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An Alternative Process for Determining Erosion Risk: The Fuzzy Method

Erozyon Riskini Belirlemek İçin Alternatif Bir Yöntem: Bulanık Metot

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ABSTRACT
This study reveals the status of erosion risk, which is a very important soil and environmental problem, in Gaziantep in order to test the reliability of the fuzzy method. The study evaluates vegetation cover, lithological structure, slope, and precipitation as erosion indicators to determine the effectiveness of the frequently used analytic hierarchy process (AHP) and Fuzzy methods at identifying erosion risk. A weight value was assigned to each parameter using both the AHP and fuzzy methods; afterwards, mapping and analysis were carried out in the program Geographic Information System (GIS). The compatibility of both methods has been provided by comparing the values at 100 geographic points that had been selected. In accordance with these results, the AHP and fuzzy methods were determined to be highly compatible with each other. When considering the evaluation obtained as a result of the methodological comparison, while values were observed to be very similar in the categories of medium and high erosion, the similarity rates decreased in the categories of low and very low erosion. As a result, the fuzzy method has been revealed to be able to be used exclusively for evaluating erosion risk in areas with semi-arid climate characteristics and to even be an effective tool for guiding actions at preventing erosion.
Keywords: Fuzzy method, AHP, erosion

ÖZ
Çalışmada Bulanı metodunun güvenilirliğini test etmek amacıyla çok önemli bir toprak ve çevre sorunu olan erozyonun Gaziantep şehrindeki risk durumu ortaya konulmuştur. Erozyon göstergeleri olarak bitki örtüsü, litolojik yapı, eğim ve yağış parametrelerinin değerlendirildiği çalışmada erozyon riskinin belirlenmesinde sıkça kullanılan Analitik Hiyerarşi Süreci (AHP) ile Bulanık metodu bir arada kullanılmıştır. Saha içerisinde her parametreye AHP ve Bulanık yöntemleri ile bir ağırlık değeri atanmış ve daha sonra Coğrafi Bilgi Sistemleri (CBS) ortamında haritalama ve analiz gerçekleştirilmiştir. Seçilen 100 noktanın AHP ve Bulanık'taki değerleri karşılaştırılarak her iki yöntemin uyumluluk durumu ortaya konulmuştur. Buna göre AHP ile BULANIK metodun yüksek oranda birbiri ile uyum gösterdiği tespit edilmiştir. Dolayısıyla Gaziantep gibi yarı kurak iklim özelliklerine sahip alanlarda erozyon risk durumunun değerlendirilmesinde BULANIK metodunun tek başına kullanılmasında bir sakınca olmadığı, hatta erozyon koruyucu eylemlere rehberlik etmek için etkili bir araç olabileceği ortaya konulmuştur.
Anahtar kelimeler: Bulanık metot, AHP, erozyon

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1. INTRODUCTION

Erosion from things such as water, wind, and ice covers the whole process involving of the Earth's surface being worn away and fragmented through kinetic energy from external factors as well as this material being transported and accumulated elsewhere (Dvořák, 1994). In fact, erosion follows a slow course and occurs constantly in nature. Despite the formation of 1 cm of soil taking 200-400 years in temperate climates (Osman, 2013), its destruction can occur much more rapidly. When soil formation equals soil loss, erosion is evaluated as a natural process and is called geological/normal erosion. In this way, highly productive areas of accumulated soil are formed, and the soil renews itself. With deforestation and ignorant agricultural policies and production techniques, the fertile upper layer of soil gets exposed to erosion and degradation. The type of erosion that occurs due to human activity is described as accelerated erosion and is considered an environmental problem due to soil erosion exceeding soil formation (Çelebi, 2010).

The increase in resource use and pressure on resources due to growing populations accelerates erosion and paves the way for desertification. Depending on the topography, erosion that occurs as a result of the human interactions among land slope, vegetation, climate, and lithological characteristics may turn into a disaster. According to the United Nations Convention to Combat Desertification (UNCCD, 2017) data, approximately 70% of arid areas in the world have been destroyed, with around 24 billion tons of soil being lost each year due to erosion.

Soil is an essential actor for all life forms, and its absence causes environmental problems and even disasters. In this sense, the productivity of eroded soil decreases and soil becomes shallow, which paves the way for desertification. Due to improper land use, rill and gully erosion increase, and agricultural areas become fragmented. Decreased agricultural productivity encourages rural-urban migration and leads to socio-economic problems in cities. Soil accumulating in dams, streams, and lakes leads to siltation in these areas and causes floods by narrowing the water beds of streams, shortening the life of dams, and making energy production difficult. When soil decomposes, organic matter both causes eutrophication in the accumulation areas as well as the carbon dioxide in the organic matter to pass from the soil to the atmosphere, which result in an increase in greenhouse gas emissions. As the ecosystem deteriorates, biodiversity decreases. In addition, water pollution increases, and soil loss prevents the infiltration of precipitation, reducing the water holding capacity of the soil. Therefore, erosion has a very important place in maintaining the normal course of vital issues and improving living conditions in terms of the world's population, biodiversity, and agriculture. For this reason, various institutions, organizations, associations, and scientists carry out studies on erosion throughout the world. As a matter of fact, many local and regional institutions and organizations around the world (National Aeronautics and Space Administration [NASA], 2021; Independent Educational Consultants Association [IECA], 2021; Turkish Foundation for Combatting Soil Erosion [TEMA], 1992-2021; Earthworm Foundation, 2021) make great efforts just to carry out these studies. In addition, many new developments have occurred regarding the techniques for determining the amount, speed, and risk of erosion. In particular, identifying erosion risk areas with less cost and in less time is extremely important in terms of resisting the regular succession of erosion on a global scale.

