

The economic optimization of investment into the territorial development of recreation

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Abstract

In the field of recreational nature management the mechanisms of attraction of investment resources have a particular specificity, which consists in necessity of consideration of objectively existing synergistic relationships between economic, social and environmental components. Recreational nature management based on the use of natural-recreational potential of certain territories foresees a need for state regulation of recreational activity in the regions.

In the article a complex economic assessment of natural-recreational potential of Sumy oblast in Ukraine was carried out, the values of regional recreational rent in districts of Sumy oblast was defined. The character of influence of change of parameters of the objective function of maximization of recreational product on the aggregate magnitude and structure of recreational services is analyzed, in accordance with methodical provisions of application the optimization instrument of dual assessments at use of natural-recreational potential of the territory: an analysis of the limits of sustainability of prices on recreational services that are included or not included to the baseline plan of recreational development in districts of oblast; analysis of limitations on recreational resources on which is absent or available reserve within the framework of defined territory.

Among the main results of conducted complex assessment of natural-recreational potential of Sumy oblast highlighted the following: defined the investment attractiveness of districts of the oblast from the perspective of development in them the recreational activity; determined the volume of investments in development of recreational activity by types of recreational services on districts of oblast; assessed the absolute values and limits of change of local natural-recreational potentials conditioned by the dynamics of prices on recreational services in districts of oblast; determined the limitations of sustainability for constraints on land and labor resources and conditioned by them change in the magnitude of local natural-recreational potential of the territory.

Keywords: secondary resources, two-tier economic model, socio-ecological modification, management, Ukraine.

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Introduction

The completion of Ukraine's transition to market conditions of economy management requires the formation of organizational-economic mechanisms, including those aimed at optimizing the attraction of investment resources that dialectically combine a set of instruments and levers of state regulation and market self-regulation based on the principles of sustainability and balance and designed to ensure vital functions of people. In the field of recreational nature management the mechanisms of attraction of investment resources have a particular specificity, which consists in necessity of consideration of objectively existing synergistic relationships between economic, social and environmental components. Recreational nature management based on the use of natural-recreational potential of certain territories foresees a need for state regulation of recreational activity

in the regions on the basis the action of market laws and the laws of conservation and restoration social and natural resources.

Thus, the actuality of theme of this study is an objective necessity of further scientific rationale and improvement of the mechanism of optimization of processes of attraction the investments in the formation and use of natural-recreational potential of the territory based on an assessment of the complex of factors that influence the processes of functioning, optimization and development of recreation at the territorial level.

To the questions of development and practice of implementation of regional policy of recreational development, to the problems of territorial organization of recreational activity, to the peculiarities of development of territorial-recreation systems, to the assessment of recreational capacity and natural-recreational potential of the territories devoted the works of Ukrainian scientists, in particular, V. S. Kravtsiv, L. S. Hryniv, and M. V. Kopach, S. P. Kuzyk (1999), T. F. Panchenko (2001), I. M. Yakovenko (2005), V. M. Kysly (2008), and works of foreign scientists: V. S. Kachanov, L. V. Panasyk, and N. S. Shukhov (1989), V. I. Azar, J. Dehez, S. Lyzer (2014), H. R. Hall, C. McCarty, and M. W. Clark (2014), S. Andkjer, J. Arvidsen (2015), T. H. Lee, F.-H. Jan, and G. W. Huang (2015), J. Li, W. Zhang, H. Xu, and J. Jiang (2015), and many others. Thus, the article by H. R. Hall, C. McCarty, and M. W. Clark (2014) analyses the principles of regulatory protection and definition for recreational uses of Florida lakes. The work by J. Dehez, S. Lyzer (2014) develops a multivariate analysis and cost analysis in outdoor recreation planning. The paper of T. H. Lee, F.-H. Jan, and G. W. Huang (2015) analyses the influence of recreation experiences on environmentally responsible behavior of economic agents. Despite of the importance and value of conducted national and foreign studies in economic sphere of recreational nature management, the issues of comprehensive approach to consideration of interrelated heterogeneous factors of recreational activity at the territorial level both theoretical-methodological and practical terms are still unresolved. Further understanding of the economic substance of natural-recreational potential of the territory as defined system of elements, interconnections and relationships in the process of satisfaction of the recreational needs through the optimal use of recreational resources is needed.

The *purpose* of a given research – is the improvement of theoretical-methodological provisions for the economic optimization of investment into the territorial development of recreation in Ukraine on the basis of complex economic assessment of natural-recreational potential.

The main results. According to forecast data of the State Scientific Research and Design Institute of Urban Planning [17], according to the “General concept of planning scheme in Ukraine” is predicted a gradual development of recreational of territories, which for the period to 2026 will constitute 48% (3665,0 thousand hectares) with respect to the potential resources (7669,0 thousand hectares - 12.8% of the country) (Table 1).

Table 1. Dynamics of perspective development of wellness and recreational areas*
in regions of Ukraine to 2026

No	Region	Oblasts as part of regions	Potential recreational and wellness territories, thousand hectares	Recreational and wellness territories that being developed, thousand hectares
1	Ukraine		7669.0	3665.0
2	Donetskyy	Donetska, Luhanska	355.8	336.1
3	Prydniprovskyy	Dnipropetrovska, Zaporizka, Kirovohradska	270.8	236.0
4	Skhidnyy	Poltavska, Sumska, Kharkivska	944.0	657.8
5	Tsentralnyy	Kyyvska, Cherkaska	430.0	191.0
6	Polisskyy	Volynska, Zhytomyrska, Rivnenska, Chernihivska	1649.4	438.1
7	Podilskyy	Vinnytska, Ternopilska, Khmel'nitska	765.9	460.0
8	Prychornomorskyy	AR Krym, Mykolayvska, Odeska, Khersonska	618.7	398.0
9	Karpatskyy	Zakarpatska, Lvivska, Ivano-Frankivska, Chernivetska	2634.4	948.0

*According to the Land Code of Ukraine (Ch. 8, 9) [11] within its territory among the various categories of land, the lands for recreational purposes are allocated that have natural curative properties, and recreational land that are used for recreation of population, tourism and conducting sporting events.

In the conditions of instability of national economy, the uncertainty of many macroeconomic and social processes, arises a problem of adaptation of the territorial socio-economic systems to external changes. In ensuring the solution of this problem it is important to establish high national socio-economic priorities and objectives of state regulation in the sphere of recreation and tourism (as defined in the laws of Ukraine "On resorts" [15], "On Tourism" [16], etc.), and as well optimization of processes of investment maintenance of territorial development of recreation.

One of the main results of theoretical studies of the essence of natural-recreational potential (NRP) of the territory is the conclusion about extremely complex multifaceted character of its economic assessment. Economic assessment of NRP of the territory is a component of the relevant organizational-economic mechanism and represents the value expression of maximum effect, obtained by the subjects of natural-recreational activity within a given territory taking into account social and environmental constraints. Most difficult part is to develop a complex approach to economic assessment of NRP of the territories which according to the situation maximally is taking into account all potential opportunities of the territory to render natural-recreational services. By drawing parallels and by finding common features between economic potential and NRP of the territory, in our opinion, broadly defined natural-recreational potential comprises in its structure:

- industrial-infrastructure and investment potential (fixed, revolving funds and etc., the possibility of increase within a given territory);
- labor potential (staff, managerial personnel, opportunity of professional development of personnel in the framework of the recreational activity of the territory);
- natural-resource and ecological potentials (natural-climatic conditions, natural-recreational resources, the possibility of expanding of recreational activity without threat of infringement of natural balance within a given territory, etc.);
- scientific-technological and innovation potential (the ability to generate new knowledge and information within the framework of recreational activity of a given territory).

The practice proves that the recreational environment can have high quality with insufficient natural-resource potential, but with high quality elements of social, technological and cultural environments. Characteristically, that inverse relationship nearly is not observed. Thus, the best recreational resources will not be properly used at a low level of development of other sectors of the recreational environment [23, p. 25]. Consequently, by the recognition of resource component as a basis of formation of NRP of the territory it should be stressed that the expediency of application exactly a complex approach to economic assessment of the system "NRP of the territory", which will allow: to give in value terms the total value of a given potential, to set the proportion of each element in the structure of the potential, to find the degree of use of the potential and so on. On the basis of determination of these values becomes possible the creation of effective mechanisms for managing and developing natural-recreational activity within a particular region.

