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Zoning of Territory on the Basis of Modeling of Efficiency of Forest Resources Use in Russian Regions' Economy

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Abstract:

The purpose of this work is development of the model of evaluation of efficiency of the use of resources in economy of regions of sparsely forested area, which allows offering a typology of zones in the region and performing zoning of territory depending on the efficiency of activities of structures which use forest resources. The offered model is peculiar for calculation of deviations of current income of state and entrepreneur from optimal income from the point of view of the most profitable use of lands. On the basis of the offered model, the typology for regions of sparsely forested area is developed, which includes four types of territories: high-profitable territories – characterized by minimal deviations of profitability of entrepreneur and state, due to which they are considered to be territories with well-balanced use of forest resources in economy; profitable territories with emphasis on state's interest, where the deviation of profitability of entrepreneur is maximal, and profitability of state is minimal; profitable territories with emphasis on interest of entrepreneurs, where deviation of entrepreneur's profitability is minimal, and of state's profitability is maximal; low-income territories, unattractive for forest use, where deviation of profitability of entrepreneur and state is maximal. This typology conforms to the task of formation of differentiated instrumentarium of well-balanced use of forest resources in territories' economy.

Key Words: *zoning, model of zoning, typology of regions.*

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Introduction

Complex development of the Russian economy depends on sustainability and complexity of development of its regions' economy. However, diversity of resources which ensure functioning of territories and their distribution determine differentiation and, correspondingly, necessity for classification of the Russian territories as to various aspects, which is caused by necessity for development of corresponding mechanisms and tools of managing the development of economy of sparsely forested area of Russia [Zinovyeva I.S., 2014].

A special place in the system of provision of complex use of forest resources in the Russian economy belongs to limited resources. These resources include forest ones. It is known that forests are distributed unevenly on the territory of Russia – mostly, under the influence of climatic and anthropogenic factors. Activities for use of forest resources on the territories of sparsely forested zone are not equal as to efficiency or profitability, while the state has to know which combination of forest resources on specific territory of sparsely forested zone provides maximal income for the state (forest income).

Entrepreneur is interested in the maximal profit (entrepreneurial income), and this is achieved in the process of complex use of forest resources on the territories of sparsely forested zone; he also has to know optimal combination of areas as to their profitability. However, entrepreneur's income is influenced by state's income in the direction of reduction, so it is necessary to find optimum for both [Morkovina S.S., Zinovyeva I.S., 2014].

Over the recent decade, the task of multipurpose choice became one of the key problems of modern systemic analysis. Growing flow of publications on this topic shows the width and diversity of offered practical tasks of multi-criteria optimization and the fact that there are still many unsolved issues in this sphere [Kolesnichenko E.A., Nesterova N.N., 2013].

Methodology

In the sphere of application of methods of multi-criteria optimization, an important place belongs to the tasks of management of economic systems, solving of which requires coordination of various goals. It is no chance that within economic & mathematical theory, a range of key concepts and principles of solving multi-criteria tasks has formed. In our case, we have two goals – increase of income of entrepreneur and increase of state's income.

The authors form a model which allows performing zoning of territory of forest areas as to values of deviations of current income of the state and entrepreneur from optimal income from the point of view of the most profitable use of lands. The task of determination of the structure of forestry lands' use that is optimal from the point

of view of profitability is studied – distribution of lands as to types of forest use. The criteria of optimization in this case are maximization of income of entrepreneur and state. Thus, the model of multi-criteria optimization is used for determination of deviations of profitability.

The basis of the model is data as to profitability of the use of forest resources, for which it is advisable to use the data of executive power bodies of the subjects of the RF in the sphere of forest relations.

The first stage supposes determination of areas of forest fund which are used by tenants for various types of forest use; determination of areas and volume of forest use as to buy-sell contracts of forest plants within state contracts and as to buy-sell contracts made as a result of auctions.

The second stage includes calculation of state's income from 1 hectare of forest fund areas under the condition of provision of forest plots for conduct of recreational activities and game husbandry, as ratio of rental contracts and area of rented plots.