For these purposes, geographical information systems (GISs) and remote sensing methods (Mitasova et al., 2013; Ganasri & Ramesh, 2016; Jabbar, 2003; Parlak, 2010; Chowdhury & Tripathi, 2013; Arabameri et al., 2018) have been prosperous in studies carried out on erosion in different continents of the world. The analytic hierarchy process (AHP) is one of the multi-criteria decision making techniques that uses parameters such as slope, precipitation, lithological structure, and vegetation and, with its proven reliability (Vulević et al., 2015; Chakraborty et al., 2016; Abuzaid et al., 2021; Belloula et al., 2020; Tairi et al., 2019; Kabo-bah et al., 2021), has been used extensively in recent years. It is one of the most reliable frequently used methods, especially for producing erosion risk maps.

In addition to the AHP method, the fuzzy method is another method that has also been used in many areas for determining erosion risk (Fauzi et al., 2017; Ojo et al., 2015; Ai et al., 2013; Bahrami et al., 2005; Neji et al., 2021).

This study uses the AHP and Fuzzy methods together, as they are frequently used to determine erosion risk. The parameters of vegetation, lithological structure, slope, and precipitation were used in both methods. As a result of using these two methods, the erosion risk map of Gaziantep was revealed using AHP, and the erosion risk situation at 100 points with Fuzzy were revealed. As a result, the values for each data point were compared in the AHP and fuzzy methods to reveal their compatibility.

2. STUDY AREA

Gaziantep Province is located in the western part of Turkey's Southeastern Anatolia Region between 37.38332°N latitude and 37.06622°E longitude. It is bordered by Kilis Province and Syria to the south, Kahramanmaraş Province to the north, Adıyaman Province to the north and northeast, Osmaniye Province to the northwest and west, Hatay Province to the west and southwest, and Şanlıurfa Province to the east (**Figure 1**).

According to the Köppen-Greiger climate classification map, Gaziantep Province has a temperate climate that is warm in the winters and very hot in summers and falls in the dry Mediterranean climate class (Csa)[1]. This means Gaziantep shows semi-arid characteristics in terms of climate. The average elevation of the field, which generally appears as a plateau, is 840 m. When the slope is too high, the kinetic energy of flowing water increases, and water doesn't have enough time to infiltrate. As a result, the amount of soil carried by surface runoff increases (Atalay, 1974). The slope in the field increases, especially toward the west and less so toward the north. Therefore, these sections are more susceptible to erosion. According to the meteorological station records of Gaziantep, total annual precipitation is 570 mm, with an irregular distribution of precipitation over the seasons. When considering the precipitation values of the stations in Gaziantep and its surroundings, precipitation is higher for the stations near Amanoslar and Sof Mountain in the west where the elevation and slope increase (Nurdağı = 734 mm; İslahiye = 824.1 mm), and the annual precipitation levels range between 416 mm in Nizip and 824.1 mm in İslahiye. The semi-arid precipitation regime of the field also triggers erosion. Steppe, garrigue, forest, and maquis vegetations are seen in the study area. However, the natural forest areas consist of oaks, which are only found in the Amanus in the north of İslahiye and Nurdağı in western Gaziantep. Most of the oaks have been transformed into garrigue vegetation. Garrigue, maquis, and alpine vegetations are seen along the slopes of the Nur Mountains. Sof Mountain in the western part has rich garrigue flora. In south Gaziantep, Karkamış and Oğuzeli are areas with large steppes as well as olive and pistachio cultivations. Peanut and cotton are common in Yavuzeli, while the kermes oak, nettle, and lemon thyme are common in Nizip, where olives, pistachios, and grapes are cultivated. Resource use is seen to be full of activity. When making a general classification in terms of the lithology of the study area, basalt, limestone, marl, serpentine, and alluvium are

