METHODS OF ECONOMIC-MATHEMATIC PROGRAMMING IN MANAGERIAL DECISION MAKING

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Abstract
The article reveals difficulties to make managerial decisions as to optimization of recreational objects' location considering economic and technological parameters of an impact with application of fuzzy modeling. The authors propose methods of evaluation of alternative variants of managerial decision making applying programs of Math Cad with the further prospect of choosing alternatives.
Key words: managerial decision, fuzzy modeling, optimization, land resources, rational use.

Introduction

While planning organization of land utilization, insufficient attention is paid to the application of economic and ecologic-mathematic modeling, especially considering the fact that intensive development of information technologies provides researchers with a powerful calculative and mathematic instruments, helping to set and solve particularly complicated and large tasks of nonlinear nature.

Methodology of the research and materials

The issue of application of the methods of economic-mathematic modeling in utilization of land resources provoked interest to its study in the late 50s of the 20th century. The interest got a scientific character in the middle 60s and has been growing ever since. These issues make an inseparable component of land use optimization and many domestic scientists devoted their works to the problem, among them are D.I. Babmindra, S.Yu. Bulyhin, D.S. Dobriak, O.P. Kanash, M.V. Kalinchyk, V.O. Leonets, A.H. Martyn, L.Ya. Novakovskyi, N.V. Palapa, B.I. Parkhuts, I.A. Rozumnyi, A.Ya. Sokhnych, M.S. Siavavko, A.M. Tretiak and others.

However, some scientific regulations require methodological and methodic argumentation of the system of land resource management under conditions of economic transformations.

The research was carried out on the grounds of the dialectical method of cognition of ecological and social-economic phenomena, system approach to the analysis of establishment process of directions of special-purpose land utilization.

The choice of the research methods was made with a consideration of a complex general theoretical comprehension of objective natural-economic processes of establishment and development of land management.

The search of efficient managerial decisions in a great variety is possible to be done if technologies of ecologic and economic modeling as well as corresponding mathematic instruments are applied. Thus, there appears a possibility to create an analytical definition of the most effective use of land for certain territory with the consideration of economic, ecological and other conditions and restrictions.

It is the very approach to optimization of land utilization with application of methods of economic-mathematic programming that determine timeliness of the given article.

Discussion and results

In land resource management, optimization is of great importance. Moreover, optimization of land utilization, being based on integrated social-economic and nature-protective factors and criteria (Sokhnych, Smolyarchuk, Sokhnych, 2005), is an urgent and the most important task of the system of land resource management under conditions of a stressed economic and ecological situation in Ukraine.

Considering land resources as an object of optimization, one should specify the most important natural and acquired peculiarities of them, viewing from ecological, economic and social aspects. Only a complex analysis and estimation of them allows making concrete conclusions as to the list of problems in land utilization in the investigated territory. It is reasonably to apply methods of mathematic modeling to solve the issues.

Application of mathematic programming in the agrarian sector of the economy enables determining of reserves in direction of saving. One observes a possibility to secure optimal use of resources in agriculture increasing the volume of output (Akulich et.al., 2003).

Such an approach helps to bring the problem of search of the most rational variant (in ecological and economic terms) of land management to a complex determination of the land area, ecologically and economically available for certain directions of utilization considering permanence of total area of land resource in space as well as to establishment of some optimized structure of land economies in the territory (Snitynskyi, Siavavko, Sokhnych, 2002).

Most tasks of land management feature multi-variant character. Thus, the main task is to choose an optimal variant among the numerous allowable ones corresponding to a defined criterion.

Under conditions of a definition for the tasks of decision making, it is particular that each separate choice gives only one value of an objective function. It means that there are no difficulties to describe advantages according to an outcome. Thus, each decision-making person works with numerous exactly defined goals and determines required advantages on the basis of them.

We propose to apply such an approach for optimization of a recreational object location in the territory of Zhovkva district in Lviv region.