It should be noted that one of the most effective approaches to the exercising of complex economic evaluation is a modeling. In the work [7, p. 49-51] are examined the examples of application of optimization models when determining socio-economic effectiveness of tourist-recreational activities through the category of "potential". Such the potential, in the opinion the authors, is a set of socio-economic relations that are implemented in order to ensure the most possible level of activity of each member of society. "In this the society is granted the new quality of system, which significantly increases the effectiveness of the entire socio-economic and productive activities of people and ensure the comprehensive personal development as self-worth, as the goal of all system life of society". To solve the problem of formalizing the objective function recreational activity is extremely difficult. Such function is system-wide concept that includes the formation and development of both socio-economic and natural potential. Its formalization is one of the fundamental economic problems in the sphere of theory and practice of recreation. Some of approximation to its solution may be systemic modeling, i.e. the development of the complex optimization models, based on the theory of multi-stage (iterative) optimization. In this the search for optimal functioning of the recreational system can be significantly facilitated if the adequate organizational-economic mechanism is created in the sphere, and the optimizing property of which will directly contribute to achieving maximum revitalizing effect of tourist-recreational activities. For such mechanisms can be attributed, for example, optimal pricing, rent payments and rent evaluations of recreational services of target assignment.

Considering the above, in our opinion, the use of exactly optimization model of mathematical programming at imposing certain limitations on its parameters that correspond to the real terms of the national economy, allows for a complex assessment of NRP of the territory taking into account type of characteristics of recreation as well as relevant interrelation of natural, human and created capital. In this study is proposed to use the optimization model of linear programming by L. V. Kantorovich [8; 9]. The most suitable indicator of efficiency of the economic system and therefore the criterial parameter in the model of economic potential is the gross regional product [22, p. 877] (with respect to the recreational sector of the territory the role of the indicator takes a regional recreational product intended for final consumption).

Given optimization model will enable to take into account:

- the maximum amount of interests (in a certain sense – levels) in the field of natural-recreational activity in the region;
- the situational approach, i.e. the results obtained by means of this model may vary depending on the dynamics of external and internal environments;
- the specific variety the recreational activity;
- enhancing the role of human resources in relation to natural, human and physical capital;
- the additional options of formation and use of NRP;
- the possibility of realization the certain balancing of recreational resources.

Mathematical description of the optimization model [19]

1. Introduction of designations:

L – gross regional product derived by enterprises of natural-recreational sphere (an indicator of economic assessment of NRP of the territories), thousand UAH.

P_h, P_r, P_s, P_e – the market marginal price of recreational services considering the most unfavorable combination of resources usage (factors), euro, respectively to type: P_h – health care recreation (sanatorium type), P_r – prolonged recreation (at the bases and rest houses, boarding houses), P_s – sports tourism (at the sports and training centers, sports meetings, etc.), P_e – the ecological tourism (the recuperation by visiting the ecosystems: green, agriculture, forest, nature reserve and route tourism), euro/service. The integration of all types of recreational diversity in these four types is advisable in view of simplifying the very complex iterative calculations, and to conduct of practical research on the example of the region for which recreational activity is not traditional and therefore requires development of types in the future.

x_h, x_r, x_s, x_e – the amount of rendered recreational services of certain type in the region during the year, thousand units.

N – overall land area of the recreational purpose (the land is the basis of concentration of manifestation the utilities of natural-recreational resources), hectares.

N_h, N_r, N_s, N_e – area of land for recreational purpose calculated per one recreational services according to environmental capacity of a particular type of recreational land at formation of and provision of recreational services in the region during the year, respectively: N_h – units of services of health care recreation, N_r – units of services at rest houses, N_s – units of services of sports type recreation, N_e – units of services of ecological type recreation, hectares / unit of services per year.

H – the total number of human resources that may be involved in the formation and provision of recreational services in the region, people.

H_h, H_r, H_s, H_e – the number of human resources that have properties in accordance with requirements of the provision of quality recreational services: the level of special education, the level of hospitality etc., calculated on the basis of labor input of certain types of services (persons), which are provided in the region during the year, respectively: H_h – units of services of health care recreation, H_r – units of services at rest houses, H_s – units of services of sports type recreation, H_e – units of services of ecological type recreation.

K – the total amount financial investments that may be involved in the formation and provision of recreational services in the region, thousand euro.

K_h, K_r, K_s, K_e – financial investment in the formation and provision of recreational services in the region during the year, respectively: K_h – units of services of health care recreation; K_r – units of services at rest houses, K_s

– units of services of sports type recreation, K_e – units of services of ecological type recreation, euro/ unit of services per year.

In broad sense, the parameter K is directed to the formation of material-technical base of natural-recreational complex (the recreational infrastructure): fixed assets, with which is carried the direct production, provision of recreational services and sale of related goods to tourists as well as auxiliary means labor that does not directly take participation in recreational process, however, affect the conditions of recreation.

2. Formulation of the objective function:

$$L = P_h \cdot x_h + P_r \cdot x_r + P_s \cdot x_s + P_e \cdot x_e \rightarrow \max \quad (1)$$

Such a formulation of the objective function corresponds to the desire of recreational enterprises to maximize their profits, and is aimed at implementation of investment policy of the region: if the investor would know the exact value of the market NRP, it will focus on the number of sales, corresponding to the maximum demand for recreational services in a particular region (the market NRP of the territory). It should be noted that creation of additional demand for investment of general economic business and recreational-tourist purpose is one of the main economic functions of recreational sphere in the region. Receipts of foreign currency from the sale of recreational product are means to settlement of payments imbalance of the region, besides the sector also stimulates an export of goods.

Should be emphasized that in making strategic decisions in natural-recreational sector the regional management bodies come out of that the purpose of functioning of the system "NRP" subordinated to purpose of the system of higher level – "economic potential" of the territory. In this an indicator of NRP of the territory is a GDP, derived by recreational sector of the region as well as increase in regional GDP considering the index of growth of human capital and related ecological indicator during the year. Since the use of NRP in practice imply the formation of appropriate long-term development programs, the time factor is taken into account by discounting the annual values of NRP.

3. Imposition of restrictions to objective function:

$$\begin{cases} N_h \cdot x_h + N_r \cdot x_r + N_s \cdot x_s + N_e \cdot x_e \leq N \\ H_h \cdot x_h + H_r \cdot x_r + H_s \cdot x_s + H_e \cdot x_e \leq H \\ K_h \cdot x_h + K_r \cdot x_r + K_s \cdot x_s + K_e \cdot x_e \leq K \end{cases} \quad (2)$$

4. The introduction of designations according to the conditions of duality:

z_N, z_H, z_K – factorial proportions of marginal prices of recreational services that generated by the cost method considering rate of return per unit of service, euro, respectively: z_N – the share of natural factor, z_H – the share of human factor, z_K – the share of financial factor.

5. The formulation of dual function:

$$L_d = N \cdot z_N + H \cdot z_H + K \cdot z_K \rightarrow \min \quad (3)$$

L_d – the function in accordance with the conditions of duality PRP assessment area. Its essence is to minimize of their expenses by recreational enterprises of the region. Thus, the dual function of NRP reveals the content of economic effectiveness of functioning of the entities of recreational activity, which is to maximize the sales while minimizing the costs for creation the recreational product.

6. The imposition of limitations on dual function:

$$\begin{cases} N_h \cdot z_N + H_h \cdot z_H + K_h \cdot z_K \leq P_h \\ N_r \cdot z_N + H_r \cdot z_H + K_r \cdot z_K \leq P_r \\ N_s \cdot z_N + H_s \cdot z_H + K_s \cdot z_K \leq P_s \\ N_e \cdot z_N + H_e \cdot z_H + K_e \cdot z_K \leq P_e \end{cases} \quad (4)$$

The given system of inequalities reflects summary resources assessment used in the creation of recreational services. In addition, it is possible to identify and carry out further analysis of price limits on certain resources that traditionally grouped into three categories: natural, human and financial resources (or capital).

