Türk Tarım ve Doğa Bilimleri Dergisi 10(3): 605–614, 2023
https://doi.org/10.30910/turkjans.1183698

TÜRK TARIM ve DOĞA BİLİMLERİ DERGİSİ

TTDB

TURKISH JOURNAL of AGRICULTURAL and NATURAL SCIENCES

www.dergipark.gov.tr/turkjans

Araştırma Makalesi

Ranking Çanakkale Districts in terms of Rangeland Quality with Multi-Criteria Decision Making Methods[¥]

Zeynep GÖKKUŞ[1*], Sevil ŞENTÜRK[2], Fırat ALATÜRK[3]

[1]Kastamonu Üniversitesi, Meslek Yüksekokulu, Bilgisayar Teknolojileri Bölümü, Kastamonu
[2]Eskişehir Teknik Üniversitesi, Fen Fakültesi, İstatistik Bölümü, Eskişehir
[3]Çanakkale Onsekiz Mart Üniversitesi, Ziraat Fakültesi, Tarla Bitkileri Bölümü, Çanakkale
*Sorumlu Yazar: z.gokkus@gmail.com

Received: 03.10.2022 Received in revised: 09.06.2023 Accepted: 09.06.2023

ABSTRACT

Based on the Project report of Determination of Rangeland Availability and Range of Rangeland Status Classes carried out by the Management of Eastern Anatolia Agricultural Research Institute, eleven districts of Çanakkale are ordered in terms of rangeland quality. For this reason, four different rankings were obtained by AHP, TOPSIS, VIKOR and WASPAS methods. According to the rankings made by the AHP, VIKOR and WASPAS methods, while the district with the highest rangeland quality was Biga, the highest rangeland quality according to the TOPSIS method was found to be the Central district.

Key words: Ranking in agricultural experiments, AHP, TOPSIS, VIKOR, WASPAS.

Çanakkale İlçelerinin Mera Kalitesi Bakımından Çok Kriterli Karar Verme Yöntemleri İle Sıralanması

ÖZ

Doğu Anadolu Tarımsal Araştırma Enstitüsü Müdürlüğü'nün yürüttüğü Mera Varlığının ve Mera Durum Sınıflarının Belirlenmesi Proje raporu kaynak alınarak, Çanakkale'nin on bir ilçesi mera kalitesi bakımından sıralanmıştır. Bunun için AHP, TOPSIS, VIKOR ve WASPAS yöntemleri ile farklı dört sıralama elde edilmiştir. AHP, VIKOR ve WASPAS yöntemleri ilen yapılan sıralamalara göre mera kalitesi en yüksek olan ilçe Biga iken TOPSIS yöntemine göre mera kalitesi en yüksek ilçe Merkez olarak bulunmuştur.

Anahtar kelimeler: Tarımsal deneylerde sıralama, AHP, TOPSIS, VIKOR, WASPAS.

INTRODUCTION

One of our most important renewable natural resources is rangelands (Altın et al., 2011). Many studies have been carried out under the coordination of TAGEM in order to classify the rangelands through vegetation studies in order to reveal the social, economic and environmental benefits of rangelands and to create breeding and management models suitable for rangeland conditions (Gökkuş et al., 2011; Gökkuş, 2020).

There are several methods used when determining rangeland conditions. One of them is to classify the rangelands by calculating climax according to the vegetation data. Rangeland health classification is based on the integration of soil, canopy, and other ecological units whereas rangeland conditions are based on botanical composition (Koç et.al. 2021). In this method, the climax is determined by summing the ratios of decreasing and increasing species (not the number of observed grasses, but the number of species) in the botanical composition (if the increasing species ratio is more than 20%, it is included in the calculation as 20%). If the climax is less than 25%, the rangeland is in poor, if it is between 26-50%, medium, if it is between 51-75%, good, and if it is between 76-100%, very good condition (Altın et al., 2011). However, this classification may not reflect the production amount of grass per unit area of the rangeland. In other words, the rangeland condition may not reflect the rangeland quality. For example, if the rate of decreasing species is low, but the grass yield of the unit area is high, more animals can graze in the rangeland and this can increase the quality of the rangeland.

In this study, it was aimed to rank the rangelands in terms of grass quality and take into account the factors that affect the vegetation of the rangelands (altitude, slope, erosion, stony and soil depth) and the families (cereals, legumes and other families) including grass species. The role of environmental factors in the proportions of families in the botanical composition is very important. Changes in any of the existing environmental factors in the rangeland affect the use of the rangeland (Sürmen and Kara, 2018). It is aimed to determine the best rangeland. For this purpose, vegetation data were examined with Multi-Criteria Decision Making methods.

MCDM methods have been developed to eliminate uncertainty and indecision in selection and ranking problems (Ilbahar et al., 2022). The aim of these methods is to rank the alternatives in terms of some criteria or to choose the best alternative. During the selection process, the opinions of decision makers are very important and effective (Atalık and Şentürk, 2019).