We propose economic indicators of optimization of a recreational object location in the territory of Zhovkva district in Lviv region:

- *Distance to the district center (DC)* – this factor is rather important, because comfortable connection and a location is required to increase a number of resting people.
- *Forests (F)* – forest favors a healthy rest of resting people and it is reasonable to have it in the territory of the recreational object or near it.
- *Shape of land plot (ShL)* – this indicator influences a compact location of constructions and buildings securing normal functioning of the recreational object.
- *Road connection (RC)* – presence of well-developed road net enables fulfilment of passenger transportation, as well as the supply of the object of recreation with necessary goods, food etc.
- *Water sources (WS)* – it is almost the most important factor for a choice of the location for the recreational center, because it provides a better rest of population.
- *Relief of place (RP)* – is not of less importance in choosing of land plot for the location of the recreational center, because it helps to choose different tourism routes: treks, skiing, bicycle, riding.

The indicators influence location of the recreational center and come out of the project requirements.

We propose grading of factors in Table 1, influencing the location of recreational center on the basis of an expert estimation, according to which paired comparison of the factors is made (Table 1).

Table 1.

Grading of factors, influencing the location of a recreational center

Factor	Grade
District center (DC)	29
Forest (F)	24
Water sources (WS)	19
Road connection (RC)	20
Shape of land plot (ShL)	15
Relief of place (RP)	7

Plots, determined for the choice, are similar in their area, but differ by the indicators.

To solve the task, we analyzed the known approaches (Martyn A.H., 2002) and applied the method of fuzzy programming (by program of Math Cad), providing mechanism for making of grounded decisions.

We consider: if *n* objects $A_1,..., A_n$; we take up

$$\omega = (\omega_1,...,\omega_n) \quad (1)$$

the vector of relative importance of them, and also

$$\sum_{l}^{n} \omega_n = 1 \quad (2)$$

The comparison of objects (in a form of the matrix) allows to find the value of correlation between them:

$$\begin{array}{cccccc} & & A_1 & & A_2 & . \quad . \quad . A_n \\ A_1 & & \omega_1/\omega_1 & \omega_1/\omega_2 ... & \omega_1/\omega_n & \\ & ... & & \ldots \quad ... & \ldots & \\ A_n & & \omega_n/\omega_1 & \omega_n/\omega_2 ... & \omega_n/\omega_n & \end{array} \quad (3)$$

The matrix is characterized:

$$A\omega = n\omega \quad (4)$$

or

$$(A - n \cdot I)\omega = 0, \quad (5)$$

where:
I – is a unit of the matrix;
ω – vector (relative weight).

In the calculation, we consider that elements of the matrix a_{ij} – are expert estimation. In such case, we take the equation:

$$(A - \lambda_{max} I)\omega = 0, \quad (6)$$

where:
λ_{max} – eigen value of the matrix (maximal).

We consider three variants of the location of land plots, where one can organize a recreational center. The variants A, B and C, variant A in the Rata village, B – in the village of Soposhyn and C – in the village of Maidan, respectively (Smolyarchuk, 2006).
The land plot of the variant A is situated in north-west part of Zhovkva district in the village of Rata. It borders roads of the district importance. The land plot is situated at the distance of 30 km from the district center, Zhovkva town, and joins the borderline of Ukrainian-Polish boundary, having a favorable position for grouping of tourists. The plot has a rectangular shape.
The land plot of the variant B is situated in the central part of Zhovkva district in Soposhyn village. The land plot is of a stretched form. The land plot borders the settlement and forest area. A road of the district importance surrounds southern side of the plot. The plot is prospective for tourism development, viewing from a favorable geographical position, particularly it is a small distance to the regional center of Lviv city, as well as the district center of Zhovkva town. The distance to the district center makes 1.5 km. It is planned to build a memorial complex near the land plot that is going to attract tourists in the future.
The third variant C of the land plot location is situated in the southern part of Zhovkva district, in Krekhiv village council, near Maidan village. The land plot is surrounded by forests from the western and southern-western side. The variant has great recreational capabilities: picturesque landscapes, forests, mushrooms and berries, water objects and sources of mineral waters (chloride-sodium). The distance to the district center makes 3 km.
We introduce the matrix of paired comparison of factors into a computer and determine eigen values of the matrix according to Math Cad program.
In the same way, on the basis of an expert's estimation, we grade variants according to each of six factors (DC, F, WS, RC, ShL, RP), influencing the location of a recreational center and performing a paired comparison of them and determine the value of their eigen values in Table 2. Afterwards, values n and $Z_{max.}$ are compared.

