

Roman Slavik*

PhD in Economics, Associate Professor
State Higher Educational Institution "Uzhhorod National University"
88000, 14 Universytetska Str., Uzhhorod, Ukraine
<https://orcid.org/0000-0002-6198-3202>

Evaluation of the recreational and tourist potential of municipalities using the fuzzy set method

Abstract. The study is relevant due to the need to improve the evaluation of the recreational and tourist attractiveness of municipalities within Ukraine's new administrative-territorial system, particularly in the communities of Zakarpattia region. The objective was to determine the level of their tourism attractiveness using fuzzy set theory to quantitatively reflect the uncertainty of multifactorial decisions. Fuzzy modeling with trapezoidal membership functions and statistical methods were used to analyse the relationship between resources and revenue from the tourism fee. The results confirmed significant heterogeneity in the spatial distribution of recreational and tourism resources: the coefficient of variation for the composite index was 105%, indicating sharp differences between communities. The group with the highest attractiveness included the Berehove, Yasinya, Uzhhorod, Koson, Mukacheve, and Irshava communities; the Mizhhirya, Pylpets, Khust, and Rakhiv communities also had significant potential. More than half of Zakarpattia's communities were among the least attractive; four of them did not have any cultural heritage sites or nature reserves. A gap had been identified between resource potential and financial results: seven communities generated 68% of the tourism fee, while the least attractive ones accounted for 22% of the potential and generated 24% of the fee, indicated the possibility of a synergistic effect through logistics, marketing, infrastructure, and human resources. In contrast, communities with 23% of the potential accounted for less than 1% of revenue, indicated "reverse synergy." Statistical analysis showed that only 1.5% of the variation in revenue was explained by the type of resources. The key factor was not the type of resource, but the ability of communities to make integrated use of their collective resource potential in cooperation with neighboring communities. The practical value of the study lied in proposition of a fuzzy model as an analytical tool for strategic planning, branding, and enhancing the competitiveness of municipalities

Keywords: territorial communities of the Zakarpattia region; fuzzy logic; territorial attractiveness index; tourist fee; sustainable tourism development; spatial and statistical analysis

INTRODUCTION

The development of any sector of the national economy requires the government to determine its priority and provide adequate investment support. Tourism is regarded as a priority area of the country's economic and cultural development, which requires the creation of favourable conditions for the sector's functioning. In this context, the state encourages investment, promotes the development of tourism as a competitive and profitable sector of the economy, and ensures the creation of new jobs. The Zakarpattia region is characterised by significant recreational and tourism potential, the effective use of which requires a scientifically

grounded analysis of demand, supply, and the market positioning of tourism products. As a result of administrative reform, local communities play a leading role in the development of the tourism sector, possessing the resource, managerial, and marketing potential necessary for the implementation of regional tourism development programs.

The war has triggered a severe crisis in Ukraine's tourism industry: a sharp decline in revenue, the destruction of infrastructure, an outflow of investment, and a drop in tourist numbers that has exceeded the impact of the pandemic. As researchers V. Yermachenko *et al.* (2024) argued,

Article's History: Received: 21.08.2025; Revised: 30.01.2026; Accepted: 26.03.2026; Published: 09.04.2026

Suggested Citation:

Slavik, R. (2026). Evaluation of the recreational and tourist potential of municipalities using the fuzzy set method. *Economics of Development*, 25(1), 41-55. doi: 10.63341/econ/1.2026.41.

*Corresponding author



Copyright © The Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (<https://creativecommons.org/licenses/by/4.0/>)

sustainable tourism development can become a key tool for the post-war recovery of local communities, provided that the interests of business and local communities are harmonised and a “win-win” approach is applied. They propose a cluster-based approach to tourism development that takes into account the extent of the impact of hostilities in the region, allowing for more effective planning of recovery and stimulation of economic growth. A number of scientific publications have been devoted to the study of the recreational and tourist complex of the Zakarpattia region and the assessment of the recreational and tourist potential of the municipalities in other regions.

The authors L. Hutsal & I. Shorobura (2023) conceptually investigated the features of the formation of the tourist attractiveness of territorial communities of Ukraine from the standpoint of a practical approach in the conditions of decentralisation. They substantiated the goals, objectives, key problems and areas of development (infrastructure development, new routes, green, cognitive, eco- and youth tourism), which should transform communities into tourist centres. Increasing the tourist attractiveness of communities ensures sustainable economic development, activation of entrepreneurship, preservation of historical and cultural heritage and requires state support and strategic planning at the local level. The authors A. Melnyk *et al.* (2023) substantiated that decentralisation has created new opportunities and resources for the development of tourism as a cross-sectoral driver of the local economy for the territorial communities. The factors of the tourist attractiveness of rural and settlement communities are studied: historical and cultural heritage, the state of tourist infrastructure (accommodation, catering, leisure, everyday life, transport) and human potential. Based on the identified problems of infrastructure, the authors propose priority measures for its modernisation and develop a “road map” of the touristification of the community space to increase their competitiveness, investment attractiveness and employment of the population.

The author N. Barvinok (2023) argue that the tourism potential of local communities is held back by inadequate infrastructure: a limited network of lodging and dining establishments, poor roads, and insufficient information services. The authors propose measures to address these issues – road reconstruction, attracting investment, marketing, and creating new attractions – to encourage socio-economic growth. The global academic community pays due attention to research on the recreational and tourism appeal of municipalities. In particular, Z. Song (2025) proposes an approach to assessing the comprehensive competitiveness of tourist destinations within cities, combining Bourdieu’s field theory and Porter’s theory of competitiveness, as well as utilising geospatial big data and machine learning for analysis. The study found that competitiveness is based on four factors (quality, popularity, spatial attractiveness, and emotional perception) and demonstrates a spatial pattern that gradually weakens from the center of Nanjing to its outskirts. M. Hou *et al.* (2023) show green tourism inspiration, environmental engagement, and green revisit intentions, while fuzzy AHP revealed that tourism engagement has the highest fuzzy-weighted score in developing the revisit intentions of Chinese tourists. Moreover, they indicated that green tourism inspiration and environmental

wellness matter most in reshaping tourists’ revisit intentions. F. Liu (2024) evaluated the tourism attractiveness in the perspective of culture and tourism integration based on the TOPSIS model. The results showed that the model can effectively assess the attractiveness of tourism destinations and provide a scientific basis for tourism development, and the results of the evaluation of tourism attractiveness through the perspective of culture and natural tourism integration show that the integration of culture and tourism resources plays an important role in enhancing the attractiveness of tourism destinations. Such studies are valuable for Zakarpattia in the context of sustainable regional development, as more than 50% of the region is covered by forests and 80% of its territory is mountainous.

The assessment of the recreational and tourist attractiveness of territories developed mainly in the direction of “tourism destination attractiveness/competitiveness” models with an emphasis on index, multi-criteria and behavioural approaches. Four large groups of works can be conditionally distinguished: spatial-behavioural models, integral indices of destination attractiveness, multi-criteria/expert models of sustainable tourism and “niche” types of mobility. The author R. Slavik *et al.* (2020) expanded and improved regional research on the assessment of investment and recreational and tourist attractiveness of territories in terms of administrative districts that existed until 2020. The new administrative system of Ukraine, the formation of territorial communities, requires improving the methods and approaches to such assessments, which determines the relevance of this study.

The purpose of this article was to study the prerequisites for the development of the recreational and tourist sphere of the Zakarpattia region in the context of territorial communities using the methodological tools of the theory of fuzzy sets, which was improved and highlighted by the author R. Slavik *et al.* (2020), based on fuzzy logic and the theory of fuzzy sets. This study was operationalised through a set of interrelated tasks. First, a database of natural and historical-cultural resources of the Zakarpattia region was compiled and spatially allocated to territorial communities, after which the communities were grouped according to the availability of recreational and tourism resources using fuzzy logic methods. The next step involved establishing the relationship between the presence of natural and historical-cultural resources and the financial revenues of communities in the form of the tourist fee. Finally, the study sought to identify territorial communities that are undervalued in the tourism market of the Zakarpattia region and to develop proposals aimed at increasing tourist attendance in the least popular communities.