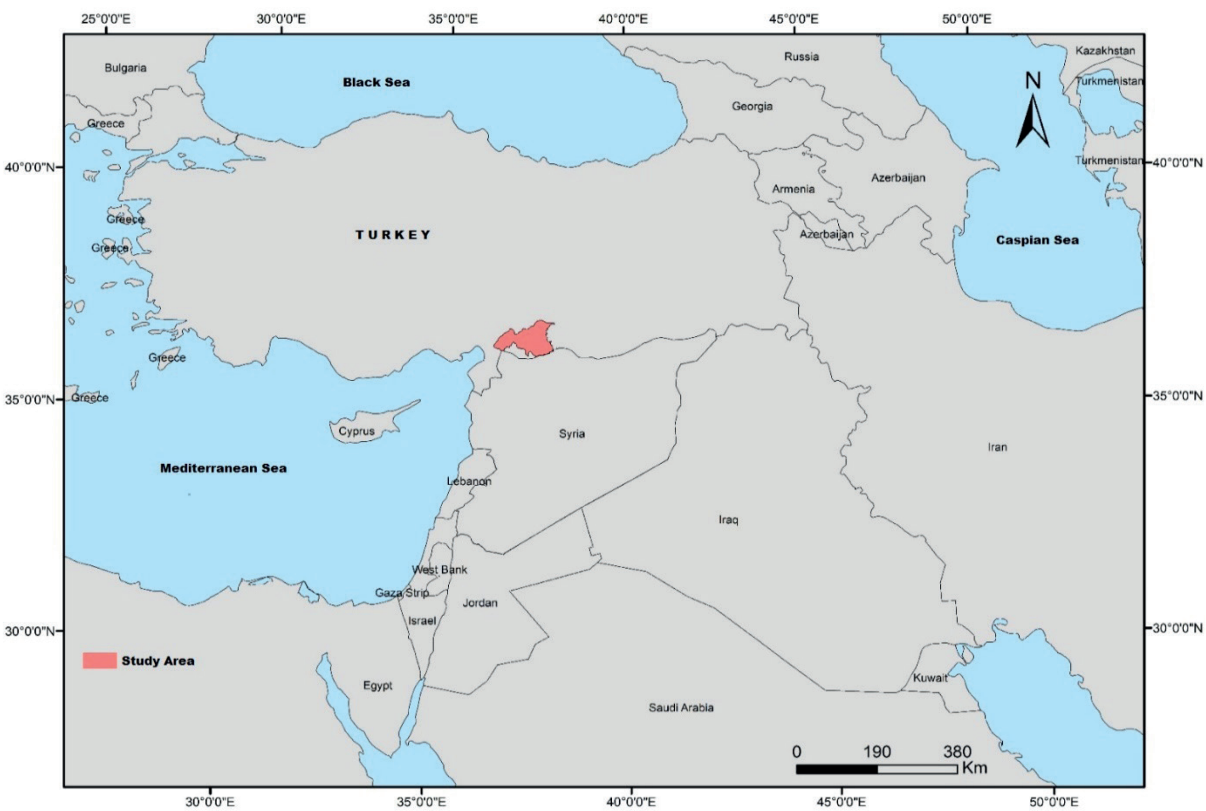

Figure1: Study Area.

1 Hot-summer Mediterranean climate is the subtype of the Mediterranean climate. In this subtype of the Mediterranean climate, precipitation in driest month of summer half of the year is less than 30 mm and less than one-third of the wettest month of the winter half. Also temperature of warmest month 22 °C or above. Csa climate mainly distributes around the Mediterranean Sea, southwestern of Australia, part of the western coast line of the US. (Britannica, 2022).

found. Although they form large surfaces, basalts are seen to have a thin layer and are a rock group with very high resistance to abrasion, limestone is less resistant due to the sediments, and marls is even less resistant to erosion due to the clay in its content. In lithology, reddish brown soils and rendzinas form in lands consisting of sedimentary limestone and clayey limestone in particular. As is known, the most important problem these soils face is erosion. Generally, alluvium is seen in old stream beds, and the lower slopes are mostly used as agricultural areas. Alluvium has low abrasion resistance due to its loose grainy structure and lack of aggregates. Serpentines from the ophiolite group, which are seen in western Gaziantep, soften easily and break down with precipitation (Sönmez, 2012).

3. AIM AND METHODS

The main purpose of the study is to determine whether the fuzzy method reliable for determining erosion risk. To examine this, the fuzzy method is compared with the AHP method, which has been proven to provide extremely reliable results regarding erosion. Therefore, both methods were applied apart from one another, with the results being compared in the Findings section.

3.1. AHP Method

While the analytical hierarchy process (AHP) method was first put forward by Myers and Albert (1998), it was actually developed by Saaty in 1977 as a multi-criteria decision-making model and has been applied to solving decision-making problems (Gülenç & Aydın Bilgin, 2010, p. 98). A pairwise comparison matrix is obtained based on the pairwise comparisons between the criteria considered suitable for use in a study, and then the weight values of these criteria are determined (Kazakis et al., 2015). AHP not only involves physical and planning factors such as landslides, earthquakes, erosion, and flooding (Boroumandi et al., 2015; Shadmaan & Ibne Islam, 2021; Wei et al., 2020; Kabo-bah et al., 2021) from education to logistics, the manufacturing industry, and health sector (Şahin & Yurdugül, 2018; Çakılcı & Öztürkoğlu, 2020; Sarjono et al., 2020; Schmidt et al., 2016), but ıt is also used extensively in many other subjects. Saaty (1987, p. 161) stated AHP to have been developed as a method that can be used in multi-criteria decision-making not only in the physical environment but also in social areas. In fact, AHP has become a reliable method used extensively in all areas of the humanities

