Sustainable development of forest recreation management as a basis for environmental safety

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Abstract. The article examines the determinants of the concept of forest recreation management. Based on a critical analysis of scientific works on the study of the component composition of recreational forest use, three components have been identified, namely: recreational resources, recreational facilities, recreational activities. Four key components of recreational forest use have been identified: resource, social, economic, innovation and investment. The main indicators of the development of forest recreation management taking into account the component distribution have been investigated. A model for determining the overall efficiency of recreational forest use by taking into account the efficiency of each selected component is proposed. Usage of Excel is suggested to predict the level of recreational forest use.

1. Introduction
As foreign experience shows [1,2,3,4,5,6], recreation is an important and large-scale strategic field of activity, which becomes more and more attractive for investment with every year and, while being the measuring point of the cultural development of the country, it is also a fairly high source of income to the state and local budgets. Recreational activities play an important role in the economy of countries and regions, ensuring the rational use and preservation of natural, ecological, cultural, historical, informational and educational resources of the territory [7]. Unfortunately, unlike many countries around the world, in Ukraine there is no effective use of the regions’ existing recreational potential, which leads to a loss of opportunities for the development of this industry. Therefore, there is a need to assess the available recreational resources and the existing recreational potential of the country as a whole and its individual administrative-territorial units and to develop directions and ways of its increasing and efficient use.

Taking into account the transformation processes of the domestic economy and its regions [8, 9], it is possible to single out the activity’s intensification of the subjects of the recreational and tourist complex. The need for the formation, justification and management decisions is kept up to date in order to improve the efficiency of recreational and tourist potential in general and each of its components in particular, along with improving the methods of organizational and financial resourcing for the development of recreation at both macro and micro levels [9].
Increasingly, in modern conditions of recreation areas’ organization one can employ different types of recreational forest use for its consumers (tourists), and traditionally, among which are utilitarian (recreational), health, sports, entertainment, treatment and prevention, excursion.

These types of forest recreation use are transformed into specialized institutions and establishments, territorial centers of various sizes and profiles. All recreational forest areas perform the following functions: biological – improving health; psychophysiological - restoration of viability and psycho-emotional health of people; socio-cultural - communication and observation of nature, personal enrichment; economic – increasing labor productivity, development of recreational forest services.

Recreation of forest use is formed on the basis of the use of recreational resources – forest plantations, open spaces, territories of natural and artificial landscapes, reservoirs, etc.; recreational facilities (cells) that perform certain recreational functions; a separate component is recreational activities, which include the management of recreational facilities, the scope of services for the provision of recreational services. In general, the recreation of forest use with its components and their functional manifestations is shown in Figure 1.

Fig: 1 Components of forest recreation management

The organization of forest recreation management is based on the components of recreational forest use, which are shown in Figure 1. The main objective of the organization is to form a full-fledged environment with the provision of consumers with recreational facilities, in compliance with regulatory pedestrian and transport accessibility, taking into account social and age groups, modern requirements and needs of consumers.

Background

One must point out the noteworthiness of the scientific work of N. Vlashchenko [10], who states that an important factor in the sustainable development of the socio-economic system and ensuring the competitive advantages of recreational activities is the availability of sanatorium services. Developing this idea, the author identifies factors that increase the level of availability of recreational services such as: reducing the cost of services; the level of state support of the arenas; targeted support of vacationers; increasing the welfare of the population; raising awareness; development of a culture of healthy lifestyle; diversification of the range of services; verification of stay terms; verification of
payment forms; introduction of innovations in the service sector [11]. In [12] the mathematical model of the optimal distribution of financial flows of the enterprise is considered. The proposed algorithm can be used with the optimal distribution of the components of recreational forest management. The article [13] proposes an approach to forecasting the development of a number of key indicators depending on a set of control parameters. Within the framework of this approach, it becomes possible to carry out scenario forecasting and control, as well as to determine the time delay when the effect of changing the control parameters can be observed.

Topicality of research into the development of forest recreation management is justified by growing uncertainty of changes in socio-eco-economic processes on tax environment climate [14].

To determine the potential of recreational forest use, it is necessary to develop a system of indicators that would characterize the components of the potential (Figure 2). The selected list of indicators should show a realistic picture of the available potential, the efficiency of its use and indicate the reserves for improving its components. The analysis of such indicator system should vector the ways and directions of solving problems related to improving the use efficiency of recreational potential of the forest management, planning further recreation development, making managerial decisions on the feasibility of further forest use for recreational purposes.

