Cogent Social Sciences

ISSN: 2331-1886 (Online) Journal homepage: www.tandfonline.com/journals/oass20

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To cite this article: Adis Puška, Miroslav Nedeljković, Anđelka Štilić, Dragan Pamučar & Darko Božanić (2025) Assessment of ecotourism potential in rural settlements in the function of rural development, Cogent Social Sciences, 11:1, 2569756, DOI: 10.1080/23311886.2025.2569756

To link to this article: https://doi.org/10.1080/23311886.2025.2569756

COGENT SOCIAL SCIENCES
2025, VOL. 11, NO. 1, 2569756
https://doi.org/10.1080/23311886.2025.2569756

LEISURE AND TOURISM | RESEARCH ARTICLE

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Assessment of ecotourism potential in rural settlements in the function of rural development

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ABSTRACT

To preserve resources for future generations and promote rural development, supporting ecotourism is essential. This paper provides guidelines for developing ecotourism, highlighting its role in environmental conservation. While mass tourism benefits rural communities, it can cause significant environmental harm. Therefore, this research promotes ecotourism as a sustainable alternative. In rural areas, ecotourism supports development by responsibly using natural resources. The study focuses on the potential of rural settlements in the Semberija region of Bosnia and Herzegovina, assessing their capacity for ecotourism to aid local development. A decision model was developed, considering four main criteria - natural, infrastructure, socio-cultural, and economic - and their sub-criteria. This model evaluates six rural communities' ecotourism potential. To determine the importance of each criterion, a fuzzy weighting method with the Bonferroni mean operator was used, revealing economic factors as the most influential. The fuzzy ranking method then ranked the settlements, with Amajlije identified as having the highest ecotourism potential. The findings suggest that promoting ecotourism in Amajlije and similar communities can support sustainable rural development, balancing environmental preservation with economic growth.

ARTICLE HISTORY
Received 20 May 2025
Revised 5 September 2025
Accepted 29 September 2025

KEYWORDS
Sustainable ecotourism; rural settlements; Semberija; decision model; fuzzy methods

SUBJECTS
Tourism; Hospitality; Rural Development

1. Introduction

Ecotourism refers to responsible travel that preserves the ecological and cultural integrity of destinations while fostering socio-economic development for local communities. This form of tourism aims to minimize environmental impact and promote conservation (Ali et al., 2021), offering a sustainable alternative to mass tourism. Managing ecotourism projects is complex and requires sophisticated decision-making tools capable of balancing diverse and often conflicting criteria, such as environmental sustainability, economic viability and social equity (Škuflić et al., 2024).

The availability of natural resources is essential for the successful implementation of ecotourism (Stanciu et al., 2022), which must be harmonized with other community resources (Musavengane & Kloppers, 2020). The collective value of these resources is crucial for the development of ecotourism. However, before initiating ecotourism in a particular area, it is important to assess the potential of that area (Khaledi Koure et al., 2023). If an area lacks the appropriate potential, significant impacts on tourism development should not be expected (Rozalia Gabor et al., 2024).

Increasing globalization has led to a decreased focus on rural communities compared to urban areas (Gigović, et al., 2016). Therefore, rural populations are declining as residents leave these areas, weakening the role of rural communities (Clausen & Rudolph, 2020). The opportunity for growth in these communities—traditionally centered on agriculture—also lies in the potential expansion of tourism (Kaymaz et al., 2020). As a quick fix, mass conventional tourism is often implemented. This form of tourism boosts

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the development of rural communities but harms the environment (Pavlinović Mršić, 2025). In this scenario, as more tourists require larger accommodations, waste and environmental pollution increase with growing tourist numbers (Fan & Yang, 2025). As a result, the natural resources available to a rural community become threatened (Kaymaz, 2021).

In this way, the desire to develop rural communities often leads to a misperception of how natural resources and cultural heritage are used in tourism. The goal of making quick profits from this type of tourism produces short-term benefits, while the long-term effects are diminished because the natural resources available to rural communities are decreasing daily, and without them, tourism cannot survive. Therefore, the approach to implementing tourism activities needs to change, shifting from mass tourism to ecotourism (Kaymaz et al., 2021). Ecotourism is a strategic framework that rural communities should aim for. This approach allows the conservation of living communities by integrating natural resource preservation into tourism offerings, ensuring long-term sustainability, which should serve as the foundation for rural tourism development. Because of that, the potential of each local community to adopt ecotourism must be evaluated, and guidelines for its development must be established. This research focuses on assessing the potential for ecotourism in rural communities and providing development guidelines. The research question is: What are the potentials of rural communities for implementing ecotourism, and how can their natural resources be used sustainably to develop tourism?

Assessing ecotourism potential requires the application of a decision model that incorporates specific criteria. In this context, multi-criteria decision-making (MCDM) has emerged as an essential instrument, enabling stakeholders to systematically assess numerous factors and ensure decisions that support broader sustainable development goals (Bouraima et al., 2024; Radovanović et al., 2024). Besides the ecotourism field, the MCDM models have been shown as powerful tools in different fields, like economic analysis (Çalikoğlu & Łuczak, 2024), education (Sarfraz & Gul, 2025a, 2025b), logistics (Konur Bilgen et al., 2025) and lean management (Božanić et al., 2024). These methods are designed to handle situations involving multiple conflicting criteria (Biswas et al., 2025; Deivanayagampillai et al., 2023), providing a comprehensive framework for evaluating and prioritizing ecotourism initiatives.

The motivation for this research is to examine the ecotourism opportunities in rural settlements for enhancing the quality and standard of living in these areas through the development of eco and similar tourism. This research aims to assess the ecotourism potential of rural areas by using an MCDM-based decision-making model. Semberija region, in northeastern Bosnia and Herzegovina, is the research's primary focus. This region is characterized by its flat terrain, and the development of ecotourism should leverage the natural resources available in this area. Based on this objective, the research offers the following contributions:

- Developing a decision-making model for assessing ecotourism potential.
- Applying a methodology that uses new MCDM methods.
- Creating a novel MCDM method for evaluating the importance of criteria.
- Providing guidelines for improving rural ecotourism in the Semberija region.

Building on previous points, this research aims to address gaps in several key areas. Firstly, ecotourism research has not been sufficiently conducted in Bosnia and Herzegovina, especially in the Semberija region, which this study focuses on. Secondly, the evaluation of ecotourism potential using decision-making models and MCDM methods has been insufficiently explored. Thirdly, the practical application of MCDM methods in tourism studies and its various forms remains underused.

2. Literature review

The following order will be used when conducting the literature review: firstly, a review of publications that examined ecotourism in rural regions, followed by a review of the use of MCDM approaches in ecotourism literature.

2.1. Ecotourism in rural areas

Ecotourism is starting to be recognized as a powerful tool for rural growth, influencing economic, socio-cultural and environmental aspects in communities worldwide. The diverse impacts that ecotourism introduces in rural areas highlight the importance of balanced strategies that address community needs, environmental conservation and economic development. The following studies exemplify these impacts and highlight the varied dimensions of ecotourism in rural settings.

Gültekin (2022) focuses on forest villagers in Turkey, whose perspectives on ecotourism are often overlooked. Through structural equation modeling, the study finds that despite some negative effects and inadequate services, ecotourism contributes positively to villagers' livelihoods. In Iran, Aghdasi et al. (2023) investigate factors influencing ecotourism entrepreneurship among rural women in Fars province. The study finds that family support, personal empowerment and institutional backing are crucial for fostering a desire to create ecotourism residences. Turning to China, Rana and Bisht (2023) explore strategies for revitalizing small mountain farming in Uttarakhand through engaging young farmers in agricultural system evolution and encouraging community-based agri-ecotourism. The study highlights the need to shift toward more dynamic and youth-oriented agricultural practices due to the declining interest of rural youth in traditional subsistence farming.