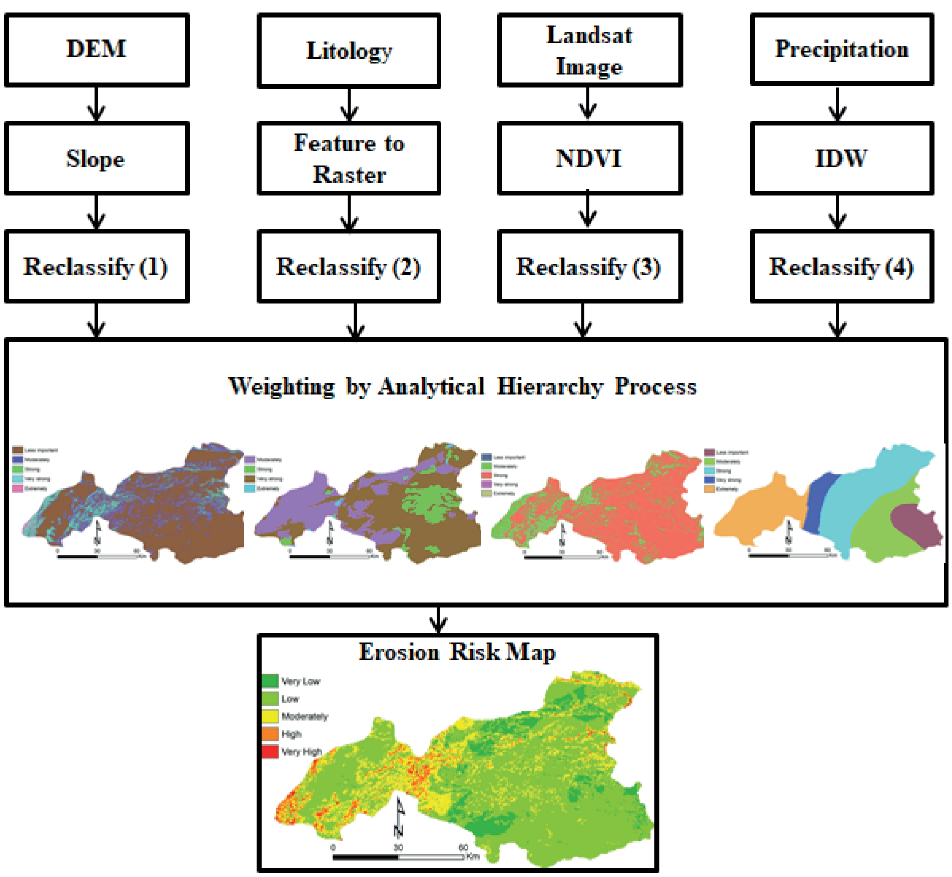

Figure 2: Work flow diagram for the multicriteria decision analysis.

and physics these days, being the era of computers and artificial intelligence.

This study produced an erosion risk map of Gaziantep city using the AHP method by following the processes shown in **Figure 2**. The study has also used the parameters of slope, vegetation, lithological structure, and precipitation to determine erosion risk. The process of evaluating these parameters using AHP method is also shown in **Figure 1**. In addition, the aforementioned parameters were first divided into subclasses, and then the weight values in the erosion risk were determined using a comparison matrix, as seen in **Table 1**.

Table 1: Comparison matrix of the 4 factors adopted.

	Slope	NDVI	Litology	Precipitation	Weight
Slope	1,00	2,00	3,00	4,00	0,466
NDVI	0,50	1,00	2,00	3,00	0,277
Litology	0,33	0,50	1,00	2,00	0,161
Precipitation	0,25	0,33	0,50	1,00	0,096

3.2. Fuzzy Method

Many uncertainties arise in daily life. Most of the time, Aristotelian logic (classical logic) is insufficient at dealing with these uncertainties, because in Aristotle logic, an element is either an element of a set or not. In other words, the membership value of an element belongs to the Set {0, 1}. If we explain this situation according to classical logic using examples from daily life, the weather is either cold or hot. Whether the weather is cool or warm cannot be explained using classical logic. Again, according to classical logic, a bottle is either full or empty. Situations such as half full, less full, and quarter full bottles cannot be explained using classical logic. Because of these shortcomings, classical logic is insufficient at explaining uncertainties. Zadeh (1965) defined fuzzy logic to explain uncertainties more precisely using mathematics. In fuzzy logic, the degree to which each element is a member of a set can be in the range of [0, 1]. Thus, the degree of membership for each element can be rated differently than in classical logic. For example, the weather can have levels such as hot, cold, warm, cool, extremely hot, or extremely cold with different degrees of membership. Thus, a more sensitive type of logic has been obtained that involves classical logic in explaining uncertainties. these days, fuzzy logic is one of the most used types of logic in decision-making applications in almost every field of science, especially in artificial intelligence applications.

In this section, we give basic information for fuzzy set and fuzzy MATLAB. Also, we give new artificial intelligence applications using the fuzzy MATLAB for find the erosion rate at geographic points

3.1.1. Fuzzy Sets

According to Zadeh (1965), let B be the universal set. A fuzzy set A of B is defined as:

$$A = \{(a, \mu_A(a); a \in B \qquad (1)$$

where, $\mu_A(a)$ is the membership function such that $\mu_A : \mathcal{B} \rightarrow [0,1]$.