■ MATERIALS AND METHODS

The existence of various constraints and risks in planning the development of the recreational sector in general, and of local communities in particular, creates an atmosphere of uncertainty for managers. Attracting additional resources (material, financial) to recreational areas requires assessing them for recreational value, infrastructure development, investment attractiveness, and so on. In other words, managers must possess the necessary tools for a comprehensive analysis of recreational areas to effectively manage them and explore opportunities for investment

development. Such a toolkit can be created, in particular, through mathematical modelling of the recreational and tourism attractiveness of local communities, which will make it possible to determine their level of competitiveness in the recreational investment market. This model provided answers to a potential manager (investor) regarding factors influencing the riskiness of investments in a given community, and to the community's local government – opportunities to improve the investment environment and regulate the number of tourists.

A specific set of recreational areas R_i ($i = \overline{1, m}$), that are of interest to the investor, or that are subject to management and evaluation, was selected for analysis F_j ; ($j = \overline{1, n}$). The various factors used to evaluate territories were standardised according to the following rule:

$$k_{ij} = \frac{F_{ij}}{F_{ijmax}}, \tag{1}$$

where k_{ij} – the standardised index of the j -th evaluation factor for the i -th territory; F_{ij} – the indicator for i -th territory regarding evaluation factor j , expressed in physical

units (UAH, people, units, km, etc.); F_{ijmax} – the maximum value of the j -th factor of the evaluation in natural units.

A matrix of standardised indices with dimensions $m \times n$ is constructed, where n – the number of territories under study and m – the number of evaluation factors (criteria). The most and least significant factors influencing the level of recreational and tourist attractiveness of communities are identified by maximising and minimising the standardised indices of each row in the matrix. The symbolic representation of this algorithm can be expressed as: $c_i = \max_i k_{ij}$; $b_i = \min_i k_{ij}$; where c_i and b_i – respectively, the maximum and minimum values in row i . A ranking of the recreational and tourist attractiveness of the municipalities under study was compiled by summing the standardised indices for each row of the matrix and assigning a rank to each territory. That is:

$$S_i = \sum_{j=1}^n k_{ij} \rightarrow r_n. \tag{2}$$

A schematic representation of the matrix is shown in Table 1.

Table 1. Matrix of standardised indices for evaluating local communities based on specified criteria

	F_1	F_2	F_3	....	F_j	$\max_i k_{ij}$	$\min_i k_{ij}$	$\sum_i k_{ij}$	rank
R_1	k_{11}	k_{12}	k_{13}	...	k_{1j}	c_{1j}	b_{1j}	S_1	r_1
R_2	k_{21}	k_{22}	k_{23}	...	k_{2j}	c_{2j}	b_{2j}	S_2	r_2
....
R_i	k_{i1}	k_{i2}	k_{i3}	....	k_{ij}	c_{ij}	b_{ij}	S_i	r_n

Source: developed by the author

This ranking of the investment attractiveness of recreational areas was generalised using the methodology of fuzzy logic. Fuzzy logic is a starting point that operates with imprecise, undefined, and even incompletely understood concepts. According to this concept, the results of complex and critical situations should mostly be estimated approximately, rather than precisely. For convenience, the set of values $S_1; S_2... S_i$ were converted to the range of values from 0 to 1 such that $S_i \min = 0$ and $S_i \max = 1$. The remaining values of the sum of standardised indices lie in the range from 0 to 1 ($S_i \in [0;1]$) and are determined by the rule:

$$S_i[0; 1] = \frac{S_i - S_i \min}{S_i \max - S_i \min}. \tag{3}$$

Next, linguistic variables $B = \{b_j, j = \overline{1, n}\}$ are introduced, which are defined on the quantitative scale [0;1] and take on values in the form of words and phrases from ordinary language. Linguistic variables and their values serve to provide a qualitative verbal description of a certain quantitative value. Any linguistic variable and all its values are associated with a specific quantitative scale. Additionally, within the range of numerical values of the terms, subsets of 100% membership of a specific community in the corresponding linguistic variable are introduced (Table 2).

Table 2. Correspondence between the names of linguistic variables and their meanings

The value of linguistic variable B – the level of recreational and tourist attractiveness of the territorial communities		A brief linguistic analysis of the terms	Range of numerical values of terms	Subsets of 100% membership
b_1	the least attractive local communities	LA	[0; 0.25]	$A_1 [0; 0.1]$
b_2	attractiveness level below average	BA	(0.1; 0.45)	$A_2 [0.25; 0.3]$
b_3	average attractiveness	AA	(0.3; 0.7)	$A_3 [0.45; 0.55]$
b_4	above average attractiveness level	AAA	(0.55; 0.9)	$A_4 [0.7; 0.75]$
b_5	the greatest recreational and tourist attractiveness	GA	(0.75; 1]	$A_4 [0.9; 1]$

Source: developed by the author

Thus, territories that do not belong to the 100% membership subsets belong to one of the neighbouring linguistic terms with a certain degree of membership, which varies in the range from 0 to 1. The membership function $\mu(B)$ is a function whose domain is the carrier S_j and whose range is the unit interval [0, 1]. The larger the value of the function $\mu(B)$,

the higher the degree of membership of the element S_i in b_j is estimated. If $S_i \in A_1; A_2; A_3; A_4; A_5$, then $\mu(S_i) = 1$. After determining the possible range of variation for the parameters $S_j, j = \overline{1, n}$, and the output variable B , the form of the membership functions for the fuzzy terms was specified. A membership function reflects elements from the set S onto a set

of numbers in the interval [0;1], which indicate the degree of membership of each element in various qualitative terms. To construct the membership functions of the five fuzzy terms of the input variable {GA, AAA, AA, BA, LA}, the ranges of

variation of the parameter S_i , $i = \overline{1,64}$ (since there are 64 territorial communities under analysis) were mapped onto a single universal set S . Five fuzzy subsets were defined, whose membership functions are shown in Figure 1.

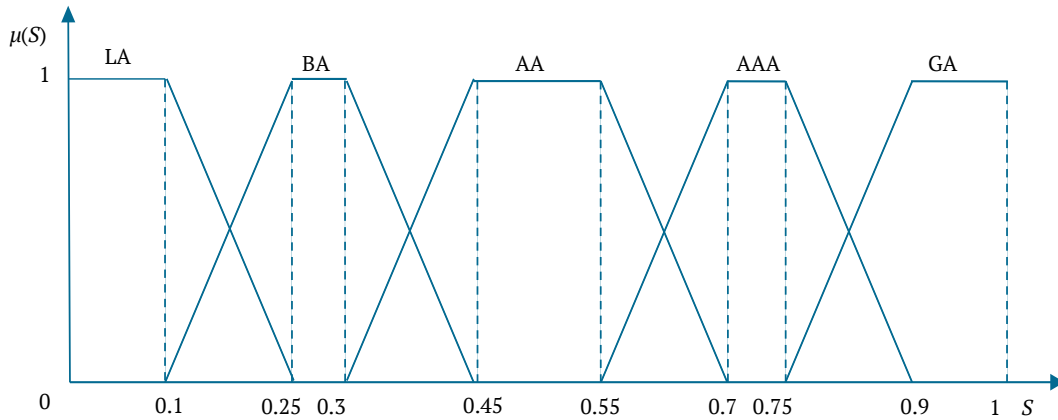


Figure 1. Fuzzy variable S_i with trapezoidal membership function

Source: developed by the author

The selection of correspondences between linguistic variables and numerical values is determined by the use of a fuzzy model for assessing the recreational and tourist attractiveness of territorial communities. The interval [0, 1] was divided into five partially overlapping intervals, ensuring a smooth transition between levels of recreational and tourist attractiveness and reflecting the uncertainty at the boundary values. The central sub-ranges of each term are defined as zones of full membership, since it is within these zones that the corresponding qualitative characteristic is most distinct and unambiguous. The range of 0-0.25 represents the low-value zone, corresponding to weak recreational and tourist attractiveness. 0.25-0.45 marks the transition to a below-average level. 0.45-0.55 is the centre of the scale, which is logically interpreted as the average level. 0.55-0.9 – a zone of gradually increasing attractiveness. 0.9-1 – the upper part of the scale, where communities have the highest recreational and tourist attractiveness. Thus, the extreme values represent communities that are either strongly or weakly attractive. The intermediate zones reflect a gradual transition. The cores of the terms define the most typical values for each category. The trapezoidal membership functions of all fuzzy terms of the input variable, showed in Figure 1, take the following analytical form:

$$\mu^{LA}(S_i) = \begin{cases} 1, & 0 \leq S_i \leq 0.1; \\ \frac{S_i - 0.25}{0.1 - 0.25}, & 0.1 < S_i < 0.25; \end{cases} \quad (4)$$

$$\mu^{BA}(S_i) = \begin{cases} \frac{S_i - 0.45}{0.3 - 0.45}, & 0.3 < S_i < 0.45; \\ 1, & 0.25 \leq S_i \leq 0.3; \\ \frac{S_i - 0.1}{0.25 - 0.1}, & 0.1 < S_i < 0.25; \end{cases} \quad (5)$$

$$\mu^{AA}(S_i) = \begin{cases} \frac{S_i - 0.7}{0.55 - 0.7}, & 0.55 < S_i < 0.7; \\ 1, & 0.45 \leq S_i \leq 0.55; \\ \frac{S_i - 0.3}{0.45 - 0.3}, & 0.3 < S_i < 0.45; \end{cases} \quad (6)$$

$$\mu^{AAA}(S_i) = \begin{cases} \frac{S_i - 0.9}{0.75 - 0.9}, & 0.75 < S_i < 0.9; \\ 1, & 0.7 \leq S_i \leq 0.75; \\ \frac{S_i - 0.55}{0.7 - 0.55}, & 0.55 < S_i < 0.7; \end{cases} \quad (7)$$

$$\mu^{GA}(S_i) = \begin{cases} \frac{S_i - 0.75}{0.9 - 0.75}, & 0.75 < S_i < 0.9; \\ 1, & 0.9 \leq S_i \leq 1. \end{cases} \quad (8)$$

The main reason for choosing trapezoidal membership functions was to harmonise the idea of “clear-cut” intervals of full membership with fuzzy transition zones between subsets, while keeping the model’s geometry and interpretation as simple as possible. A trapezoidal function differs from a triangular one by having a plateau with $\mu(S_i) = 1$ on the interval, rather than just at a single point. Trapezoidal (as well as triangular) functions provide linear interpolation between 0 and 1, so the calculation of membership degrees remains computationally simple and stable and does not complicate the implementation of the model (Khairuddin *et al.*, 2021). In applied problems (including spatial analysis of the tourist attractiveness of territories), trapezoidal/triangular functions are recommended as the “standard” due to the balance between accuracy and computational efficiency (Nuriyev, 2022). This form allows for flexible adjustment of the width of transition zones (how “blurred” the transition between classes of tourist attractiveness is) without changing the intervals of full membership themselves. Equipped with the tools of this methodology, a manager (investor) can also identify the competitive advantages of a given territory over others if it is selected as a priority for investment development. It is also possible to rank territories not based on all factors, but selectively based on those that are decisive for the development of a specific type of recreation (landscapes, geological landmarks, thermal springs, etc.). To determine the degree of influence of natural or historical and cultural resources on the amount of the tourist fee of the territory, a statistical method was used to determine the influence

of grouping features on the total variation of the feature, using the following values (Roshchuk, 2010).

Total variance:

$$\sigma^2 = \frac{\sum(x_i - \bar{x})^2 f_i}{\sum f_i} \quad (9)$$

Within-group variance:

$$\frac{\sum(x_i - \bar{x})^2 f_{ij}}{\sum f_{ij}} \quad (10)$$

Average of intragroup variances:

$$\bar{\sigma}^2 = \frac{\sum \sigma_j^2 f_j}{\sum f_j} \quad (11)$$

Intergroup variance:

$$\delta^2 = \frac{\sum(\bar{x}_j - \bar{x})^2 f_j}{\sum f_j} \quad (12)$$

Coefficient of determination:

$$\frac{\delta^2}{\sigma^2} \quad (13)$$

Correlation coefficient:

$$\sqrt{\frac{\delta^2}{\sigma^2}} = \sqrt{\eta^2} = \eta, \quad (14)$$

where x_i – is the median value of the tourist fee in the i -th interval; \bar{x} – average of a variable characteristic; \bar{x}_j – the average for the j -th group; f_i – the number of local communities with the x_i attribute in the total set; $f_j = \sum f_{ij}$ – the total number of local communities in the j -th group; f_{ij} – number of local communities with the x_i attribute i -th group. To determine the uniformity of the distribution of recreational and tourism resources, or of revenue from the tourism fee, among local communities, this study uses the quadratic coefficient of variation:

$$V_\sigma = \frac{\sigma}{\bar{x}} \times 100\%, \quad (15)$$

where σ – the standard deviation of the standardised indices of communities' recreational and tourism resources, or the amounts of the tourism tax in the general population; \bar{x} – the average arithmetic mean of standardised indices of communities' recreational and tourism resources, or the rates of the tourism fee. To determine the relationship between the availability of resources and revenue from the tourism fee in communities, Pearson's correlation coefficient was used:

$$r = \frac{n \sum xy - \sum x \sum y}{\sqrt{(n \sum x^2 - (\sum x)^2)(n \sum y^2 - (\sum y)^2)}}, \quad (16)$$

where $n = 64$ – number of territorial communities in Zakarpattia region; x – the value of the standardised index of recreational and tourism resources in a specific community; y – the amount of the tourist fee in a specific community.

There is no universal scale for interpreting Pearson's correlation coefficient in studies examining the relationship between recreational and tourism resources and tourism revenue. Given that tourism is a multifaceted phenomenon and that the communities in Zakarpattia region are highly heterogeneous, it is advisable to use moderately

strict (medium) intervals that accurately reflect the actual complex relationships. Therefore, to assess the strength of the relationship between the resource endowment of local communities and the amount of the tourism fee, it is advisable to use Pearson's correlation coefficient, interpreted as follows: weak correlation – up to 0.30, moderate – 0.30-0.49, strong – 0.50-0.69, very strong – 0.70 and above. The empirical data for this study were compiled through an analysis of databases on the nature reserve sites in Zakarpattia (The Nature Reserve Fund of Zakarpattia..., n.d.), immovable cultural heritage (Ministry of Culture of Ukraine, n.d.). Data on the tourist fee in the Zakarpattia region in terms of territorial communities is not published for public access and is considered an internal document of Department of Tourism and Resorts of Zakarpattia Regional State Administration (2025). At the request of the author of the publication, the most recent data for 2025 was provided. The accuracy of the data regarding the amount of the tourist fee can be verified on the website of the Ministry of Finance of Ukraine (n.d.).

■ RESULTS

The 2020 administrative reform introduced significant changes to the administrative-territorial division of the Zakarpattia region: 64 territorial communities and 6 enlarged districts were formed: Rakhiv, Khust, Tyachiv, Mukachevo, Uzhhorod, Berehove (Resolution of Verkhovna Rada of Ukraine No. 33, 2020). To the latter were transferred control over resources from the former district administrations. On the one hand, this opened up new opportunities for local communities, on the other hand, it increased responsibility for the control and use of resources. One of the factors of socio-economic development can be the availability of recreational and tourist resources, which are one of the most important means of positioning in the tourism market. The use of the latter on the principles of the concept of sustainable development is the task of local communities. A set of recreational and tourist resources was highlighted as indicators for evaluating the attractiveness of territorial communities, after which they were combined and an integral indicator for each of them was derived. Thus, territorial communities were examined in quantitative aspects. Summary information on recreational and tourist resources of the Zakarpattia region, which are proposed for analysis in terms of territorial communities, is presented in Table 3.

The Zakarpattia region also has UNESCO heritage sites, such as the Church of the Ascension of the Lord (Strukivska) in the village of Yasinya and the Church of St. Michael the Archangel in the village of Uzhok (Stavne territorial community), but they have the status of cultural heritage sites of national significance. Natural UNESCO heritage sites include the "Primeval Beech Forests of the Carpathians and Other Regions of Europe," which are part of the primeval forests within the Carpathian Biosphere Reserve and adjacent protected areas of Zakarpattia. In accordance with the model described in the "Materials and Methods" section, a 64×17 matrix of grouped data is generated, since there are 64 communities in Zakarpattia region that are analysed according to 17 criteria for evaluating recreational and tourism resources. Moreover, criteria $F1 \dots F3$ refer to historical

and cultural resources, while $F_4 \dots F_{17}$ refer to natural recreational and tourism resources. The numerical values of the F parameters in this model are presented in Table 4 as

the number of resource units available in a specific territorial community. The exception is the numerical parameters of factors F_4 and F_5 , which are expressed in m^3/day .