Moswete et al. (2022) further explore the socio-economic effects of community-driven ecotourism in Khawa Village, Botswana, providing additional insights into the benefits and challenges of such initiatives. In a different context, Shi et al., 2022 examine the effects of tourism development around Wolong Nature Reserve in China using the sustainable livelihood framework. Their findings reveal that while tourism has improved livelihood capitals and benefited full-time tourism operators, it has also led to a change in livelihood strategies from traditional practices to tourism-related activities. In Ghana, Bonye et al. (2021) investigate the Wechiau Community Hippo Sanctuary Project (WCHSP). Their research reveals that WCHSP has drastically boosted social, economic, health and infrastructural conditions in local communities.

The above papers are relevant to this research topic because they emphasize the multidimensional effects of ecotourism activities on rural communities. The studies by Gültekin (2022), Aghdasi et al. (2023) and Moswete et al. (2022) emphasize the importance of ecotourism in terms of socio-economic benefits, while the works of Rana and Bisht (2023) and Shi et al. (2022) focus on how ecotourism can transform rural communities and create employment opportunities for local residents, helping to prevent migration from these areas. These points of importance demonstrate how the development of ecotourism could impact the growth of rural communities in Semberija, and thus, these papers are cited as examples of how to implement good practices in the selected case.

2.2. MCDM in ecotourism

MCDM methods are essential for addressing the challenges of decision-making in ecotourism, where multiple, often conflicting criteria must be balanced. These methods provide crucial tools for evaluating and harmonizing diverse factors, including environmental impact, economic benefits and social equity, with the overarching goal of achieving sustainable development that maximizes benefits across all dimensions.

Recent studies reflect the increasing focus on ecotourism within the broader context of MCDM research, highlighting its growing importance in promoting ecological sustainability. For instance, Tajer and Demir (2022) and Tajer and Demir (2024) have explored the application of novel quantitative methods, integrating the best and worst method (BWM) with strengths -weaknesses-opportunities-threats (SWOT) analysis, to develop and prioritize ecotourism strategies in Iran's Masouleh village and Golestan protected area. Complementing this, Ocampo et al. (2022) introduced a computational platform that combines the criteria importance through intercriteria correlation method with the weighted sum method to assess ecotourism potential. In a similar manner, Withanage et al. (2024) and Karakuş (2024) used geographic information system (GIS) and fuzzy multi-criteria decision analysis to determine whether land is suitable for ecotourism. Withanage et al. (2024) focused on a UNESCO World Heritage city in Sri Lanka, identifying areas with high suitability for sustainable tourism development, while Karakuş (2024) applied

a fuzzy logarithm methodology of additive weights (LMAW) in Türkiye's Sivas province to assess ecotourism potential. Additionally, Ruano et al. (2023) and Sobhani et al. (2024) used integrated MCDM approaches to assess sustainable ecotourism indicators and land potential in Belize and Iran, respectively. Ruano et al. (2023) combined the Delphi method with Fuzzy Decision Making Trial and Evaluation Laboratory (DEMATEL) to analyze the interdependencies among 51 key indicators across six dimensions.

The above papers demonstrate a connection to this research because they apply a fuzzy approach based on linguistic values. Their significance lies in showing how uncertainties and insecurities can be incorporated into decision-making processes, allowing subjective decisions about developing ecotourism. Therefore, these papers illustrate how MCDM methods can be used to assess the potential of ecotourism offerings. The research by Tajer and Demir (2022, 2024) explores initiatives in ecotourism implementation, which aligns with this research as it investigates potential implementation. However, this can also be viewed as an initiative, given that the ecotourism offer in rural Semberija communities remains underutilized. Withanage et al. (2024) and Karakuş (2024) analyzed spatial advantages for implementing tourism, which can also be applied in this research because rural communities are seen as spaces for ecotourism development. In this way, it is clear that the above research also influences the implementation of this study.

3. Evaluation criteria for ecotourism potential

A review of previous research on ecotourism shows various approaches, with different criteria used to evaluate the current state of ecotourism and the potential of specific locations for its development. Based on the research goals and focus, this study aims to assess the rural potential of Semberija for implementing ecotourism. To do this, we need to analyze the selected rural settlements from multiple viewpoints. Accordingly, the main and sub-criteria for this study were established. These criteria were identified through a systematic process: firstly, potential criteria were listed and organized. Then, a panel of experts reviewed these criteria and selected those they believed best supported the research objectives. Drawing from previous studies, experts indicated that ecotourism should not be viewed solely through an economic lens but should also incorporate broader criteria such as social, ecological and institutional factors related to the infrastructure of these settlements (Fischer, 2025). Gültekin (2022) highlights the economic significance of ecotourism, Aghdasi et al. (2023) emphasize the social dimension to achieve economic benefits, Moswete et al. (2022) focus on both economic and social aspects, while Shi et al. 2022 stress sustainability and natural conditions. All of these studies also point to the necessity of institutional support. Influenced by these and other studies, experts prioritized the main criteria for this research model, which are as follows:

- Natural criteria (C1)
- Infrastructure (C2)
- Social and cultural criteria (C3)
- Economic criteria (C4)

These criteria, from a holistic perspective, do not focus on preserving natural resources and beauty; instead, they promote the growth of local communities. They ensure a positive influence on both the natural environment and the well-being of the local community. Each main criterion is further divided into additional sub-criteria (Table 1) to better evaluate the potential of the selected rural settlements based on these criteria. Additionally, each main criterion is subdivided into an equal number of sub-criteria to ensure they are weighted equally in the evaluation process.

3.1. Natural criteria

In ecotourism, natural criteria focus on the preservation of natural resources at tourist destinations. It is not enough to just possess natural resources; it is equally important to preserve them. Strategies for resource preservation must be implemented (Mihalic, 2016) to reduce the negative environmental impact. The quality of natural resources, particularly the cleanliness of land, water and air—fundamental

Table 1. Main and sub-criteria used in the research.

