VI. МАТЕМАТИЧНІ МЕТОДИ, МОДЕЛІ Й ІНФОРМАЦІЙНІ ТЕХНОЛОГІЇ В ЕКОНОМІЦІ

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ECONOMIC-MATHEMATICAL BASIS FOR FORMING COMPLEX PROGRAMS OF RECREATION BALANCED DEVELOPMENT

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Summary. The purpose *of the research is to analyze and improve the economic-mathematical basis of formation of the complex programs of equilibration of recreational development.* ***Methodology of research.*** *The theoretical basis of the study includes the following provisions: the principles of economy and management of the national economy in its sectoral context as well as the socio-economic theoretical propositions of recreation; the conceptual provisions of economic development.* ***Findings.*** *In the article, in analyzing the functioning of recreational sector the theoretical propositions of program method application are disclosed as well as its relationship with the method of the theory of optimal control. It is substantiated that the complex program of its development in its base has the goals tree; decision-making processes in the recreational industry, the effects of which are considered in the medium term, have the multistep nature and should reflect the aspects of regulatory policy and organizational-economic mechanism of distribution of recreational resources.* ***Practical value.*** *The proposed in the work the theoretical and methodological economic-mathematical approach to the formation of complex program of development of recreation can be applied in practical plane of administrative-territorial management of the national economy; and also used by individuals who make managerial decisions when developing and implementing socio-economic recreational programs based on a step by step public and private financial and investment designing.*

Keywords: *recreation economics, complex program, balanced development, dynamic programming.*

Introduction. The socio-economic development is a complex process that requires adequate mathematical programming approaches. The recreational sector of the national economy in turn, is not an exception; its study has a transdisciplinary nature especially in the context of complex programs of its development. In examining equilibrium states in the recreational activity, do not dispense with the appropriate methods of economic-mathematical modeling, in particular, such as linear and dynamic programming.

In the conditions of unstable external environment, when with more or less of a high probability one can forecast and therefore form programs of such complex socio-economic phenomena and processes as recreation, in the medium term, as well as at this giving preference to step by step analysis of the possibility of future organizational activities – the priority is given to a balanced dynamic programming of recreational development.

Brief Literature Review. The question of forming and realization of complex socio-economic programs of the country and its certain territories development were investigated by internationally renowned scientists in particular L. V. Kantorovich [1] and N. N. Moiseev [2–3].

Representatives of modern Ukrainian economics, related to recreational programming and modeling tourism, to forecasting socioeconomic development, to design mechanism theory in relationship with natural resources, – conduct a detailed analysis in their researches, particularly B. T. Pushkar and Z. M. Pushkar [4], S. G. Svetunkov, I. S. Svetunkov, N. A. Kizim, and T. S. Klebanova [5], M. M. Petrushenko [6] and others. Modeling and forecasting the dynamic behavior of recreants are in the work of foreign scientists K. A. Baerenklau and B. Provencher [7]. Issues of dynamic competition in tourism is analyzed in the work of J. Li, W. Zhang, H. Xu, and J. Jiang [8]. At the same time, issues of economic- mathematical modeling of recreational balance reflected in complex programs need further development.

Purpose. The purpose of the research is to analyze and improve the economic-mathematical basis of formation of the complex programs of equilibration of recreational development.

Presentation of the main material of research with justification of received scientific results. According to the opinion of N. N. Moiseev [3, 196–198, 206–207], under the program should be understood the totality of measures providing the achievement of the ultimate goals of the given phase of socio-economic development. Thus it is important to understand how the programs at a higher national level are formed. The classification of such programs includes the following: the programs for achievement of a given level of consumption, the program of social development, the environmental programs and so on.

When forming the socio-economic program, along with its description it is necessary to figure out the possibilities of its implementation, providing with the required resources, determine the terms the completion etc. Therefore, the models that describe the functioning and development of various sectors of the economy are necessary; within the complex program such models are more detailed than the models of forecasting of the industry development.

The program method is a holistic system of views on management of complex cybernetic systems with many subjects, including economic systems. Preliminary socio-economic forecasting, the formation of complex program and planning the based on it should be completed with their implementation that is impossible without designing specific mechanisms for realization.

In the work [9, 25] the multicriteria optimization within the framework of formation of the program of the industry development is emphasized, as well as on the contradiction of objectives, including "increased spending on improving living standards (social purpose) makes it difficult to the achievement of financial and economic objectives etc."

The complex program of the development of recreational industry at its core has a goals tree of this industry and the national economy as a whole. Within this, the notion of the goal is supplemented by the notion of criterion – "... the requirements that define the rule of unambiguous choice of means to achieve the goal" [10, 102]. From the perspective of systems analysis such a criterion may be a criterion of functioning, the index of effectiveness, a criterion of optimality, the objective function and so on. Since the recreational industry is a complex socio-economic system in which the achievement of several goals is needed simultaneously and the relations among separate goals and means of achieving them are not obvious – it is necessary the formation of complex programs in which the whole complexity of the management of recreational activity takes a certain shape, simplifies decision-making in this area. A criterion in its turn, ensures that the vector chosen to achieve a particular goal of subsystem (recreational sector) do not contradict the general objective of the system (national economy) and the objectives of other subsystems (other sectors of the national economy: as the services sector and the production sector). By using economic criterion the benefits for the society from the functioning of the system and the cost of its creation and maintenance can be correlated, i.e. to determine the economic efficiency by selecting the variants of the goal achievement.