According to Dubois & Prade (1980), a triangular fuzzy number $\tilde{n} = [k_1, l_1, m_1]$ is a special fuzzy set in the real number set R, whose membership function is defined as: (2)

$$\mu_{\tilde{n}}(a) = \begin{cases} (a-k_1)/(l_1-k_1), & \text{if } (k_1 \le x < l_1) \\ 1, & \text{if } (a = l_1) \\ (m_1-a)/(m_1-l_1), & \text{if } (l_1 < a \le m_1) \\ 0, & \text{if otherwise} \end{cases}$$

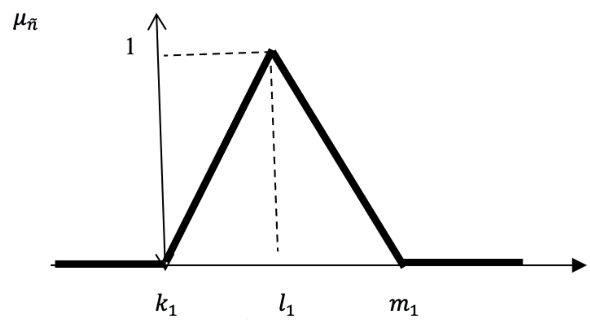

Figure 3: $\tilde{n} = [k_1, l_1, m_1]$ triangular fuzzy membership function.

According to Dubois and Prade (1980), a trapezoidal fuzzy number $\tilde{n} = [k_1, l_1, m_1, n_1]$ is a special fuzzy set in the real number set R, whose membership function is defined as: (3)

$$\mu_{\tilde{n}}(a) = \begin{cases} 0, & \text{if } a \le k_1 \\ (a-k_1)/(l_1-k_1), & \text{if } (k_1 < a < l_1) \\ 1, & \text{if } (l_1 \le a \le m_1) \\ (m_1-a)/(m_1-l_1), & \text{if } (m_1 < a \le n_1) \\ 0, & \text{if otherwise} \end{cases}$$

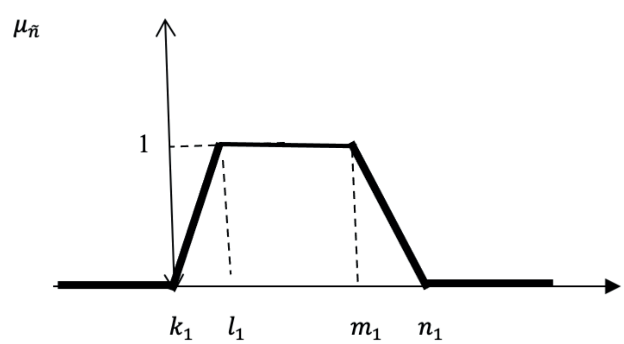

Figure 4: $\tilde{n} = [k_1, l_1, m_1, n_1]$ trapezoidal fuzzy membership function.

3.1. 2. Fuzzy MATLAB Application

Figure 5 shows the process in the fuzzy MATLAB application.

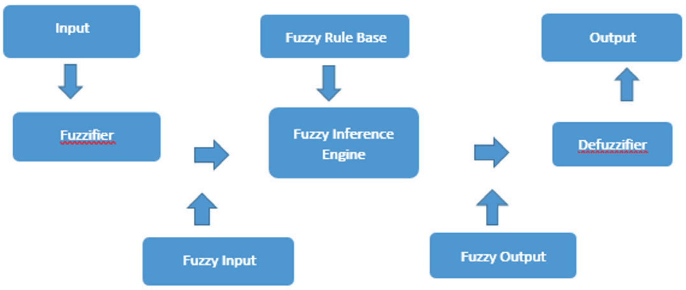

Figure 5: Fuzzy Matlab Algorithm.

We give the inputs for this fuzzy MATLAB application in **Table 2**.

Table 2: Inputs for this fuzzy matlab application.

Input	Abbreviation
NDVI	NDVI
Precipitation	P
Slope	S
Lithology	LI

We give the fuzzy membership functions of these inputs and the representation of these functions as fuzzy numbers in **Tables 3, 4, 5,** and **6**. In this section, we use the triangular fuzzy numbers and the trapezoidal fuzzy numbers.

Table 3: Fuzzy Membership Functions of NDVI.

Fuzzy Membership Functions	Abbreviation	Fuzzy Number
Very Little	VL	[0.5, 0.6, 1, 1]
Little	L	[0.2, 0.6, 0.8]
Medium	M	[-0.2, 0.2, 0.6]
High	H	[-0.6, -0.2, 0.2]
Very High	V.H	[-1, -1, -0.6]

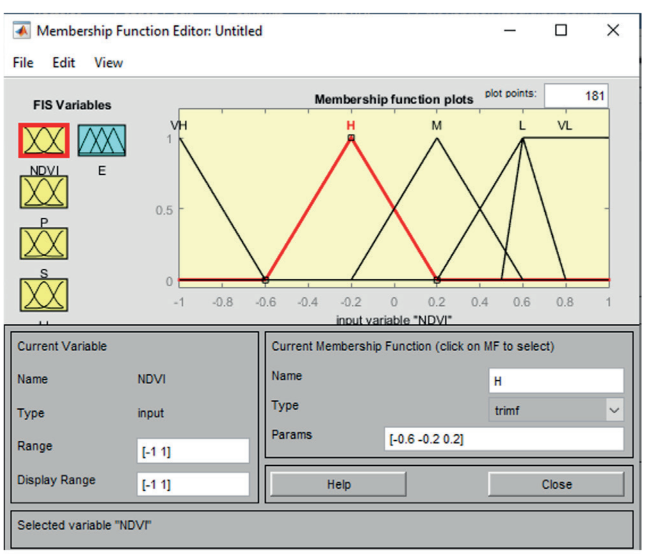

Figure 6: Fuzzy Membership Functions of Fuzzy Matlab for NDVI.

