Comparative analysis of anthropogenic impact levels and payments for natural resource use in the Russian model areas

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Abstract. An assessment of the effectiveness of the existing system of paid nature natural resource usage in terms of the effect of reducing the negative impact on the environment by nature users is considered. The theory and practice of the effectiveness of environmental investment, as well as environmental management fees, were used as the basis of the methodology. The basis of the methodological tools consists of calculation and analytical, comparative methods, methods of system and structural analysis. The model territories of the ecological rating of the constituent entities of the Russian Federation are determined, the degree of anthropogenic impact is estimated on the basis of specific pollution indicators, the analysis of environmental investment features in the selected territories is carried out, the need for improving environmental policy is proved on the basis of the assessment of the ratio of payment for regulatory and excess pollution by environment.

1. Introduction
The rating assessment has recently become very widespread in almost all fields of activity, including the environmental field. Ratings are expressed through a numerical or ordinal indicator indicating the degree of importance or significance of a particular subject of discussion. Ratings are one of the main tools to improve the efficiency of a particular activity. Territory coverage ratings can be global, regional (national), local, and by field of activity – industry-specific. Modern environmental ratings in Russia assess the ecological state of cities (Federal Service for Hydrometeorology and Environmental Monitoring, Domofond, etc.), the ecological state of the regions (Green Patrol public organization, Russian Geographical Society, WWF Russia, RIA Rating, etc).

Research by Russian scientists in the field of constructing environmental ratings is based on the calculation of an indicator (system of indicators) that takes into account environmental sustainability. In the work of Bobylev S N the ecological-economic index of the regions of Russia is presented, the ranking according to this indicator is carried out [1]. The principles of the development of the index of adjusted net savings [2], for the calculation of which the available statistical base is used, formed the basis for the construction of the ecological-economic index.

Ryumina E V proposes the construction of an ecological index based on the indicator of the number of air and water samples exceeding the MACs, as a percentage of the total number of samples examined [3]. Bityukova V R a methodology for a comprehensive assessment of anthropogenic impact on the atmosphere, water resources, land resources, the impact of the agrarian complex, on forest resources, and radiation impact has been developed [4]. Komarov V M and Kotsyubiisky V A consider
the indicators of the environmental load on the territory and on the population to be objective for cities and regions of Russia [5].

This study proposes to assess the objectivity of the environmental rating of the regions of the Russian Federation, taking into account the positive and negative references in the media of the constituent entity of the Russian Federation, and to assess the effectiveness of the existing system of paid environmental management in terms of the effect of reducing the negative impact on the environment in model territories with high, medium and low indicators in the rating.

2. Models and Methods
The ranking of regions and the choice of model territories of the Russian Federation is based on the data of the ecological rating of the constituent entities of the Russian Federation (conducted by the Russian public organization “Green Patrol”), which is the result of public monitoring and is based on the principles of sustainable development [6]. The aggregate rating indicator is based on the environmental index, industrial and environmental index, social and environmental index. Each of the indices is calculated on the basis of a quantitative assessment of positive or negative mentions in the media in three areas. The ranking and selection of model territories of the Russian Federation is proposed to be carried out by the method of intervals according to the level of the ecological state of the regions.

To conduct a comparative analysis of the selected model territories of the Russian Federation on the basis of Rosstat materials for each of the model territories, the following indicators are determined:

- volume of emissions of pollutants from stationary and mobile sources (per unit of GRP, per 1 km² of territory, per 1 person);
- volume of polluted waste water discharge into surface water bodies (per unit of GRP, per 1 km² of territory, per 1 person);
- volume of production and consumption waste generation (per unit of GRP, per 1 km² of territory, per 1 person);
- share of environmental investments in the structure of investments in fixed assets;
- structure of environmental investments by natural environment;
- payment for normative and over-normative impact on the environment (water bodies, atmospheric air, disposal of production and consumption waste).

3. Results and Discussion
We analysed the values of the composite environmental index for 2016, which range from 35 (minimum value) to 66 (maximum value). We have ranked the regions according to the level of ecological status into prosperous (56-66), medium (45-55), and disadvantaged (35-44). Based on this rating, we have identified 6 model territories of the Russian Federation that have high, medium and low indicators in the rating (Table 1).