Table 3. Classification of recreational and tourist resources in Zakarpattia region

Resource classification		Designation of the evaluation factor	Number of units or debit (m^3/day) for balneological resources.	
Historical, architectural and intangible cultural heritage sites	Objects of historical and architectural heritage of national significance	F_1	84	
	Objects of historical and architectural heritage of local significance	F_2	59	
	Intangible cultural heritage objects	F_3	36	
Natural	Balneological	Thermal waters	F_4	11,488 m^3/day
		Mineral waters	F_5	7,483 m^3/day
	Objects of the nature reserve fund	Botanical gardens of national significance	F_6	1
		Dendrological parks of local significance	F_7	2
		Monuments of landscape gardening art of national significance	F_8	1
		Monuments of landscape gardening art of local significance	F_9	32
		Local nature reserves	F_{10}	44
		Nature reserves of national significance	F_{11}	21
		Protected tracts	F_{12}	12
		Regional landscape parks	F_{13}	2
		National natural parks	F_{14}	3
		Biosphere reserves	F_{15}	1
		Natural landmarks of national significance	F_{16}	9
	Natural monuments of local significance	F_{17}	316	

Source: prepared by the author based on data of The nature reserve fund of Zakarpattia oblast by territorial community (n.d.), Ministry of Culture of Ukraine (n.d.) and Department of Tourism and Resorts of Zakarpattia Regional State Administration (n.d.)

Table 4. Numerical values of the assessment factors for local communities in Zakarpattia region

Evaluation factor Community	F_1	F_2	F_3	F_4 (m^3/day)	F_5 (m^3/day)	F_6	F_7	F_8	F_9	F_{10}	F_{11}	F_{12}	F_{13}	F_{14}	F_{15}	F_{16}	F_{17}
Baranyntsi				50					1								5
Velyky Berezny					58				2					1			3
Velyka Dobron											1		1				
Dubrynychy-Maly Berezny	2				121												6
Kostryno	3	1			135					2				1		1	3
Onokivtsi	1															1	4
Perechyn					152												4
Serednje	1								1	1							3
Stavne	4				50					2	1			1			6
Surte	4		1						1				1				
Turya-Remeta	1				37					1	2	1					8
Uzhhorod	7	15		179	1,263	1			10								2
Chop			1										1				
Kholmok	2		1	150													1
Mukachevo	5	13		388	12		1		4	2		1					4
Svaljava	1																3
Volovets	3		1		9						2						3
Zhdenijevo	2		1		3					3						1	4
Kolchyno				200													2

Table 4. Continued

Evaluation factor Community	F_1	F_2	F_3	F_4 (m^3/day)	F_5 (m^3/day)	F_6	F_7	F_8	F_9	F_{10}	F_{11}	F_{12}	F_{13}	F_{14}	F_{15}	F_{16}	F_{17}
Chynadiyevo	3	1		375				1				1	1				4
Velyky Luchky													1				
Verkhny Koropets					29		1										1
Horonda																	
Ivanivtsi												1					1
Nelipyno																	
Nyzhny Vorota	3	1	1							2							2
Poliana					600					3							9
Batjove			1		480												1
Berehove	8	15	2	2,880	369				3	1		1					3
Velyky Berehy	1		1									1	1			1	
Velyka Biyhan	1		1	80	81					4							5
Vylok	2		1										1				1
Vinogradiv	4	4	1	160					4	2	1		1		1		4
Korolevo	3		1		36								1				
Kamjanske	1				3												
Pyterfolvo	1	2	1	525						2	1		1				2
Koson	1		1	6,000								1					
Bilky	1																2
Vyshkovo		1		205	34												6
Horinchovo																	3
Dovhe		3										1					2
Drahove														1	1		2
Zarichcha																	
Irshava	4			296	100					1	1			1		1	4
Kolochava	2		1		174									1			1
Keretsky					69				1			2					4
Mizhhirya	4		1		1,015						1					2	27
Pylypets	9		1		571												14
Synevir	1		1							2	1			1			4
Khust	8	2	1		95										1		19
Bedevlja																	
Bushtyno					184				2			2					6
Vilchivtci					75												2
Dubove					8					1							1
Neresnytsa					64										1		11
Solotvyno	4																3
Teresva																	1
Tjachiv	1								1								4
Uglja	2				15										1		15
Ust-Chorna					66					5	6	1					8
Rakhiv	1	1	4		220				1	1					1	1	24
Bohdan			3		2					4					1		9
Velyky Bychkiv			3		244					2	1				1		16
Yasynya	3		5		1,109				1	3	2				1	1	34

Source: prepared by the author based on data of The nature reserve fund of Zakarpattia oblast by territorial community (n.d.), Ministry of Culture of Ukraine (n.d.) and Department of Tourism and Resorts of Zakarpattia Regional State Administration (n.d.)

The existence of various restrictions and risks in planning the development of the recreational sector in general, and local communities in particular, creates an environment of uncertainty for regional management. Attracting additional resources (material, financial) to local communities requires studying them in terms of their recreational and tourist value, infrastructure development, investment attractiveness, etc. In other words, managers must have the necessary tools for comprehensive analysis of recreational areas for effective management and study

of socio-economic development opportunities. Such tools can be created, in particular, with the help of the fuzzy set theory mentioned above, through mathematical modelling of the recreational and tourist attractiveness of territories, which will make it possible to determine their level of competitiveness in the recreational investment market. Using Formula (1), the absolute values of the F criteria are converted into standardised indices for local communities ranging from 0 to 1. In this context, the evaluation factors are grouped into historical and cultural resources and



natural recreational and tourism resources. The trapezoidal membership functions $\mu(S_i)$ of all fuzzy terms of the

output variable shown in Figure 1 will take the analytical form shown in Table 5.

Table 5. Affiliation of territorial communities of Zakarpattia region to a specific linguistic term as a result of the assessment of recreational and tourist resources

Linguistic terms	Sum of historical and cultural resource indices $S_i [0;1]$	Sum of natural resource indices $S_i [0;1]$	Territorial communities	Degree of belonging (%)	Sum of indices for all resources $S_i [0;1]$
The greatest recreational and tourist attractiveness (GA)	1	0.62	Berehove	100	1
	0.32	1	Yasinya	78	0.867
	0.88	0.46	Uzhhorod	47	0.821
Above average attractiveness level (AAA)			Yasinya	22	0.867
			Uzhhorod	53	0.821
	0.08	0.86	Koson	57	0.636
	0.72	0.305	Mukachevo	49	0.624
	0.16	0.72	Irshava	23	0.584
Average attractiveness (AA)			Koson	43	0.636
			Mukachevo	51	0.624
			Irshava	77	0.584
	0.44	0.42	Khust	100	0.541
	0.2	0.62	Mizhhirya	100	0.536
	0.24	0.58	Rakhiv	100	0.532
	0.4	0.36	Pylypets	100	0.478
	0.36	0.29	Vinogradiv	70	0.405
	0.12	0.44	Velyky Bychkiv	47	0.37
	0.12	0.38	Kholmok	19	0.329
Attractiveness level below average (BA)			Vinogradiv	30	0.405
			Velyky Bychkiv	53	0.37
			Kholmok	81	0.329
	0	0.42	Ust-Chorna	100	0.284
	0.08	0.32	Uglja	100	0.267
	0.12	0.28	Bohdan	100	0.26
	0.08	0.29	Dubrynychy-Maly Berezhny	95	0.243
	0.16	0.197	Chynadiyevo	85	0.227
	0	0.33	Poliana	83	0.225
	0.16	0.19	Pyterfolvo	83	0.225
	0.16	0.185	Stavne	79	0.219
	0.16	0.164	Kostryno	69	0.204
	0.04	0.25	Turya-Remeta	63	0.194
	0.08	0.2	Velyka Biyhan	57	0.185
	0.12	0.16	Zhdenijevo	53	0.179
	0.2	0.085	Nyzhni Vorota	49	0.173
	0	0.25	Neresnytsa	49	0.173
	0.16	0.103	Volovets	42	0.163
	0	0.23	Bushtyno	37	0.156
	0.08	0.144	Synevyr	30	0.145
0.2	0.04	Surte	30	0.145	
0.16	0.059	Solotvyno	22	0.133	
0.04	0.15	Vyshkovo	18	0.127	
0.12	0.067	Kolochava	10	0.115	
0.16	0.22	Korolevo	5	0.108	
0	0.15	Keretsky	3	0.105	