The third stage supposes determination of volumes of rental payments and payments of buy-sell contracts during procurement of timber.

Characteristics which determine the profitability of forest plot can be expressed by two large groups:

- forestry (forest area, type of allowed forest use, area of forest lands, species composition, plantings age, timber stock, productivity, felling system, etc.)
- economic (minimal rates of payment for forest resources item and forest areas item, exceeding of minimal rate, area of forest plots which is rented out, etc.) [Pintsukova S.D., 2011].

Thus, the results of performed calculations should be the basis of forming a databank on income from forest plot item as to timber procurement and other types of forest use (state's position) [Bykovskiy B.K., 2008].

The source of information for formation of databank is the data of the State Forest Register (formed by automatized informational system "AIS GLR"). In order to answer the question of profitability of forest plots it is necessary to develop a methodological approach to determination of income that account for an item of forest plot area.

It is known that enterprise's income is calculated by profit reflected in the last chart of accounting forms. However, diversity of organizational and legal forms of conduct of business activities in the system of forest husbandry – unitary enterprises, individual entrepreneurs, limited liability companies, etc. – does not allow evaluating the financial result of activities in forest husbandry and approximate it for future period.

Due to that, for the purpose of evaluation of profitability of a forest plot, we used the indicator of commercial output in cost measurement or cost of services.

Based on expected areas for various types of forest use and income, which account for an item of forest plot (1 hectare), a two-criterion optimization task is built. The first criterion is maximization of entrepreneur's income, and the second criterion is maximization of state's income.

The following keys are used:

S_1, S_2, S_3, S_4 – area of forestry, allocated for timber procurement, recreation, agriculture, and game husbandry;

d_1, d_2, d_3, d_4 – income of entrepreneur which accounts for an item of area of forest plot, allocated for timber procurement, recreation, agriculture, and game husbandry;

n_1, n_2, n_3, n_4 – state's income which accounts for an item of area of forest plot, allocated for timber procurement, recreation, agriculture, and game husbandry.

The above areas have their marginal (predicted) values – maximal possible areas. They are indicated as $S_1^{пред}$, $S_2^{пред}$, $S_3^{пред}$, $S_4^{пред}$. They can be varied by redistribution of areas between types of forest use within expected volume. Then, it is possible to write down limitations for the sought areas:

$$S_1 + S_2 + S_3 + S_4 \le S \quad (1)$$

$$0 \le S_1 \le S_1^{пред} \quad (2)$$

$$0 \le S_2 \le S_2^{пред} \quad (3)$$

$$0 \le S_3 \le S_3^{пред} \quad (4)$$

$$0 \le S_4 \le S_4^{пред} \quad (5)$$

Values S_1, S_2, S_3, S_4 should be chosen so that income of entrepreneur and state are maximal.

Total income of entrepreneur depends on the income which accounts for an item of area of forest plot and size of rented plots for each type of forest use:

$$П_{пр}(S_1, S_2, S_3, S_4) = d_1 S_1 + d_2 S_2 + d_3 S_3 + d_4 S_4 \quad (6)$$

Let's write down the same function for state.

$$П_{\text{гос}}(S_1, S_2, S_3, S_4) = n_1 S_1 + n_2 S_2 + n_3 S_3 + n_4 S_4 \quad (7)$$

As the goal is maximization of income of entrepreneur and state, we have the following task:

$$d_1 S_1 + d_2 S_2 + d_3 S_3 + d_4 S_4 \to \max \quad (8)$$

$$n_1 S_1 + n_2 S_2 + n_3 S_3 + n_4 S_4 \to \max \quad (9)$$

$$S_1 + S_2 + S_3 + S_4 \le S \quad (10)$$

$$0 \le S_1 \le S_1^{пред} \quad (11)$$

$$0 \le S_2 \le S_2^{пред} \quad (12)$$

$$0 \le S_3 \le S_3^{пред} \quad (13)$$

$$0 \le S_4 \le S_4^{пред} \quad (14)$$

This task is a two-criterion task of linear programming and belongs to the class of tasks of multi-criteria optimization.