7. The formulation of conditions of analysis of coefficients of the objective function as well as limitations on resources:

$$L = (P_h + \Delta P_h) \cdot x_h + (P_r + \Delta P_r) \cdot x_r + (P_s + \Delta P_s) \cdot x_s + (P_e + \Delta P_e) \cdot x_e \rightarrow \max, \quad (5)$$

where ΔP_h , ΔP_r , ΔP_s , ΔP_e – the magnitude of price changes on recreational services, in accordance to recreational subsystems: ΔP_h – health care, ΔP_r – prolonged rest, ΔP_s – sports, ΔP_e – ecological.

The coefficients of the objective function is a the averaged prices for the recreational services in a particular region, that are calculated by methods of market, indirect market or indirect non-market evaluation – depending on the stage of development of market of the recreational services. The current state of the recreational industry in Ukraine allows to speak about the existence of quasi-market relations in traditional recreation regions and elite types of recreation and the embryonic state of the recreational market - in other regions and relative to social and ecological directed recreation.

In this situation in the formulation of conditions of price changes the crucial importance in the market of recreational services will have a factor of growth in effective demand of population. At present decrease in aggregate demand for domestic of recreational product is explained by complication of socio-economic situation in the country as well as low quality of services in the traditional recreational regions and the underdevelopment of recreational sector in other territories. In conditions of development of economy one of the ways out from the crisis for the recreational sector is to bring to match with international standards the prices and quality of recreational services, modernization of material-technical base of recreation, expansion of the circle of consumers by improving the welfare of local people and attraction of foreign tourists.

The dynamics of limitations on resources is also explained both by market factors and regulatory factors. In formulating the limitations on resources two cases are considered: a) the resources on which there is no reserve; b) resources on which there is a reserve.

Thus, if during the iterative study would be determined that, for example, limitations on the labor force does not foresee a reserve, then it will affect the amount of recreational services and therefore by the amount of NRP. A change in the amount of resources on which there is reserve will not affect the magnitude of PRP.

$$\begin{cases} N_h \cdot x_h + N_r \cdot x_r + N_s \cdot x_s + N_e \cdot x_e \leq N + \Delta N \\ H_h \cdot x_h + H_r \cdot x_r + H_s \cdot x_s + H_e \cdot x_e \leq H + \Delta H, \\ K_h \cdot x_h + K_r \cdot x_r + K_s \cdot x_s + K_e \cdot x_e \leq K + \Delta K \end{cases} \quad (6)$$

where ΔN , ΔH , ΔK – the magnitude of changes of the resources, accordingly: natural, human and financial. The change Δ can have both positive and a negative value.

The results of approbation of proposed complex approaches to the economic assessment of NRP of the territory are presented below.

The complex economic assessment of natural-recreational potential of the territory that was conducted on the basis the model we have developed on the example of Sumy region that does not belong to traditional of recreational territories, however, in our opinion, possesses due potential to meet the recreational needs of the population. The local potentials of administrative districts of Sumy region were assessed, where expedient organization of recreational activity on the basis of appropriate natural resources, taking into account the entire complex of relationships between all concerned parties and objects of recreational activity. At the same in the framework of this research was analyzed prolonged rest outside the towns of oblast. By summation of local potentials was received total value of NRP of Sumy region.

The first stage of complex assessment of NRP of the territory is the allocation on it recreational areas according to territorial-administrative basis, – Sumy region comprises 18 administrative districts. Then through zoning of the territory each of the districts we get the micro-territory for the organization of recreational activity. In this are distinguished four types of micro-territory in each of the administrative regions of the oblast: the most valuable, valuable, not valuable micro-territory and not recreational specialization.

In calculating the NRP of the Sumy region were used the most valuable areas of the recreational micro-territories. As such territories are considered unique territorial complexes – park-monuments of landscape architecture, territories of natural-reserve fund as well as existing recreational objects of the oblast (based on the

source [21]). This approach does not contradict the priority directions of development tourism-recreational sector in Ukraine: Strategy of development of tourism and resorts for the period to 2026 in Ukraine [14].

Consider the assessment of local NRP of one of the regions on the basis of statistical socio-economic information by the Sumy region. In this the value of parameters, set out below in the system of equations 8 and respectively in the table 2 correspond to the results of the conducted analysis of the structure and the quantities of recreational resources and prices for different types of services of prolonged rest. In particular, in determining the prices of recreational services (duration of 7 days) were taken into account the following factors as: the prices for similar services of recreational-attractive areas where residents of Sumy region traditionally vacationing; the income level of residents of researched area (based on source [20]); the significance of competitive advantages of vacation without substantial transport costs and therefore time-consuming, acclimatization and so on. In particular, as a basis for establishing prices for recreational services was taken the percentage (12% – in line with European norms on vacation spending, based on [6]) of annual average income of the population of certain districts of oblast.

In formulating the limitations on financial resources, we previously proceeded from the level of profitability that does not exceed 50% and meets conditions of normal profits in the recreational sphere. The total amount of financial resources which is calculated as a weighted average (according to the values of the parameters in table 5):

$$K = N \cdot (K_h \cdot N_h + K_r \cdot N_r + K_s \cdot N_s + K_e \cdot N_e) / (N_h + N_r + N_s + N_e). \quad (7)$$

$K = 200(50000+350003+400003+300005)/(1+3+3+5)$; $K \approx 7000000$ euro, – based on the fact that exactly land resources are the basic in the recreational field. The indicated value will vary along with districts of the region in accordance with their level of investment attractiveness.

Table 2. Initial data for the calculation of local NRP and the regional recreational rent in Sumy oblast, in annual terms

Parameter	Units of measurement	The values by districts			
		1st district	2nd district	3rd district	4th district
P_h	Euro/1000 of services	100000	120000	100000	110000
P_r	Euro /1000 of services	70000	90000	90000	80000
P_s	Euro /1000 of services	80000	80000	80000	80000
P_e	Euro /1000 of services	60000	70000	60000	80000
N	Hectares	200	240	180	300
N_h^*	Hectares /1000 of services	1	1	1	1
N_r	Hectares /1000 of services	3	3	3	3
N_s	Hectares /1000 of services	3	3	3	3
N_e	Hectares /1000 of services	5	5	5	5
H	Persons	400	480	420	400
H_h^{**}	Persons /1000 of services	8	8	8	8
H_r	Persons /1000 of services	4	4	4	4
H_s	Persons /1000 of services	4	4	4	4
H_e	Persons /1000 of services	2	2	2	2
K	Euro	7000000	10000000	7000000	13000000
K_h	Euro /1000 of services	50000	60000	50000	55000
K_r	Euro /1000 of services	35000	45000	45000	40000
K_s	Euro /1000 of services	40000	40000	40000	40000
K_e	Euro /1000 of services	30000	35000	30000	45000

Notes: *Parameter values N_h, N_r, N_s, N_e meet the norms of numbers of maintenance personnel for different recreational objects, based on the source [2]. **Parameter values H_h, H_r, H_s, H_e is the reciprocal to the normative parameters of recreational load on natural complexes according to the types of recreational activity, based on the source [18].

In determining the limitations on human resources was used the following statistical information on researched region (based on source [4]): the number of employed, the level of unemployment, the number of employed in the service sector, the number of employed in restaurant and hotel business, the amount of

dismissed from that business and so on. It should be noted that the proposal of expanded development of the recreational complex in the region has a positive aspect on creation of new jobs and a partial solution to the problem of unemployment, especially in rural areas. However, it should be reckoned to the quality of human resources and approached selectively to the formation of labor potential in the recreational sphere. It is primarily about the creation of additional competitive advantages over traditional recreational territories, where the question of hospitality, professional expertise in recreational businesses, qualifications of physicians and etc. remain rather problematic. Furthermore, when considering the structure of the unemployed as a potential of future personnel of recreational enterprises should take into account respective alternatives regarding other sectors of the regional economy. In determining the total amount of lands for recreational purpose in the Sumy region were taken into account the following factors: the degree of suitability of recreational land, the proximity of industrial facilities, the development of transport routes, the distance from the oblast center, ecological factors, landscape features and the availability of tourist routes for weekend (based on source [21]). In this the special attention was paid to such nature objects and resources as protected areas of national importance, hydrological nature monuments, park-monuments of garden and park art, sources of mineral waters etc. – in accordance to maximal approach on quality of natural-recreational resources of attractive areas. In this taken into account the pioneerdom of stages of development of recreational sector in Sumy oblast and orientation of recreational needs of the population for obtaining therapeutic and aesthetic effects from the recreation during the prolonged rest "at home", that are equivalent to traditional recreation near the sea or in the mountains.