Id	Criteria	Description	References
C1	*Natural criteria*		
C11	Diversity of natural resources	The richness and diversity of the ecosystem, including the variety of plant and animal life.	del Río-Rama et al. (2020), Ali et al. (2021)
C12	Preservation of natural resources	The current state of natural resources in a specific tourist destination.	Harahab et al. (2021), Zeng et al. (2022)
C13	Ecological awareness of the population	The level of understanding, engagement and responsibility of the local community toward environmental conservation.	Chen et al. (2023), Darvishmotevali and Altinay (2022)
C14	Existence of sustainable practices	The existence and implementation of strategies for the sustainable conservation of natural resources.	Sardana et al. (2020), Petrov et al. (2024)
C15	Quality and purity of water and land	The condition and conservation of water and land in a specific area.	Sudipa et al. (2020), Sun and Liu (2020)
C16	Level of air pollution	The quality and cleanliness of the air in a specific area.	Zhang et al. (2020), Zeng et al. (2022)
C2	*Infrastructure*		
C21	Accessibility to the location	The ease of arrival and departure from the tourist location without harming the natural environment.	Tomej and Liburd (2020), Latinopoulos (2020)
C22	Walking paths	The existence and marking of walking paths that do not disturb natural resources.	Gao and Schmöcker (2021), Witte (2023)
C23	Waste management	The existence of effective waste management practices to conserve natural resources.	Obersteiner et al. (2021), Camilleri (2021), Voukkali et al. (2021)
C24	Infrastructure for conducting ecotourism	The development and maintenance of infrastructure facilities for providing tourist services.	Bezuhla (2020), Imani and Alavi (2022)
C25	Accommodation facilities	The presence of accommodation facilities designed to preserve the natural environment.	Üzümoğlu and Turkan (2022), Xiang et al. (2020)
C26	Transport infrastructure	The presence of sustainable transport infrastructure which enables safe connection to the tourist destination.	Saidmamatov et al. (2020), Imani and Alavi (2022)
C3	*Social and cultural criteria*		
C31	Social potential	The potential for participation and acceptance by the local population in tourism activities.	Phoek et al. (2021), Ocelli Pinheiro et al. (2021)
C32	Availability of local guides	The engagement and training of the local population to guide tourists.	Sangpikul (2020), Khaledi Koure et al. (2023)
C33	Support from the local community	The local community's participation and cooperation to encourage tourism.	Khaledi Koure et al. (2023), Hatma Indra Jaya et al. (2024)
C34	Presence of historical sites	The existence and preservation of historical and cultural sites within the tourist offering.	Ambecha et al. (2020), Ocelli Pinheiro et al. (2021)
C35	Tradition and culture	The preservation and promotion of local customs and traditional ways of life.	Phoek et al. (2021), Long (2020)
C36	Education of the population	The information and education provided to the local population.	Mulyadi (2020), Arsad et al. (2021)
C4	*Economic criteria*		
C41	Potential for new jobs	The possibility for new jobs to be created in local communities as tourism develops.	Saidmamatov et al. (2020), Thompson (2022)
C42	Increasing the standard of living	The opportunity to increase the population's income and quality of life through tourism expansion.	Wardana et al. (2021), Arsad et al. (2021)
C43	Effectiveness of communication channels	The ability and quality of communication among all participants in the tourism sector.	Chai-Arayalert (2020), Harahab et al. (2021)
C44	Local gastronomic offer	The inclusion and promotion of traditional dishes in the tourist offering.	Astari et al. (2023) Medina et al. (2023)
C45	Sustainable use of resources	The sustainable engagement of human and natural resources to achieve economic stability.	Harahab et al. (2021), Stanciu et al. (2022)
C46	Authentic products	The availability of locally produced products that reflect the cultural heritage of the community.	Saidmamatov et al. (2020), Mulyadi (2020)

resources—is of highest importance (Barać et al., 2024). Maintaining these resources ensures a diverse range of natural assets. In contrast, if these resources become polluted, it will result in the decline of local flora and fauna, negatively affecting the community's ecotourism potential.

3.2. Infrastructure

Tourism development requires appropriate infrastructure that provides tourists with safety, comfort and accessibility. This infrastructure should be aligned with sustainable development principles to minimize environmental impact. Key infrastructural elements include access roads and accommodation facilities (Yu & Zhao, 2021). Beyond these, tourist destinations should also feature additional amenities such as restaurants, museums and walking or cycling paths to enhance their attractiveness. However, it is crucial to recognize that these infrastructural developments can negatively impact the ecosystem. Therefore, it is essential to adopt sustainability strategies when developing infrastructure to reduce environmental impacts.

3.3. Social and cultural criteria

The successful execution of tourism activities, including ecotourism, requires human resources (Saleh et al., 2020). However, it is important first to train and educate the local population and to equip them with the necessary knowledge for ecotourism implementation (Sukharev, 2025). A well-trained population can then take on roles such as guiding visitors. Additionally, using local traditions, customs and culture is vital for promoting tourism. Incorporating cultural elements into ecotourism offerings enhances their completeness. This approach not only strengthens social unity but also improves the well-being of local communities by fostering active participation in tourism activities. Furthermore, historical sites within the community (Abdinematabad et al., 2024) contribute to a richer tourist experience, offering visitors a unique blend of natural, social and cultural attractions.

3.4. Economic criteria

Tourism activities aim to improve the standard of living for the local population by increasing their income through active participation in the tourism sector (Streimikiene et al., 2021). This involvement, whether direct or indirect, contributes to reduced unemployment. Every form of tourism, including ecotourism, generates income for local communities. In addition to offering food and beverages, local residents should enhance their offerings by providing local specialties to visitors (Alfdool et al., 2025). Authentic products, such as crafts, food items and other region-specific goods, can also be marketed to tourists. However, big number of tourists can have negative ecological impacts, including increased waste production, requiring robust waste management practices.

4. Research methodology

This research uses the fuzzy calculation of weights with Bonferroni mean operator (CAWBOM) and fuzzy ranking of alternatives with weights of criterion (RAWEC) methods in evaluating Semberija's rural potential for ecotourism development. The fuzzy versions of these methods were used because the evaluations are expressed in linguistic form; they must be transformed to appropriate numerical values (Rahman & Muhammad, 2024) to obtain results using these methods. The CAWBOM method is used to calculate the main and sub-criteria's importance. This new method was selected to simplify the calculation of criteria weights, thereby facilitating the decision-making process. The fuzzy RAWEC method was used to rank selected rural settlements in Semberija based on their potential for ecotourism. Figure 1 presents the research framework.

The research framework also illustrates the phases of this study. Firstly, the subject and objectives were defined, followed by the creation of a research model based on these elements. This model included criteria and alternatives specific to rural communities, integrated with fuzzy methods. The process began with assessing the importance of each criterion using linguistic values, which were then converted into

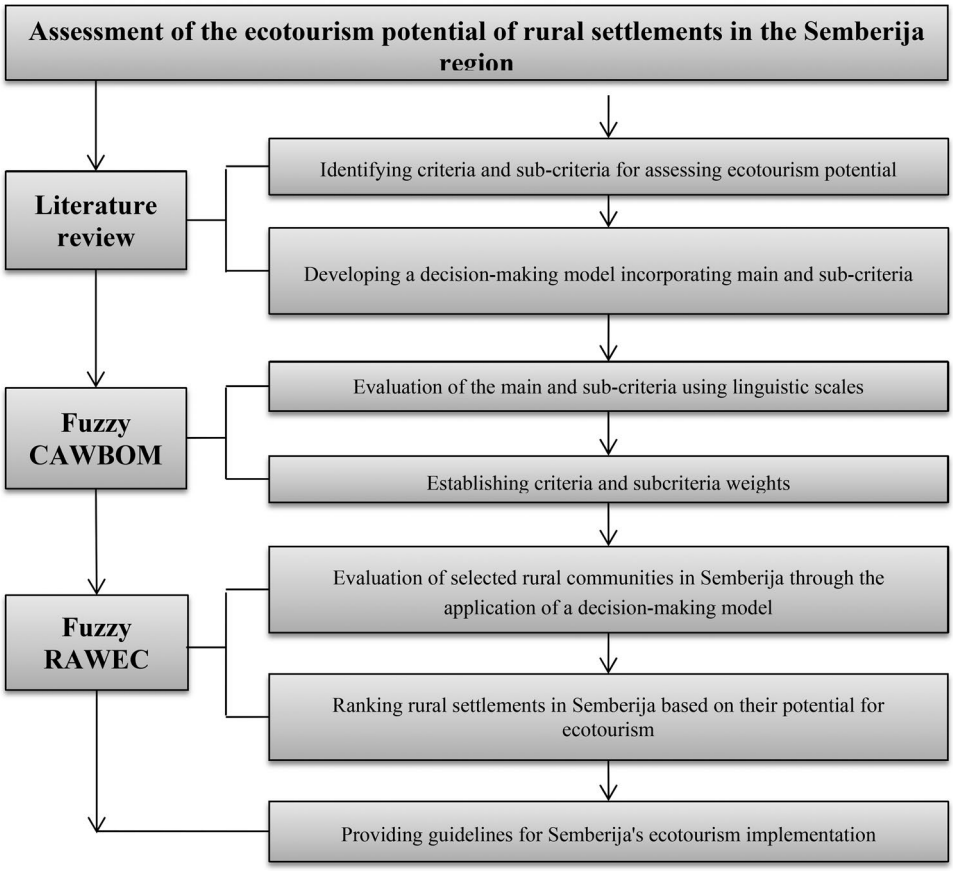

Figure 1. Research methodology.

fuzzy numbers through a defined membership function. These fuzzy values were used to calculate the weights of both main and sub-criteria via the fuzzy CAWBOM method. This approach enables more transparent and straightforward calculation of weights compared to some other fuzzy methods. The resulting weights were used to rank rural communities according to their ecotourism potential, alongside ratings of individual communities. For this ranking, the fuzzy RAWEC method was used. The final phase involved interpreting the results, providing explanations for why these outcomes occurred and offering guidelines to promote ecotourism in these areas. These phases are organized within a research framework that ensures a logical and coherent flow, making the study systematic and consistent.