In this study, firstly, four MCDM methods, AHP, TOPSIS, VIKOR and WASPAS are explained. Then, when the vegetation data of Çanakkale districts are examined with these methods, the ranking of the districts in terms of rangeland quality is given and the best district is selected.

MCDM methods are generally applied for observational data, scales or scores. In this study, MCDM methods were applied to an experimental data. In this study, for the first time, rangeland quality was evaluated and ranked with MCDM methods.

MATERIAL AND METHOD

Application Data

The data of the Çanakkale part of the project named "Project for Determination of Rangeland Existence and Rangeland Condition" are summarized below (Gökkuş, 2020). Four different sampling were done from each district. Tables were created by taking the arithmetic mean of the proportional sizes of the sampling points for all sub-criteria (Table 2-4).

Table 2. Distribution of soil and topographic properties affecting vegetation by districts (Gökkuş, 2020)

Districts	Altitude (%)	Slope (%)	Erosion (%)	Stony (%)	Soil depth (%)
Central d.	0.03	0.06	0.11	0.07	0.06
Ezine	0.08	0.10	0.09	0.12	0.06
Lapseki	0.03	0.11	0.09	0.12	0.07
Gökçeada	0.14	0.13	0.09	0.10	0.06
Ayvacık	0.21	0.07	0.09	0.08	0.07
Bayramiç	0.06	0.06	0.07	0.08	0.10
Gelibolu	0.05	0.10	0.07	0.07	0.10
Eceabat	0.01	0.10	0.07	0.10	0.09
Biga	0.01	0.06	0.07	0.07	0.11
Yenice	0.21	0.07	0.07	0.07	0.09
Çan	0.07	0.06	0.07	0.07	0.09

Table 3. Distribution of families by districts (Gökkuş, 2020)

Districts	Cereals (%)	Legumes (%)	Other families (%)
Central d.	31.86	10.27	57.87
Ezine	20.285	20.5925	59.1225
Lapseki	21.075	11.5825	67.3425
Gökçeada	16.66	13.085	70.255
Ayvacık	18.9125	21.355	59.7325
Bayramiç	21.3875	18.42	60.1925
Gelibolu	41.495	16.2825	42.2225
Eceabat	20.2425	14.9475	64.81
Biga	34.03167	13.99833	51.97167
Yenice	29.0225	10.12	60.8575
Çan	42.3925	4.5725	53.035

Table 4. Distribution of the species affecting grazing by districts and rangeland condition (Gökkuş, 2020)

Districts	Decreasing species	Increasing species	Invasive	Climax	Rangeland
Central d.	24.29575	7.1235	68.58075	31.41925	Medium
Ezine	8.9135	18.8345	72.2525	27.748	Medium
Lapseki	9.7615	4.8715	85.367	14.633	Poor
Gökçeada	6.25575	8.59325	85.151	14.849	Poor
Ayvacık	8.698	17.704	73.598	26.402	Medium
Bayramiç	10.12425	9.4665	80.40925	19.59075	Poor
Gelibolu	6.5305	20.311	73.1585	26.5305	Medium
Eceabat	7.41325	8.06575	84.521	15.479	Poor
Biga	18.2735	16.89775	64.82875	35.17125	Medium
Yenice	9.305	13.0095	77.6855	22.3145	Poor
Çan	12.57475	5.67175	81.753	18.2465	Poor

AHP

The AHP method, developed by Thomas L. Saaty (1977) for the solution of complex problems, is the most widely applied multi-criteria decision-making method in the literature (Özbek, 2013; Kubler at al., 2016). The AHP method has a structure with at least three hierarchical levels, each level consisting of at least one element (Özbek, 2017). Based on the assumption that a sub element affects a top element, pairwise comparisons are made and the relative importance of the elements in the hierarchically sub level with respect to the top element is determined. At the top of the AHP structure is the goal. A sub-level (main) criteria includes sub-criteria, if any. At the bottom level, decision alternatives are given (Ecer and Küçük, 2008).

When applying the AHP method in a decision-making problem, the four axioms determined by Saaty (1986) must be provided. These; i) correspondence (in pairwise comparison matrices, each element must be symmetric with respect to the x=-y line, its inverse with respect to multiplication), ii) homogeneity (one criterion cannot be considered infinitely superior to the other in pairwise comparisons), iii) independence (alternatives and criteria are completely independent of each other) and iv) decision problem can be designed in hierarchical structure.

The steps of the AHP method are given below, respectively.

Step 1: The decision problem is designed according to the hierarchical structure of the AHP. The goal, criteria and alternatives are determined .

Table 5. Comparison Scale (Saaty, 2008)

Relative	Reciprocal of relative	Definition
1	1	Equally importance
3	1/3	Moderate importance of one over another
5	1/5	Essential or strong importance
7	1/7	Demonstrated importance
9	1/9	Extreme importance
2, 4, 6, 8	1/2, 1/4, 1/6, 1/8	Intermediate values between two adjacent

Step 2: Using the scale given in Table 5, the decision maker(s) construct a pairwise comparison matrix for each pairwise comparison, as represented in Table 6.