**Fig: 2 Components of forest use potential**

Examining the work of domestic and foreign experts on the assessment of recreational potential, one can determine that there are many points of view on determining the recreational potential components. I. Zorin studies the tourist and recreational system in general and believes that this system is formed at the junction of three separate subsystems – nature, society, economy – and contains components of these subsystems: natural resources, tourists, tourism facilities [15]. A. Drozdov also explores the tourist and recreational potential, but proposes to identify the following components: the first component – the natural and cultural landscapes, the second - the means and conditions of tourist and recreational activities [16, p. 122]. N. Sviatokho [17, p. 32] and V. Herasymenko [18] consider the tourist and recreational potential of the territories through the allocation of four main components: natural-resort, historical-cultural, economic and social, which are interconnected and interact with each other. Professor A. Terebukh [19, p. 341] considers the tourist and recreational potential as a set of five components: natural, natural-anthropogenic, historical-
cultural, infrastructural, investment. N. Korzh and D. Basiuk [20, p. 56] and I. Smirnov [21] distinguish the following components of tourist and recreational potential: resources, personnel, finance, marketing, innovation. T. Shelemetieva in her work [22] defines that the fact that the basis of tourist and recreational potential are tourist resources is indisputable. Tourist resources are a set of natural and anthropogenic resources of the respective territory, which meet the various needs of tourists and can be used for recreation, tourism and health [23]. Only due to the presence of springs, lakes, rivers, historical and cultural monuments, favorable climatic conditions, picturesque landscapes in a certain area, tourist and recreational activities can be developed, which is well known fact [24, p. 17]. However, to obtain a high socio-economic effect from the development of tourist and recreational activities is possible only as a result of recreational development of the territory, its improvement, development of material and technical base, etc. [25].

2. Methodology
Summing up the results of previous research, one can conclude that scientists focus on identifying the components of tourism and recreational potential in general, when we propose to study one of the components of tourism and recreational potential, namely the potential of recreational forest use. Thus, based on the experience of previous research, the following structural components of the potential of recreational forest use can be formed: resource component; social component, economic component, innovation and investment component.

The overall efficiency of recreational forest use depends on the efficiency of use of each component of the recreational forest use potential. Thus, it is possible to reflect the overall efficiency of recreational forest use by the following system of inequalities:

\[
\begin{aligned}
E_{p2} &= \sum_{i=1}^{n} e_i; \\
e_i &= f(x_{i1}, x_{i2}, \ldots, x_{ij}); \\
x_{ij} &\in R
\end{aligned}
\]

e_i – the efficiency of use of the \(i\)-th component of the recreational forest use potential; 
\(x_{ij} \) – \(j\)-th characteristic of the use efficiency of the \(i\)-th component of the recreational forest use potential.

Each of the components of recreational forest use is characterized by a system of indicators of efficiency of its use. According to the above characteristics of each of the components, we can offer the following system of indicators, which is shown in Table 1.

The resource component of the potential of recreational forest use is the most important, as the availability of tourist resources already ensures the minimal development of this potential and provokes its use. This is due to the fact that for a person to restore the energy spent during work is enough to change the traditional environment, travel beyond the place of residence, even if there is no comfortable accommodation and quality tourist infrastructure [7]. This component is characterized by qualitative and quantitative characteristics (indicators).

The authors [7] determine the indicators for assessing the components of tourism and recreational potential, which are listed in Table 3.1.

It is known that for a comprehensive assessment of any economic process or its components one should use methods of integrated indicators constructing using various economic and mathematical methods and approaches. The complexity of the assessment is to evaluate the potential of recreational forest use, taking into account the development of all its components. Therefore, we propose to assess the potential of recreational forest use by performing the following stages: to determine the components of the potential of recreational forest use; to develop and form a system of quantitative and qualitative indicators (indicators) for assessing the effectiveness of the potential of recreational forest use by its component composition; to assess the effectiveness of recreational forest use in the region by individual components of the potential of recreational forest use using certain indicators; comprehensively assess the effectiveness of each component of the potential of recreational forest use;
to conduct an integrated assessment of the effectiveness of recreational forest use using taxonomic analysis methods and fuzzy set theory; to determine the level of use of the potential of recreational forest use by comparing the value of the integrated indicator with its normative (critical) values [7].

Table 1 Indicators for assessing the components of tourism and recreational potential