4.1. Fuzzy CAWBOM method

The fuzzy CAWBOM is a new method for the subjective assessment of weights. This method was intended to simplify the steps involved in obtaining the weights of criteria necessary for decision-making. Previous methods have used various approaches to determine weights: the analytic hierarchy process method uses pairwise comparisons of criteria (Saaty, 1987), the stepwise weight assessment ratio analysis method combines ranking and comparison of criteria (Keršulienė et al., 2010), the BWM method compares criteria relative to the best and worst ranked ones (Rezaei, 2015), the LMAW method uses natural logarithms and simple evaluations of criteria (Pamučar et al., 2021), and the direct weight calculation method directly calculates weights based on expert ratings (Puška, Nedeljković, et al., 2024). Each method has specific steps (de Oliveira & Steffen, 2025) or requirements that must be followed before calculating weights.

There are several reasons why the CAWBOM method is used to determine the weights of criteria. The CAWBOM method depends on experts' assessment of individual criteria, without requiring them to compare or rank the criteria. Instead, they simply rate the importance of each criterion. This method involves normalizing expert ratings. The purpose of normalization when calculating criteria weights is to equalize all ratings. Therefore, different normalization techniques are used from those employed when ranking

alternatives, to prevent favoring any particular criterion and to ensure all criteria are treated equally, maintaining the ratings' level (Katranci et al., 2025). An important aspect is that this method uses the Bonferroni mean operator to reconcile experts' ratings for the criteria. The advantage of this operator is that classic means assume all ratings are independent, but in decision-making, ratings are influenced by the exchange of information among experts (Sarfraz & Gul, 2025a, 2025b). Their opinions can change after discussions. To account for this, the operator incorporates ratings iteratively when calculating the average (Hadžikadunić et al., 2023). As a result, the mean values produced by this operator are more flexible than those from traditional formulas, supporting aggregation based on experts' preferences. Additionally, the method is valued for its simplicity, as it involves fewer steps and is easier to apply when determining criteria weights. All these factors led to the decision to use the CAWBOM method in this research.

The following steps are used for calculating the weights of the criteria:

Step 1: Evaluation of the importance of the criteria by experts. Experts use linguistic values to evaluate the importance of criteria, forming an initial decision matrix.

Step 2: Transforming linguistic values to fuzzy numbers. The membership function of the linguistic values corresponding to fuzzy numbers is used in this step. To achieve this, linguistic values and their membership functions must be established (Table 2), leading to a fuzzy initial decision matrix.

Step 3: Normalization of the fuzzy decision matrix. Here, all values are divided by the largest fuzzy number in the matrix:

$$\tilde{n}_{ij} = \frac{x_{ij}^{l}}{max\, x_{ij}^{u}}, \frac{x_{ij}^{m}}{max\, x_{ij}^{u}}, \frac{x_{ij}^{u}}{max\, x_{ij}^{u}} \tag{1}$$

where $x_{ij\max}$ is the maximum value of fuzzy numbers in the initial decision matrix.

Step 4: Harmonization of normalized values by calculating the Bonferroni mean operator. This step calculates the mean value for individual criteria using the Bonferroni mean operator formula:

$$\tilde{v}_j = \left(\frac{1}{k(k-1)} \sum_{\substack{i,j=1 \\ i \neq j}}^{k} \tilde{n}_i^{(UL)p}\, \tilde{n}_i^{(UL)q} \right)^{\frac{1}{p+q}} \tag{2}$$

Step 5: Criteria weight calculation. The sum of the individual weight values is calculated and then divided by the individual values:

$$\tilde{w}_{ij} = \frac{\tilde{v}_{ij}}{\sum_{j=1}^{n} \tilde{v}_{ij}} \tag{3}$$

By following these steps, the criteria weights are established. The first value of the fuzzy number must be less than or equal to the second value, and the second value must be less than or equal to the third value.

Table 2. Linguistic values and membership function.

Linguistic values	Marking	Membership function
Extremely bad	EB	(1, 1, 1)
Very bad	VB	(1, 2, 4)
Bad	B	(1, 3, 5)
Medium bad	MB	(2, 4, 6)
Medium	M	(3, 5, 7)
Medium good	MG	(4, 6, 8)
Good	G	(5, 7, 9)
Very good	VG	(6, 8, 9)
Extremely good	EG	(7, 9, 9)

4.2. Fuzzy RAWEC method

Introduced by Puška, Štilić, et al. (2024), the RAWEC method ranks alternatives by calculating the deviation of the alternatives relative to the weights of the criteria (Petrović et al., 2024; Trung et al., 2025). The reasons for using this method in this research are several. Its main feature is that the same normalization process is applied twice. Simple linear normalization is used (Tufan & Ulutaş, 2025), first converting all values into benefit values where a higher value indicates a better alternative, and then transforming all values into cost values where a lower value indicates a better option. By applying two normalizations, expert assessments are evaluated in two different ways, which enhances the reliability of the evaluations (Katranci et al., 2025). Another unique aspect of this method is that it does not require weighting the normalized values, as the weighting is also derived from the deviation. This makes the method simpler to implement compared to some other MCDM techniques. Moreover, the results obtained from this method are consistent (Puška, Štilić, et al., 2024) and show a strong correlation with newer MCDM methods such as multi-attributive border approximation area comparison (MABAC), measurement alternatives and ranking according to compromise solution (MACROS), additive ratio assessment (ARAS) and similar approaches, as well as with older methods like technique for order of preference by similarity to ideal solution (TOPSIS) or vilsekriterijumska optimizacija i kompromisno resenje (VIKOR). For these reasons, this method was chosen for use in this research.

The method's steps are as follows (Puška, Štilić, et al., 2024):

Step 1: Forming the initial decision matrix. When evaluating the alternatives, the same linguistic values will be used as those applied when evaluating the criteria (Table 2). This approach was chosen to simplify the decision-making process.

Step 2: Transforming linguistic values into fuzzy numbers.

Step 3. Normalizing of the fuzzy decision matrix:

Maximum normalization:

$$n_{ij} = \frac{x_{ij}^{l}}{\max x_{j}^{u}}, \frac{x_{ij}^{m}}{\max x_{j}^{u}}, \frac{x_{ij}^{u}}{\max x_{j}^{u}} \tag{4}$$

Minimum normalization:

$$n'_{ij} = \frac{\min x_{j}^{l}}{x_{ij}^{u}}, \frac{\min x_{j}^{l}}{x_{ij}^{m}}, \frac{\min x_{j}^{l}}{x_{ij}^{l}} \tag{5}$$

where x_{jmin} is the minimum value of a specific criterion, and x_{jmax} is the maximum value of a specific criterion.

Step 4. Calculating the deviation from the criterion weight.

$$\tilde{v}_{j} = \sum_{i=1}^{n} \tilde{w}_{j} \cdot \left(1 - \tilde{n}_{ij}\right) \tag{6}$$

$$\tilde{v}'_{j} = \sum_{i=1}^{n} \tilde{w}_{j} \cdot \left(1 - \tilde{n}'_{ij}\right) \tag{7}$$

where $\tilde{w}_{j}$ is the weight of the criteria.

