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Regional Resource Management System Necessary to Increase Its Ecological Security

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Abstract. The article examines the ecological security aspect of regional management system. Central and regional authorities in Russian Federation and every other country become more and more aware of the necessity to prevent or reduce ecological threats in order to provide people a higher standard of living. Some guaranteed level of ecological security should be one of the primary purposes of regional management. For this reason, it is required to identify and assess major threats to ecological security of the territory. Since Russian legislature only makes the first steps in regulating this issue we reviewed the existing methodologies and chose the ones that allow to make calculations and compare the results to the threshold values. Therefore, we applied an integrated methodology combining the two approaches (indicative and comparative one suggested by Tatarkin and the other – by S. Mityakov, E. Mityakov, and N. Romanova) that allow adequate comparison. For Primorsky Krai positive and negative trends were identified and the necessary actions recommended.

1. Introduction and literature review

Ecological issues have become more and more crucial for regional development in Russia.

When an analysis of tendencies and changes in ecological security is undertaken it turns evident that resource-intensive and energy-intensive national economy may not only deplete land, water, mineral and biotic resources but be the reason for major threats for economic security especially in its ecological and anthropogenic aspects.

Globalization induces governments to actively participate in international processes related to ecological threats' prevention or reduction, introduce the best world practices, and apply risk-oriented approach for the protection of country's population against different hazards.

Therefore, ensuring a guaranteed level of ecological security (comparable with the one of developed countries) should be one of the primary purposes of regional management. For this reason, it is highly necessary to analyze current anthropogenic threats in a comprehensive manner and develop well-reasoned measures intended to prevent and reduce negative consequences.

Ecological security is considered by many researches like S.Ya. Kazantsev, E.L. Lyubarsky, O.R. Sarkisov [1], E.E. Tonkov, V.Yu. Turanin [2]. At the same time only a scarce number of research papers is related to the evaluation of regional ecological security [3;4;5;6;7;8].

For the Russian Federation, no critical values have been developed for determining the level of ecological security for each district and subject because each of them has a different potential, demographic, transport load, production volume, etc. The identification of optimal values for the ecological indicators is only planned for the 4th quarter of 2020 [9] Therefore we will apply some

indicators from the Strategy of Ecological Security of Russian Federation but with adjustment as presented in two methodologies described further.

The methodology by L. Archipova and M. Grigoryan is based on the indicative method [10]. The assessment suggests that territories are classified according specific indicators:

- air emission from stationary sources;

- air emission from mobile sources;

- pollutants capture;
- waste water discharge;
- forest replanting;
- general expenses затраты на окружающую среду;
- investments.

Regions are divided into 4 groups. The first includes those with relatively normal ecological security status; the second and the third groups identify middle level when some hazards are identified; for the fourth group of regions ecologic hazards are extremely high, so this group is in critical or crisis situation.

The problem of this methodology is the fact that so-called "crisis group" is identified on the basis of data for a certain time period and is, therefore, dependent on the year, territory and the results may not be completely comparable.

Another methodology was developed by Glinsky V.V., L.K. Serga, M.S. Khvan [11]. It is also based on complex evaluation of 3 groups of indicators: socio-economic development level, ecological situation and human potential. The authors applied a typological groupment (the data was broken into three groups with equal intervals) and cluster analysis ("the closest neighbor" method) on the basis of portfolio matrix.

According to the typology territories are attributed to one of the 3 classes of ecological security: low, middle, or high. The determinants of ecological security are described by quantitative characteristics. Theoretic qualitative analysis is used in order to select indicators for each area. Then the indicators and a composite index are calculated by adjusted multidimensional average methodology.

We do not choose to apply the above methodology in this article since Primorsky Krai is made of too dissimilar territories (especially when compared by "The level of ecological situation" component) and it is not possible to neutralize the differences and get comparable values.