Denoting *i-th* partial criterion through $Z_i(X)$, where X – allowable solution, Q – sphere of allowable solution, received the general form of targeted function:

$$Z(X) = (Z_1(X), Z_2(X), ..., Z_m(X)) \to \max \quad (15)$$

$$X \in Q. \quad (16)$$

If partial criterion $Z_i(X)$ is minimized, it is possible to go to maximum, taking it with opposite sign.

The following methods are used for solving the tasks of criteria optimization [Terelyanskiy P.V., 2000]:

- optimization of one criterion, which is considered to be the most important – at that, the rest perform the role of additional limitations;
- adjustment of the set multitude of criteria and successive optimization for each of them (for example, through successive yields);

– bringing many criteria to one through implementation of expert weight coefficients for each criterion so that more important criterion receives larger weight.

Ideally, it is possible to search for the solution that belongs to intersection of many optimal solutions for all single-criterion tasks. However, this intersection is usually empty multitude, so a co-called multitude of effective solutions is usually viewed (optimal as to Pareto) [Sozonov S.V., 2010].

One of the popular methods of solving multi-criteria tasks is the methods of bringing a multi-criteria task to single-criterion through contraction of vector criterion to super-criterion. This is the most used method of "scalarization" (fold) of task (15) - (16), which allows replacing vector criterion of optimality $Z(X) = (Z_1(X), Z_2(X), ..., Z_m(X))$ to scalar one $J : Q \to R$. It is based on linear combination of all partial targeted functionals $Z_1(X), Z_2(X), ..., Z_m(X)$ into one:

$$J(X) = \sum_{i=1}^{m} \alpha_i Z_i(X) \to \max \quad (17)$$

$$\alpha_i > 0 \quad (18)$$

$$\sum_{i=1}^{m} \alpha_i = 1 \quad (19)$$

Weight coefficients α_i can be viewed as indicators of relative importance of particular criterial functionals $Z_i(X)$. The larger value is given to criterion $Z_i(X)$, the larger contribution into the sum (17) he must give and, correspondingly, the larger value of α_i should be chosen. With significantly different partial criteria, it is usually difficult to state the final set of coefficients α_i on the basis of informal ideas, related, as a rule, to results of expert analysis. There are various ways for selection of coefficients α_i. One of them is assignment of α_i depending in relative importance of criteria. Such selection of the stated coefficients could be performed according to Table 1.

Table 1. Scale of relative importance

Intensity of relative importance	Definition
1	Equal importance of compared requirements
3	Moderate (weak) superiority of one over another

5	Strong (significant) superiority
7	Obvious superiority
9	Absolute (overwhelming) superiority
2,4,6,8	Intermediate solutions between two adjacent evaluations

As in our case the importance of criteria is equal, we used the method of bringing two-criterion task to one-criterion task, and the values of weight coefficients are considered equal

$$\alpha_1 = \alpha_2 = 1/2. \quad (20)$$

Thus, we have the following task of linear programming:

$$\frac{1}{2}(d_1S_1+d_2S_2+d_3S_3+d_4S_4) + \frac{1}{2}(n_1S_1+n_2S_2+n_3S_3+n_4S_4) \to \max \quad (21)$$

$$S_1 + S_2 + S_3 + S_4 \le S \quad (22)$$

$$0 \le S_1 \le S_1^{пред} \quad (23)$$

$$0 \le S_2 \le S_2^{пред} \quad (24)$$

$$0 \le S_3 \le S_3^{пред} \quad (25)$$

$$0 \le S_4 \le S_4^{пред} \quad (26)$$

Results

Having found solution to the task (21) – (26), we received values of rental areas S_1^*, S_2^*, S_3^*, S_4^*. These values allow determining the share of each type of forest use in the total volume of rental:

$$D_1 = \frac{S_1^*}{S},\ D_2 = \frac{S_2^*}{S},\ D_3 = \frac{S_3^*}{S},\ D_4 = \frac{S_4^*}{S} \quad (27)$$

Having solved all tasks for all forest husbandries of the viewed region, we received optimal distribution of areas as to types of forest use.