Step 5. Defuzzification of deviation from the criterion weight.

$$v_{jdef} = \frac{v_i^l + 4v_i^m + v_i^u}{6} \tag{8}$$

$$v'_{jdef} = \frac{v'^l_i + 4v'^m_i + v'^u_i}{6} \tag{9}$$

Step 6. Calculating the value of the RAWEC method.

$$Q_i = \frac{v'_j - v_j}{v'_j + v_j} \tag{10}$$

When it comes to ranking, the alternative with the highest value is considered the best, and the one with the lowest value the worst. This decides the ranking of the alternatives.

4.3. Case study

Tourism is increasingly gaining importance (Seidualin et al., 2025), with more attention being dedicated to its development and impact. Additionally, tourism is becoming more common in rural areas, providing an additional source of income for local populations (Mukherjee et al., 2023). Bosnia and Herzegovina is a developing country that is increasingly focusing on tourism (Mrkaić Ateljević, 2025). Numerous initiatives have emerged from this focus, involving all regions in the tourism development process. Semberija, positioned in Bosnia and Herzegovina's northeast, is situated between the Drina and Sava rivers. The strategic objective of this region is to promote and enhance ecotourism and rural tourism. Semberija hosts different types of tourism, including religious tourism, ethnic tourism, hunting and fishing tourism, rural tourism, excursion tourism and other.

In collaboration with the Ecological Association 'Eko-put', the greatest potential for ecotourism advancement in rural areas was identified. This association is dedicated to expanding the tourism offerings in Semberija through the promotion of ecotourism. Therefore, they were chosen to assist due to their focus on developing Semberija's tourist potential. Through this partnership, ten experts were recognized as candidates for this study. These experts are from the fields of tourism and ecology and are members of this association. Additionally, since they live near these rural communities, they are familiar with their natural potential. As a result, they are well-suited to assess these rural areas. Seven of the contacted experts agreed to participate in the evaluation and gave informed consent electronically, while the remaining three were unable to take part due to other commitments. The selected experts first evaluated which rural settlements have the ecotourism development potential and identified six of them: Amajlije, Crnjelovo, Međaši, Ostojićevo, Popovi and Velino Selo. These villages were chosen as alternatives because of their geographical locations and the natural resources they possess.

Amajlije (A1) is located within the municipality of Bijeljina, on the eastern side of the Semberija region. It lies along the Drina river's banks and is a lowland village with fertile land. Traditionally, agricultural activities have been prominent, but recently, tourism, particularly ecotourism, has been gaining momentum. The reason for this is the rapid growth of ecological camps along the Drina River and protected coastal areas. The site also acts as a recreational hub where many residents of the Bijeljina municipality gather.

Crnjelovo (A2) is a typical Semberija village known for its well-developed agricultural activities, especially vegetable production. In addition, the settlement offers tourist attractions, including recreational centers and local associations dedicated to protecting the natural environment. Local events are held throughout the year where local customs and traditions are showcased. Recently, hunting associations have gained popularity, and the village's close proximity to the Sava River provides active vacations that are typical of this region.

Međaši (A3) is situated in the northeastern area of Semberija, close to Drina River. Known for its unique cultural activities, such as the 'Children's Embassy', the village also offers tourist attractions,

including preserved rural households and activities related to the Drina River. Hunting activities have also been developed, along with initiatives to protect wildlife. By collaborating with local activists, it has been possible to preserve the immediate environment along the Drina River through the promotion of camping tourism.

Ostojićevo (A4) is situated in the northern part of the Semberija region, along the Sava River. The village is rich in tradition and is historically home to boatmen and scaffolders. The proximity of the Sava River provides numerous possibilities for growth in terms of rural and ecotourism. The proximity to the border with Serbia provides an advantage in attracting tourists and gaining a better understanding of this region. Local events focus on preserving the traditions of the former village and promoting organic production.

Popovi (A5) is a well-developed Semberija settlement located in the Bijeljina municipality's eastern part. It is known for its dedicated hosts and a unique settlement within it called Slobomir. Situated close to the Drina River, Popovi has developed infrastructure that offers a wide range of activities related to active rural tourism. Most of the content focuses on hunting and fishing activities, and ecological camps are also increasing, organized to educate young people about protecting the local environment.

Velino Selo (A6) is a border town close to Serbia, located in the northern part of the Semberija region. The Velinska Atar area is home to the oldest lowland peat bog, Gromiželj, which contains rare plants, including some that have long since disappeared from Europe. The development of cultural life dates back to the century before last, thanks to the growth of rafting and crossing natural borders with neighboring countries. Local events and associations that focus on environmental protection have also been well-developed in this area.

The uniqueness of these settlements is their location along the Sava or Drina rivers, and they are all classified as lowland villages. Agriculture is the primary activity, making it possible to develop agrotourism alongside ecotourism in these communities. These are typical rural communities of Semberija with similar culture, customs and heritage, since all these settlements are situated relatively close to each other, as shown in Figure 2. The advantage of these villages lies in their natural resources, which form the basis for ecotourism. Therefore, these settlements were included in this research.

5. Results

When evaluating the ecotourism potential in this research, fuzzy CAWBOM and fuzzy RAWEC methods are used. The initial step in assessing ecotourism potential is to calculate the importance of the criteria

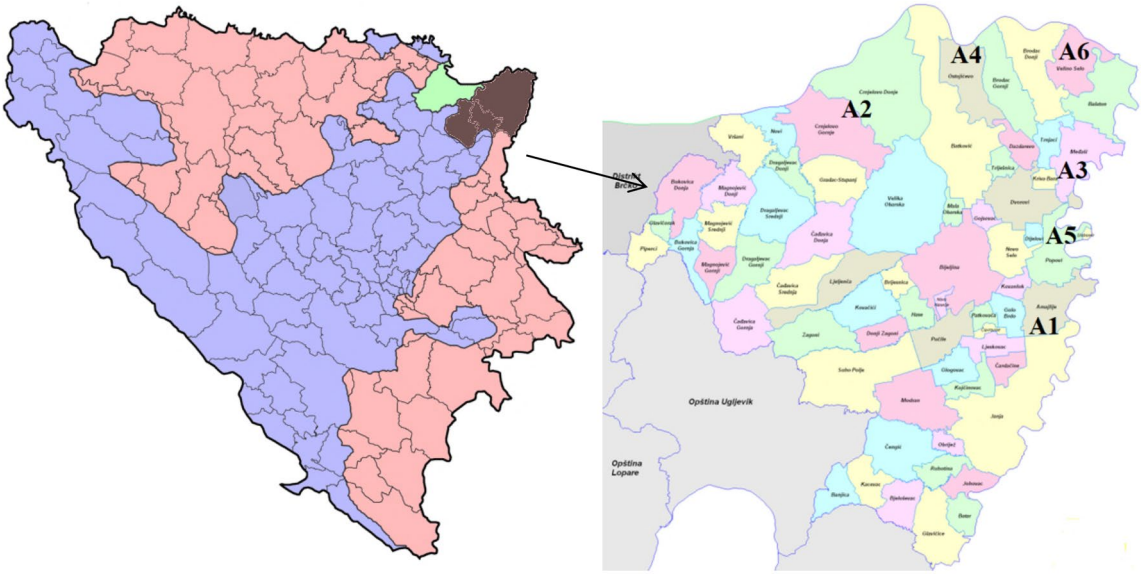

Figure 2. Location of Semberija and rural settlements.

using the fuzzy CAWBOM method. The implementation of the fuzzy CAWBOM will be explained using the example of the main criteria.

This step involves assessment by experts, where experts evaluate the importance of the criteria by choosing a certain degree of agreement with the stated claims, using linguistic evaluations (Table 2). Based on these evaluations, the initial linguistic decision-making matrix is formed (Table 3).