In other words an integrated approach to achieving the competitiveness of non-traditional of recreational territories compared with traditional regions of recreation is used. Along with to such factors as the lower level of expenses of recreants (especially on transportation), lower level of recreational risks, lack of acclimatization period, the highest level of hospitality compared to similar institutions of rest by "nonnative" regions – in our view, in assessing the NRP one should focus on the minimum gap in the quality of recreational resources (land and natural) of comparable territories.

Thus, according to the formulas (1) and (2) we present the calculation of NRP of one of the districts of Sumy oblast, recorded in the form of system of linear equations (according to the solution of optimizational problems of linear programming [9]):

$$\begin{cases} L = 0 - (-100 \cdot x_h - 70 \cdot x_r - 80 \cdot x_s - 60 \cdot x_e) \\ Y_N = 200 - (x_h + 3 \cdot x_r + 3 \cdot x_s + 5 \cdot x_e) \\ Y_H = 400 - (8 \cdot x_h + 4 \cdot x_r + 4 \cdot x_s + 2 \cdot x_e) \\ Y_K = 70000 - (50 \cdot x_h + 35 \cdot x_r + 40 \cdot x_s + 30 \cdot x_e) \end{cases} \quad (8)$$

In Table 3, the values in the upper left corner of each cell are recorded in accordance with the parameters of the system of equations (8). In the lower right corner of cells the calculated parameters are written in accordance with the optimization column, row and cell (in this iteration, respectively: $X_h, Y_H, \lambda=1/8$). The rules of filling in a standard table are given in the work [9].

Table 3. Standard form of recording parameters and variables of functiof on local NRP

The baseline variables	Free parameter	Free variables			
		X_h	X_r	X_s	X_e
L	0 5 000 000	-100 000 12 500	-70 000 50 000	-80 000 50 000	-60 000 25 000
Y_N	200 -50	1 -1/8	3 -1/2	3 -1/2	5 -1/4
Y_H	400 50	8 $\lambda=1/8$	4 1/2	4 1/2	2 1/4
Y_K	7 000 000 -2 500 000	50 000 -6 250	35 000 -25 000	40 000 -25 000	30 000 -12 500

In the next iterations is carried out the replacement of the basic and free variables (Tables 4 and 5), is achieved an optimum in the value of function L (NRP) – L^* , since a sign of all free variables is positive (Table 5). In this an equality $L^* = L^*_d$ is fair, i.e. the value of NRP coincides with the value of dual function of minimization of recreational resources.

Thus, the main results of the conducted iterative analysis as follows: $L^*=L^*_d=6\ 800\ 000$ euro; $X^* (20\ 000; 0; 60\ 000; 0)$; $Y^* (0; 0; 3\ 600\ 000)$; $Z^* (12\ 000; 11\ 000; 0)$.

That is, the economic assessment of local NRP of Sumy region – 6 800 000 euro; in the implementation of services of health care (at a price $P_h=100$ euro) and sports (at a price $P_s=80$ euro) recreation in volume $X_h=20\ 000$ units and $X_s=60\ 000$ units respectively; resources on which the reserve is depleted – the land Y_N and human Y_H recreational resources; the savings on investments is $Y_K=3\ 600\ 000$ euro; factorial proportions of marginal prices per unit of land and human resources in implementing the unit of recreational services equal $Z_N=12$ euro and $Z_H=11$ euro respectively.

Table 4. Transfer of limitations on recreational lands to free variables

The baseline variables	Free parameter	Free variables			
		Y_H	X_r	X_s	X_e
L	5 000 000 1 800 000	12 500 -1 500	-20 000 30 000	-30 000 12 000	-35 000 57 000
Y_N	150 60	-1/8 -1/20	5/2 1	5/2 $\lambda=2/5$	19/4 19/10
X_h	50 -30	1/8 1/40	1/2 -1/2	1/2 -1/5	1/4 -19/20
Y_K	4 500 000 -900 000	-6 250 1/48000	10 000 -15 000	15 000 -6 000	17 500 -28 500

Table 5. The final iteration of complex assessment of the local NRP of territory

The baseline variables	Free parameter	Free variables			
		Y_H	X_r	Y_N	X_e
L	6 800 000	11 000	10 000	12 000	22 000
X_s	60	-0.05	1	0.4	1.9
X_h	20	0.15	0	-0.2	-0.7
Y_K	3 600 000	-6 250	-5 000	-6 000	-11 000

We proceed to determining the value of a regional recreational rent (RRR) in districts of Sumy oblast (the results recorded in Table 12).

Baseline data, as mentioned above, derived from information concerning recreational activity in the Sumy oblast (Table 2). In this for simplification of mathematical optimization procedure, as in the case of calculation of local NRP described above, recording is conducted on 1000 units of services (iteration for the 1st district in Tables 6-8).

According to formula 9 under the terms of optimization of dual function: $L^*_d=L^*$, we will use the iterative filling of Tables 3-5 and respectively – the specific application of simplex-method in calculating of RRR (Tables 6-11).

$$\left\{ \begin{array}{l} B = |L^*_d; V_1; V_2; \dots; V_n; Z_H; Z_N| \\ V_{1,2,\dots,n} \geq 0 \\ Z_N \geq 0; \quad Z_H \geq 0 \end{array} \right. , \quad (9)$$

where B – basis of variables at the final iteration of optimization of dual function $L_{max}=L^*_d$ (optimal use of NRP of the district);

$V_{1,2,\dots,n}$ – the variables that correspond to recreational services of the types that are not appropriate to produce in the district without additional organizational arrangements;

Z_N, Z_H – the value of factorial proportions of marginal prices per unit of land and human resources respectively in implementing the unit of recreational services at the optimum value of NRP ($L_{max}=L^*_d$).

Table 6. Standard form of recording the parameters and variables of dual function

		The baseline variables				
		L_{m0}	V_h	V_r	V_s	V_e
Free parameter		0 5 000 000	-100 000 12 500	-70 000 50 000	-80 000 50 000	-60 000 25 000
Free variables	Z_N	200 -50	1 -1/8	3 -1/2	3 -1/2	5 -1/4
	Z_H	400 50	8 $\lambda=1/8$	4 1/2	4 1/2	2 1/4
	Z_K	7 000 000 -2 500 000	50 000 -6 250	35 000 -25 000	40 000 -25 000	30 000 -12 500

Table 7. Transfer of limitations on recreational lands to baseline variables

		The baseline variables				
		L_d	Z_H	V_r	V_s	V_e
Free parameter		5 000 000 1 800 000	12 500 -1 500	-20 000 30 000	-30 000 12 000	-35 000 57 000
Free variables	Z_N	150 60	-1/8 -1/20	5/2 1	5/2 $\lambda=2/5$	19/4 19/10
	V_h	50 -30	1/8 1/40	1/2 -1/2	1/2 -1/5	1/4 -19/20
	Z_K	4 500 000 -900 000	-6 250 1/48000	10 000 -15 000	15 000 -6 000	17 500 -28 500

Table 8. The final iteration of optimization of dual function (1st district)

		The baseline variables				
		L_d^*	Z_H	V_r	Z_N	V_e
Free parameter		6 800 000	11 000	10 000	12 000	22 000
Free variables	V_s	60	-0.05	1	0.4	1.9
	V_h	20	0.15	0	-0.2	-0.7
	Z_K	3 600 000	-6 250	-5 000	-6 000	-11 000

The value of free variables V on the final iteration, multiplied by 1000, display the number of recreational services in the districts. The value of the basic variable Z on the final iteration, divided by the 1,000 that correspond to factorial proportions of marginal prices on recreational resources calculated per one service (Tables 9-11).