Therefore, we will apply the methodology developed by a group of researchers of Institute of Economy of Ural branch of Academy of Sciences of Russia led by A, Tatarkin.[12]

- The level of threats is calculated on the basis of two indicators:
- the density of air emissions from stationary sources;
- specific dirty water discharges.

The situations are graded for risk identification. Indicators' current values are compared to the threshold values and crisis zone is determined. The most complex part is to calculate crisis zones.

In the methodology by S. Mityakov, E. Mityakov, and N. Romanova the ecological security situation is determined according to the level of ecological risk assessment [13]. Among the economic security indicators there is ecological block including 3 indicators reflecting the following issues: air emissions from stationary sources; dirty water discharge; forest replantation. Those indicators are quite suitable for the analysis. Since all indicators have different dimensions, it is necessary to normalize them for joint analysis.

The common idea of almost every modern methodology is their specificity: solution of only a particular problem, the use of expert assessments, the complexity of obtaining the necessary information, an assessment of one component of ecological security, impossibility of end-to-end assessment of socio-economic systems of various aggregation levels. For this reason, the results of such studies, as a rule, are not comparable, difficult to verify; and it almost impossible to repeat them at another object [11].

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2. Research methodology

We reviewed several methods that allow to assess the level of regional ecological security (starting from the legislative one and proceeding to those developed by different Russian researchers) and used two of them to calculate the main indicators for the Primorsky Krai. Both methodologies suggest comparison of real data with threshold values. Therefore, we applied an integrated methodology combining the two approaches (indicative and comparative) that allow adequate comparison. At first, we assembled data on 16 indicators for Primorsky Krai, calculated their values for the period of 5 years. After that we compared the calculated indicators to their threshold values (according to Tatarkin's methodology) to identify the crisis zone and determine positive and negative tendencies. For the selected indicators we provide a short analysis of the causes. The research was complemented by the evaluation approach by S. Mityakova, E. Mityakova, N. Romanova in its "Ecologic development" perspective.

3. Analysis and results

Ecological security Strategy of Russian Federation for the period until the 2025 suggests 18 indicators . All of them are fractional and, therefore, applicable for the analysis of regional ecological security. We calculated 16 indicators for Primorsky Krai for the period of 2014-2019 (Table 1).

Indicators	2014	2015	2016	2017	2018	2019			
proportion of population living									
at the territories where	2,07	2,07	2,07	2,07	2,07	2,06			
environment does not meet	et _,,,,,,								
quality of life standards, %									
proportion of population living									
at the territories where quality of	16,7	15,6	15,5	15,1	14,6	12,9			
water not meet sanitary									
standards, %									
ratio of greenhouse gases	105.0	107 72	102.00	102.00	100.01	00 5 4			
emission for current year to	105,8	107,72	105,98	105,98	100,91	99,54			
1990, $\%$									
accumulated wastes of the 1	0.000					0.000			
of Gross Domestic Product	30	0,00019	0,00172	0,00013	0,00007	0,000			
thousands/rub	39					07			
accumulated wastes of the 2^{nd}									
hazard category volume per unit						0,000			
of Gross Domestic Product	0,003	0,00336	0,00345	0,00016	0,00015	18			
thousands/rub.						10			
accumulated wastes of the 3 rd									
hazard category volume per unit	0.00.6	0.40.400			0.00000	0.044			
of Gross Domestic Product,	0,086	0,10492	0,05993	0,04832	0,00989	0,046			
thousands/rub.									
accumulated wastes of the 4th									
hazard category volume per unit	1,355	1 4217	0 4242	0 4121	0.2401	0.206			
of Gross Domestic Product,	5	1,4317	0,4542	0,4121	0,3481	0,580			
thousands/rub.									
accumulated wastes of the 5th									
hazard category volume per unit	61,94	54,60	44,95	43,60	42,05	33,85			
of Gross Domestic Product,									

Table 1. Ecological security indicators of Primorsky Krai.