| Component of tourist and recreational potential | Indicators |
|------------------------------------------------|------------|
| Resource component                              |            |
| potential of natural resources by separate categories; |
| degree of development of natural tourist resources; |
| recreational capacity of the territory;         |
| norms of admissible recreational load on the territory; |
| resistance of natural complexes to recreational load; |
| saturation of the territory with historical and cultural monuments; |
| the level of significance of historical and cultural monuments; |
| the amount of necessary and sufficient time to review the values; |
| historical, cultural, other value of monuments; |
| current state and level of preservation of historical and cultural resources. |
| provision of the territory with accommodation for different categories of tourists and vacationers; |
| number of seats, load factor, profit per 1 place in accommodation facilities; |
| the number of employees in the industry;        |
| the average area of accommodation per 1 place;  |
| the number of enterprises and the number of seats at restaurant enterprises per thousand inhabitants of the region; |
| turnover of restaurant enterprises;             |
| the number of media in the region;              |
| the level of development of mass media, information systems and technologies; |
| state subsidies in the field of tourism and recreation; |
| funds of business entities aimed at the development and implementation of new technologies for the use of tourist resources; |
| financing of measures aimed at improving the level of tourist services and the quality of services provided; |
| volume of domestic and foreign investments in the tourist and recreational sphere; |
| funds of investors aimed at construction, reconstruction and modernization of tourist and recreational enterprises; |
| funds of investors aimed at the creation or development of enterprises of tourist and recreational infrastructure; |
| the number of newly formed enterprises due to investment activities; |
| legal acts regulating the activity of the tourist-recreational sphere; |
| indicators of management efficiency.            |
| number of employees in the tourist and recreational sphere; |

| Social component Economic component |            |
|-------------------------------------|------------|
| the number of educational institutions of all types that train specialists in tourism; |
| licensed volume of educational institutions of all types for the training of tourism specialists |

Source: calculated by the authors
Based on the experience of previous research on the problems of recreational forest use, the following structural components of the potential of recreational forest use can be formed: resource component, social component, economic component, innovation and investment component. Each of the components of recreational forest use is characterized by a system of efficiency indicators. The article [7] has proposed a method for calculating the potential of forest use on the example of a typical forestry of the Western region of Ukraine, which included 8 forestries. According to the results of the assessment of recreational forest use, it was concluded that the potential of recreational forest use in Ukraine is at a low level (Figure 1, Table 2), so it is necessary to take measures that will improve the results of recreational activities and develop the industry. According to the calculations, first of all it is necessary to develop the economic and innovation-investment component of the potential of recreational forest use in Ukraine.

![Integral indicator of recreational forest management level](image)

**Table 2** Taxonomic Analysis Results of Recreational Forest Management of a Typical Forestry

| Indicator                                      | Forestry 1 | Forestry 2 | Forestry 3 | Forestry 4 | Forestry 5 | Forestry 6 | Forestry 7 | Forestry 8 |
|------------------------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|
| Taxonomic indicator of resource component      | 1.00       | 0.51       | 0.33       | 0.36       | 0.32       | 0.33       | 0.31       | 0.33       |
| Taxonomic indicator of social component         | 1.00       | 0.56       | 0.56       | 0.30       | 0.30       | 0.21       | 0.39       | 0.39       |
| Taxonomic indicator of economic component       | 0.00       | 0.00       | 0.00       | 0.00       | 0.00       | 0.00       | 0.00       | 0.00       |
| Taxonomic indicator of innovation and investment component | 0.00       | 0.00       | 0.00       | 0.00       | 0.00       | 0.00       | 0.00       | 0.00       |
| Integral indicator of recreational forest management potential level | 0.50       | 0.27       | 0.22       | 0.16       | 0.16       | 0.14       | 0.17       | 0.18       |

Taking into account the obtained results of calculations of the integrated indicator of recreational forest use, it is important to forecast it for future periods. As a base of research we will choose the studied forestry of the Western region. Forecasting can be done using MS Excel software to build different trend lines. To do this, we calculate the overall taxonomic index of recreational forest use. The obtained calculations of the generalized taxonomic indicator are shown in Figure 3.
To determine the optimal trend line, use the wizard to build all possible trend lines in Excel. The results are shown in Figures 4 - 6.

![Integral indicator of the level of recreational forest use potential](image)

**Fig: 4** Integral indicator of the level of recreational forest use potential

Therefore, based on the obtained constructed trend lines, the most representative is a third-order polynomial, as the regression coefficient for this trend is the closest to 1, namely 0.871. The regression levels for all other used trend lines are shown in table 3.

**Table 3.** Economic and mathematical models for forecasting the level of recreational use potential

| The name of the trend line | Trend line equation | Reliability of approximation |
|----------------------------|---------------------|------------------------------|
| Linear                     | $y = -0.0187x + 0.2954$ | $R^2 = 0.4544$               |
| Degree                     | $y = 0.3146x^{-0.335}$ | $R^2 = 0.5322$               |
| Logarithmic                | $y = -0.077ln(x) + 0.314$ | $R^2 = 0.6439$               |
| Polynomial 2 order         | $y = 0.0089x^2 - 0.0985x + 0.4284$ | $R^2 = 0.8637$               |
| Polynomial 3 order         | $y = 0.0006x^3 + 0.0003x^2 - 0.066x + 0.3971$ | $R^2 = 0.871$               |
Thus, from the obtained projected values of the recreational forest use potential level indicator it can be concluded that over the next two years it will grow and in 2020 will be 0.26, and in 2021 - 0.37, which indicates a positive trend provided that previous development factors of recreational areas and their component composition are maintained.