Table 5. Continued

Linguistic terms	Sum of historical and cultural resource indices $S_i [0;1]$	Sum of natural resource indices $S_i [0;1]$	Territorial communities	Degree of belonging (%)	Sum of indices for all resources $S_i [0;1]$	
Least attractive territorial communities (LA)			Dubrynychy-Maly Berezhny	5	0.243	
			Chynadiyevo	15	0.227	
			Poliana	17	0.225	
			Pyterfolvo	17	0.225	
			Stavne	21	0.219	
			Kostryno	31	0.204	
			Turya-Remeta	37	0.194	
			Velyka Biyhan	43	0.185	
			Zhdenijevo	47	0.179	
			Nyzhny Vorota	51	0.173	
			Neresnytsa	51	0.173	
			Volovets	58	0.163	
			Bushtyno	63	0.156	
			Surte	70	0.145	
			Synevyr	70	0.145	
			Solotvyno	78	0.133	
			Vyshkovo	82	0.127	
			Kolochava	90	0.115	
			Korolevo	95	0.108	
			Keretsky	97	0.105	
		0.12	0.04	Dovhe	100	0.098
		0.12	0.04	Vylok	100	0.098
		0.04	0.1	Serednje	100	0.093
		0.04	0.1	Onokivtsi	100	0.093
		0.04	0.1	Tjachiv	100	0.093
		0.08	0.06	Velyky Berehy	100	0.087
		0	0.13	Velyky Berezny	100	0.0867
		0	0.123	Baranyntsi	100	0.0857
		0.04	0.085	Batjove	100	0.08
		0	0.11	Perechyn	100	0.072
		0.04	0.6	Svaljava	100	0.064
		0	0.085	Drahove	100	0.059
		0.04	0.0339	Bilky	100	0.052
		0	0.068	Kolchyno	100	0.046
	0	0.06	Horinchovo	100	0.041	
	0	0.053	Vilchivtci	100	0.036	
	0.04	0.017	Chop	100	0.035	
	0	0.47	Verkhny Koropets	100	0.032	
	0	0.043	Dubove	100	0.03	
	0	0.04	Ivanivtsi	100	0.029	
	0	0.04	Velyka Dobron	100	0.0289	
	0.04	0.0004	Kamjanske	100	0.023	
	0	0.017	Velyky Luchky	100	0.017	
	0	0.02	Teresva	100	0.014	
	0	0	Nelipyno	100	0	
	0	0	Horonda	100	0	
	0	0	Bedevlja	100	0	
	0	0	Zarichcha	100	0	

Source: prepared by the author based on data of The nature reserve fund of Zakarpattia oblast by territorial community (n.d.), Ministry of Culture of Ukraine (n.d.) and Department of Tourism and Resorts of Zakarpattia Regional State Administration (n.d.)

The data in the table allows the following preliminary conclusions to be drawn. There is an uneven distribution of recreational and tourism resources among communities (the quadratic coefficient of variation is 1.05, or 105%).

The communities of Berehove, Yasinya, Uzhhorod, Koson, Mukachevo, and Irshava have the greatest recreational and tourist appeal in terms of resource potential. Mizh-hirya, Pylypets, Khust, and Rakhiv can also be considered

significant. More than half of the territorial communities are included in the subset of the least recreationally and touristically attractive communities. Four communities have no recorded tangible or intangible historical and cultural heritage sites or protected natural areas of local or national significance (Nelipyno, Horonda, Zarichcha, Bedevlja).

The most significant resources that act as tourist magnets in the Berehove, Koson, and Khust territorial communities are the significant thermal water resources with developed infrastructure for balneological recreation, historical and architectural resources, in particular, Khust Castle, architectural ensembles in the centres of Khust and Berehove, as well as rural green tourism and ethno-tourism in Hungarian villages. The basis for the development of recreation and tourism in the Uzhhorod and Mukachevo territorial communities is the concentration of the most valuable historical and architectural monuments (Mukachevo Castle “Palanok”, Uzhhorod Castle, Holy Cross Cathedral with the Bishop’s Residence, etc.)

combined with the presence of thermal and mineral waters, as well as a developed logistics and tourism infrastructure. The prerequisite for the development of tourism and recreation in the Irshava, Mizhhirya, Pylypets, and Rakhiv territorial communities is the landscape resources based on protected natural areas, such as the Synevyr National Nature Park, the Carpathian Biosphere Reserve, Zacharovany Krai National Nature Park, Shipit Waterfall, Lake Synevyr, etc. It should also be noted that belonging to the category of the least tourist-attractive communities does not mean that there are no prospects for the development of the recreation and tourism sector in them. It only reflects the resource potential in relation to other communities. Communities in the above category accumulate 22% of the recreational and tourism resource potential of the Zakarpattia region, while generating 24% of the region’s tourism fee. Figure 2 shows the territorial communities whose share in tourism revenue is incomparably greater than their resource potential.

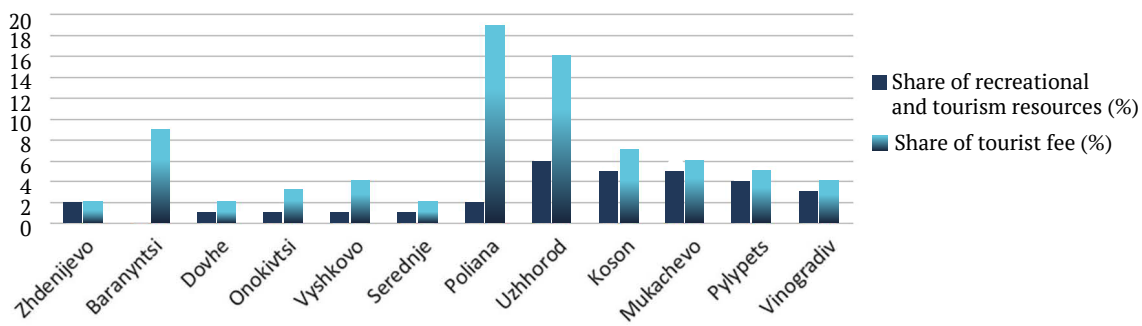


Figure 2. Ratio of local community revenues to their recreational and resource potential as a percentage of the regional total

Source: prepared by the author based on data of The nature reserve fund of Zakarpattia oblast by territorial community (n.d.), Ministry of Culture of Ukraine (n.d.) and Department of Tourism and Resorts of Zakarpattia Regional State Administration (n.d.)

As can be seen from the figure, even communities with the smallest share of resource potential can have a significantly greater financial impact by using socio-economic levers: logistics, marketing, infrastructure, human resources, etc. There is a certain synergistic effect that can serve as an example for communities with relatively poorer resource potential. The communities of Poliana, Uzhhorod, Baranyntsi, Vyshkovo, and Onokivtsi are leaders

in this regard. A number of communities also exhibit reverse synergy. Despite their significant resource potential, these communities generate relatively lower financial returns (Fig. 3). Communities such as Irshava, Rakhiv, Velyky Bychkiv, Kholmok, Ust-Chorna, Bohdan, Dubrynychy-Maly Bereznyy, Stavne and Kostryno, which control over 23% of the region’s recreational and tourism potential, together generate less than 1% of tourism fee.