The second step in the fuzzy CAWBOM method is the transformation of linguistic values to fuzzy numbers by using the membership function (Table 2). Using it, a fuzzy value is assigned to the corresponding linguistic value. For example, the value 'Medium (M)' is assigned a fuzzy number (3, 5, 7). By doing this, the fuzzy initial decision matrix is created (Table 3). Next, the normalization of the fuzzy initial decision matrix is done. Here, the highest value in the fuzzy decision matrix, which is nine (9), is identified, and all values in the decision matrix are divided by nine. For example, for E1 and C1, the normalization is calculated like:

$$n_{11} = \left(\frac{3}{9} = 0.33, \frac{5}{9} = 0.56, \frac{7}{9} = 0.78 \right)$$

By applying normalization in this manner, all criteria are uniformly observed, and the expert's assessments are preserved (Çelik, 2024). To harmonize the experts' ratings into a single rating, this method uses the Bonferroni mean operator (Equation (3)). This mean operator is chosen for its simplicity, wide applicability and control of Type I error. By applying this operator, unique values are obtained for the observed criteria (Table 4). After this, the values of all fuzzy numbers obtained with the Bonferroni mean operator are summed, and the individual values are divided by that total (Equation (4)). For criterion C1, this is represented as follows:

$$w_{11} = \left(\frac{0.43}{3.62} = 0.12, \frac{0.65}{2.81} = 0.23, \frac{0.87}{1.91} = 0.46 \right)$$

Like this, the weights of all other criteria are calculated (Table 4). The results of this method indicate that the most important criterion for experts is the economic criterion (C4), while the significance of the other criteria is relatively equal, showing little difference among them.

By applying the same method, the weights of sub-criteria are calculated (Table 5). The final sub-criteria weights are calculated by multiplying the weights of the sub-criteria by the weights of the corresponding main criteria. These weights are then used to rank the observed rural settlements in the context of their potential for ecotourism.

After calculating the importance of main and sub-criteria using the fuzzy CAWBOM method, the alternatives are ranked. The first step with ranking these alternatives is for experts to assess the ecotourism potential (Table 6). Following this, the transformation of linguistic values to fuzzy numbers is done by applying the membership function (Table 2), similar to the fuzzy CAWBOM method. Next, the aggregate decision matrix is formed.

Table 3. Initial linguistic and fuzzy decision matrix for the main criteria.

Criteria	C1	C2	C3	C4	C1	C2	C3	C4
Experts	Linguistic values				Fuzzy numbers			
Expert 1 (E1)	M	MB	MB	G	(3, 5, 7)	(2, 4, 6)	(2, 4, 6)	(5, 7, 9)
Expert 2 (E2)	M	M	MG	VG	(3, 5, 7)	(3, 5, 7)	(4, 6, 8)	(6, 8, 9)
Expert 3 (E3)	MG	G	MG	VG	(4, 6, 8)	(5, 7, 9)	(4, 6, 8)	(6, 8, 9)
Expert 4 (E4)	MG	MG	G	VG	(4, 6, 8)	(4, 6, 8)	(5, 7, 9)	(6, 8, 9)
Expert 5 (E5)	M	MG	MG	VG	(3, 5, 7)	(4, 6, 8)	(4, 6, 8)	(6, 8, 9)
Expert 6 (E6)	G	MG	MG	G	(5, 7, 9)	(4, 6, 8)	(4, 6, 8)	(5, 7, 9)
Expert 7 (E7)	G	MG	G	VG	(5, 7, 9)	(4, 6, 8)	(5, 7, 9)	(6, 8, 9)

Table 4. Initial linguistic and fuzzy decision matrix for the main criteria.

	C1	C2	C3	C4
BMO	(0.43, 0.65, 0.87)	(0.41, 0.63, 0.86)	(0.44, 0.67, 0.89)	(0.63, 0.86, 1.00)
w	(0.12, 0.23, 0.46)	(0.11, 0.23, 0.45)	(0.12, 0.24, 0.46)	(0.18, 0.31, 0.52)

Table 5. Initial linguistic and fuzzy decision matrix for the main criteria.

	C11	C12	C13	C14	C15	C16	C21	C22	C23	C24	C25	C26
E1	M	MB	M	M	MB	M	G	MB	MB	MB	MB	MB
E2	MB	MB	MG	M	G	M	MG	MB	M	MB	M	M
E3	M	VG	G	M	VG	M	VG	MB	MG	MB	VG	VG
E4	MB	VG	M	MB	VG	EG	EG	M	M	MB	EG	VG
E5	MB	EG	MG	B	EG	MG	EG	M	G	MB	G	VG
E6	G	VG	VG	MB	VG	MG	VG	M	MG	M	VG	VG
E7	MG	G	VG	MG	VG	G	VG	MG	MG	MB	VG	VG
	C31	C32	C33	C34	C35	C36	C41	C42	C43	C44	C45	C46
E1	MB	B	MB	M	MG	G	VG	VG	G	G	G	G
E2	MB	M	MG	M	MG	VG	VG	VG	VG	G	G	G
E3	MB	G	MG	MG	MG	VG	VG	VG	G	VG	G	VG
E4	M	G	MG	MG	VG	VG	VG	EG	G	VG	G	VG
E5	MB	G	VG	MG	MG	VG	VG	VG	MG	VG	G	VG
E6	MB	VG	MG	MG	G	VG	VG	G	G	VG	G	G
E7	M	VG	MB	MG	MG	VG	VG	G	VG	VG	MG	G
C11			C12		C13		C14		C15		C16	
(0.01, 0.03, 0.13)			(0.01, 0.04, 0.15)		(0.01, 0.04, 0.15)		(0.01, 0.03, 0.12)		(0.01, 0.05, 0.16)		(0.01, 0.04, 0.15)	
C21			C22		C23		C24		C25		C26	
(0.01, 0.05, 0.16)			(0.01, 0.03, 0.12)		(0.01, 0.03, 0.14)		(0.01, 0.03, 0.11)		(0.01, 0.04, 0.15)		(0.01, 0.04, 0.15)	
C31			C32		C33		C34		C35		C36	
(0.01, 0.03, 0.12)			(0.01, 0.04, 0.15)		(0.01, 0.04, 0.14)		(0.01, 0.04, 0.15)		(0.01, 0.04, 0.16)		(0.02, 0.05, 0.17)	
C41			C42		C43		C44		C45		C46	
(0.02, 0.05, 0.14)			(0.02, 0.05, 0.14)		(0.02, 0.05, 0.14)		(0.02, 0.05, 0.14)		(0.02, 0.05, 0.14)		(0.02, 0.05, 0.14)	

Table 6. Evaluation of alternatives using linguistic values.