Table 4: Fuzzy Membership Functions of Precipitation.

Fuzzy Membership Functions	Abbreviation	Fuzzy Number
Very Little	VL	[350, 350, 450]
Little	L	[450, 500, 550]
Medium	M	[500, 550, 600]
High	H	[550, 600, 650]
Very High	V.H	[575, 600, 900, 900]

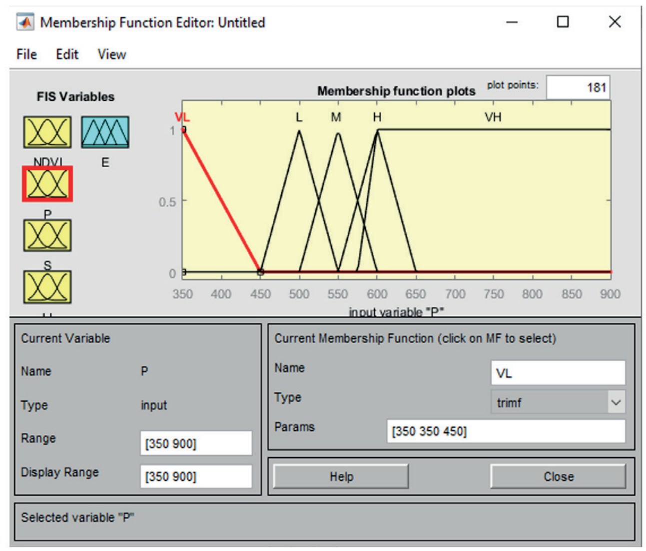

Figure 7: Fuzzy Membership Functions of Fuzzy Matlab for Precipitation.

Table 5: Fuzzy Membership Functions of Slope.

Fuzzy Membership Functions	Abbreviation	Fuzzy Number
Very Little	VL	[0, 0, 7]
Little	L	[7, 14, 21]
Medium	M	[14, 21, 28]
High	H	[21, 28, 35]
Very High	V.H	[25, 28, 45, 45]

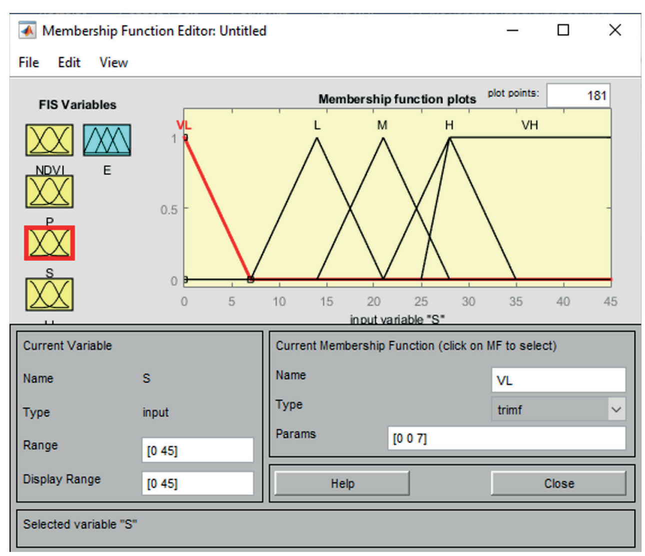

Figure 8: Fuzzy Membership Functions of Fuzzy Matlab for Slope.

Table 6: Fuzzy Membership Functions of Lithology.

Fuzzy Membership Functions	Abbreviation	Fuzzy Number
Very Little	VL	[0, 1, 1.5]
Little	L	[1, 2, 2.5]
Medium	M	[2, 3, 3.5]
High	H	[3, 4, 4.5]
Very High	V.H	[4, 5, 5]

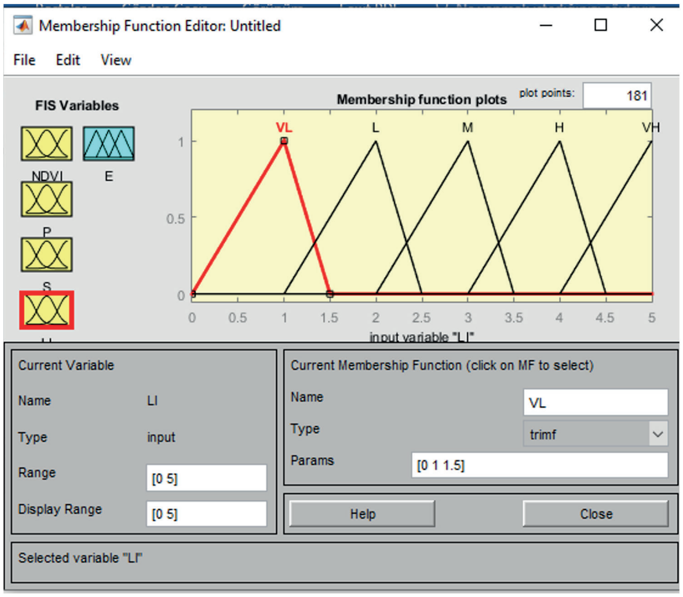

Figure 9: Fuzzy Membership Functions of Fuzzy Matlab for Lithology.