Table 6. Pairwise comparison matrix (Wind and Saaty, 1980)

A	Criterion 1	Criterion 2	Criterion 3	…	Criterion n
Criterion 1	1	a_{12}	a_{13}	…	a_{1n}
Criterion 2	$a_{21} = 1/a_{12}$	1	a_{23}	…	a_{2n}
Criterion 3	$a_{31} = 1/a_{13}$	$a_{32} = 1/a_{23}$	1	…	a_{3n}
…	…	…	…	…	…
Criterion n	$a_{n1} = 1/a_{1n}$	$a_{n2} = 1/a_{2n}$	$a_{n3} = 1/a_{3n}$	…	1

Step 3: The pairwise comparison matrix is normalized and obtained by applying Equation (1) to each element in the matrix.

$$a'_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \quad (1)$$

Step 4: The sum of each column in the normalized matrix is 1. The sum of each row is averaged by dividing by the matrix size with Equation (2), and the importance weights are calculated for each criterion. These weights are called priority vectors.

$$w_i = \left(\frac{1}{n}\right) \sum_{i=1}^{n} a'_{ij}\,, \quad i, j = 1, 2, \ldots, n \quad (2)$$

Step 5: Consistency rate is calculated at the end of following transactions (Özbek and Eren, 2013), [15-16].

$$\lambda_{max} = \frac{1}{n} \sum_{i=1}^{n} \left[\frac{\sum_{j=1}^{n} a_{ij} w_j}{w_i}\right] \quad (3)$$

$$CI = \frac{\lambda_{max} - n}{n-1} \quad (4)$$

$$CR = \frac{CI}{RI} \quad (5)$$

The consistency ratio should be less than 0.10. Otherwise, the decision maker(s) must rearrange the pairwise comparison matrix. It is concluded that matrices with CR<0.10 are consistent. Here RI is the "Random Index" value. Calculated for matrices with a maximum size of 15. If the number of criteria in a decision-making problem is too high, the probability of obtaining consistent results as a result of evaluating all criteria together weakens (Uden, 2004). RI values for pairwise comparison matrices are given in Table 7

Table 7. RI values for pairwise comparison matrices (Özbek, 2017)

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0	0,58	0,9	1,12	1,24	1,32	1,41	1,45	1,49	1,51	1,53	1,56	1,57	1,59

Step 6: For each (sub)criterion, the alternatives are compared in pairs. For this, Steps 1-5 are applied for each criterion.

Step 7: The overall weights of the criteria are found in accordance with the hierarchical order of the decision problem (by multiplying the priorities of the main and sub-criteria). The criterion-weighted value of each alternative is determined by multiplying the overall weight of each criterion with the preference values of the alternatives according to that sub-criterion. The weighted values of each alternative are summed and sorted from largest to smallest. This ranking is the final ranking of the alternatives by the AHP method.

TOPSIS

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) was developed by Hwang and Yoon (Hwang and Yoon, 1981). In this method, the alternative closest to the positive ideal solution (PIS) and farthest from the negative ideal solution (NIS) is selected as the best alternative. With TOPSIS, the relative distances of all alternatives from PIS and NIS are calculated using the Euclidean distance. When the relative distances are sorted, the searched order for the alternatives is also obtained (Özden, 2011).

The steps of the TOPSIS method as follows (Özbek, 2013).

Step 1: The decision makers create the decision matrix (D), the rows of which show the alternatives and the columns the criteria.

$$D_{ij} = \begin{bmatrix} d_{11} & d_{12} & \ldots & d_{1n} \\ d_{21} & d_{22} & \ldots & d_{2n} \\ \ldots & \ldots & \ldots & \ldots \\ d_{i1} & d_{i2} & \ldots & d_{in} \\ \ldots & \ldots & \ldots & \ldots \\ d_{m1} & d_{m2} & \ldots & d_{mn} \end{bmatrix} \quad (6)$$

Step 2: By applying the normalization in Equation (7) and (8) to the decision matrix, the standard decision matrix in Equation (9) is obtained.

$$\forall d_{ij} \neq 0;\; r_{ij} = \frac{d_{ij}}{\sqrt{\sum_{k=1}^{m} d_{kj}^2}};\; \forall i = 1, \ldots, m,\; \forall j = 1, \ldots, n \quad (7)$$

$$\forall d_{ij} = 0;\; r_{ij} = 0;\; \forall i = 1, \ldots, m,\; \forall j = 1, \ldots, n \quad (8)$$

$$R_{ij} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ r_{i1} & r_{i2} & \cdots & r_{in} \\ \cdots & \cdots & \cdots & \cdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix} \quad (9)$$

Step 3: At this stage, the weighted standard decision matrix (V) is found by multiplying the predetermined criteria weights w_j and the elements in the standard decision matrix.

$$V_{ij} = \begin{bmatrix} w_1 r_{11} & w_2 r_{12} & \cdots & w_n r_{1n} \\ w_1 r_{21} & w_2 r_{22} & \cdots & w_n r_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ w_1 r_{i1} & w_2 r_{i2} & \cdots & w_n r_{in} \\ \cdots & \cdots & \cdots & \cdots \\ w_1 r_{m1} & w_2 r_{m2} & \cdots & w_n r_{mn} \end{bmatrix} \quad (10)$$