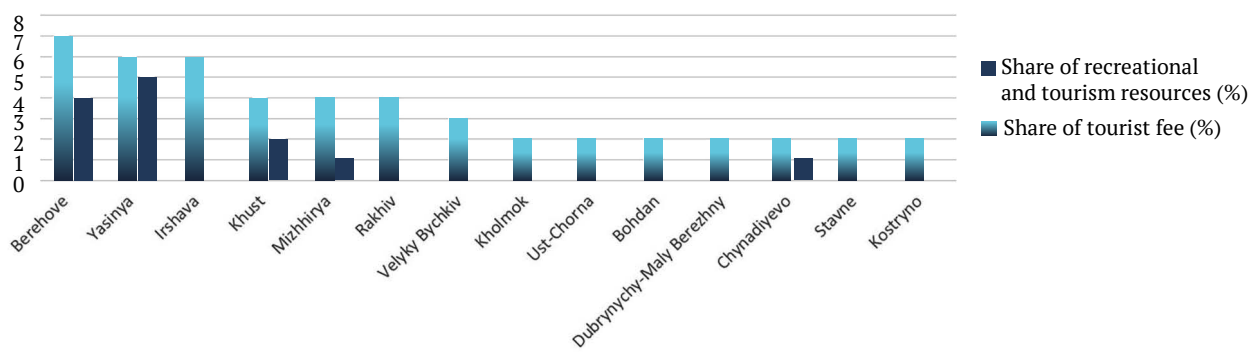


Figure 3. Ratio of local community revenues to their recreational and resource potential as a percentage of the regional total

Source: prepared by the author based on data of The nature reserve fund of Zakarpattia oblast by territorial community (n.d.), Ministry of Culture of Ukraine (n.d.) and Department of Tourism and Resorts of Zakarpattia Regional State Administration (n.d.)

Using the methodology of compiling and grouping statistical data, and analysing variations and correlations between dispersions, the degree of correlation between the availability of natural or historical and cultural resources in local communities and the amount of tourist revenue generated was determined. To do this using Sturges method for selecting the number of groups (intervals)

in a variation series (Roshchik, 2010), 64 territorial communities in Zakarpattia Oblast were classified into one of seven groups based on the criterion of income from the tourism fee. Using the data of Table 5, communities were divided into those for which natural or historical and cultural resources play a dominant role. The summary data are presented in Table 6.

Table 6. Distribution of territorial communities by natural and historical-architectural resources depending on the amount of tourist fee (thousand UAH)

Amount of tourist fee (thousand UAH)	Total number of communities,	Number of communities with a predominance in natural resources,	Number of communities with a predominance of historical and cultural resources,
Up to 500	49	36	13
500 – 1,000	5	3	2
1,000 – 1,500	3	1	2
1,500 – 2,000	3	1	2
2,000 – 2,500	1	1	-
2,500 – 3,000	1	1	-
3,000 or more	2	1	1
In total	64	44	20
The dispersion	General $\sigma^2 = 513,431$	$\sigma_1^2 = 460,098$	$\sigma_2^2 = 597,500$
Intergroup dispersion	$\delta^2 = 7,645$		
Coefficient of determination $\frac{\delta^2}{\sigma^2} = 0.15$; Correlation coefficient $\sqrt{\frac{\delta^2}{\sigma^2}} = \sqrt{\eta^2} = \eta = 0.12$			

Source: developed by the author

Thus, assessing the strength of the relationship between the size of the tourist fee and the presence of one of the types of recreational and tourist resources (natural or historical and cultural), it was found that the level of income is only 1.5% influenced by the presence of one of them. Since the correlation coefficient corresponds to the range [0-0.3], we concluded that there is a weak connection between the level of income and the type of recreational and tourist resources. After calculating Pearson's correlation coefficient using Equation 16 and the data from Table 5, it was found that the presence of recreational and tourism resources generally has a moderate effect on the amount of the tourism fee ($r=0.46$). The presence of either historical and cultural resources ($r=0.43$) or natural recreational and tourism resources ($r=0.33$) also has a moderate impact on the amount of tourism fees collected by local communities and falls within the same range of values [0.3-0.49]. Calculation of the coefficient of variation of tourist fee for 64 territorial communities based on the general set established its value at 2.23, or 223%, which indicates its heterogeneity. A total of 7 communities generate 68% of the tourist fee in Zakarpattia region. The median value of the tourist fee is estimated at UAH 47.3 thousand (the maximum is UAH 6,177.3 million in the Poliana territorial community).

DISCUSSION

The results confirmed the very high spatial heterogeneity of the recreational and tourism potential of communities in Zakarpattia, as well as even greater variation in tourism fee. It was found that only 7 communities account for 68% of tourism fee, while four communities have no cultural heritage sites or nature reserves at all. A weak correlation was found between the type of resources (natural or historical and cultural) and the size of the tourist fee, which is

interpreted as the importance of the dominance of the “integral management factor” (logistics, infrastructure, marketing, and community cooperation). Methodologically, a combination of the classical index model with subsequent fuzzy classification (trapezoidal membership functions for five linguistic levels of recreational and tourist attractiveness) and spatial statistical analysis of Pearson's correlation coefficient, variation and dispersion was proposed. This allowed not only for the development of a rating but also for its interpretation in terms of “lowest/below average / average / above average / highest attractiveness”, with the possibility of partial membership of communities in adjacent subsets. These conclusions are then superimposed on financial results (tourism fee) to identify synergistic and “anti-synergistic” effects within communities.

A number of foreign studies also use fuzzy logic to assess tourism attractiveness, but the emphasis is placed on other aspects. For example, the authors X. Gu *et al.* (2022), in their assessment of the attractiveness of natural destinations based on the fuzzy-AHP approach, focused primarily on the structure of the criteria (landscape aesthetics, ecological sensitivity, accessibility, infrastructure), while fuzziness was introduced primarily into the weights and expert judgments. Unlike this study, where fuzzy logic is applied to an integrated index at the municipal level, the study by the above-mentioned authors works with more detailed spatial units (local nature-oriented destinations) and emphasises the ecological dimension of sustainability. At the same time, both approaches agree that a strict “clear” division of evaluation criteria (for example, based solely on the number of protected natural areas) does not reflect actual attractiveness, and flexible fuzzy gradations based on the analysis of multiple criteria are necessary. A group of researchers led by A. Nguyen *et al.* (2026), who, using a hybrid method combining Fuzzy AHP and Fuzzy

TOPSIS, identified the transportation system as the most influential criterion for the sustainable development of agritourism in one of Vietnam's regions, followed by the attractiveness of tourism resources and the diversity of landscape resources. The authors recommend priority policy directions at the national and local levels to improve infrastructure, engage communities, and promote digital transformation for the purpose of sustainable agritourism. Such conclusions demonstrate the importance of multi-criteria analysis specifically of recreational and tourism resources, as conducted in this study, as an important (but not sufficient) condition for regional development.

The model of regional tourism competitiveness based on the Fuzzy Delphi-Fuzzy AHP-PROMETHEE method, developed for the counties of the West Pomeranian Voivodeship in Poland, is also based on the multifactorial nature of attractiveness (natural and man-made attractions, location, and recreational infrastructure). Researchers A. Stecyk *et al.* (2021) use numerical values to formalise experts' linguistic assessments and obtain a stable competitiveness ranking of tourist destinations. The approach to ranking territorial communities in the Zakarpattia region in this study is fundamentally similar in the logic of fuzzy index modelling, but the difference lies in the fact that in this work, the fuzziness is based not on subjective expert opinions, but on standardised objective indicators (number of sites, water discharge, area of protected natural areas), which reduces the risk of prejudice and increases the model's reproducibility in new territories. The relevance of such approaches was also demonstrated by researcher A. Nuriyev (2022), who argued that for selecting tourist destinations in countries with limited statistical data, it is advisable to use multi-criteria models based on Z-scores, which account for both the fuzziness and reliability of information. The proposed Z-TOPSIS and Z-PROMETHEE methods with direct calculations allow for the correct ranking of alternatives without loss of information, showing consistent results for the regions of Azerbaijan.