| Regions          | The value of the rating index “Green Patrol” | Place in the rating | Position in the rating | Assessment of the ecological state |
|------------------|---------------------------------------------|---------------------|------------------------|-----------------------------------|
| Altaiskiy region | 57                                          | 3                   | high                   | favourable                         |
| Kemerovsky region| 49                                          | 30                  | average                | average                           |
| Krasnoyarsky region | 41                                         | 66                  | low                    | unfavourable                      |
| Republic of Buryatia | 40                                        | 78                  | low                    | unfavourable                      |
| Republic of Tatarstan | 46                                        | 43                  | average                | average                           |
| Tambovskiy region  | 66                                          | 1                   | high                   | favourable                         |

Table 1. Assessment of the composite index of the ecological rating “Green Patrol” of model territories of the Russian Federation (2016).
According to the results of the ecological rating of the public organization “Green Patrol”, Kemerovsky region is classified as a constituent entity of the Russian Federation with an average position, however, according to official statistics, the region is characterized by the largest volume of emissions per unit of territory among the regions under consideration (16.5 t/km²) (Table 2).

Table 2. Pollutant emissions on model territories from stationary and mobile sources of the Russian Federation (2016).

| Regions               | Emissions of pollutants per unit GRP, t/mln RUB | per 1 km² of territory, t/km² | per 1 person, t/person |
|-----------------------|-----------------------------------------------|------------------------------|------------------------|
| Altaisky region       | 2.3                                           | 2.7                          | 0.2                    |
| Kemerovsky region     | 1.5                                           | 16.5                         | 0.6                    |
| Krasnoyarsky region   | 9.5                                           | 1.1                          | 0.9                    |
| Republic of Buryatia  | 4.7                                           | 0.6                          | 0.2                    |
| Republic of Tatarstan | 0.3                                           | 9.8                          | 0.2                    |
| Tambovsky region      | 0.5                                           | 4.6                          | 0.2                    |
| Average for Russian regions | 0.8                                           | 5.0                          | 0.3                    |

This indicator was one of the highest in the Russian Federation. The Kemerovsky region is a highly urbanized industrial region, where 58% of Russian coal was mined in 2016. Throughout the history of development, it was distinguished by the highest level of concentration of industrial production in a compact area [7]. The city of Novokuznetsk of the Kemerovsky region is annually included in the Priority list of cities with the highest level of air pollution in Russia [8]. In 2016, the maximum values of the emission index per unit area were typical for the Moscow (22.4 t/km²) and Lipetsk regions (19.1 t/km²). The average value for the regions of Russia was 5 t/km². A high value of emissions into the atmosphere per unit of gross regional product is typical for the Krasnoyarsky region (9.5 tons/million RUB).

The highest values of the indicators of the discharge of polluted wastewater into surface water bodies per 1 km² among the model territories are typical for the Republic of Tatarstan (4.8 thousand m³/km²) and the Kemerovsky region (4.6 m³/km²) (Table 3). In the Republic of Tatarstan, the pollution of water bodies is carried out mainly by the discharges of insufficiently treated wastewater from industrial and municipal enterprises with low efficiency of treatment facilities [9]. According to the specific indicators of the discharge of pollutants per unit of GRP and per 1 person, the rest of the model territories have homogeneous values.

Table 3. Pollutant discharge on model territories of the Russian Federation (2016).

| Regions              | Discharge of waste water into surface water bodies per unit GRP, t/h thous. m³ RUB | per 1 km² of area, thous. m³/km² | per person, thous. m³/person |
|----------------------|---------------------------------------------------------------------------------------|-------------------------------|----------------------------|
| Altaisky region      | 0.04                                                                                  | 0.1                           | 0.01                        |
| Kemerovsky region    | 0.5                                                                                   | 4.6                           | 0.2                         |
| Krasnoyarsky region  | 0.2                                                                                   | 0.1                           | 0.1                         |
| Republic of Buryatia | 0.2                                                                                   | 0.1                           | 0.04                        |
| Republic of Tatarstan| 0.2                                                                                   | 4.8                           | 0.1                         |
| Tambovsky region     | 0.1                                                                                   | 1.2                           | 0.04                        |
| Average for Russian regions | 0.3                                         | 2.4                           | 0.1                         |
On average, in the regions of Russia, the rate of discharge of polluted wastewater was 2.4 thousand m³/km². In 2016, the maximum values of discharges per km² were observed in the Moscovsky region (23.3 thousand m³/km²), Krasnodarsky region (11.9 thousand m³/km²), the Republic of North Osetia (11.0 thousand m³/km²).