Step 4: PIS (A^*) and NIS (A^-) solution sets are generated. For this, benefit criteria are selected as max (J) to PIS and min to NIS. On the contrary, in the cost criterion, max (J′) to NIS and min to PIS are applied.

$$A^* = \left\{\left(\max_i v_{ij}, j \in J\right), \left(\min_i v_{ij}, j \in J'\right), i = 1, \dots, m\right\} \quad (11)$$

$$A^* = \left\{v_1^*, v_2^*, \dots, v_j^*, \dots, v_n^*\right\}$$

$$A^- = \left\{\left(\min_i v_{ij}, j \in J\right), \left(\max_i v_{ij}, j \in J'\right), i = 1, \dots, m\right\} \quad (12)$$

$$A^- = \left\{v_1^-, v_2^-, \dots, v_j^-, \dots, v_n^-\right\}$$

Step 5: The positive and negative ideal separation measures, respectively S_i^* and S_i^-, for each of the compared A_i alternatives are calculated using the Euclidean distance as follows.

$$S_i^* = \sqrt{\sum_{j=1}^{n}\left(v_{ij} - v_j^*\right)^2}, \ \forall i = 1, \dots, m \quad (13)$$

$$S_i^- = \sqrt{\sum_{j=1}^{n}\left(v_{ij} - v_j^-\right)^2}, \ \forall i = 1, \dots, m \quad (14)$$

Step 6: Using S_i^* and S_i^-, the relative affinities to PIS, C_i^*, are calculated for each alternative and sorting in descending order.

$$C_i^* = \frac{S_i^-}{S_i^- + S_i^*}, \quad 0 \le C_i^* \le \forall i = 1, \dots, m \quad (15)$$

Here, for the ith alternative, it is said that if $C_i^* = 1$ it is at the PIS, if $C_i^* = 0$ it is at the NIS point.

VIKOR

Opricovic and Tzeng (2004) proposed the VIKOR (VIse Kriterijumska Optimizacija I Kompromisno Resenje-Multi-Criteria Optimization and Compromise Solution) method for multi-criteria decision making problems that are measured in different units and/or consist of conflicting criteria. The aim of the method is to reach the compromise solution that is closest to the ideal solution in ranking the alternatives. In this method, criterion weights are assumed to be known in advance and decision makers are allowed to influence the result (Opricovic and Tzeng, 2007).

The application steps of the VIKOR method are as follows.

Step 1: The decision matrix is created as follows, with i and j representing the alternatives and criteria, respectively.

$$X_{ij} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{i1} & x_{i2} & \cdots & x_{in} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}, \ i = 1, \dots, m, \ j = 1, \dots, n \quad (16)$$

Step 2: The best f_j^* and worst f_j^- values are determined for each criterion, depending on whether the criteria are of benefit or cost oriented.

$$f_j^* = \max_i x_{ij}, \ f_j^- = \min_i x_{ij}; \ \textit{if the jth function is from benefit oriented} \quad (17)$$

$$f_j^* = \min_i x_{ij}, \ f_j^- = \max_i x_{ij}; \ \textit{if the jth function is from cost oriented} \quad (18)$$

Step 3: S_i and R_i values are calculated, while w_j represents the weights of the criteria.

$$S_i = \sum_{j=1}^{n} w_j \left(f_j^* - x_{ij}\right)/\left(f_j^* - f_j^-\right) \quad (19)$$

$$R_i = \max_j\left[w_j\left(f_j^* - x_{ij}\right)/\left(f_j^* - f_j^-\right)\right] \quad (20)$$

Here, S_i and R_i represent the mean and worst scores of the second alternative, respectively (Akyüz, 2012). Also, S_i represents maximum group utility as "majority" and R_i represents minimum individual regret as "opponent" (Opricovic and Tzeng, 2004).
Step 4: The Q_i index, in which both strategies are evaluated together, is calculated to represent v maximum group utility and $1 - v$ the weight of the strategy providing individual regret (Opricovic, 2011). Compromise can be achieved by "majority vote" $(v > 0{,}5)$, "consensus" $(v = 0{,}5)$ and "veto" $(v < 0{,}5)$ (Kizielewicz and Bączkiewicz , 2021).
The researcher can determine the value of v, but it is usually necessary to be close to the value calculated by the equation $v = (m + 1)/2m$. (In this study, it was calculated as approximately $v = (11 + 1)2 * 11 = 0{,}545$, and the calculation was made for $v = 0{,}5$.)

$$Q_i = \frac{v(S_i - S^*)}{(S^- - S^*)} + \frac{(1-v)(R_i - R^*)}{(R^- - R^*)} \quad (21)$$

$$S^* = \min_i S_i\,,\; S^- = \max_i S_i\,,\; R^* = \min_i R_i\,,\; R^- = \max_i R_i$$