Table 9. The final iteration of optimization of dual function (2nd district)

		The baseline variables				
		L_d^*	Z_H	Z_N	V_s	V_e
Free parameter		9 360 000	13 500	12 000	10 000	17 000
Free variables	V_r	72	-0.05	0.4	1	1.9
	V_h	24	0.15	-0.2	0	-0.7
	Z_K	5 320 000	-6 750	-6 000	-5 000	-8 500

Table 10. The final iteration of optimization of dual function (3rd district)

		The baseline variables				
		L_d^*	Z_H	Z_N	V_s	V_e
Free parameter		7 290 000	10 500	16 000	10 000	41 000
Free variables	V_r	51	-0.05	0.4	1	1.9
	V_h	27	0.15	-0.2	0	-0.7
	Z_K	3 355 000	-5 250	-8 000	-5 000	-20 500

For example, for recreation of health care type, on condition of unboundedness of investment resources (free variable $Z_K = 0$) can be written:

$$N_{h1} \cdot z_N + H_{h1} \cdot z_H = P_{h1} \Rightarrow \begin{cases} \overline{Z}_{N1} = N_{h1} \cdot z_N = x\% \\ \overline{Z}_{H1} = H_{h1} \cdot z_H = y\% \\ \overline{Z}_{N1} + \overline{Z}_{H1} = P_{h1} = 100\% \end{cases} \quad (10)$$

A digital index "1" indicates to the ordinal number of the district in which NRP is assessed.

Similarly, we find the proportions of factorial particles in prices on recreational services of other types and in other districts.

According to the formula 10 for the 1st district, relatively to values of the parameters for the 1st district obtained in Table 8, for health care recreation (formula 11) and sports recreation (formula 12) we write the equation:

$$N_{h1} \cdot z_N + H_{h1} \cdot z_H + K_{h1} \cdot z_K = P_{h1}, \quad (11)$$

$$1 \cdot z_N + 8 \cdot z_H + 50000 \cdot z_K = 100000.$$

$$N_{s1} \cdot z_N + H_{s1} \cdot z_H + K_{s1} \cdot z_K = P_{s1}, \quad (12)$$

$$3 \cdot z_N + 4 \cdot z_H + 40000 \cdot z_K = 80000.$$

Table 11. The final iteration of optimization of dual function (4th district)

	L_d^*	Z_H	V_r	V_s	Z_N	
Free parameter	8 230 000	12 368	2 632	2 632	11 053	
Free variables	V_e	52	-0.03	0.53	0.53	0.21
	V_h	37	0.13	0.37	0.37	-0.05
	Z_K	8 605 263	-6 052.63	-3 947.37	-3 947.37	-6 578.95

According to the values Z_N, Z_H, Z_K in Table 8, we find the proportions of factorial particles in prices in (11) and (12). In this at initial determination of these proportions the condition is performed: $Z_K = 0$ – as a free variable:

$$1 \cdot 12000 + 8 \cdot 11000 = 100000 \Rightarrow \overline{Z}_N = 12\%; \overline{Z}_H = 88\%;$$

$$3 \cdot 12000 + 4 \cdot 11000 = 80000 \Rightarrow \overline{Z}_N = 45\%; \overline{Z}_H = 55\%.$$

In the real structure of service is $Z_K > 0$ (the proportion of amortization of fixed assets, intangible and material resources in the price of unit of recreational service). Then, according to (10):

$$N_{h1} \cdot z_N + H_{h1} \cdot z_H + K_{h1} \cdot z_K = P_{h1} \Rightarrow \overline{Z}_{N1} + \overline{Z}_{H1} + \overline{Z}_{K1} = P_{h1} = 100\% \quad (13)$$

In formula 13 we will obtain the adjusted considering the value of Z_K proportions of factorial particles in the price of unit of recreational service of certain type. Similarly – for recreational services of other types and in other districts.

According to formula 13, we transfer the actual proportions to the structure of services and get the real value of particles of the land factor in the prices calculated per one service:

$$\overline{Z}_N + \overline{Z}_H + 50 = 100 \Rightarrow 6 + 44 + 50 = 100,$$

$$\overline{Z}_N + \overline{Z}_H + 40 = 80 \Rightarrow 18 + 22 + 40 = 80.$$

Thus, the share of the land factor in the 1st district is 6 euro – at a price of 100 euro per unit of health care services; 18 euro – at a price of euro 80 per unit of sports type services.

Weighted average value of share of land factor for the 1st district in calculated per one averaged recreational service (taking into account all types of services that are not included in the basis, i.e. their production expedient for the district):

$$\bar{Z}_{N1} = \frac{\bar{Z}_{N1h} \cdot V_{r1} + \bar{Z}_{N1s} \cdot V_{r2} + \dots + \bar{Z}_{N1r} \cdot V_m}{V_{r1} + V_{r2} + \dots + V_m}, \tag{14}$$

where $V_{r1,2,\dots,n}$ – the number of recreational services (free variables) of those types which are expedient for production in the district without additional organizational actions.

Similarly, we find the weighted average values of particles of land factor per one averaged recreational service for other districts.

According to formula 14, we find the weighted average value of share of land factor for the 1st district calculated per one averaged recreational service. At the same time as coefficients of weighing acts the number of recreational services: 20000 services of health care type, 60000 services of sports type (Table 8):

$$(6 \cdot 20000 + 18 \cdot 60000) / (20000 + 60000) = 15 \text{ euro.}$$

Similarly, we find the weighted average value of share of land factor for the 2nd, 3rd and 4th districts. A result we get:

2nd district: 15 euro; 3rd – 18.3 euro; 4th – 18.4 euro.

Next we find the closing district with a minimum value of the weighted average value of share of land factor per one averaged recreational service:

$$\bar{Z}_{Ncl} = \min\{\bar{Z}_{N1}; \bar{Z}_{N2}; \dots; \bar{Z}_{Nm}\}, \tag{15}$$

where m – the number of districts.

$$RRR_1 = \bar{Z}_{N1} - \bar{Z}_{Ncl}, \tag{16}$$

where RRR_1 – the regional recreation rent of 1st district.

Similarly calculate the value of RRR for all other districts within a particular territory.

We find the total value of the regional recreational rent for the 1st district (RRR_{S1}):

$$RRR_{S1} = RRR_1 \cdot \sum_{i=1}^n V_{ri}. \tag{17}$$

Similarly, we calculate the total value of RRR for all other districts within a particular territory.

According to formulas, 15-17 the district with the lowest magnitude of share of land factor is closing district. In our case it is the 1st and 2nd districts with a share of 15 euro. In the 3rd and 4th districts we obtain the RRR at the level of $18.3 - 15 = 3.3$ (euro/service) and $18.4 - 15 = 3.4$ (euro/service), respectively. Aggregate RRR is the multiplication of RRR calculated per one service to the number of services in district (Table 12).

Table 12. The structure of recreational services and regional recreational rent in some districts of Sumy oblast

Indicator	1st district	2nd district	3rd district	4th district
The number of recreational services within a year:				
➤ of health care type	20000	24000	27000	37000
➤ of rest houses type	–	72000	51000	–
➤ of sports type	60000	–	–	–
➤ of ecological type	–	–	–	52000
Regional recreational rent, euro/service	0	0	3.3	3.4
Aggregate regional recreational rent, thousands euro	0	0	257.4	302.6

By comparing the total values of RRR in different districts is determined most attractive district for investment (in which the RRR has a maximum value – RRR_{inv}) for the development of recreational activity in it:

$$RRR_{inv} = \max\{RRR_1; RRR_2; \dots; RRR_m\}. \tag{18}$$

As a result of comparison of all districts we obtain an overall picture of investment attractiveness, which has NRP. Consequently, the presented approach is based on economic meaning of RRR, which lies in the fact that the structure of recreational services of specified district is more optimal compared with other districts of the district that achieved through more effective organization of recreational activity in the district. According to this the main directions of RRR use are:

1. optimization of the structure of recreational services (formation of structure of recreation economy) in the region;
2. optimization of structure of investments in the recreational sphere of the region by identifying more promising, investment attractive regions;
3. increasing competition between the regions during formation of and provision of recreational services to the population;
4. creation of new jobs in the region;
5. the overall development of recreational sector and the region in a whole, to the market direction taking into account social and ecological interests.

Within the one region economic importance of recreational rent lies in the fact that some of recreational companies use higher quality recreational land in comparison with other companies, and therefore receive additional income, which is the basis for the differential (of the first and of the second kind) recreational rent. In a basis of use of given recreational rent should be laid its targeted reinvestment in reconstitution of recreational resources of the region and complex development of its natural-recreational potential.

