An assessment of the regional development well-being taking into account the environmental component

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Abstract. The paper presents the results of socio-ecological and economic well-being estimation of the Russian regions using a multiplicative model, based on the A. Sen extended function. This model includes GRP per capita, share of the personal incomes in GRP, the regional cost of living index, the intra-regional income inequality and the integrated environmental index. It is defined as average of the specific environmental indices calculated on the basis of the following indicators: the share of the negative air, water and soil tests. Calculations have revealed that there is a significant interregional differentiation in the level of social well-being. The inclusion of the environmental component into the multiplicative model had a significant impact on the results of a comprehensive assessment of regional development. In some Russian regions, the environmentally adjusted level of well-being was significantly lower than the indicator that does not take this aspect into account. It is shown that the role of the environmental factors in the quality of life in the East of Russia is quite significant. The research novelty is to take into account the environmental component in assessing the well-being of the regions using a multiplicative model, based on the A. Sen extended function. The analysis results can be used in the process of making management decisions in the field of environmental and economic interactions, as well as in the preparation of strategic documents for sustainable regional development.

1. Introduction
The problem of taking into account the environmental factor in assessing the achieved level of economic development is actively discussed around the world in the ecological and economic scientific literature [1]. In some Russian regions where the economy is built around the raw materials industry, the level of negative impact on the environment is very high. This situation is also typical for most of the territories in the East of the Russian Federation, where the economic development is still based on natural resources [2].

One of the most crucial issues in Russia is not only the significant degree of its interregional inequality, but also the high rate of its deepening. This leads to a dynamic migration of the population and a deterioration in the quality of human capital in the peripheral regions. In the East of Russia, these processes are particularly noticeable [3]. The level of education in Russia remains quite high, young educated people are the first ones to leave for the West. Only for the period from 2006 to 2017 the absolute losses of the far Eastern regions in the interregional population exchange amounted to 263 thousand people [4]. This is also dangerous for the national economy as a whole: natural resources are largely concentrated in the East. Their effective use is a significant factor in both the economic growth and the welfare of the entire country's population.
These trends are fully recognized by the Government of the Russian Federation. To overcome them, special institutional tools have been developed: the Ministry for the Development of the Russian Far East and several investment funds have been created. A Program for the development of the Far East and the Baikal region has been developed providing significant financial support from the Federal budget to stimulate the economic development of these territories. These measures have produced some results, and the flow of investment has actually increased. However, the gap in the per capita GRP remains, and even deepens. The only exceptions are the regions where large deposits of oil, gas, gold and diamonds are being actively developed. Migratory outflow of the population continues. The Southern regions of the East of Russia remain to be the outsiders, despite their convenient geographical location, and the possibility of cross-border contacts as well as the high demand for resources in China which are assumed to create significant comparative advantages for these territories.

The initiators, owners and beneficiaries of large enterprises in the mineral resource sector are national-level companies whose management centres are usually located in Moscow. Many Russian studies note the "colonial nature" of subsoil use, which also occurs in the Eastern territories of Russia [5]. This is revealed, in particular, in the low quality of environmental measures in production processes and, consequently, in a high degree of negative impact on the environment. This creates additional discomfort of living, in addition to extreme climatic conditions. Therefore, we have set a task to determine the quantitative indicators of the impact of environmental conditions on the well-being of local residents.

2. Models and methods
The purpose of this work is to study the socio-ecological and economic well-being of Russian regions using a multiplicative model based on the A. Sen extended function [6]. This model was adapted for the study of social well-being of the Russian sub-federal units [7]. It includes four components:

$$S_i = \frac{Y_i}{N_i} \times \frac{D_i}{Y_i} \times \frac{CI}{CI_i} \times (1 - G_i)$$

where $S_i$ – level of social well-being of the $i^{th}$ region; $Y_i/N_i$ is the GRP per capita of the $i^{th}$ region; $D_i/Y_i$ is the share of personal incomes in GRP of the $i^{th}$ region; $CI/CI_i$ is the cost of living index in the $i^{th}$ region (it is calculated as the ratio of the cost of a fixed set of consumer goods and services in the entire country to the cost of this set in the $i^{th}$ region); $(1 - G_i)$ – is the erosion of income ($G_i$ – the Gini coefficient in $i^{th}$ region).

This multiplicative model can be expanded to include new welfare components [8]. In this study, we will supplement it with an indicator that takes into account an important component of well-being: the quality of natural environment:

$$S_{Ei} = \frac{Y_i}{N_i} \times \frac{D_i}{Y_i} \times \frac{CI}{CI_i} \times (1 - G_i) \times E_i$$

Where $E_i$ – the integrated environmental index characterizing the quality of the environment in the $i^{th}$ region.