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thousands/rub. the proportion of recovered and disposed wastes of the 1st hazard category in total volume of 92,38 88,67 5.83 89.98 313,33 222,4 the 1st hazard wastes of category, % the proportion of recovered and disposed wastes of the 2nd hazard category in total volume 98,38 95,95 98,18 91,67 235,94 149,0 of wastes of the 2nd hazard category, % the proportion of recovered and disposed wastes of the 3rd hazard category in total volume of wastes of the 3rd hazard 98,70 97,80 category, % 95,83 98,98 901,04 206,7 the proportion of recovered and disposed wastes of the 4th hazard category in total volume of 57,30 12,13 60,86 54,30 12,00 19,54 4^{th} wastes of the hazard category, % the proportion of recovered and disposed wastes of the 5th hazard category in total volume of 0,35 0,39 0.39 0,28 0,19 1,28 5^{th} wastes of the hazard category, % 0,05 0,05 0,06 disturbed lands proportion, % 0,10 0,10 0,10 proportion of specially protected 5,11 5.11 5.14 5,15 12,46 12,82 natural areas, % proportion of forest lands, % 72,59 73,70 73.79 73,80 73,79 73,80

Source: calculated on the basis of https://primstat.gks.ru/ [14]

Indicators presented in the above table show both positive and negative trends.

The following positive tendencies may be identified:

- ratio of greenhouse gases emission for current year is decreasing during the analyzed period. Such improvement is produced by the reduction of air emission from stationary sources. In 2019 this indicator came up 0,20 ton per unit of Gross Domestic Product (in accordance with regional program "Environment protection in Primorsky Krai" this indicator was supposed to go down to 0,21 ton) [5;

- share of population living at the territories where quality of water not meet sanitary standards went down as well;

- high indicators "the proportion of recovered and disposed wastes of (I–III) hazard categories in total volume of wastes of (I–III) hazard categories" means that wastes from previous periods were disposed of.

- disturbed lands proportion declined so we may assume that area reconstruction works were conducted;

- the growth in proportion of specially protected natural areas indicates that authorities take some serious efforts. However, we can hardly expect a target of 17% set by the regional program to be reached in 2020.[15]

In general, positive changes may be explained by several actions of regional government: steamelectric plants are switched to gas, new specially protected natural areas are created, modern waste recycling facilities are constructed etc.

Among the negative results are:

- the indicator "proportion of population living at the territories where environment does not meet quality of life standards" remains at the same level;

- low level of utilization for the waste s of 4^{th} and 5^{th} hazard categories which leads to the appearance of unauthorized dumping grounds that, in turn, contaminate soil, water and air.

Negative trends and lack of changes in them demand for structural changes in regional governance.

So far there are no critical levels necessary to identify the level of ecological security for every subject of Russian Federation since it is difficult due to their potential, demographic and transport burden, production volume and other issues. [16] Optimal values for ecological security indicators should be identified only in the 4th quarter of 2020 according the measures on Ecological Strategy of Russian Federation application for the period until 2025.[17]

To get a more thorough presentation of ecological security in Primorsky Krai we used (partially) the evaluation approach by S. Mityakova, E. Mityakova, N. Romanova ("Ecologic development" perspective). This methodology allows to exclude the issue of dimensions and compare the resulting indices with set values. Ecological security indicators for Primorsky Krai are presented at table 2.

Indicator	2015	2016	2017	2018	2019	Threshold value
Waste water discharge, thousands. sq. m./ sq. km.	1,77	1,68	1,63	1,61	1,57	\le 0,3
Air emission from stationary sources, t/sq. km.	1,17	1,13	1,13	1,1	1,08	\leq 0,5
Forest replantation (proportion of replanted forests, %)	0,29	0,26	0,14	0,62	0,23	≥0,15

Table 2. "Ecologic development" perspective indicators for Primorsky Krai.

The table clearly proves that two ecologic indicators (Waste water discharge and Air emission from stationary sources) are well above the threshold values. Such tendency may be observed during the whole period of research which means that the authorities do not take all the necessary measures in order to prevent ecological hazards.