Step 5: S_i, R_i and Q_i parameters are ordered ascending sort to obtain three rankings.
Step 6: If both conditions (C1 and C2) given below are fulfilled, a' at the top of the Q_i rank is considered the best alternative.
C1. Acceptable advantage: Let a' and a'' be the best and second best alternatives of the Q_i rank, respectively. The condition in the follow-up is tested, with $DQ = \frac{1}{m-1}$ (if the number of alternatives is < 4, $DQ = 0.25$).

$$Q(a'') - Q(a') \geq DQ \quad (22)$$

C2. Acceptable stability in decision making: a' should also be the best choice for S_i and/or R_i rankings.
If one of these conditions is not fulfilled, the agreed set of common solutions is suggested as follows (Özbek, 2017).
If C1 is not fulfilled; the alternatives $a', a'', \ldots, a^m$ are the best compromised solution set. a^m is determined by the formula $Q(a^m) - Q(a') < DQ$ for maximum m.
If C2 is not provided; Alternatives a' and a'' are the best compromised solution.

WASPAS

Zolfani et al. (2013) and Zolfani et al. (2013) developed the Weighted Aggregated Sum Product ASsessment (WASPAS) method to reveal the performance values of the alternatives according to the criteria by using the criterion weights. This method is a MCDM method based on Weighted Sum Model (WSM), in other words Simple Additive Weighting and Weighted Product Model (WPM) methods. With this method, it is aimed to achieve high consistency by optimizing the weighted integrated function (Lashgari at al., 2014; Özbek, 2019).
In this method, there is no restriction to determine the criterion weights. Researchers can weight the criteria with the help of the techniques in the literature or the scoring scale (Özbek, 2017).
The steps of the WASPAS method are given at below (Özbek., 2019).
Step 1: The decision matrix is created as given by Equation (16) in the VIKOR method.
Step 2: The decision matrix is normalized with the linear normalization method, taking into account whether the criteria are benefit or cost oriented. If the criterion is benefit-oriented, Equation (23) is used, if cost-oriented, Equation (24) is used.

$$x_{ij}^* = \frac{x_{ij}}{\max_i x_{ij}} \quad (23)$$

$$x_{ij}^* = \frac{\min_i x_{ij}}{x_{ij}} \quad (24)$$

Step 3: The relative performance of the alternatives according to the WSM method is calculated by summing the alternative values weighted according to each criterion.

$$P_i^{(1)} = \sum_{j=1}^{n} x_{ij}^* \, w_j \quad (25)$$

Step 4: The relative performance of the alternatives according to the WPM method is calculated by multiplying the alternative value according to each criterion by the power of the criterion weight with the same index.

$$P_i^{(2)} = \prod_{j=1}^{n} \left(x_{ij}^*\right)^{w_j} \quad (26)$$

Step 5: The final performance (P_i) of the alternatives showing their position in the overall ranking is obtained as follows.

$$P_i = 0{,}5 P_i^{(1)} + 0{,}5 P_i^{(2)} \quad (27)$$

The α parameter converts the WASPAS method to the WPM method for 0 and the WSM method for 1. In Equation (27) (and in this study), $\alpha = 0.5$ was chosen. Researchers decide which value to choose for α, and can calculate α also by Zolfani (2013) method.
Step 6: P_i values are sorted in descending order. This ranking gives the alternatives in order from best to worst.

APPLICATION

Three main criteria were determined in order to rank Çanakkale districts in terms of rangeland quality with AHP, TOPSIS VIKOR and WASPAS methods. These main and sub-criteria are shown in Table 8.

Table 8. Criteria used in AHP, TOPSIS VIKOR and WASPAS

Main criteria	**Vegetation**	**Families**	**Grazing**
Sub-criteria	Altitude	Cereals	Decreasing species
	Slope	Lagumes	Increasing species
	Erosion	Other families	Invasive species
	Stony		
	Soil depth		

The slope, erosion, stony and invasive species have negative effects (cost oriented) on the rangeland quality, while the other criteria have positive effects (benefit oriented) (Gökkuş et al, 2011; Gökkuş, 2020).
A single decision maker (one expert opinion) was obtained for the main criteria by the research team that carried out this study. The scaling of the sub-criteria for the alternatives was done in accordance with the experimental data. Experimental data were obtained from each alternative (district) in four replicates. Initially, these repetitions were considered as four decision makers, but it was understood that the repetitions were very close to each other, therefore the same scale values should be given to all four repetitions. As a result, it was decided to evaluate the scale values of the alternatives for the sub-criteria according to the average of four repetitions as one decision maker. In fact, these scalings reflect the performances of the alternatives on the criteria and do not contain a personal opinion (Opricovic and Tzeng, 2004; Deng et al.., 2000). All methods were applied according to the opinion of a single expert. Studies performed with a single expert opinion are available in the literature (Opricovic and Tzeng, 2007; Kizielewicz and Bączkiewicz , 2021).
The structure of the MCDM problem summarized in Table 8 is presented in Figure 1.