Knowing optimal S_1^*, S_2^*, S_3^*, S_4^* and current $S_1^{тек}$, $S_2^{тек}$, $S_3^{тек}$, $S_4^{тек}$ values of

rented areas as to types of forest use, we calculated the deviations of the levels of income of entrepreneur and state from optimal income, comparing optimal value of combinations as to criteria of forest income for state and entrepreneurial income with actual state of profitability of forest plots.

$$\Delta_{пред} = П_{пр}(S_1^{тек}, S_2^{тек}, S_3^{тек}, S_4^{тек}) - П_{пр}(S_1^*, S_2^*, S_3^*, S_4^*) =$$
$$= d_1(S_1^{тек} - S_1^*) + d_2(S_2^{тек} - S_2^*) + d_3(S_3^{тек} - S_3^*) + d_4(S_4^{тек} - S_4^*) \quad (28)$$

$$\Delta_{гос} = П_{гос}(S_1^{тек}, S_2^{тек}, S_3^{тек}, S_4^{тек}) - П_{гос}(S_1^*, S_2^*, S_3^*, S_4^*) =$$
$$= n_1(S_1^{тек} - S_1^*) + n_2(S_2^{тек} - S_2^*) + n_3(S_3^{тек} - S_3^*) + n_4(S_4^{тек} - S_4^*) \quad (29)$$

The received deviations are a basic tool for managerial decisions. As values of optimal and current areas can differ to greater or smaller extent, we received different values of deviations. They might be positive or negative.

A very important aspect in provision of well-balanced development of economy of regions of sparsely forested zone is selection of instrumentarium of provision of development of economy. The basis for selection of this instrumentarium is the developed model of efficiency of the use of resources in economy of regions of sparsely forested zone. However, in order to perform zoning of territory, it is necessary to determine deviations from optimal model. Let us determine the limits of deviations which allow assigning them to one of the two following categories:

- maximal deviation,
- minimal deviation.

Let us depict the received values, putting deviations of entrepreneur's income on axis x, and state's income – on axis y (Figure 1).

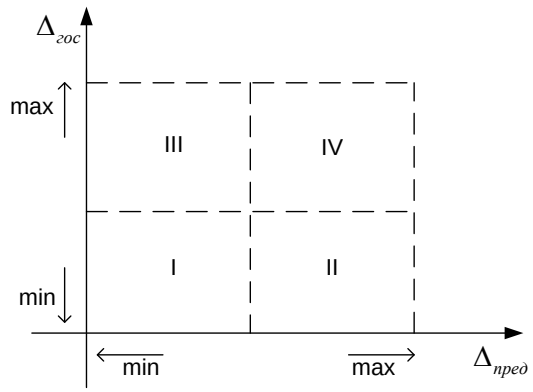

Figure 1. Types of profitability deviation

As deviations of actual income from optimal values often show insufficient level of income (and not their excess) as compared to their optimal level, we receive four spheres (types):

Type I – high-income territories. They are characterized by minimal deviations of income of entrepreneur and state, so they are considered to be territories with well-balanced use of forest resources in economy.

Type II – profitable territories with emphasis on state's interest, where deviation of entrepreneur's income is maximal and deviation of state's income is minimal.

Type III – profitable territories with emphasis on interest of entrepreneur, where deviation of entrepreneur's income is minimal and deviation of state's income is maximal.

Type IV – low-income territories which are unattractive for forest use, with maximal deviation of income of entrepreneur and state.

On the basis of modeling results, it is possible to form economic & forestry map of zoning of territories by the principles of complex forest use and differentiation of state's and entrepreneurship's income in view of top-priority types of forest use.