According to the formula 18 comparing the received values of RRR, it can be concluded about the existence of advantage in opportunity to obtain greater rent effects in districts with higher value of PPP (results is presented in Table 17 below). We proceed to analysis of the nature of the influence of change of parameters in accord with formulas 5 and 6 in keeping with methodical provisions of the application optimization model of dual assessments at use of NRP of the territory:

1. Analysis of the limits of constancy of prices on recreational services that was not included in the basic plan for the development of recreation in the district (analysis of changes in coefficients of the objective function L with free variables ΔP). From the results of the conducted complex assessment of NRP of the territory (Table 5) is evident that the free variables (volumes of recreational services of relevant types) – X_r and X_e . Hence, we will examine the changes of coefficients (prices on service) $P_r = 70$ euro and $P_e = 60$ euro (according to the first equation of the system of equations 8). Consider the economically acceptable limits of changes of the coefficient P_r .

Provide the objective function

$$L = 100 \cdot x_h + 70 \cdot x_r + 80 \cdot x_s + 60 \cdot x_e \rightarrow \max$$

with increment

$$L' = 100 \cdot x_h + (70 + \Delta P_r) \cdot x_r + 80 \cdot x_s + 60 \cdot x_e \rightarrow \max$$

Then in Table 3 will get $70 + \Delta P_r$ instead of 70.

As a result of solving of given form we will obtain on the final iteration (according to Table 5) the following form – Table 13.

Table 13. Change in the price on recreational services in rest houses according to the final iteration of complex assessment of NRP of the territory

The baseline variables	Free parameter	Free variables			
		Y_H	X_r	Y_N	X_e
L	6 800 000	11 000	10 000	12 000	$22\ 000 - \Delta P_r$
X_s	60	-0.05	1	0.4	1.9
X_h	20	0.15	0	-0.2	-0.7
Y_K	3 600 000	-6 250	-5 000	-6 000	-11 000

From Table 13 evident that the only change that is caused by the transition from $70 + \Delta P_r$ to ΔP_r is the change of coefficient in row of the objective function in the column X_e , which is an additional dual assessment of V_e (Table 8). That is for the $70 + \Delta P_r$ and the corresponding optimum value of $V_e^* = 22000$ change occurs $V_e^{**} = 22000 - \Delta P_r$.

The economic importance of additional dual assessment is to explain none expediency of provision of recreational services of relevant type.

Thus $V_e^* = 10000$ means that the marginal cost on production of service of the ecological type of recreation exceed the price of a given service $10000/1000 = 10$ euro.

On the basis of optimality the value of the objective function will be optimal at

$$22000 - \Delta P_r \geq 0 \Rightarrow \Delta P_r \leq 22000$$

$$V_r^* = 22000 \Rightarrow \max \Delta P_r = V_r^* = 22000$$

Since the X_e is not included in the optimal solution (NRP of the territory), the ΔP_r can be arbitrarily small, i.e. $\min \Delta P_r = -\infty$.

Then the limits of change ΔP_r : $-\infty < \Delta P_r \leq 22000$

We proceed from ΔP_r to P_r :

$$\min P_r = P_r + \min \Delta P_r;$$

$$\max P_r = P_r + \max \Delta P_r;$$

$$\min P_r \leq P_r \leq \max P_r.$$

Since the negative value of P_r , which means the price of recreational service is meaningless, then $\min P_r = 0$ and the limits of change P_r will look like:

$$0 \leq P_r \leq \max P_r;$$

$$0 \leq P_r \leq P_r + V_r^*.$$

In our case calculated per one service $P_r = 70$ euro, $V_e^* = 22$ euro.

Then the limits of change will be equal to: $0 \leq P_r \leq 92$.

That is the changes of P_r in these limits leads only to change of V_r :

$$V_r^{**} = V_r^* - \Delta P_r.$$

All the latest characteristics of optimal solution remain unchanged.

Similarly to the above algorithm were determined the limits of sustainability for the price of recreational services of ecological type: $0 \leq P_e \leq 70$.

2. Analysis of the limits of sustainability of prices on recreational services that was included in the baseline plan of development of recreation in the district (analysis of changes in the coefficients of the objective function L at baseline variables ΔP).

From Table 5 is evident that the basic variables (volumes of recreational services of health care and sports recreation) – X_h and X_s . Hence, we are going to examine change of coefficients (the prices on services) $P_h = 100$ euro and $P_s = 80$ euro (according to the first equation of the system of equations 8). Consider the economically acceptable limits of change of coefficient P_h .

Provide the objective function

$$L = 100 \cdot x_h + 70 \cdot x_r + 80 \cdot x_s + 60 \cdot x_e \rightarrow \max$$

with increment

$$L' = (100 + \Delta P_h) \cdot x_h + 70 \cdot x_r + 80 \cdot x_s + 60 \cdot x_e \rightarrow \max.$$

Then will get $100 + \Delta P_h$ instead of 100 in Table 3.

As a result of solving of given form we will obtain on the final iteration (according to Table 5) the following form – Table 14.

Table 14. Change in the price on service of health care recreation according to the final iteration of complex assessment of NRP of the territory

The baseline variables	Free parameter	Free variables			
		Y_H	X_r	Y_N	X_e
L	6 800 000+ $+20 \Delta P_h$	11 000+ $+0,15 \Delta P_h$	10 000	12 000 – $-0,2 \Delta P_h$	22 000 – $-0,7 \Delta P_h$
X_s	60	-0.05	1	0.4	1.9
X_h	20	0.15	0	-0.2	-0.7
Y_K	3 600 000	-6 250	-5 000	-6 000	-11 000

We get the system of inequalities:

$$\begin{cases} 11000 + 0.15\Delta P_h \geq 0 \\ 12000 - 0.2\Delta P_h \geq 0 \\ 22000 - 0.7\Delta P_h \geq 0 \end{cases} \Rightarrow \begin{cases} \Delta P_h \geq -73333 \\ \Delta P_h \leq 60000 \\ \Delta P_h \leq 31429 \end{cases} \Rightarrow -73333 \leq \Delta P_h \leq 31429$$

Hence calculated per one service:

$$\begin{cases} \min \Delta P_h = -73.3 \\ \max \Delta P_h = 31.4 \end{cases} \Rightarrow \begin{cases} \min P_h = P_h + \min \Delta P_h \\ \max P_h = P_h + \max \Delta P_h \end{cases} \Rightarrow 26.7 \leq P_h \leq 131.4$$

Given that it is forecasted the positive trend of change in prices for recreational services, then according to the initial price on the service of health care recreation:

$$100 \leq P_h \leq 131.4$$

When changing the P_h in the defined limits are kept the structure of recreational services that provided in the district. The row of objective function is changing – in our case:

1. The value of NRP is changing by the equation $L^{**} = L^* + 20\Delta P_h$:

$$5333340 \leq L^{**} \leq 12761920;$$

2. Factorial proportions of marginal prices on recreational land and human resources are changing (calculated per one service), respectively:

$$\begin{cases} Z_N^{**} = Z_N^* - 0.2\Delta P_h \\ Z_H^{**} = Z_H^* + 0.15\Delta P_h \end{cases} \Rightarrow \begin{cases} 0 \leq Z_N^{**} \leq 26.7 \\ 0 \leq Z_H^{**} \leq 15.7 \end{cases}$$

Similarly to the above algorithm were determined the limits of sustainability for the price of recreational services of sports type:

$$\begin{cases} 11000 - 0.05\Delta P_s \geq 0 \\ 10000 + \Delta P_s \geq 0 \\ 12000 + 0.4\Delta P_s \geq 0 \\ 22000 + 1.9\Delta P_s \geq 0 \end{cases} \Rightarrow \begin{cases} \Delta P_s \leq 220000 \\ \Delta P_s \geq -10000 \\ \Delta P_s \geq -30000 \\ \Delta P_s \geq -11579 \end{cases} \Rightarrow -10000 \leq \Delta P_s \leq 220000;$$

calculated per one service:

$$\begin{cases} \min \Delta P_s = -10 \\ \max \Delta P_s = 220 \end{cases} \Rightarrow \begin{cases} \min P_s = P_s + \min \Delta P_s \\ \max P_s = P_s + \max \Delta P_s \end{cases} \Rightarrow 70 \leq P_s \leq 300$$

$$L^{**} = L^* + 60\Delta P_h;$$

$$6200000 \leq L^{**} \leq 20000000.$$

$$\begin{cases} Z_N^{**} = Z_N^* + 0.4\Delta P_s \\ Z_H^{**} = Z_H^* - 0.05\Delta P_s \end{cases} \Rightarrow \begin{cases} 8 \leq Z_N^{**} \leq 1000 \\ 0 \leq Z_H^{**} \leq 11.5 \end{cases}$$