Researchers B. Gavurova & V. Polishchuk (2025) developed a new hybrid model of sustainable tourism in the Visegrad Group countries (a matrix of normalised scores by criteria groups + an expert assessment of the sustainability level based on a survey of 2,343 respondents). Authors B. Gavurova *et al.* (2025) also applied multi-criteria approach to assess the tourist attractiveness of regions. Although there is no "classical" fuzzy logic there, the authors effectively work with linguistic variables (perception of sustainability, satisfaction, etc.), the conversion of which into numerical indices is similar to the methodology of this study regarding the transition from linguistic levels to trapezoidal membership functions. This confirmed the validity of the thesis in the proposed study regarding the advisability of hybrid models that combine statistical (variation, correlation) and fuzzy tools to support managerial decisions in tourism. A separate body of research shifts the focus from resources to the actual behaviour of tourists. Author K. Kondo (2025) proposed a regional attractiveness index derived from a model of trip choice and inter-municipal flows, which is scale-independent and based on actual trip destination choices. The author demonstrates that destinations with relatively limited resource potential but unique attractions (theme parks, events) can have a high

attractiveness index, while resource-rich areas remain "underutilised" in tourist flows. These findings fully correlate with the idea of the proposed study regarding "synergistic" and "reverse-synergistic" communities. Some communities with low resource potential exceed the expected level of tourist revenue thanks to infrastructure, marketing, and logistics, while others, resource-rich communities, fail to transform their potential into financial results.

Global city attractiveness indices based on "digital footprints" (such as the Yanolja Attractiveness Index) generally model attractiveness as a function of reputation and information "noise" on social media and in search queries, combining sentiment analysis with flow statistics. In this approach, the authors S. Jang *et al.* (2025) argued that natural and cultural resources indirectly influence rankings through tourists' perceptions and experiences. In contrast, this study demonstrates a "resource-oriented" approach in the first stage, but the conclusions highlight the importance of the behavioural level, affirming that the ability of communities to integrate resources, develop logistics, marketing, and cooperation is decisive. Thus, the empirical results of this study confirm the current trend away from purely resource-based models toward models where tourist behaviour and managerial decisions modulate realised attractiveness. A similar conclusion was reached by M.J. Ibáñez *et al.* (2024), who argued that the attributes of tourist destination attractiveness do not operate in isolation but in configurations that differently stimulate the volume of leisure travel in the pre- and post-COVID periods. In the pre-pandemic period, two types of configurations were identified—"safety-oriented" (focused on safety and hygiene) and "eco-systemic" (emphasising tourism priorities, sustainable development, and infrastructure), whereas post-pandemic, priorities regarding public health, high-quality tourism infrastructure, and cultural resources have become key, with a relative decline in the role of safety and security. Similar studies on changes in the recreational and tourism appeal of regions under the influence of external factors are relevant to this work, where the subject is the Zakarpattia region, which borders four European Union countries and, following the external factor of Russia's full-scale invasion, became a place of rest and recovery for the rest of Ukraine, as the safest region without a curfew.

Another trend is the emergence of niche attractiveness indices focused on specific groups of mobile users, such as the Digital Nomad Friendliness (DNF) Index. According to the authors M. Zhang *et al.* (2026), the attractiveness of cities for digital nomads is assessed using a requirements tree and the multi-criteria MIVES (Integrated Value Model for Sustainable Evaluation) model, where the weights of the criteria (landscape aesthetics, quality of public spaces, community, safety) are determined by stakeholders. The authors emphasise that landscape aesthetics and the presence of an active local community, rather than just economic parameters, proved to be the decisive drivers. This aligns with the thesis of this study that resources without corresponding local interaction, infrastructure, and event practices do not guarantee high revenues. This study derives general indices of recreational tourism attractiveness, indicating the possibility of ranking territories based on specific subsets of factors for particular types of recreation. This idea conceptually resonates with niche DNF indices

and similar models (for sports, event, and gastronomic tourism), where criteria are selected for a specific segment and the implementation of fuzzy membership functions can be adapted. Given international examples, such segmentation of the model proposed in this study can be considered a promising direction for further research.

In a study on the multi-criteria assessment of the recreational potential of a post-industrial region, author I. Merylova (2025) also examined comprehensive indices of a territory's suitability for various types of recreation, combining natural, historical-cultural, and socio-economic criteria. As in the present study, strong spatial heterogeneity was identified, and territories were classified by potential level, highlighting the cores of recreational development. However, the multi-criteria evaluation method in the aforementioned author's work operates on a "clear" scoring scale, whereas the fuzzy model proposed in this study allows for the formalisation of transitional states and uncertainty when assigning communities to classes. Thus, the approach of this study is consistent with international practice in multi-criteria territorial assessment but complements it with a more flexible fuzzy toolkit.

■ CONCLUSIONS

The study's findings revealed significant disparities in the distribution of recreational and tourism resources and tourism fee revenues among the local communities of Zakarpattia region. Four communities have neither cultural heritage sites nor nature reserves, and in eleven, no payment of the tourism fee has been recorded at all; all of them belong to the group with the lowest tourism appeal. At the same time, the analysis showed that even such communities possess alternative resources capable of stimulating tourism development. These include logistical resources (border location, proximity to transportation hubs), industrial resources (manufacturing facilities, farms, industrial heritage sites), as well as gastronomic and event-based resources. In particular, the use of Vyl'ok's border location and the "Maly Berezny-Ublia" border

crossing, as well as the transport hub in Batyovo, looks promising. Tyachiv and the Teresva community also have significant potential due to their proximity to Ukrainian villages in Romania. The Borzhava narrow-gauge railway, the chocolate factory in Bushtyno, the buffalo farms in Horinchevo and Oleshnyk, as well as the traditions of greenhouse vegetable farming in a number of villages, could become important tourist attractions. Statistical analysis has shown that community revenues depend not so much on individual types of resources as on the ability to use them comprehensively in cooperation with other communities. This underscores the need for spatial planning of territorial development, the formulation of effective strategies, and the consolidation of efforts by academia, business, government, and the public. A perspective for further research is the development of integrated indices that take into account not only natural and cultural resources but also alternative factors – logistical, industrial, gastronomic, and event-related. This will allow for a more objective identification of the "hidden" tourism potential of communities with low traditional attractiveness scores. Efforts should focus on modeling various forms of cooperation among local communities (clusters, tourist routes, joint brands) and assessing their impact on revenue, tourist flows, and local development. The use of GIS technologies and economic-mathematical models will make it possible to determine optimal directions for the development of transport, border, and service infrastructure, as well as to identify "bottlenecks" in the territorial organisation of tourism.

■ ACKNOWLEDGEMENTS

None.

■ FUNDING

None.

■ CONFLICT OF INTEREST

None.

■ REFERENCES

- [1] Barvinok, N. (2023). Assessment of tourist and recreational potential and tourist infrastructure in individual united territorial communities of Kirovograd region. *Economies' Horizons*, 2(24), 4-20. doi: [10.31499/2616-5236.2\(24\).2023.281149](https://doi.org/10.31499/2616-5236.2(24).2023.281149).
- [2] Department of Tourism and Resorts of Zakarpattia Regional State Administration. (2025). *Tourist tax monitoring data by communities*. Retrieved from <https://zaktour.gov.ua/u-2025-rotsi-na-zakarpatti-splatyly-majzhe-32-mln-hrnturystychnoho-zboru/>.
- [3] Gavurova, B., & Polishchuk, V. (2025). Knowledge management in tourism: Leveraging fuzzy modelling to understand and predict tourist behaviour in the V4 countries. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, 20(3), 1165-1208. doi: [10.24136/eq.3819](https://doi.org/10.24136/eq.3819).
- [4] Gavurova, B., Polishchuk, I., & Polishchuk, V. (2025). Multi-criteria hybrid model of region assessment in the context of sustainable tourism. *Journal of Business Economics and Management*, 26(4), 880-900. doi: [10.3846/jbem.2025.24601](https://doi.org/10.3846/jbem.2025.24601).
- [5] Gu, X., Hunt, C.A., Jia, X., & Niu, L. (2022). Evaluating nature-based tourism destination attractiveness with a fuzzy-AHP approach. *Sustainability*, 14(13), article number 7584. doi: [10.3390/su14137584](https://doi.org/10.3390/su14137584).
- [6] Hou, M., Zhang, M., & Sun, Y. (2023). Greening tourism with environmental wellness: Importance of environmental engagement, green tourist intentions, and tourists' environmental stimulus. *Environmental Science and Pollution Research International*, 30(33), 79846-79860. doi: [10.1007/s11356-023-28052-4](https://doi.org/10.1007/s11356-023-28052-4).
- [7] Hutsal, L., & Shorobura, I. (2023). Formation of tourist attractiveness of territorial communities in Ukraine. *Economy and Society*, 49. doi: [10.32782/2524-0072/2023-49-47](https://doi.org/10.32782/2524-0072/2023-49-47).
- [8] Ibáñez, M.J., Ponce Oliva, R.D., & Diaz Avendaño, J. (2024). Tourism metamorphosis: Reshaping destination attractiveness in a post-pandemic world. *Journal of Infrastructure, Policy and Development*, 8(7), article number 4806. doi: [10.24294/jipd.v8i7.4806](https://doi.org/10.24294/jipd.v8i7.4806).