The formulation of the criteria for the systems of highest rank, i.e. the territorial and sectoral, the inter-sectoral, the cluster systems, is not an easy task, especially since it can be complicated by the necessity of additional social and other criteria. It is about a set of criteria, wherein however the major one or two-three of basic criteria can be isolated and the ranks of other criteria can be determined, to complement the goals of functioning and development of the recreational sector of national economy.

The decision making processes in the recre-

ational industry, the effects of which are considered in the medium term, tend to have a multistep character. It is known that mathematical apparatus is adequate to necessity of adoption of such decisions, offers a dynamic programming method (dynamic programming concept created by R. Bellman [11]), which closely intersects with optimal control theory by L. Pontryagin [12].

On the basis of recommendations set forth in the works [1, 64–67; 2, 182–185; 3, 196–206; 9; 11, 65–76; 12], we propose to form a complex program of balanced development of recreation based on the optimization principle and respectively method of dynamic programming, including in conjunction with optimal control method adapted to the specifics of socio-economic studies, namely as follows.

Such a program generalized can be presented as a set of projects for the development of recreation over the medium term. Suppose it is necessary to select such projects that have a common goal (to increase the profits of the sector at provision to the population qualitative recreational services) and certain features of socio-economic development of the recreation with the total volume of public and private financial investments *FI*. To accomplish this it is necessary to solve the following problem of the extreme type:

$$\begin{cases} \sum_{i=1}^{N} rp_i v_i \to \max \\ \sum_{i=1}^{N} rp_i ke_i \le FI \\ rp_i = 0,\ 1,\ 2,\ \ldots \end{cases} \qquad (1)$$

where *FI* – the volume of public and private financial investments aimed at the development of recreation within the complex socio-economic program;

rp_i – the number of projects of recreational development of *i* type;

i – the sequence number of the type of recreational development;

N – the number of types of projects of recreational development;

v_i – the volume of investments on the project of *i*-type of recreational development;

ke_i – the coefficient of equilibration at *i*-type of recreational development ($ke_i \ge 1$; $ke_i = 1$ – socially oriented type of project; ke_i maximally distant from 1 – the type of project, oriented to maximizing the financial result, without a purposeful consideration of social, cultural, environmental and other factors of the process of satisfying recreational needs).

The scheme of solving this problem is as follows. First, consider the projects of the first type (*i*=1). Then the maximum volume of investment on projects of the first type defined as follows:

$$\begin{cases} f_1(FI) = \max\{rp_1 v_1\} \\ rp_1 ke_1 \le FI \\ rp_1 = 0,\ 1,\ 2,\ \ldots \end{cases} \qquad (2)$$

where $f_1(FI)$ – the function of financial investment aimed at the development of recreation by implementation of first type projects.

Whereas $rp_1 \ \ FI / ke_1$, and for each maximum must be taken rp_1 the greatest possible, then $rp_1 = [FI / ke_1]$ (an expression taken in square brackets $[FI / ke_1]$ means the greatest integer not more than FI / ke_1) and $f_1(FI) = [FI / ke_1] v_1$.

The next step is to examine the projects of first and second types simultaneously (in this study we do not give specific names to the types of recreational development for the present, for example, the projects of socially oriented recreational development, because at this stage it does not play an important role). The maximum amount of investment on the projects in this case will be $f_2(FI)$. If we take rp_2 *of* the projects of second type, then the first type of projects (considering the entire volume of financial investment, which, of course, all the time remains a limited resource) we can take not more than $FI - rp_2 ke_2$. Thus, the maximum volume of investment of the second type projects is equal to $f_1(FI - rp_2 ke_2)$, and the total amount of investments on the projects in this case will be $rp_2 \cdot v_2 + f_1(FI - rp_2 ke_2)$. It is necessary to determine rp_2. The value of $f_2(FI)$ as maximum volume of investment on the projects of the first and second types of recreational development, is defined as the maximum for all choice variants rp_2, namely:

$$f_2(FI) = \max_{0 \le rp_2 \le [FI / ke_2]} \{rp_2 v_2 + f_1(FI - rp_2 ke_2)\}. \qquad (3)$$

By analogy, perpetrating a step by step analysis of maximization the function of the volume of investment on projects of various types of recreational development , after *N* steps we will obtain the following:

$$f_N(FI) = \max_{0 \le rp_N \le [FI / ke_N]} \{rp_N v_N + f_{N-1}(FI - rp_N ke_N)\}, \qquad (4)$$

where $f_N(FI)$ – the maximum volume of investments on N types projects;

$rp_2 \cdot v_2$ – the volume of investments on project of N-type;

$f_{N-1}(FI - rp_N ke_N)$ – the maximum volume of investments on projects $(N - 1)$-type.