3. Analysis of limitations on recreational resources on which reserve is absent within the defined territory.

The results of the final iteration of complex assessment of NRP of the territory in Table 5 indicate that the reserve on recreational lands ($N = 200$ hectares) and human recreational resources ($H = 400$ persons) is absent. Consider the change of area recreational lands. We change the N to ΔN according to formula 6. In this limitation on recreational lands becomes:

$$x_h + 3 \cdot x_r + 3 \cdot x_s + 5 \cdot x_e \leq 200 + \Delta N$$

After reduction to standard form:

$$Y_N = (200 + \Delta N) - (x_h + 3 \cdot x_r + 3 \cdot x_s + 5 \cdot x_e)$$

As a result, of search of optimal solution (Table 15) we get:

Table 15. Change in limitations on recreational land according to the final iteration of complex assessment of NRP of the territory

The baseline variables	Free parameter	Free variables			
		Y_H	X_r	Y_N	X_e
L	$6\,800\,000 + 12\,000\Delta N$	11 000	10 000	12 000	22 000
X_s	$60 + 0.4\Delta N$	-0.05	1	0.4	1.9
X_h	$20 - 0.2\Delta N$	0.15	0	-0.2	-0.7
Y_K	$3\,600\,000 - 6\,000\Delta N$	-6 250	-5 000	-6 000	-11 000

$$\begin{cases} 60 + 0.4\Delta N \geq 0 \\ 20 - 0.2\Delta N \geq 0 \\ 3\,600\,000 - 6\,000\Delta N \geq 0 \end{cases} \Rightarrow \begin{cases} \Delta N \geq -150 \\ \Delta N \leq 100 \\ \Delta N \leq 600 \end{cases} \Rightarrow -150 \leq \Delta N \leq 100$$

$$\begin{cases} \min N = N + \min \Delta N \\ \max N = N + \max \Delta N \end{cases} \Rightarrow \min N \leq N \leq \max N \Rightarrow 50 \leq N \leq 300$$

Change of areas of recreational lands within certain limits will not violate the structure of the recreational services that provided in the district. However, the value of NRP of the territory will change (1) and the number of services on the types of recreational activity in the district (2):

1) $L^{**} = L^* + 12\,000\Delta N$:

$$500\,000 \leq L^{**} \leq 8\,000\,000$$

2) $\begin{cases} X_h^{**} = X_h^* - 0.2 \cdot \Delta N \\ X_s^{**} = X_s^* + 0.4 \cdot \Delta N \end{cases} \Rightarrow \begin{cases} 0 \leq X_h^{**} \leq 5000 \\ 0 \leq X_s^{**} \leq 10000 \end{cases}$

Similarly to the above algorithm were determined the limits of sustainability for constraints on human resources:

$$\begin{cases} 60 - 0.05\Delta H \geq 0 \\ 20 + 0.15\Delta H \geq 0 \\ 3\,600\,000 - 6\,250\Delta H \geq 0 \end{cases} \Rightarrow \begin{cases} \Delta H \leq 1200 \\ \Delta H \geq -133 \\ \Delta H \leq 576 \end{cases} \Rightarrow -133 \leq \Delta H \leq 576$$

$$\begin{cases} \min H = H + \min \Delta H \\ \max H = H + \max \Delta H \end{cases} \Rightarrow \min H \leq H \leq \max H \Rightarrow 267 \leq H \leq 976$$

1) $L^{**} = L^* + 11\,000\Delta H$:

$$5337000 \leq L^{**} \leq 13136000$$

$$2) \begin{cases} X_h^{**} = X_h^* + 0.15 \cdot \Delta H \\ X_s^{**} = X_s^* - 0.05 \cdot \Delta H \end{cases} \Rightarrow \begin{cases} 0 \leq X_h^{**} \leq 10640 \\ 3120 \leq X_s^{**} \leq 6665 \end{cases}$$

4. Analysis of limitations on recreational resources on which are the reserve within the defined territory.

The results of the final iteration of complex assessment of NRP of the territory in Table 5 indicate that there is a reserve on financial recreational resources ($K = 7000000$ euro). Consider the change of financial recreational resources. We change the K to ΔK (according to Formula 6). In this limitation on recreational lands becomes:

$$50 \cdot x_h + 35 \cdot x_r + 40 \cdot x_s + 30 \cdot x_e \leq 7000000 + \Delta K .$$

After reduction to standard form:

$$Y_K = (7000000 + \Delta K) - (50 \cdot x_h + 35 \cdot x_r + 40 \cdot x_s + 30 \cdot x_e) .$$

As a result, of search of optimal solution (Table 16) we get: with compliance the initial conditions of investment, i.e. positive tendency of change of financial investments ($\Delta K \geq 0$) and setting the upper limit of investment ($K \leq 7000000$):

$$\begin{cases} \min K = K + \min \Delta K \\ \max K = K + \max \Delta K \end{cases} \Rightarrow \min K \leq K \leq \max K \Rightarrow 3600000 \leq K \leq 7000000 .$$

Table 16. Change in limitations on financial recreational resources according to the final iteration of complex assessment of NRP of the territory

The baseline variables	Free parameter	Free variables			
		Y_H	X_r	Y_N	X_e
L	6 800 000	11 000	10 000	12 000	22 000
X_s	60	-0.05	1	0.4	1.9
X_h	20	0.15	0	-0.2	-0.7
Y_K	3 600 000 + ΔK	-6 250	-5 000	-6 000	-11 000

Change in financial resources within certain limits will not affect the value of the objective function (NRP of the territory) and the structure and amount of recreational services in the district. The only value that changes is the reserve on financial recreational resources. The main results of conducted research on the example of NRP of Sumy oblast are set out in Tables 17-23.

Table 17. The investment attractiveness of districts of Sumy oblast from the perspective of development of recreational activity

District	Indicator of attractiveness ($\bar{Z}_{N(1)}$)	Rating (from I to III)	District	Indicator of attractiveness ($\bar{Z}_{N(1)}$)	Rating (from I to III)
Bilopilsky	5.5	III	Nedryhaylivsky	10.4	II
Burynsky	6.9	III	Okhtyrsky	14.6	I
Velykopusarivsky	12.3	II	Putyvlsky	15.7	I
Hlukhivsky	13.4	I	Romensky	12.5	I
Konotopsky	10.8	II	Seredynobudsky	9.0	III
Krasnopilsky	9.3	III	Sumsky	14.5	I
Krolevetsky	11.2	II	Trostanetsky	13.0	I
Lebedynsky	15.9	I	Shostkynsky	10.1	II
Lypovodolynsky	7.8	III	Yampilsky	6.7	III

Table 18. Investments in development of recreational activity by type of recreational services by districts of Sumy oblast

District	Types of recreational activity	Investments, ths. euro	District	Types of recreational activity	Investments, ths. euro
Bilopilskyy	health care sports	3 400	Nedryhaylivskyy	health care sports	4 147
Burynskyy	health care rest houses	3 645	Okhtyrskyy	health care rest houses	4 680
Velykopusarivskyy	health care ecological	4 027	Putyvlskyy	health care ecological	4 132
Hlukhivskyy	health care ecological	4 106	Romenskyy	health care rest houses	4 115
Konotopskyy	health care sports	4 442	Seredynobudskyy	sports ecological	3 853
Krasnopilskyy	health care sports	3 580	Sumskyy	rest houses ecological	5 635
Krolevetskyy	health care rest houses	4 081	Trostianetskyy	health care rest houses	3 637
Lebedynskyy	health care sports	5 114	Shostkynskyy	health care rest houses	4 819
Lypovodolynskyy	sports ecological	2 974	Yampil'skyy	health care rest houses	4 120

Table 19. Absolute values and limits of change (caused by price dynamics on recreational services) of values for local NRP on districts of Sumy oblast

