the enterprises of the basic industrial centres (without NIR) had been analyzed. The considered emission data covers at an average 60 % of emissions from stationary sources in the region.

The cities which are the leaders on pollution volumes of the basic contaminants are Krasnoyarsk, Achinsk and Nazarovo (Table 2). This fact is caused, first of all, by industrial production structure in these cities. It is known that the external sources providing the basic volume

of total emissions of contaminants in territory of Krasnoyarsk region are the enterprises of metallurgical production and production of ready metal products (OGSC Mining and Metallurgical Company «Norilsk nickel», OGSC «RUSAL Achinsk», OGSC «RUSAL Krasnoyarsk»); the enterprises for manufacture and distribution of the electric power, gas and water (the basic state district power stations and thermal power station); transport; other sources.

So, the considered cities demonstrate the following structure of manufacture. 80 % of the whole pollution volume in Achinsk is emitted by the metallurgical enterprises. In Krasnoyarsk metallurgical manufactures produces 47 % of the whole pollution, the power enterprises – only 34,2 %. In Nazarovo the power enterprises (the main enterprise – the Nazarovsky state district power station) emits 94,7 % of the whole pollution volume. Three remained cities are characterized by a bit different structure of industrial production though there are also power enterprises, but they have much smaller volumes of output. So, in Kansk the electric power industry enterprises does 53 % of emissions, 21 % of emissions is the share of chemical manufacture. In Lesosibirsk 24,7 % of emissions are presented by emissions of timber processing complex, the share of the enterprises of housing and communal services is 23,4 %. In Minusinsk power enterprises emit about 70 % of the whole pollution volume.

Besides, according to the data of Table 2, in the considered cities there are only 31,9 % of the industrial enterprises of Krasnoyarsk region, thus, as already has been told above, they share about 60-70 % of contaminants emissions. First of all, it is caused by the fact that mentioned industrial enterprises represent the lead manufactures of the region. For comparison in Table 2 the data on the basic enterprise of the NIR – Polar Division of the Mining and Metallurgical Company «Norilsk nickel» are presented. It demonstrates that the

sulfur dioxide is the basic contaminant because of Mining and Metallurgical Company «Norilsk nickel» traditionally takes the first place on total emissions of contaminants not only among the enterprises of Krasnoyarsk region, but also among the enterprises of the Russian Federation (the sulfur dioxide makes 98 % in structure of total emissions of Mining-and-Metallurgical Company).

On the whole, from the viewpoint of authors, major factors which are expedient for considering at modelling of an ecological situation within concrete territory and subsequently at decision-making on rational rates of economic growth, are the following:

I. Operated (controllable) factors.

1) the structure of the industrial production of the territory;

2) scales of production and current production technologies on the basic industrial enterprises;

3) population size and population density (those factors indirectly characterizes the quantity of motor transport which is available within particular territory);

4) the area of green plantings in particular settlement and prevailing species of wood.

II. Uncontrollable factors.

5) Characteristics of environmental conditions of territory (average annual temperature of the air, average annual speed of the wind, an average daily amount of precipitation (an average for a year), average daily air pressure (an average for an year)).

It is important to consider the uncontrollable factors for understanding what contribution they bring into a variance of the indicator of the ecological pressure on the territory, and, hence, what share of a resulting indicator variation can be operated by introduction of appropriate economic mechanisms. In our research we consider maximum permissible concentration of basic and specific contaminants to concerned

objects as the basic criterion of “ecological well-being” of the selected territory.

Thus, authors of this research suggest the two-level model described below.

$$\left\{ \begin{array}{l} CC_n = PC(X_1, X_2, \dots, X_p, C_k) \\ EG = EG(X_1, X_2, \dots, X_p) \rightarrow \max \\ b'_1 X_1 + b'_2 X_2 + \dots + b'_p X_p \leq PC_{\max}^n \end{array} \right. ,$$

where CC_n (*contaminants concentration*) is the concentration of n -th contaminant function;

EG (economic growth) is the economic growth function;

X_p is a factor of economic growth;

C_k is a climatic characteristic of territory;

b'_p is a factor reflecting the contribution of X_p to change of CC_n ;

CC_{\max}^n is the maximum permissible concentration of n -th contaminant at which the territory remains favorable for population residing.

The first level of the presented model allows to reveal the most significant factors influencing on concentration of contaminants in considered territories. Also, this equation quantitatively estimates the contribution of each of them to a variance of a resulting indicator.

The second level of the model corresponds to the mechanism, which is necessary

for decision-making about rational rates of economic growth by regional or local authorities. The offered mechanism, on the one hand, reflects an economic target of territory development – maximization of a gross regional product. On the other hand, it shows what economic growth rates should be kept, so as the comfortable level of the economic well-being and good parameters of the quality of life (population health, recreational characteristics of territory) will be provided.

Conclusion

In conclusion, coming back to a role which regional and municipal authorities play in maintenance of a sustainable development of territories, it is necessary to note the following. The regional and local authorities have real tools for providing balance between the economic growth rates and appeal of territory in respect to maintenance of the high living standards. As a result it will allow to improve the quality of life of the future generations. It is obvious that the mechanisms discussed by authors are actual for territories with high rates of development (similar to such ones of Krasnoyarsk region) and for the developing territories characterized by a commercial inefficiency of spatial organization of economics (for example, northern areas of Krasnoyarsk region).

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Экологический баланс территории: ключевые факторы и механизм регуляции

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В статье показано территориальное распределение выбросов загрязняющих веществ по федеральным округам РФ и регионам Сибирского федерального округа. Проанализирована структура загрязняющих веществ в крупнейших промышленных центрах Красноярского края. Выявлены группы факторов, влияющих на экологическую ситуацию территории. Предложен механизм, позволяющий регулировать темпы экономического роста с учетом экологических ограничений.

Ключевые слова: Экономический рост, окружающая среда, промышленные предприятия, выбросы загрязняющих веществ, экологические ограничения, концепция устойчивого развития.