From the obtained recurrent ratios consistently functions can be found $f_1(FI), f_2(FI), \ldots, f_{N-1}(FI), f_N(FI)$, and thus the numerical solution of the problem concerning equilibrated recreational development in the framework of complex socio-economic program. An additional analysis results can be obtained by applying the method of linear programming [1; 13].

In our opinion, any complex program of socio-economic development along with the proper traditional aspects of programming should also reflect the aspects of regulatory policy as well as a mechanism (according to mechanism design theory) and the interrelation with the structural and organizational component of the task on which programming is oriented. In the case of formation of equilibrated recreational development programs in the context mentioned above, it is also expedient to display the complex organizational and economic instruments needed to implement the planned measures. For example, this refers to public-private partnerships or granting interest-free loans to the subjects of recreational business for innovations, relating to the provision of socio-ecologically oriented services.

If consider the general provisions on the combination of the economic aspects of the recreational industry to its other sides, that can give probable financial benefits mainly in the long run, then in the basis of forming the programs of equilibrated development of recreation, the principles of indicative planning should be considered as a mechanism for coordination and harmonization of interests of the state and private business in the medium term.

Conclusions. So, as a result of the conducted study can be made the following conclusions. Firstly, in analyzing the functioning of recreational sector the theoretical propositions of program method application are disclosed as well as its relationship with the method of the theory of optimal control. It is substantiated that the complex program of its development in its base has the goals tree; decision-making processes in the recreational industry, the effects of which are considered in the medium term, have the multistep nature. Secondly, the theoretical and methodological approach to dynamic programming of recreational activities is proposed as an economic-mathematical basis of formation of complex programs that are presented as a collection of investment projects of equilibration of recreational development. It is substantiated, that such complex programs should reflect the aspects of regulatory policy and organizational-economic mechanism of distribution of recreational resources.

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***Анотація. Мета** статті полягає у проведенні аналізу та вдосконаленні економіко-математичного базису формування комплексних програм зрівноваженого розвитку рекреації. **Методика дослідження.** Теоретична основа дослідження містить такі положення: принципи економіки та управління національною економікою в її галузевому розрізі, а також соціально-економічні теоретичні положення рекреації; концептуальні положення економічного розвитку. Методами дослідження є: метод системного аналізу та метод динамічного програмування. **Результати.** У статті в результаті аналізу функціонування рекреаційної галузі розкрито теоретичні положення застосування програмного методу, а також його взаємозв'язок із методом теорії оптимального управління. Обґрунтовано, що комплексна програма її розвитку у своїй основі має дерево цілей; процеси прийняття рішень у рекреаційній галузі, наслідки яких розглядаються в середньостроковій перспективі, мають багатокроковий характер, а також повинні відображати аспекти регуляторної політики та організаційно-економічного механізму розподілу рекреаційних ресурсів. **Практична значущість результатів дослідження.** Запропонований у роботі теоретико-методичний економіко-математичний підхід до формування комплексної програми розвитку рекреації може бути застосований у практичній площині адміністративно-територіального управління національною економікою, а також використаний особами, які приймають управлінські рішення, під час розробки й реалізації соціально-економічних рекреаційних програм на основі державного та приватного покрокового фінансово-інвестиційного проектування.*

***Ключові слова:** економіка рекреації, комплексна програма, зрівноважений розвиток, динамічне програмування.*

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***Аннотация. Цель** статьи заключается в проведении анализа и совершенствовании экономико-математического базиса формирования комплексных программ уравновешенного развития рекреации. **Методика исследования.** Теоретическая основа исследования включает следующие положения: принципы экономики и управления национальной экономикой в ее отраслевом разрезе, а также социально-экономические теоретические положения рекреации; концептуальные положения экономического развития. Методами исследования являются: метод системного анализа и метод динамического программирования. **Результаты.** В статье при анализе функционирования рекреационной отрасли раскрыты теоретические положения применения программного метода, а также его взаимосвязь с методом теории оптимального управления. Обосновано, что комплексная программа ее развития в своей основе имеет дерево целей; процессы принятия решений в рекреационной отрасли, последствия которых рассматриваются в среднесрочной перспективе, имеют многошаговый характер, а также должны отражать аспекты регуляторной политики и организационно-экономического механизма распределения рекреационных ресурсов. **Практическая значимость результатов исследования.** Предложенный в работе теоретико-методический экономико-математический подход к формированию комплексной программы развития рекреации может быть применен в практической плоскости административно-территориального управления национальной экономикой, а также использован лицами, принимающими управленческие решения, при разработке и реализации социально-экономических рекреационных программ на основе государственного и частного пошагового финансово-инвестиционного проектирования.*

***Ключевые слова:** экономика рекреации, комплексная программа, уравновешенное развитие, динамическое программирование.*