District	NRP, ths. euro	NRP – ΔNRP, ths. euro	NRP + ΔNRP, ths. euro	District	NRP, ths. euro	NRP – ΔNRP, ths. euro	NRP + ΔNRP, ths. euro
Bilopilskyy	6 800	5 980	7 615	Nedryhaylivskyy	8 295	4 330	12660
Burynskyy	7 290	5 609	10089	Okhtyrskyy	9 360	6 090	13440
Velykopusarivskyy	8 053	3 880	11230	Putyvlskyy	8 263	6 005	11380
Hlukhivskyy	8 211	6 554	10950	Romenskyy	8 230	5 670	12770
Konotopskyy	8 884	4 980	11090	Seredynobudskyy	7 706	3 680	10095
Krasnopilskyy	7 159	4 320	9 980	Sumskyy	11271	7 990	14640
Krolevetskyy	8 192	4 890	11240	Trostianetskyy	7 273	4 780	11440
Lebedynskyy	10228	7 460	14070	Shostkynskyy	9 637	5 580	12030
Lypovodolynskyy	7 947	4 440	9 550	Yampil'skyy	8 240	4 225	10035

Table 20. Dynamics of prices on recreational services of certain types while maintaining the structure of NRP of the territory

District	Type of service	Price, euro		District	Type of service	Price, euro	
		min	max			min	max
Bilopilskyy	health care sports	1000 800	1320 1210	Nedryhaylivskyy	health care sports	1050 800	1275 1005
Burynskyy	health care rest houses	1000 900	1220 1050	Okhtyrskyy	health care rest houses	1200 900	1340 1105
Velykopusarivskyy	health care ecological	1100 700	1325 970	Putyvlskyy	health care ecological	1100 800	1290 1030
Hlukhivskyy	health care ecological	1180 870	1490 1300	Romenskyy	health care rest houses	1220 880	1490 1100
Konotopskyy	health care sports	1100 980	1410 1155	Seredynobudskyy	sports ecological	840 780	1040 905
Krasnopilskyy	health care sports	970 800	1205 1080	Sumskyy	rest houses ecological	1220 800	1560 1350
Krolevetskyy	health care rest houses	1190 900	1410 1170	Trostianetskyy	health care rest houses	1040 870	1200 1100
Lebedynskyy	health care sports	950 1000	1320 1200	Shostkynskyy	health care rest houses	900 910	1270 1235
Lypovodolynskyy	sports ecological	780 800	975 940	Yampil'skyy	health care rest houses	1160 880	1340 990

Table 21. Volumes and upper limit of forecasted increase of recreational services by districts of Sumy oblast

District	Type of service	Volume of services, units	Volume + max Δ , units	District	Type of service	Volume of services, units	Volume + max Δ , units
Bilopil'skyy	health care sports	20000 60000	37000 85000	Nedryhayliv'skyy	health care sports	31000 63000	42800 80100
Buryn'skyy	health care rest houses	27000 51000	30700 67900	Okhtyr'skyy	health care rest houses	24000 72000	30100 80500
Velyko-pusariv'skyy	health care ecological	57630 24470	80550 29750	Putyv'skyy	health care ecological	36840 52630	43000 73000
Hlukhiv'skyy	health care ecological	41840 37630	65750 67100	Romenskyy	health care rest houses	35000 45000	43600 87000
Konotop'skyy	health care sports	13500 75500	19000 86000	Seredyno-bud'skyy	sports ecological	77140 15710	105450 20700
Krasnopil'skyy	health care sports	7000 81000	15300 120500	Sum'skyy	rest houses ecological	112140 710	130700 2600
Krolevet'skyy	health care rest houses	28000 54000	34500 72400	Trostianet'skyy	health care rest houses	23500 55500	34500 90700
Lebedyn'skyy	health care sports	14500 88500	18900 104300	Shostkyn'skyy	health care rest houses	9000 97000	20350 128000
Lypovo-dolyn'skyy	sports ecological	83570 17860	114300 24000	Yampil'skyy	health care rest houses	24000 62000	35700 90700

Table 22. Limits of sustainability for limitations on land resources and conditioned by them changes of value of local NRP by districts of Sumy oblast

District	Area of recreational lands		NRP – Δ NRP, thousands euro	NRP + Δ NRP, thousands euro
	– max Δ , hectares	+ max Δ , hectares		
Bilopil'skyy	170	230	5 960	7 605
Buryn'skyy	150	210	5 579	10069
Velykopusariv'skyy	150	210	3 860	11210
Hlukhiv'skyy	200	260	6 534	10930
Konotop'skyy	210	270	4 960	11070
Krasnopil'skyy	220	280	4 300	9 950
Krolevet'skyy	160	220	4 870	11210
Lebedyn'skyy	250	310	7 440	14060
Lypovodolyn'skyy	310	370	4 420	9 520
Nedryhayliv'skyy	190	250	4 310	12630
Okhtyr'skyy	210	270	6 070	13420
Putyv'skyy	270	330	6 000	11350
Romenskyy	140	200	5 650	12750
Seredynobud'skyy	280	340	3 640	10055
Sum'skyy	310	370	7 970	14620
Trostianet'skyy	160	220	4 760	11410
Shostkyn'skyy	270	330	5 560	12010
Yampil'skyy	180	340	4 205	10015

Table 23. Limits of sustainability for limitations on human resources and conditioned by them changes of value of local NRP by districts of Sumy oblast

District	The number of human resources involved in recreational activity		NRP – Δ NRP, ths. euro	NRP + Δ NRP, ths. euro
	– max Δ , persons	+ max Δ , persons		
Bilopil'skyy	370	440	5 960	7 635
Buryn'skyy	400	465	5 600	10120

Table 23 (cont.). Limits of sustainability for limitations on human resources and conditioned by them changes of value of local NRP by districts of Sumy oblast

District	The number of human resources involved in recreational activity		NRP – ΔNRP, ths. euro	NRP + ΔNRP, ths. euro
Velykopusarivskyy	460	550	3 820	11430
Hlukhivskyy	370	430	6 524	10990
Konotopskyy	380	440	4 960	11290
Krasnopilskyy	350	420	4 300	9 995
Krolevetsky	410	475	4 860	11290
Lebedynskyy	440	505	7 430	14170
Lypovodolynskyy	330	385	4 410	9 590
Nedryhaylivskyy	470	535	4 300	12690
Okhtyrskyy	440	520	6 000	13540
Putyvlskyy	360	435	6 000	11490
Romenskyy	420	505	5 650	12790
Seredynobudskyy	310	370	3 650	10135
Sumskyy	520	590	7 970	14690
Trostianetsky	340	455	4 750	11490
Shostkynskyy	430	500	5 560	12130
Yampil'skyy	410	495	4 220	10080

Conclusions

As a result of the conducted research the following conclusions can be made. Firstly, a complex economic assessment of natural-recreational potential of Sumy oblast was carried out, the values of regional recreational rent in districts of Sumy oblast was defined. The character of influence of change of parameters of the objective function of maximization of recreational product on the aggregate magnitude and structure of recreational services is analyzed, in accordance with methodical provisions of application the optimization instrument of dual assessments at use of natural-recreational potential of the territory: an analysis of the limits of sustainability of prices on recreational services that are included or not included to the baseline plan of recreational development in districts of oblast; analysis of limitations on recreational resources on which is absent or available reserve within the framework of defined territory.

Secondly, among the main results of conducted complex assessment of natural-recreational potential of Sumy oblast highlighted the following: defined the investment attractiveness of districts of the oblast from the perspective of development in them the recreational activity; determined the volume of investments in development of recreational activity by types of recreational services on districts of oblast; assessed the absolute values and limits of change of local natural-recreational potentials conditioned by the dynamics of prices on recreational services in districts of oblast; researched the dynamics of prices on recreational services of defined types of while maintaining the structure of natural-recreational potential of the oblast; determined the volumes and upper limits of forecasted increase of recreational services on districts of oblast; determined the limitations of sustainability for constraints on land and labor resources and conditioned by them change in the magnitude of local natural-recreational potential on districts of oblast.

Further studies will be focused on the development of models of management of investment recreational resources in the system of the national economy, especially in view of the recreational impact on health of the population.

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