E1	C11	C12	C13	C14	C15	C16	C21	C22	C23	C24	C25	C26
A1	VG	G	MG	MB	M	G	MG	M	MB	MG	G	G
A2	M	B	M	B	MG	G	G	MB	MB	M	MG	M
A3	MG	MB	MB	B	G	G	G	B	B	M	M	G
A4	G	MG	M	B	MG	MG	G	B	MB	MB	MB	MB
A5	MB	M	MB	MB	MG	MG	M	VB	MB	M	MB	MB
A6	B	M	MB	B	G	G	M	B	B	MG	MB	VB
E1	C31	C32	C33	C34	C35	C36	C41	C42	C43	C44	C45	C46
A1	MG	B	MB	B	MG	G	M	G	M	G	VG	M
A2	G	B	VB	M	M	M	MG	G	MB	VG	VG	M
A3	MG	B	B	MG	MG	MG	MG	G	M	MG	G	MB
A4	G	MB	MB	MB	G	MB	G	MG	M	G	MG	M
A5	MG	B	B	M	MG	B	VG	MG	M	VG	M	MG
A6	MG	B	MB	M	G	MB	M	G	M	G	MB	M
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
E7	C11	C12	C13	C14	C15	C16	C21	C22	C23	C24	C25	C26
A1	MG	MG	MG	MB	MG	G	G	M	MB	MG	MG	G
A2	M	MB	M	B	M	M	MG	MB	MB	MG	MG	G
A3	MG	MB	M	MG	G	G	G	G	MG	G	MG	G
A4	G	M	M	MB	MG	MG	G	MG	M	MB	MB	MB
A5	M	MB	MB	MB	G	MG	MB	VB	MB	G	MB	M
A6	B	M	MB	B	G	VG	M	B	B	MG	G	VB
E7	C31	C32	C33	C34	C35	C36	C41	C42	C43	C44	C45	C46
A1	MG	B	MB	G	MG	G	M	G	MG	G	G	VG
A2	G	MG	MB	M	MG	MG	VG	VG	MG	VG	G	M
A3	VG	M	G	MG	MG	G	G	G	M	MG	M	MB
A4	G	M	MB	MB	MG	M	MG	MG	G	G	G	M
A5	MG	MG	MG	M	MB	B	EG	M	M	G	M	G
A6	MG	B	G	G	G	MB	M	G	MG	G	MB	M

Legend: Amajlije (A1), Crnjelovo (A2), Međaši (A3), Ostojićevo (A4), Popovi (A5) and Velino Selo (A6).

The fuzzy RAWEC develops further with the normalization of the aggregate decision matrix as the next step. Unlike similar methods, the fuzzy RAWEC method uses two normalization processes. The first normalization transforms all criteria into benefit-type criteria and maximizes these criteria, while the second normalization converts all criteria into cost-type criteria and minimizes them. This dual normalization is performed to calculate the deviation from these values. For example, using criterion C11 and Expert 1, the calculations are as follows:

$$n_{11} = \left(\frac{3.45}{8.85} = 0.39, \frac{5.55}{8.85} = 0.63, \frac{7.48}{8.85} = 0.84 \right)$$

Table 7. The fuzzy RAWEC's results.

Alternative	$\tilde{v}_j$	v_j	$\tilde{v}'_j$	v'_j	Q_i	Rank
A1	(0.02, 0.31, 1.92)	0.529	(0.11, 0.61, 2.47)	0.835	0.225	1
A2	(0.03, 0.33, 2.03)	0.567	(0.10, 0.59, 2.44)	0.820	0.183	3
A3	(0.02, 0.32, 1.95)	0.541	(0.10, 0.60, 2.47)	0.830	0.211	2
A4	(0.03, 0.35, 2.06)	0.579	(0.09, 0.59, 2.43)	0.813	0.168	4
A5	(0.05, 0.40, 2.24)	0.648	(0.06, 0.55, 2.38)	0.775	0.090	6
A6	(0.04, 0.38, 2.18)	0.626	(0.07, 0.57, 2.41)	0.792	0.117	5

Legend: Amajlije (A1), Crnjelovo (A2), Međaši (A3), Ostojićevo (A4), Popovi (A5) and Velino Selo (A6).

$$n'_{11} = \left(\frac{1.29}{7.48} = 0.17, \frac{1.29}{5.55} = 0.23, \frac{1.29}{3.45} = 0.37 \right)$$

In the normalization process for criterion maximization, all criteria are divided by the greatest value of the fuzzy number for the criterion in question. In the process of criterion minimization, the smallest value of the fuzzy number for a certain criterion is divided by the values for that criterion. Using C11 and A1 as an example, the calculation is as follows:

$$\tilde{d}_{11} = 0.01 \cdot (1 - 0.84) = 0.00, 0.03 \cdot (1 - 0.63) = 0.01, 0.13 \cdot (1 - 0.57) = 0.08$$

$$\tilde{d}'_{11} = 0.01 \cdot (1 - 0.37) = 0.00, 0.03 \cdot (1 - 0.23) = 0.02, 0.13 \cdot (1 - 0.17) = \mathbf{0}.11$$

After the deviation is calculated for the individual criteria, the results are summed. These fuzzy values are then defuzzified into crisp numbers (Equations (8) and (9)). For alternative A1, the calculations are as follows:

$$v_{1def} = \frac{0.02 + 4 \cdot 0.31 + 1.92}{6} = 0.529; \quad v'_{1def} = \frac{0.11 + 4 \cdot 0.61 + 2.47}{6} = 0.835$$

Next, the value of the fuzzy RAWE is calculated. For A1, the calculation is done as follows:

$$Q_1 = \frac{0.835 - 0.529}{0.835 + 0.529} = 0.225$$

The results show that Amajlije (A1) has the highest potential for ecotourism, followed by Međaši (A3) (Table 7). These two settlements stand out from the other rural settlements considered in this research. Popovi (A5) showed the lowest potential. However, when examining the results produced from the fuzzy RAWEC method, it becomes evident that all rural settlements exhibit positive outcomes. This outcome suggests that there are no significant deviations in the ecotourism potential across the rural villages that were observed.

6. Discussion

The natural resources available at a particular location determine the potential for engaging in specific types of tourism (Mrkaić Ateljević et al., 2024). To use these natural resources for tourism, they must be protected to prevent their degradation through tourism development. This is achievable only through the adoption of sustainable tourism strategies. Semberija, a region in the extreme northeast of Bosnia and Herzegovina, situated between the Sava and Drina rivers, holds significant potential for ecotourism. The Semberija area is predominantly lowland, located at the base of the Majevica mountain, and lacks the resources necessary for mountain tourism. The natural resources evaluated in this research are primarily found along the banks of these rivers, where rural settlements are situated.

To evaluate the potential of this region, a decision-making model was developed, incorporating four main criteria: natural resources, infrastructure, social and cultural factors, and economic considerations. These criteria were chosen for specific reasons. For a local community to engage in ecotourism, it must

first have natural resources (del Río-Rama et al. 2020). Without natural wealth, attracting tourists and engaging in ecotourism is impossible (Zeng et al., 2022). When a location has these resources, as the rural settlements in Semberija do, it is necessary to provide infrastructure, particularly road infrastructure, to enable access for tourists. The protection of natural resources must be addressed while developing this infrastructure (Harahab et al., 2021). Additionally, it is essential to have accommodation facilities in these localities (Le et al., 2024). None of this is possible without the active participation of locals (Ocelli Pinheiro et al., 2021), which is why social and cultural criteria were included. Ultimately, all tourism activities aim to generate income (Streimikiene et al., 2021), which is why economic criteria were integrated into this model.

The importance of these criteria within the ecotourism potential assessment model was evaluated using the fuzzy CAWBOM method. This method was selected to simplify decision-making for the experts, who were tasked only with determining the importance of each criterion according to a linguistic scale. Through this approach, the significance of the main and sub-criteria was determined. The results indicated that experts assigned less priority to economic criteria compared to others. One reason for this is the understanding that without economic benefits from tourism, it will not succeed (Jaković et al., 2024). As the economic benefits for the local population from tourism increase, tourism itself develops (Streimikiene et al., 2021), as the population becomes more invested in tourism activities. However, for there to be economic benefits, it is necessary to provide tourists with a unique experience to maximize their satisfaction and encourage repeat visits. Therefore, the results highlight the importance of the other main criteria in evaluating the ecotourism potential in the rural areas of Semberija.

The fuzzy RAWEC was used for ranking the rural settlements in Semberija. This method was chosen not only because it is a new approach in multi-criteria analysis but also because it provides results that closely align with those of other methods (Puška, Štilić, et al., 2024). The results revealed that all the rural settlements in Semberija possess significant potential for ecotourism. This is particularly evident in the results, as all settlements had a positive value. Therefore, it can be concluded that no single settlement dominates over the others, but each has certain advantages according to specific criteria.