It is useful to apply norming functions since we can better visualize results and understand risk extent which shows how far are the calculated values from the threshold ones.

The indicators have different dimensions therefore they should also be normed. In result they should be "no more" or "no less" of their threshold values. The norming functions are chosen so that after the procedure all indicators become "effective" (for "costly" indicators, an inversion is made). After norming an indicator should be higher than 1 (threshold). If an indicator is lower than 1, a threat to economic (ecological) security is present [18].

For the first two indicators we used a norming ratio function of the "not more":

$$y = 2^{-\log_{10}/3a}, \text{ if } \frac{x}{a} \ge 1$$
 (1)

where x — is a calculated value of an indicator, while индикатора, a – is a threshold value. The results are presented at Fig. 1 and 2.



Figure 1. Waste water discharge.

The indicator "Waste water discharge" has a weak positive tendency for the period of 5 years. It hits the zone of "critical risk" – the sector between 0,25 and 0,5. This means that an indicator's initial value is 3 to 10 times different from its threshold value. Such a situation is quite dangerous and calls for strategic decisions [19].

The indicator "Air emission from stationary sources" shows a better situation (Fig. 2).



Figure 2. Air emission from stationary sources.

This indicator falls into the zone of "significant risk" - in the sector between 0,5 and 0,75: an indicator's initial value is 1,6 to 3 times different from its threshold value. It is considered that it is not possible to improve such situation quickly [19]. % years is not a sufficient period to approach the zone border.

For the third indicator "Forest replantation" we used the norming ratio functions of a type "not less" [18]:

$$y = 2^{(1-\frac{a}{x})/\ln\frac{10}{3}}, \text{ if } \frac{x}{a} > 1$$
 (2)

$$y = 2^{-\log_{10}/3^{\frac{1}{x}}}$$
, if $\frac{x}{a} \le 1$ (3)

Normed indicator «Forest replantation» is presented at Fig. 3.



Figure 3. Forest replantation.

Fig. 3 shows that almost all the indicators (except for the year 2017) fall into zone of "stability" – outside of the sector limited by the line y=1. In this area any value is considered positive. The line y=1 corresponds to the exact coincidence of the indicator value with the threshold value, the line y=1,25 – exceeding it by 1.6 times, the line y=1,5 - by 3,3 times.[19]

4. Conclusions and discussion

Ecological security analysis for Primorsky Krai has shown the following results:

One of the worst problems among the identified is the disposal of the wastes of the 4th and 5th hazard categories. The best solution would be a complex sorting of household wastes followed by their usage for production but the region makes only its first steps in this direction: in 2020 single regional ecological operator started its activity; there are special programs expected to teach people to dispose wastes in a more civilized manner, but fast results cannot be expected.

The reduction of waste volumes will decrease a number of unauthorized waste dumps which, in turn, will help to reduce the square of disturbed lands, and volumes of air and water pollution.

The negative trend of the indicator "Waste water discharge" over the analyzed period appeals to strategic decisions in this sphere.

Regional air basin is in unfavorable ecological stance which is the result of unsufficient reduction of air emissions from stationary and mobile sources. The main reasons include: the rise of motorvehicle pool despite the lack of infrastructure, the use of obsolete technology of coal loading at marine terminals, low quality of fuel etc.

The analysis of regional ecological security level has also identified the lack of "specified" (regional) statistic data on Primorsky Krai indicators presented in the Ecological Security Strategy of the Russian Federation for the period up to 2025 [20]. If it was possible to get such data, we could have compared Primorsky Krai to some leading regions of Russia and apply their best practices in the area of ecological security.

Generally speaking, despite some positive trends, ecological situation in Primorsry Krai is still disturbing: the majority of indicators do not reach threshold values. The most concerning issue is air, soil, and water pollution. Consequently, it is not possible to provide high living standards and ecological security level without a decrease of environmental load.

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