The index $E_i$ is defined as the average of specific ecological indices, calculated on the basis of the following indicators: the share of the tests of air, water and soil exceeding maximum permissible concentration in a total number of the studied tests within the regular monitoring by the government agencies. To determine the specific ecological indices, we will use the approach proposed in [9] to take into account the environmental component in the construction of an environmentally adjusted human development index:

$$P_i = \frac{x_{max} - E_i}{x_{max} - x_{min}}$$

Where $x_{i}$, $x_{max}$, $x_{min}$ – factual, maximum and minimum specific weight of negative water, air and soil tests in the total number of the studied tests.
The value of coefficient $E$ varies in the range from 0 to 1: the higher it is, the better the state of the environment in region. Thus, on the territories with the best environmental conditions (with the least amount of negative water, air and soil tests), the environmentally adjusted level of well-being ($S_E$) will correspond to the value obtained from the four-component model ($S$).

The study used official data of the Federal Service for Surveillance on Consumer Rights Protection and Human Wellbeing and the Federal State Statistics Service. The monetary indicators (GRP and average per capita money income of the population) were given to a comparable form (the base year is 2008). The analysis of spatial distribution of the considered indicators in the study was performed using GIS tools.

3. Results and discussion

This section presents the results of calculations based on the data for 2012 and 2017 for the Russian regions (in constant prices, 2008). By comparing them, we can estimate the changes that occurred in this time interval.

The spatial distribution analysis of the average per capita money income showed a high inter-regional differentiation: in 2017, the difference between the regions with the lowest (Republic of Kalmykia (8) – 8040) and the highest (Yamal-Nenets Autonomous Area (89) – 44960) value of the indicator was 5.6 times (figure 1).

Values higher than the national average are observed mainly in the regions located in the Eastern and North-Western parts of the country. These territories are also characterized by a higher cost of living (on the figure 1, regions where the cost of a fixed set of consumer goods and services is higher than the cost of a similar set in the Russian Federation are highlighted with hatching). It is noteworthy that in almost all border regions of the Far East, the average per capita money income does not reach the national level. The only exceptions are Primorye Territory (25) and Khabarovsk (27) Territory.

Figure 2 shows the distribution of Russian regions by the value of the indicator $S$, obtained on the basis of a four-component multiplicative model. In more than a third of the sub-federal units, the level...
of social well-being exceeded the national average value (9247 Russian Rubles per capita in 2017). The most prosperous territories (where indicator $S$ exceeds 12000 Russian rubles per capita) included the city of federal importance Moscow (77), Moscow Region (50), Republic of Tatarstan (16) and the main oil and gas extracting territories: Yamal-Nenets Autonomous Area (89), Khanty-Mansi Autonomous Area – Yugra (86). The Far East in this group is represented by Sakhalin Region (65) and Chukotka Autonomous Area (87).

Figure 2. Social well-being of the Russian regions according to the four-component multiplicative model in 2017 (Russian Rubles per capita, in 2008 prices).

Figure 3. Social well-being of the Russian regions according to the five-component multiplicative model ($S_e$) in 2017 (Russian Rubles per capita, in 2008 prices).
Among the Eastern border regions, the Trans-Baikal Territory (75) and Jewish Autonomous Region (79) can be emphasized. These territories were in the group of the least prosperous and also showed negative dynamics in the analyzed indicator in the period from 2012 to 2017.

The inclusion of an environmental component in a comprehensive assessment of the social well-being has had a significant impact on this assessment outcome. In most of the Russian regions, the ecologically adjusted development characteristic $S_E$ was significantly lower than the indicator obtained on the basis of the four-component multiplicative model. The number of territories where the well-being level was higher than the national average ($S_E = 7723$ Russian Rubles per capita in 2017) did not change, but the composition of this group changed somewhat (figure 3). Kamchatka Territory (41), Murmansk Region (51) and Orenburg Region (56) joined the group of the most prosperous regions (table 1). The city of federal importance St. Petersburg (78), Magadan Region (49) and Lipetsk Region (48), on the contrary, worsened their position in the rating after the inclusion of the environmental component in the multiplicative model.

**Table 1.** Comparative characteristics of the most prosperous sub-federal Russian regions (according to the five-component multiplicative model, $S_E$).