Discussion

Each of the received types requires a set of managerial decisions:

Type I – territories characterized by well-balanced use of resources, which is manifested in obtaining high income by business structures which use the key resource of the territory – forest one, and by public authorities. Results of a lot of research show that situation when the use of forest resources on certain territory of sparsely forested zone gives maximal financial effect for regional authorities and business structures is rare – however, it requires development and implementation of corresponding instrumentarium on this territory [Popkova E.G., 2013]. In our opinion, in this case (for these regions in the region) it is advisable to apply the policy of non-interference from the state under the condition of permanent control.

Type II – zones, the use of forest resources on the territory of which is characterized by high income for state, but insufficient profitability for business structures. In this case, agreeing with opinion of a range of scientists, we deem it advisable to use mechanisms of public private partnership [Morkovina S.S., 2014]. Traditionally, mechanism of public private partnership was used during realization of investment projects, creation of forest infrastructure and during construction of forest roads, later – during forest engineering. Growing role of public private partnership sets new requirements to methodologies and approaches of management and requires implementation of new standards of evaluation of results of such cooperation

[Korchagin O. M., 2014].

Type III – zones, the use of forest resources on the territory of which is characterized by high profitability for business structures, but low profitability for state. In these zones, there is a necessity for regional regulation of forest relations in the sphere of correction of rental fee and stimulation of multipurpose use of forest plots [Petrov A.P., 2012].

A range of forest plots have the most profitability for entrepreneur, пwith profitability for state being minimal. However, there are plots, on which there is feedback. Therefore, we understand that in the regional level, there should be developed optimization model of differentiation of forest plots.

Type IV – zones peculiar for ineffective use of forest resources. In this case, we consider it necessary to transform the system of state regulation of forest resources use. As many researchers note, the existing system of state regulation and financing of forestry does not conform to requirements of sustainable management of forests. It is archaic, primitive, and does not fulfill its duties, preserving all drawbacks of "centralized budget operational system", which functioned with centralized and planned economy [Morkovina S.S., 2014]. Thus, the system of management unites forest, as an object of management, and forestry, as means of management, and decisions of corresponding subjects of management, and it has to conform to well-planned and weighted long-term state forest policy, on the basis of which forest law should be based, which regulates all forest relations. The role of state for formational and implementation of such system of forest management is primary. The existing system, when, on the one hand, regional authorities do not have responsibility for forest resources which they control, and, on the other hand, tenant, who received a right for temporary use of forest, is not interested in additional investments into development of territory, led to destructive processes. L. Chernyakevich thinks that formation of institutional conditions for effective forest use under the conditions of state property rights for forests is the most important task of regulation in forestry management [Chernyakevich L.M., 2010].

Conclusions

The conducted research showed that an actual problem at the modern stage is the necessity for provision of well-balanced use of limited resources in the Russian economy, which will allow, though indirectly, achieving a complex use of forest resources in the economy of territory. Under the existing conditions, the objective regularities and tendencies, which characterize regional economic policy, require attention and study with further correction of many provisions of the Russian law, models, and instrumentarium of the use of forest resources in the Russian economy. Global reduction of forest areas on the planet in the XX century led to the Russian forests' occupying a special role among other economic resources of the world; this problem is especially actual for Russian regions of sparsely forested zone. On these

territories, forest resources are not just an ecological carcass of biosphere – they are resources for development of business, industry, and recreational sphere. That's why their preservation and increase belong to the most important aspects in the system of provision of complex development of territories (in global scale, preservation and rational use of forest resources belong to the problem, the search for solution to which is very important for the whole population of Earth).

Nowadays, it is obvious that well-balanced use of forest resources in the economy of sparsely forested zone and prevention of ecological disaster require something more that legal measures, requirements, and norms – they require development of theoretical and methodological foundations for solution of this problem, i.e., rational use of forest resources, which is an actual problem and an important economic problem.

Thus, the received model allows substantiating complex forest use on rented forest plots and rent-free plots as a main tool of provision of well-balanced development of key resource component of sparsely forested region. Moreover, it is possible to use it in order to determine perspectives and vectors of cooperation of state and forest business in the sphere of forest relations with strict observation of principles of forest law.

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