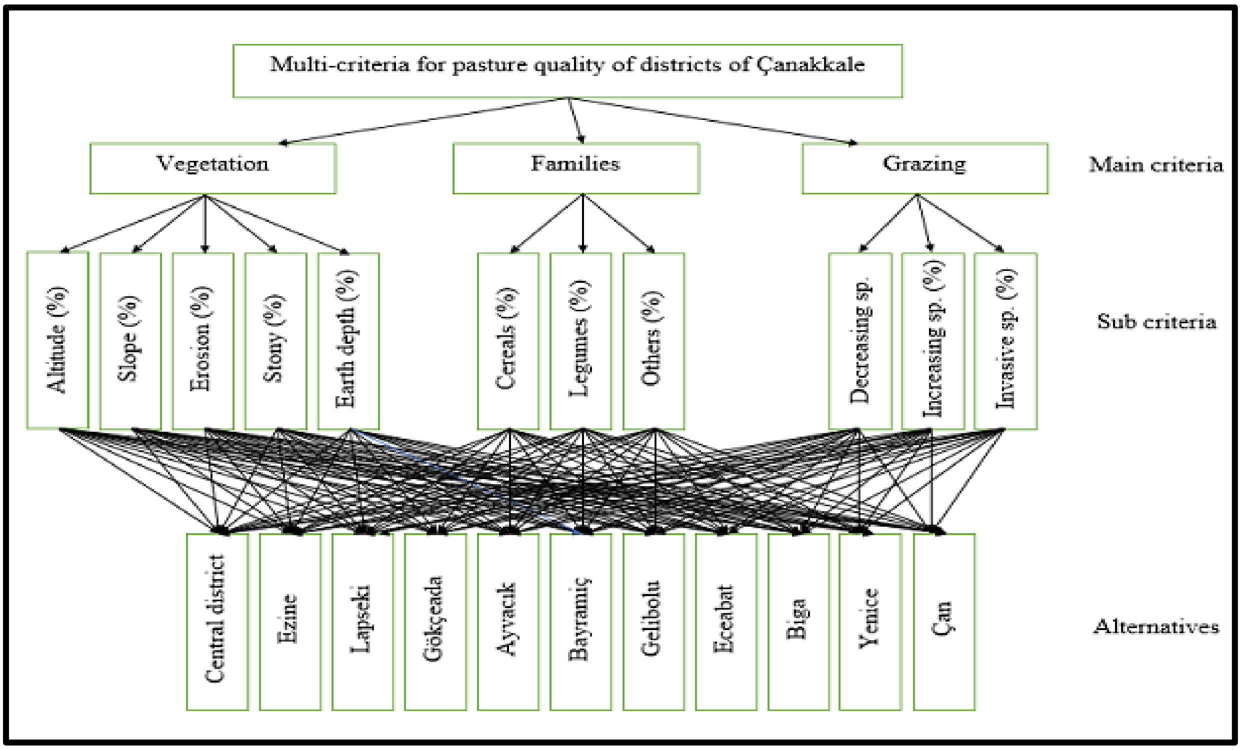

Figure 1. Structure of the MCDM problem

Preference values and rankings obtained from the AHP, TOPSIS, VIKOR and WASPAS methods applied in order to rank Çanakkale districts in terms of rangeland quality and/or to determine the best one are given in Tables 9 and 10, respectively.

Table 9. Preference values obtained from AHP, TOPSIS, VIKOR and WASPAS methods

Alternatives	AHP	TOPSIS	VIKOR	WASPAS
Central district	0.1211	0.7321	0.1186	0.6827
Ezine	0.0735	0.2662	0.7234	0.5407
Lapseki	0.0625	0.1854	0.8308	0.4292
Gökçeada	0.0454	0.1449	1	0.4240
Ayvacık	0.0769	0.2982	0.6519	0.5975
Bayramiç	0.0955	0.2513	0.6326	0.5516
Gelibolu	0.1062	0.2460	0.7318	0.5474
Eceabat	0.0688	0.1165	0.8959	0.4182
Biga	0.1691	0.6367	0	0.7299
Yenice	0.0692	0.2876	0.6280	0.5932
Çan	0.1118	0.3368	0.5445	0.5386

Table 10. Rankings obtained from AHP, TOPSIS, VIKOR and WASPAS methods

Rank	AHP	TOPSIS	VIKOR	WASPAS
1	Biga	Central district	Biga	Biga
2	Central district	Biga	Central district	Central district
3	Çan	Çan	Çan	Ayvacık
4	Gelibolu	Ayvacık	Bayramiç	Yenice
5	Bayramiç	Yenice	Yenice	Bayramiç
6	Ayvacık	Ezine	Lapseki	Gelibolu
7	Ezine	Bayramiç	Ezine	Ezine
8	Yenice	Gelibolu	Ayvacık	Çan
9	Eceabat	Lapseki	Eceabat	Lapseki
10	Lapseki	Gökçeada	Gelibolu	Gökçeada
11	Gökçeada	Eceabat	Gökçeada	Eceabat

The similarities in ranking the alternatives with the four MCDM methods are represented in Figure 2 (Kizielewicz and Bączkiewicz, 2021).