- [9] Jang, S., Choi, K., & Yoon, H.W. (2025). [Yanolja attractiveness index: Understanding a metric for measuring the attractiveness of global tourism cities](#). *Yanolja Research Insights*, 30.
- [10] Khairuddin, S.H., Hasan, M.H., Akashah, E.P., & Hashmani, M.A. (2021). Generating type 2 trapezoidal fuzzy membership function using genetic tuning. *Computers, Materials & Continua*, 71(1), 717-734. [doi: 10.32604/cmc.2022.020666](#).
- [11] Kondo, K. (2025). Measuring the attractiveness of trip destinations based on human mobility data. *Scientific Reports*, 15, article number 45485. [doi: 10.1038/s41598-025-29023-0](#).
- [12] Liu, F. (2024). Design and application of a TOPSIS-based fuzzy algorithm: A case study from tourism attraction evaluation. *International Journal of Advanced Computer Science and Applications*, 15(12), 427-434. [doi: 10.14569/IJACSA.2024.0151245](#).
- [13] Melnyk, A.V., Melnyk, N.V., Kacharovskiy, R.Ye., & Selezniova, O.V. (2023). Determinants of forming the tourist attractiveness of amalgamated territorial communities. *Agrosvit*, 2, 35-41. [doi: 10.32702/2306-6792.2023.2.35](#).
- [14] Merylova, I. (2025). Multi-criteria evaluation of recreational potential in post-industrial landscapes: A case study of the Prydniprovsk region. *Civil Engineering and Architecture*, 13(6), 4179-4193. [doi: 10.13189/cea.2025.130607](#).
- [15] Ministry of Culture of Ukraine. (n.d.). *State register of immovable monuments of Ukraine*. Retrieved from <https://mcsc.gov.ua/kulturna-spadshchyna/derzhavnyy-reiestr-nerukhomykh-pam-iatok-ukrainy/>.
- [16] Ministry of Finance of Ukraine. (n.d.). *Execution of local budget revenues*. Retrieved from <https://www.mof.gov.ua/uk/vykonannia-dokhodiv-mistsevykh-biudzhetiv>.
- [17] Nguyen, A.T., Nguyen, T.L., Le, N.A., Phuong, N.T., Do, T.T., Thi, T.T., & Le, H.T. (2026). A hybrid approach combining Fuzzy AHP and Fuzzy TOPSIS to rank agritourism destinations in Tan Cuong green tea region, Thai Nguyen, Vietnam. *Environmental and Sustainability Indicators*, 29, article number 101039. [doi: 10.1016/j.indic.2025.101039](#).
- [18] Nuriyev, A.M. (2022). Fuzzy MCDM models for selection of the tourism development site: The case of Azerbaijan. *F1000Research*, 11, article number 310. [doi: 10.12688/f1000research.109709.1](#).
- [19] Resolution of Verkhovna Rada of Ukraine No. 33 "On the Formation and Liquidation of Districts". (2020, July). Retrieved from <https://zakon.rada.gov.ua/laws/show/807-20#Text>.
- [20] Roshchuk, I.A. (2010). *Socio-economic statistics*. Rivne: National University of Water and Environmental Engineering.
- [21] Slavik, R., Saliuk, M., & Mykyta, M. (2020). Assessment of socio-economic indicators of administrative districts of Zakarpattia region in the context of recreation and tourism infrastructure development. *Journal of Socio-Economic Geography*, 28, 78-88. [doi: 10.26565/2076-1333-2020-28-09](#).
- [22] Song, Z. (2025). Research on assessing comprehensive competitiveness of tourist destinations within cities, based on field theory and competitiveness theory. *Sustainability*, 17(1), article number 90. [doi: 10.3390/su17010090](#).
- [23] Stecyk, A., Sidorkiewicz, M., & Orfin-Tomaszewska, K. (2021). Model of regional tourism competitiveness: Fuzzy multiple-criteria approach (FDM-FAHP-PROMETHEE II framework). *European Research Studies Journal*, 24(3), 638-663. [doi: 10.35808/ersj/2376](#).
- [24] The nature reserve fund of Zakarpattia oblast by territorial community. (n.d.). Retrieved from <https://pzf.land.kiev.ua/pzf-obl-7.html>.
- [25] Yermachenko, V., Melnychenko, S., Sidak, M., Dupliak, T., & Losytka, T. (2024). Sustainable tourism in the post-war reconstruction of territorial communities in Ukraine. *Access Journal*, 5(1), 34-57. [doi: 10.46656/access.2024.5.1\(3\)](#).
- [26] Zhang, M., Zhong, Y., Tan, L., Shi, H., Liu, J., Jiang, Y., & Wang, M. (2026). Mapping the attractiveness of globally important agricultural heritages to digital nomads: A stakeholder-driven, multi-criteria evaluation framework. *Heritage Science*, 14, article number 21. [doi: 10.1038/s40494-025-02240-6](#).

Роман Славiк

Кандидат економічних наук, доцент
Державний вищий навчальний заклад «Ужгородський національний університет»
88000, вул. Університетська, 14, м. Ужгород, Україна
<https://orcid.org/0000-0002-6198-3202>

Оцінка рекреаційного та туристичного потенціалу муніципалітетів з використанням методу нечітких множин

■ **Анотація.** Дослідження є актуальним у зв'язку з необхідністю вдосконалення оцінювання рекреаційно-туристичної привабливості муніципалітетів у межах нової адміністративно-територіальної системи України, зокрема громад Закарпатської області. Метою роботи було визначення рівня їх туристичної привабливості з використанням теорії нечітких множин для кількісного відображення невизначеності багатофакторних рішень. Для аналізу взаємозв'язку між ресурсами та надходженнями від туристичного збору застосовано нечітке моделювання з трапецієподібними функціями належності та статистичні методи. Отримані результати підтвердили значну неоднорідність просторового розподілу рекреаційно-туристичних ресурсів: коефіцієнт варіації інтегрального індексу становив 105 %, що свідчить про різкі відмінності між громадами. До групи з найвищою привабливістю увійшли Берегівська, Ясінянська, Ужгородська, Косоньська, Мукачівська та Іршавська громади; значний потенціал також мають Міжгірська, Пилипецька, Хустська та Рахівська громади. Понад половина громад Закарпаття належить до найменш привабливих; чотири з них не мають жодних об'єктів культурної спадщини або природно-заповідного фонду. Виявлено розрив між ресурсним потенціалом і фінансовими результатами: сім громад забезпечують 68 % надходжень від туристичного збору, тоді як найменш привабливі акумулюють 22 % потенціалу та генерують 24 % надходжень, що вказує на можливість синергетичного ефекту завдяки логістиці, маркетингу, інфраструктурі та людським ресурсам. Натомість громади з 23 % потенціалу формують менше 1 % доходів, що свідчить про «зворотну синергію». Статистичний аналіз показав, що лише 1,5 % варіації доходів пояснюється типом ресурсів. Ключовим чинником є не тип ресурсу, а здатність громад інтегровано використовувати сукупний ресурсний потенціал у співпраці з сусідніми громадами. Практична цінність дослідження полягає у запропонованні нечіткої моделі як аналітичного інструменту для стратегічного планування, брендингу та підвищення конкурентоспроможності муніципалітетів

■ **Ключові слова:** територіальні громади Закарпатської області; нечітка логіка; індекс територіальної привабливості; туристичний збір; сталий розвиток туризму; просторовий і статистичний аналіз