A significant share of extractive activities is determined by high rates of production and consumption waste generation (Table 4).

| Regions              | Wastes of production and consumption are generated per unit GRP, t/mln RUB | per 1 km² of territory, t/km² | per 1 person, t/person |
|----------------------|-------------------------------------------------------------------------|------------------------------|------------------------|
| Altaisky region      | 5.6                                                                     | 16.9                         | 1.2                    |
| Kemerovsky region    | 3,237.1                                                                 | 29,270.3                    | 1,032.4                |
| Krasnoyarsky region  | 210.2                                                                   | 155.1                       | 127.8                  |
| Republic of Buryatia | 228.0                                                                   | 128.7                       | 46.0                   |
| Republic of Tatarstan| 1.7                                                                     | 48.3                        | 0.8                    |
| Tambovsky region     | 14.7                                                                    | 127.1                       | 4.2                    |
| Average for Russian regions | 120.7                                                           | 673.2                      | 50.2                   |

In 2016, the maximum value of the production and consumption waste generation indicator per unit area is typical for the Kemerovsky region (29,270.3 t/km²), which was more than 40 times higher than the national average. Currently, in the Kemerovsky region, more than 50% of coal is mined by open pit mining, which causes significant damage to the environment and leads to an irreversible loss of the value of ecosystem services [7]. First of all, highly fertile soils with an average class quality of 75 points, wetlands and habitats of rare and endangered species of plants and animals are irretrievably lost. High rates of production and consumption waste generation per unit of GRP and per 1 person are also typical for the Kemerovsky region.

Comparison of the volume and directions of distribution of environmental investments by components of the natural environment in the model territories characterizes the main priorities of the environmental policy of the regions. The share of environmental investments in the structure of investments in fixed assets shows in figure 1.

The greatest value of the share of environmental investments was observed in the Krasnoyarsky region (3.2%), the Republic of Buryatia (1.1%), the Kemerovsky region (0.9%), which is associated with a high level of impact on the components of the natural environment. However, the current level of environmental investment is insufficient. In the Krasnoyarsky region the largest volume of
investments was directed to the protection of atmospheric air (20.8%), other types of environmental protection (54.4%). In the Republic of Buryatia, the main purposes of environmental investment were the protection of water bodies (53.7%), the protection of the environment from the harmful effects of production and consumption waste (30.8%). In the Kemerovsky region the main priorities of the environmental policy were the protection of water resources (75.2%).

The payment for the excess pollution of natural objects exceeds the standard payment, which proves that the anthropogenic load, especially on water systems, in the Krasnoyarsky region and the Kemerovsky region is significant (Table 5).

Table 5. The ratio of fees for regulatory and excess environmental impact of model territories, % (2016).

| Regions               | Total  | Water bodies | Atmospheric air | Disposal of production and consumption waste |
|-----------------------|--------|--------------|-----------------|---------------------------------------------|
| Altaisky region       | 69 / 31| 73 / 27      | 88 / 12         | 63 / 37                                     |
| Kemerovsky region     | 82 / 18| 14 / 86      | 59 / 41         | 97 / 3                                      |
| Krasnoyarsky region   | 51 / 49| 31 / 69      | 61 / 39         | 44 / 56                                     |
| Republic of Buryatia  | 72 / 28| 81 / 19      | 77 / 23         | 65 / 35                                     |
| Republic of Tatarstan | 78 / 22| 78 / 22      | 92 / 8          | 75 / 25                                     |
| Tambovsky region      | 60 / 40| 16 / 84      | 73 / 27         | 70 / 30                                     |
| Average for Russian regions | 69 / 31| 73 / 27      | 88 / 12         | 63 / 37                                     |

In 2016, the ratio of payments for regulatory and excess pollution of water bodies in the Krasnoyarsky region was 31/69, in the Kemerovsky region – 14/86, in the Tambovsky region – 16/84, which indicates that water users do not strive to reduce the excess pollution. By paying these payments out of profit, they reduce the profitability of production. Enterprises-water users of the Krasnoyarsky region, Kemerovsky region and Tambovsky region could finance their own water protection measures and reduce the level of excess pollution. However, economic operators prefer to pollute and pay for pollution today than invest today and reduce pollution tomorrow, which proves the lack of environmental priorities in the development strategy.

4. Conclusion
Thus, the analysis of the anthropogenic load on the model territories showed the objectivity of the ecological rating of the regions of Russia, taking into account the positive and negative references in the mass media of the constituent entity of the Russian Federation. The calculated specific indicators of pollution per unit area characterize a high degree of economic impact, and the existing environmental investment in disadvantaged regions is insufficient. Comparison of payments for normative and over-normative impacts showed the ineffectiveness of payment for water use in the Kemerovsky region, Krasnoyarsky region, Tambovsky region, therefore, one of the directions for improving environmental policy, especially in relation to water bodies, should be the improvement of the system of payments for environmental pollution.

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