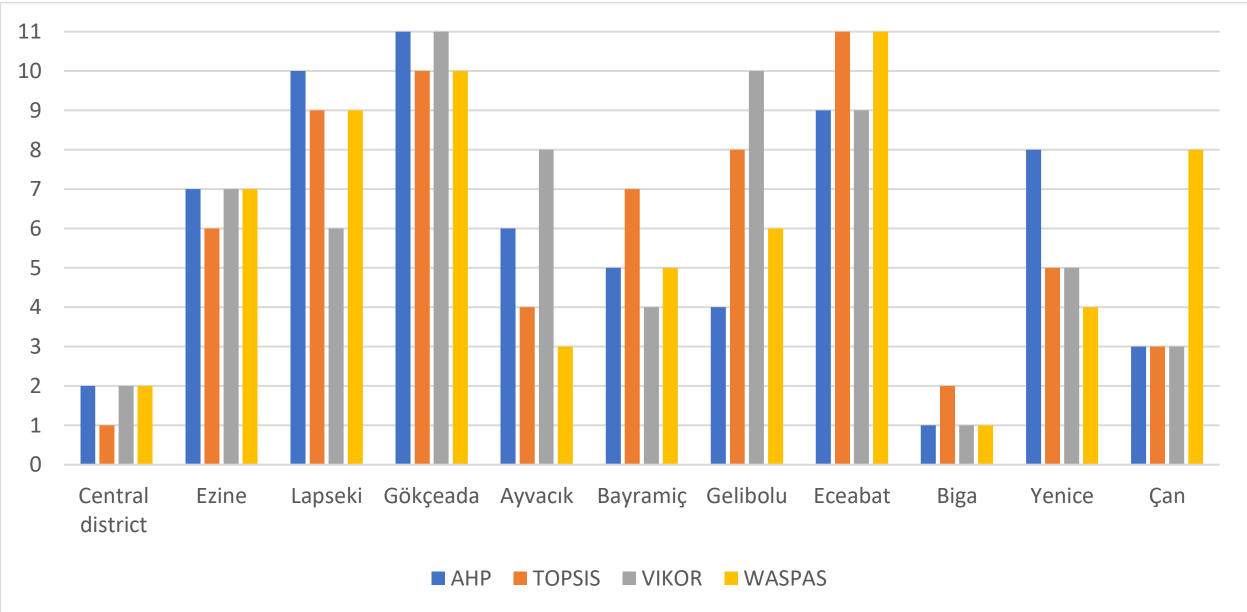

Figure 2. Comparison of rankings received with AHP, TOPSIS, VIKOR and WASPAS

RESULTS AND DISCUSSION

In this study, eleven districts of Çanakkale were evaluated in terms of rangeland quality by AHP, TOPSIS, VIKOR and WASPAS methods, taking into account 11 vegetation factors. When Table 3.3 is examined, it is seen that Biga is the district with the best rangeland quality in the rankings obtained by AHP, VIKOR and WASPAS. The expert team (that carried out the experiment) stated that Biga's being in the first place is an expected result and that the AHP and VIKOR results are close to the expected order (Gökkuş et al, 2011; Gökkuş, 2020). In the ranking obtained by the WASPAS method, Çan was left behind in the ranking, while Biga took the second place in the ranking of the TOPSIS method. These situations do not reflect what is expected.Table 3.2 shows the preference values obtained from all four methods. When these values are examined, it is clear that Biga, Central district and Çan in AHP, and Biga and Central district in other methods are quite different from other districts. In the ranks after the first three, the preference values of the alternatives are very close to each other, but weak. For this reason, the rankings change after the first three in each method. One of the reasons why the rankings of these four methods differ from each other is the small number of sampling stations. As the sampling stations increase, the rankings are likely to be more similar. When the rangeland conditions given in Table 2.3 and the rankings obtained in this study are examined, it is seen that the rangeland conditions of some districts should be handled in more detail. When the rangeland conditions determined by the number of observed species, not the grass yield per unit area, were evaluated alone, the rangeland condition of Çan was determined as *poor.* Whereas, AHP, TOPSIS, VIKOR rankings and Gökkuş et al. (2011) and Gökkuş (2020) stated that Çan is at the top of the ranking. Therefore, with this study, it is recommended to support similar studies (determination of rangeland condition) with MCDM methods. In this study, classical MCDM methods were studied. The study data were obtained by experimentation, not by the personal evaluations of the decision makers. In future studies, it is planned to study fuzzy MCDM methods for different types of fuzzy numbers with experimental data.

[¥]: This study was presented orally at Applied Statistics Congress (UYIK 2022).

Conflict of Interest

The authors have declared that there is no conflict of interest.

REFERENCES

AKYÜZ, G. A. 2012. Supplier selection with the fuzzy VIKOR method. Ataturk University Journal of Economics and Administrative Sciences, 26(1), 197-215 (Turkish).

Altın, M., A. Gökkuş and A. Koç. 2011. Meadow and Rangeland Management (Volume 2). Ministry of Agriculture and Rural Affairs, General Directorate of Agricultural Production and Development. Ankara (Turkish).