Given the research on the development of recreational areas, it should be noted that taking into account the trends of sustainable development of economic systems in general and each of its components in particular, including recreational forest use.

Therefore, to ensure the sustainable development of recreational forest use, taking into account the conditions of environmental safety, it is necessary to comprehensively develop individual measures that would contribute to the recreational development of forest areas. These include: the implementation of forest facilities own opportunities for the development of recreational and tourist facilities; development and implementation of specific local projects in order to create the necessary infrastructure in the most recreationally valuable forest areas; creation of local eco-settlements; modernization of existing departmental recreation facilities; intensification of efforts in the field of interstate cooperation in the recreational and environmental direction.

All work on the recreational use of the potential of forests is organized through forestry. This state of recreational forest use, in our opinion, is very positive, because the effect of vacationers on the forest is environmentally negative if it is disorganized, and with a certain organization by foresters, the negative impact is minimized. Analyzing the current state of recreational forest use in forestry, we have concluded that this type of forest use is already in second place in economic importance after wood resources in forestry, and with the implementation of a number of effective measures will be the main. Scientists and foresters-practitioners have accumulated considerable experience in forestry, aimed at improving the sanitary and aesthetic properties of forests. By improving them, foresters take into account the climatic and natural-historical features of their region. The idea of the beauty of forest landscapes, as well as the idea of the rest itself, does not remain constant. It is transformed depending on the customs of society and the development of its productive forces. As the productive forces of society grow and the environment is cultured, people are increasingly returning to their natural environment in their spiritual aspirations.

The construction of campsites, motels, tourist parking lots and other means of household services in the modern recreational forest is closely connected with traditional forestry measures to improve the aesthetic and sanitary properties of forest stands. The scientific and technological revolution, which we witnessed and participated in, affected all branches of production. One of its manifestations in
forestry is the widespread use of forests for recreational purposes. Thus, forest improvement is a qualitatively new aspect of forestry work. It is impossible to ignore this. The forest in places of rest, besides the basic functions to give high-quality wood, should have also ability of beneficial emotional action on the person. The feeling of joy and pleasure should promote leisure activities. The basis of emotional rest are the so-called landscape emotions. Nature with the help of colors, smells, sounds acts on the human body. When forming recreational forests, first of all, it is necessary to pay attention to the rational combination of areas of different closure, which has both aesthetic and psychological significance. Recreational forest care is a whole complex of forestry works, which includes forest reclamation, clearing of debris, planting, felling of forestry purposes, landscaping and a number of other works. Landscaping includes the creation of a trail network, equipment for recreation and accommodation, preparation of playgrounds and firewood for fires, shelters in case of bad weather, accumulation of various equipment (tent pegs, equipment for cleaning accommodation), improvement of springs and springs, ecological trails, arrangement of observation decks, playgrounds, children's forest grounds, parking lots, garbage cans. It is going to be a good thing to have furniture in forest – tables and benches, where you can sit with lunch, as well as places of personal hygiene. All this, of course, must be done so as not to disturb the landscape, not to bring disharmony into nature [2]. In the current situation, the goal of forestry should be to meet the growing needs of the population in forest recreation while unconditionally ensuring the non-depletion of forest use in general and recreational forest use in particular. Broadening the range of forest areas, which could be used for recreational purposes is also a matter of time, and this requires the implementation of the relevant measures mentioned above. When considering recreational forest use, it is necessary to realize that this is a complex, multifaceted, contradictory phenomenon, which includes the positive effect of the forest on vacationers and negative - vacationers on the forest, future and present interests, profits and costs, social benefits and environmental damage. Recreational forest use is a set of phenomena that occur in connection with the use of forests for tourism and recreation. Its essence is a two-way connection: the impact of the forest on vacationers and vacationers on the forest [6]. The influence of the forest is passive, the influence of vacationers is active. In the first case there are mostly positive social, and in the second - negative environmental results of recreation in the forest. The subjects of recreational forest use are: 1) vacationers (tourists and vacationers); 2) enterprises that serve them directly in the forest; 3) organizations - suppliers of vacationers; 4) forestry.

In order to preserve the recreational and other useful properties of forests that promote leisure activities and to make full use of their potential and ensure their sustainable development without creating threats to environmental safety, it is necessary to: limit logging in recreational forests; increase the share of recreational forests through the construction of roads, trails and other infrastructure and their protection; allocate new objects of nature reserve fund in forests and achieve their optimal use for recreation; evenly distribute the recreational load on the forest ecosystems of the Carpathians, preventing recreational digression; to carry out appropriate educational work among tourists and vacationers in order to ensure the preservation of unique recreational natural complexes; set a fee for the recreational use of forests, and use these funds to restore the recreational properties of forests.

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