| Regions                        | Level of social well-being in 2017, Russian Rubles per capita | Place in the rating | The difference between $S$ and $S_E$ (2012 / 2017), % | Specific ecological indices $^b$ | Changes for the period from 2012 to 2017, % |
|-------------------------------|---------------------------------------------------------------|---------------------|-------------------------------------------------------|---------------------------------|------------------------------------------|
| Yamal-Nenets Autonomous Area  | 20367 / 1                                                     | 18890 / 1           | 17 / 7                                                | 1.00 0.69 0.91 1.00 0.97 1.00 0.93 | 19.3 33.0                                |
| Republic of Tatarstan (16)    | 12528 / 7                                                     | 11716 / 2           | 20 / 6                                                | 0.98 0.83 0.94 1.00 0.88 0.97 0.94 | 4.9 22.5                                |
| Sakhalin Region (65)          | 13021 / 5                                                     | 11132 / 3           | 30 / 15                                               | 0.99 0.68 0.76 0.95 0.85 0.90 0.85 | 32.1 62.0                               |
| Khanty-Mansi Autonomous Area  | 13195 / 4                                                     | 10651 / 4           | 18 / 19                                               | 1.00 0.16 0.81 1.00 0.92 0.96 0.81 | 9.1 7.0                                 |
| Republic (86)                 |                                                               |                     |                                                       |                                 |                                          |
| Moscow Region (50)            | 11497 / 8                                                     | 10162 / 5           | 14 / 12                                               | 1.00 0.70 0.76 0.98 0.94 0.92 0.88 | -4.9 -2.3                               |
| Belgorod Region (31)          | 11432 / 9                                                     | 9972 / 6            | 21 / 13                                               | 0.97 0.82 0.69 0.98 0.87 0.90 0.87 | 2.4 12.6                                |
| Moscow                        | 12893 / 6                                                     | 9417 / 7            | 35 / 27                                               | 1.00 0.63 0.42 0.71 0.68 0.95 0.73 | -0.9 11.0                               |
| Kamchatka Territory (41)      | 9477 / 28                                                     | 9365 / 8            | 9 / 1                                                 | 1.00 1.00 0.96 1.00 1.00 0.97 0.99 | 12.2 22.4                               |
| Murmansk Region (51)          | 10820 / 13                                                    | 9282 / 9            | 34 / 14                                               | 0.97 0.82 0.83 0.69 0.83 1.00 0.86 | 2.7 32.7                                |
| Orenburg Region (56)          | 9248 / 33                                                     | 9145 / 10           | 3 / 1                                                 | 1.00 0.99 1.00 0.97 1.00 0.98 0.99 | 2.4 4.4                                 |

$^a$ The region numbers (indicated in brackets after the region names) are given in accordance with the map on figures 1-2. Nenets Autonomous Area and Chukotka Autonomous Area are not included in the table 1 due to the lack of data necessary for evaluating the integrated environmental index.

$^b$ Specific ecological indices calculated on the basis of the following indicators: share of air tests, exceeding maximum permissible concentration ($P_1$); share of water tests that do not meet hygienic requirements in terms of sanitary-chemical and microbiological indicators ($P_2$, $P_3$); share of soil tests that do not meet hygienic requirements in terms of sanitary-chemical, microbiological and parasitic indicators ($P_4$-$P_6$).

In almost a third of the regions (25 out of 81), the difference between the studied characteristics $S$ and $S_E$ was from 18.6 to 51.3% in 2017, which is significantly higher than the national average – 16.5 % (figure 4). In the European part Russia, a significant difference between the indicators is observed in Novgorod Region (53) and St. Petersburg (78). These territories have low values of the integrated environmental index – 0.66 and 0.59, respectively. For them, the problem of water bodies and soils pollution is relevant. Thus, St. Petersburg (78) stands out among the Russian regions in terms of the negative water tests number. In 2017, the maximum share of water tests that do not meet hygienic
requirements in terms of microbiological indicators recorded in this region – 82.7% of their total number.

Figure 4. Difference between $S$ and $S_E$ in 2017 (%).

Our calculations results show that the role of the environmental factors in the quality of life in the Russian Far East is significant, but in general it meets the average Russian level. Among the Eastern regions, the Primorye Territory (25) stands out in particular, in which the difference between $S$ and $S_E$ was the highest in the country – 51.3%. This territory is the leader in the number of negative soil samples: 44% and 37.3% in terms of the sanitary-chemical and microbiological indicators, respectively. High level of environmental problems in water bodies is observed in Magadan Region, where none of the studied tests met the hygienic standards for the sanitary-chemical indicators.

In the period from 2012 to 2017, there was no significant improvement in the environmental situation in some Eastern regions (moreover, in Jewish Autonomous region (79) and Primorye Territory (25) the difference between the studied indicators even increased during the period under review). The only exceptions are Trans-Baikal Territory (75), Republic of Buryatia (3) and Khabarovsk Territory, where there is a trend of positive environmental changes.

4. Conclusion

The results of our study showed that there is a significant interregional differentiation in the level of well-being. The inclusion of the environmental component in the multiplicative model had a significant impact on the results of the comprehensive regional development assessment. The environmentally adjusted level of Russian regions well-being was lower than the indicator that does not take this aspect into account (by 1.1-51.3%).

In the Eastern territories of Russia, the role of the environmental factors in the quality of life is also very significant. The experience of the Soviet Union in the 60-80 years of the 20th century shows that severe climatic conditions can be compensated by a significant increase in the income of citizens in the North and East of the country and, in principle, are not insurmountable obstacles to attracting and increasing the population. But poor environmental living conditions are difficult to replace with monetary income, especially for the educated and qualified citizens. Combined with the discomfort of
a colder climate, the weak social infrastructure, and low incomes, this leads to a reduction in the permanent population and a deterioration in the quality of human capital. Environmental legislation in Russia is quite modern and advanced. However, the practice of its application under the conditions of the weak "basic" institutions, including the compliance with the principle of "no taxation without representation", independent courts, freedom of the media, etc., does not yield the expected results. The "far Eastern" institutional transformation initiated by the Federal government and aimed at attracting investment does not solve the problem of preserving human capital, so it cannot ensure the sustainable development of these territories.

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