Deng, H., Yeh, C. H., and Willis, R. J., 2000. Inter-company comparison using modified TOPSIS with objective weights. Computers & Operations Research, 27(10), 963-973.

Fatih, E. and Küçük, O., 2008. Analytical hierarchy method in supplier selection and an application. Journal of Atatürk University Social Sciences Institute, 11(1), 355-369 (Turkish).

Gökkuş, A., 2020. A Review on the Factors Causing Deterioration of Rangelands in Turkey. Turkish Journal of Range and Forage Science, 1(1), 28-34.

Gökkuş, A., Alatürk, F. and Özaslan Parlak, A., 2011. The importance of grassing areas in livestock in Çanakkale. Canakkale Agriculture Symposium (past, present and future).

Hwang, C. L. and Yoon, K., 1981. Methods for multiple attribute decision making. In Multiple attribute decision making (pp. 58-191). Springer, Berlin, Heidelberg.

Ilbahar, E., Kahraman, C., and Cebi, S., 2022. Risk assessment of renewable energy investments: A modified failure mode and effect analysis based on prospect theory and intuitionistic fuzzy AHP. Energy, 239, 121907.

Koç, A., Gökkuş, A., Güllap, M.K., Erkovan, H. İ. and Sürmen, M., 2021. Changes in Rangeland Condition and Health of Palandoken Mountain Rangelands Over two Decades. Turkish Journal of Range and Forage Science , 2 (2) , 37-43 . DOI: 10.51801/turkjrfs.987396

Kubler, S., Robert, J., Derigent, W., Voisin, A. and Le Traon, Y., 2016. A state-of-the-art survey & testbed of fuzzy AHP (FAHP) applications. Expert Systems with Applications, 65, 398-422.

Kizielewicz, B. and Bączkiewicz, A., 2021. Comparison of Fuzzy TOPSIS, Fuzzy VIKOR, Fuzzy WASPAS and Fuzzy MMOORA methods in the housing selection problem. Procedia Computer Science, 192, 4578-4591.

Kwiesielewicz, M. and Van Uden, E., 2004. Inconsistent and contradictory judgements in pairwise comparison method in the AHP. Computers & Operations Research, 31(5), 713-719.

Lashgari, S., Antuchevičienė, J., Delavari, A. and Kheirkhah, O., 2014. Using QSPM and WASPAS methods for determining outsourcing strategies. Journal of Business Economics and Management, 15(4), 729-743.

Opricovic, S. and Tzeng, G.H., 2004. Compromise solution by MCDM methods: A comparative analysis of VIKOR and TOPSIS. European journal of operational research, 156(2), 445-455.

Opricovic, S. and Tzeng, G. H., 2007. Extended VIKOR method in comparison with outranking methods. European journal of operational research, 178(2), 514-529.

Opricovic, S., 2011. Fuzzy VIKOR with an application to water resources planning. Expert Systems with Applications, 38(10), 12983-12990.

Özden, Ü. H., 2011. Ranking of European Union member and candidate countries according to economic indicators by Topsis method. Trakya University Journal of Social Sciences, 13(2), 215-236 (Turkish).

Özbek, A., 2013. Performance evaluation of learning management system. NWSA-Education Sciences, 8(2), 164-178.

Özbek, A. and Eren, T., 2013. Multiple criteria decision making methods for selecting third party logistics firms: A literatur review. Sigma, 31, 178-202.

Özbek, A., 2017. Multi-criteria decision making methods and problem solving with excel. Seçkin Publishing, Ankara (Turkish).

Özbek, A., 2019. ORDERING THE PROVINCES IN TURKEY ACCORDING TO LIFEABILITY CRITERIA AND EDAS AND WASPAS METHODS. Kırıkkale University Journal of Social Sciences, 9(1), 177-200 (Turkish).

Paksoy, T., Pehlivan, N. Y. and Kahraman, C., 2012. Organizational strategy development in distribution channel management using fuzzy AHP and hierarchical fuzzy TOPSIS. Expert Systems with Applications, 39(3), 2822-2841.

Saaty, T. L., 1977. A scaling method for priorities in hierarchical structures. Journal of mathematical psychology, 15(3), 234-281.

Saaty, T. L., 2008. Decision making with the analytic hierarchy process. International journal of services sciences, 1(1), 83-98.

Souissi, D., Zouhri, L., Hammami, S., Msaddek, M. H., Zghibi, A. and Dlala, M., 2020. GIS-based MCDM–AHP modeling for flood susceptibility mapping of arid areas, southeastern Tunisia. Geocarto International, 35(9), 991-1017.

Sürmen, M. and Kara E., 2018. Yield and quality characteristics of pasture vegetation with different slopes in Aydın province ecological conditions.. Derim, 35(1), 67-72 (Turkish).

Wind, Y. and Saaty, T. L., 1980. Marketing applications of the analytic hierarchy process. Management science, 26(7), 641-658.

Zavadskas, E. K., Turskis, Z., Antucheviciene, J. and Zakarevicius, A., 2012. Optimization of weighted aggregated sum product assessment. Elektronika ir elektrotechnika, 122(6), 3-6.