Table 7: Output for this fuzzy matlab application.

Output	Abbreviation
Erosion	E

We give the triangular fuzzy membership functions and trapezoidal fuzzy membership functions of this output in **Table 8**.

Table 8: Fuzzy Membership Functions of Output.

Triangular Fuzzy Membership Functions	Abbreviation	Triangular Fuzzy Number
Very Little	VL	[0, 0, 20]
Little	L	[20, 40, 60]
Medium	M	[40, 60, 80]
High	H	[60, 80, 100]
Very High	VH	[80, 100, 100]

4. FINDINGS

Both the AHP and fuzzy results at 100 different geographic points in the study are given in Table 9. Values in the range of 0-100 are divided into five equal classes as given in **Table 9**.

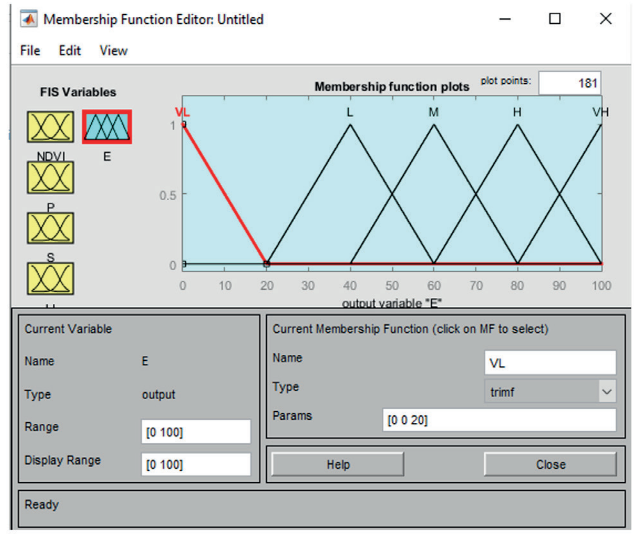

Figure 10: Fuzzy Membership Functions of Fuzzy Matlab for output.

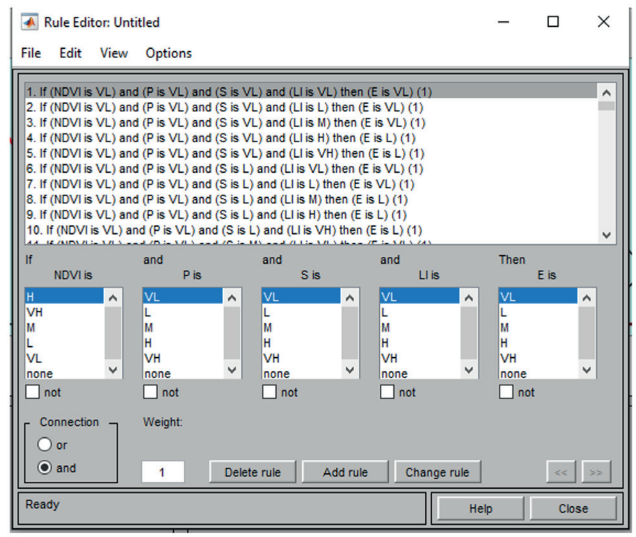

Figure 11: Representation of Fuzzy Rules in Fuzzy Matlab.

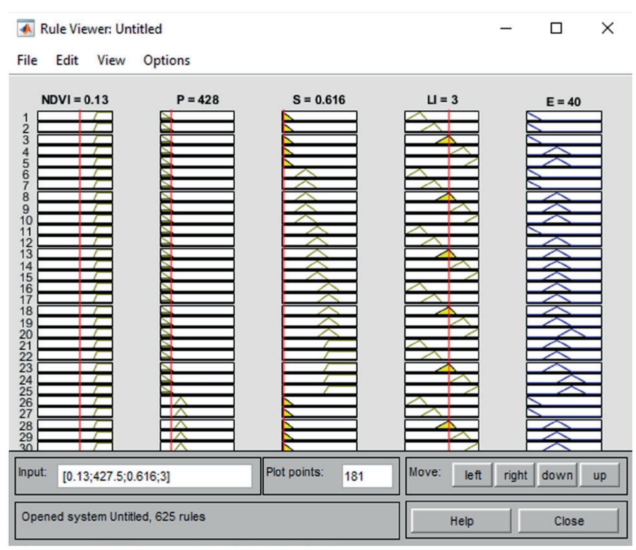

Figure 12: Getting Results with Fuzzy Matlab Rules.

Table 9: Classification of risk level.

Value	Risk Level
0-19,9	Very Low
20-39,9	Low
40-59,9	Moderate
60-79,9	High
80-100	Very High

Table 11: Similarity of points according to AHP and Fuzzy Method.

	FUZZY	AHP
Very Low	3	0
Low	7	5
Moderate	69	73
High	20	20
Very High	1	2

Table 10: AHP and Fuzzy Risk Categories and Values of Selected Points.