Furthermore, this research has shown that the rural community of Amajlije (A1) has the best indicators. This rural community stands out compared to other observed communities because it has good natural resources along the Drina River, an already developed infrastructure for tourist activities such as camping tourism, and strong support from the local community. All of these factors have contributed to this rural community being ranked the highest. The second-ranked community is Međaši (A3), which offers authentic cultural heritage to visitors. Combined with its natural resources, this makes it suitable for ecotourism. To further develop its potential, efforts should focus on improving communal infrastructure. The rural community of Crnjelovo (A2) has well-established agricultural production, but it also needs to work on natural resources and community engagement to unlock its full potential. Additionally, the settlements of Ostojićevo (A4) and Velino Selo (A6) require infrastructure improvements to enhance their prospects. Lastly, the lowest-ranked community was Popovi (A5). Despite good economic characteristics and a favorable location, it still needs to improve through authentic tourist offerings and infrastructure development. Overall, local communities should focus on developing infrastructure, raising ecological awareness among residents and increasing community involvement to create synergistic effects that will promote ecotourism development in these areas.

Therefore, it is important to focus on promoting tourism development in Semberija, with an emphasis on ecotourism and sustainable tourism. By adopting these forms of tourism, the natural resources available to these settlements can be preserved for future generations. To maximize the ecotourism potential of rural settlements in Semberija, incorporating modern technologies could also be beneficial. Achieving this requires considerable effort, beginning with the education of the local population and continuing through various programs that encourage tourism development in these areas.

6.1. Theoretical and practical implications

The research had multiple theoretical and practical implications for the development of ecotourism and MCDM methods. When studying the ecotourism potential of rural communities in Semberija, a research model was created that included natural, infrastructure, social, cultural and economic criteria. Using these

criteria, a decision-making model was developed that makes a significant theoretical contribution. This model incorporates sustainability criteria and the available infrastructure resources of these settlements. In this way, ecotourism was connected to sustainability goals. Besides its theoretical importance, this model was practically applied to a case study, demonstrating good results in practice. Its development also influenced the application of MCDM methods in this research. An important outcome of this study is the development of the new CAWBOM method, which adds depth to the application of MCDM methods in decision-making. Theoretical foundations for this method were established, along with its practical implications for determining the importance of criteria. Ultimately, examining ecotourism in Semberija provides valuable insights for tourism development in these areas. Practical guidelines are offered on how to protect the natural resources available to rural communities in Semberija through ecotourism. Developing ecotourism in these regions will also impact their growth, helping to retain local populations and strengthen the role of these communities in the broader development of Semberija, the region and the country.

6.2. Research limitations

Any research that involves the use of research models and MCDM methods imposes limitations regarding the criteria and alternatives included in the model. Firstly, why were these main and auxiliary criteria selected and used? This is because, in both theory and practice, many criteria can be used to assess ecotourism potential, and one criterion may be chosen over another. Therefore, when developing a decision-making model, careful consideration should be given to which criteria are selected. However, this research provides guidelines on how to evaluate the ecotourism potential of rural communities, and future studies should build upon this foundation. Similarly, the selection of rural communities included in this research is a limitation. The limitation arises from the fact that only certain local communities were chosen and others were not, and the reasons for not including all communities. These communities were selected in collaboration with experts to ensure they represent a sample that can serve as a basis for developing ecotourism in Semberija. The evaluation results of these rural settlements can be compared with other communities to gain a more comprehensive understanding of which areas are better suited for development and where investments should be directed. Another limitation may be the methods used, particularly the CAWBOM method developed in this paper. These methods were chosen because they present new approaches to applying MCDM techniques, making decision-making easier. The unique aspect of this method is that criteria importance can be determined by directly assessing individual criteria, eliminating the need for experts to compare and rank criteria, as required in other MCDM methods for determining criteria weights.

6.3. Future research

Future research should focus on developing additional models for ecotourism and other types of tourism to make Semberija's tourism offerings more recognizable and diverse. It is noteworthy to recognize that tourism in the region should not rely on a single type of tourism but rather on different kinds of tourism to offer a more comprehensive experience to visitors. Therefore, there is a need to develop spa tourism, particularly around Banja Dvorovi, and ethnic tourism, like the ethnic village of Stanišić, as well as other types of tourism. Additionally, organizing various events and activities will be essential to stimulate interest and increase visitor numbers to the Semberija region. All of this should be considered in future research.

Furthermore, future research should focus on refining the established model for assessing ecotourism potential. It is important to solely examine specific criteria in upcoming studies to determine which are most effective for evaluating ecotourism potential. If local communities express interest in expanding ecotourism in rural areas, more of these communities should be included in future research to identify those with the greatest potential. This is especially crucial because developing tourism often requires infrastructure investments. If a rural community lacks the potential for developing such tourism, investments should be limited and redirected to communities with higher potential. Therefore, future research should also consider which types of tourism each rural community is best suited for.

In addition to improving the model, future work should also enhance the MCDM methods used in this study. The methods applied are relatively new and have not been widely adopted in research yet, particularly the CAWBOM method, which is novel. Furthermore, new approaches to applying these methods should be developed. Future research should compare the CAWBOM method with other similar techniques for assigning subjective weights to criteria, supporting ongoing development to address its limitations and highlight its advantages as a new MCDM method.

7. Conclusions

This research aimed to evaluate the current potential of rural settlements in Semberija for engaging in ecotourism. Based on expert evaluations, six rural settlements in Semberija were selected for evaluation. To examine their ecotourism potential, a model was developed with four main criteria, each of which included six sub-criteria. This structure was chosen to ensure that no single main criterion would disproportionately influence the assessment. The experts evaluated these criteria, and the fuzzy CAWBOM was applied to calculate the criteria weights. The analysis revealed that experts assigned the greatest importance to economic criteria. However, further analysis indicated that the other criteria were also considered significant, with their importance not varying significantly from that of the economic criteria.

In selecting the rural settlements in Semberija for their ecotourism potential, six settlements were chosen, all located along the banks of the Sava and Drina rivers. This prioritization of river tourism over mountain tourism reflects the geographic characteristics of Semberija, which is situated at the foot of the Majevica mountain. The ranking of these settlements was conducted using the fuzzy RAWEC. Results demonstrated that Amelije (A1) has the highest potential, while Popovi (A5) has the lowest. However, these results should be interpreted with caution, as each settlement demonstrated strong potential in certain criteria. To enhance ecotourism, these settlements must focus on developing tourism that leverages their strengths, particularly in terms of natural resources, infrastructure and human resources.

Acknowledgments

Credit: Adis Puška: Conceptualization, methodology, software, writing—original draft preparation; *Anđelka Štilić:* Validation, resources, writing—review and editing, visualization; *Miroslav Nedeljković:* Validation, investigation, funding acquisition; *Dragan Pamučar:* Validation, supervision; *Darko Božanić:* Validation, formal analysis. All authors have read and approved the final work.

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Disclosure statement

No potential conflict of interest was reported by the authors.

Ethical approval

Ethical approval was not required, as the study did not involve sensitive personal data or vulnerable populations and fell within the scope of standard professional consultation.

Funding

This research was supported by Ministry of Science, Technological Development and Innovation of the Republic of Serbia [No. 451-03-136/2025-03/200009 and No. 451-03-66/2024-03/200009] from 4 February 2025.

Patient consent

Participants in this research provided their informed consent electronically.

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Data availability statement

All data generated or analyzed during this study are included in this published article. This study used publicly available and anonymized secondary data. All procedures were conducted in accordance with relevant ethical guidelines and regulations. No personal identifying information was used, and no additional ethical approval was required.

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