Table 2

Paired comparison of factors influencing the location of a recreational object

	DC	**F**	**WS**	**RC**	**ShL**	**RP**	**∑**
DS	1	29/24	29/19	29/20	29/15	29/7	**11,261**
F	24/29	1	24/19	24/20	24/15	24/7	**9,319**
WS	19/29	19/24	1	19/20	19/15	19/7	**7,378**
RC	20/29	20/24	20/19	1	20/15	20/7	**7,766**
ShL	15/29	15/24	15/19	15/20	1	15/7	**5,825**
RP	7/29	7/24	7/19	7/20	7/15	1	**2,700**
∑	**3,931**	**4,750**	**6,000**	**5,700**	**7,600**	**16,286**	**44,259**

n=6 Z_{max} = 6,000,
where:
n – is the size of matrix;
Z_{max} – maximal eigen value of matrix.

The next step is to determine the vector of the matrix according to its maximal eigen value with the use of Math Cad program:

0,586
0,485
0,384
0,404
0,303
0,141
∑=2,303

We determine a particular value of the matrix:

	1	2	3	4	5	6
W_o =	0,254	0,211	0,167	0,175	0,132	0,061

On the basis of the calculation, we normalize data in Table 3.

Table 3

Normalized matrix

Variant	**Characteristics**						
	DC	**F**	**WS**	**RC**	**ShL**	**RP**	**∑**
A	0,087	0,508	0,408	0,238	0,240	0,331	**1,812**
B	0,603	0,197	0,244	0,159	0,327	0,290	**1,847**
C	0,283	0,294	0,345	0,603	0,433	0,379	**2,337**
∑	**1**	**1**	**1**	**1**	**1**	**1**	**6,000**

Having made the calculation, we get the value: W_A = 1,812; W_B = 1,847; W_C = 2,337.
Results of the calculation show that it is the most reasonable to make a positive decision in favor of the variant C, which is by 18% better than the variant A, more than by 21% better than the variant B. Thus, results of the calculation lead to the conclusions that a recreational center is reasonable to be located on the land plot C. Therefore, the suggested indictors with application of fuzzy programming enabled making of managerial decisions on the basis of concrete calculations.

Conclusions

In everyday life, the situations of decision-making do not satisfy requirements of the presented scheme. Nowadays, the theory of production management achieves the level when uncertainty plays a substantial role. The capability to solve uncertainties or work with them requires careful attitude to environment. It causes the necessity to consider decisions making, in which aims and restrictions are not exactly determined. It is important to be able to identify tasks of such type, characterize peculiarities of their solutions and develop methods of the solutions. Such approaches can be applied in a wide range of optimization tasks of land utilization.

In Ukraine, development and efficiency of land utilization will depend on its conditions and use as well as on changes in the structure of land fund of the country caused by the land reform and land policy of the state. Thus, progressive land utilization of each country in any period should be based on the combination of three dimensions – past, present and future. One can realize its progress or regress only by combination of the three dimensions, because they help to open genetic code of the national land management. Comprehension of the essence of growth or reduction of land utilization efficiency of past ages and presence, which was based and is based on organization of social relations concerning land, labor on it and use of optimal profits, i.e. capital, is an important precondition for a break in the future.

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