Point Number	AHP Value	AHP Risk	Bis Risk	Bis Value	Point Number	AHP Value	AHP Risk	Bis Risk	Bis Value
1	51,09	M	M	58	51	53,71	M	M	42
2	69,43	H	H	79,2	52	43,23	M	M	40
3	85,15	VH	H	65	53	43,23	M	M	41
4	49,78	M	M	59	54	49,78	M	M	40
5	61,57	H	M	40	55	45,85	M	M	43,9
6	43,23	M	M	40	56	43,23	M	L	30,6
7	62,88	H	H	61	57	49,78	M	M	41
8	69,43	H	H	61,7	58	53,71	M	M	59,6
9	72,05	H	M	58,3	59	62,88	H	M	50
10	47,16	M	M	58,3	60	56,33	M	M	50
11	62,88	H	M	40	61	45,85	M	M	42
12	44,54	M	M	42,8	62	49,78	M	M	41
13	53,71	M	M	40,6	63	41,3	M	M	43
14	72,05	H	H	62,2	64	53,71	M	M	43,9
15	81,22	VH	H	63,9	65	47,16	M	M	40
16	45,85	M	M	40	66	62,88	H	M	42,2
17	66,81	H	H	70	67	56,33	M	M	40,6
18	72,05	H	M	42,8	68	36,68	L	L	39,8
19	49,78	M	M	40	69	49,78	M	M	40
20	53,71	M	M	50	70	56,33	M	M	40,6
21	48,47	M	M	41,1	71	58,95	M	M	40
22	41,92	M	M	58,7	72	44,54	M	M	43,3
23	48,47	M	M	59,3	73	57,64	M	M	58,3
24	48,47	M	M	52,8	74	70,74	H	H	60
25	53,71	M	H	70	75	57,64	M	M	52,8
26	41,92	M	M	40	76	57,64	M	H	70
27	41,92	M	M	41	77	70,74	H	H	61,1
28	48,47	M	M	41,1	78	69,43	H	H	79,8
29	44,54	M	VL	11,7	79	48,47	M	H	62,2
30	53,71	M	M	41,1	80	61,57	H	H	60
31	57,64	M	M	59,2	81	32,75	L	M	42,8
32	36,68	L	VL	11,7	82	45,85	M	M	40
33	53,71	M	M	40,1	83	49,78	M	M	40
34	43,23	M	L	26,7	84	62,88	H	M	40
35	39,3	M	M	39,4	85	40,61	M	M	40
36	39,3	L	L	28,9	86	43,23	M	L	26,1
37	49,78	M	M	39,6	87	53,71	M	M	40
38	47,16	M	VL	13,9	88	47,16	M	M	40
39	40,61	M	M	40	89	53,71	M	M	59,8
40	53,71	M	M	59,4	90	57,64	M	M	49,4
41	78,6	H	VH	94,4	91	57,64	M	M	59,7
42	57,64	M	M	59,8	92	73,36	H	M	45,6
43	41,92	M	M	59,7	93	57,64	M	M	56,1
44	55,02	M	M	59,4	94	41,92	M	H	63,3
45	48,47	M	M	41,1	95	41,92	M	M	59,3
46	48,47	M	M	50	96	48,47	M	H	66,1
47	51,09	M	M	59,6	97	61,57	H	H	60
48	51,09	M	H	65,6	98	48,47	M	H	63,9
49	57,64	M	H	70	99	49,78	M	M	44,4
					100	49,78	M	M	40

Upon considering the classification in **Table 9**, the AHP and fuzzy values of the 100 previously determined geographic points are then compared in **Table 10**. Consequently, the AHP and fuzzy methods provide consistent results for 74 geographic points. While one-step differences were found between the AHP and fuzzy method values at 24 geographic points, this difference increased to double digits at two geographic points. The differences between the AHP values and fuzzy values at 28 geographic points were also less than five, 28 geographic points had differences for the AHP and fuzzy values between 5-10, and 34 geographic points had differences for the AHP and fuzzy values greater than 10.

The connection between the fuzzy method and the AHP method is that the erosion intensity at 100 geographic points were compared using a precise location of the values (**Table 10**). Consequently, the numerical similarity between the two methods is striking. As a matter of fact, while three geographic points were evaluated in the category of very low erosion using the fuzzy method, there are no geographic point in the very low erosion category occurred using the AHP method. While the fuzzy method evaluated seven geographic points in the low erosion category, AHP evaluated five. In addition, both methods were observed to evaluate a similar high number of points in the medium erosion category, with the fuzzy method evaluating 69 geographic points at medium erosion and AHP evaluating 73 at medium erosion. The category that provided the highest similarity between methods regarding the number of geographic points evaluated was the category of high erosion. Each method evaluated 20 geographic points in this category. Also, when comparing the two methods, the total number of points each method evaluated for the category of very high erosion only differed by one. When considering the evaluations obtained as a result of the methodological comparison, while the similarity rates are high for the medium and high erosion categories, the similarity rate is seen to have decreased for the low and very low erosion categories. Looking at the similarity rates overall, both methods can be said to be consistent with each other. Therefore, just like AHP is widely used in erosion risk assessments around the world, the fuzzy method may also be used with high reliability and can be scientifically supported in such studies.

5. RESULTS

This study has evaluated the scientific validity and reliability of the AHP method, which is used for evaluations in many fields from planning to economics, risk analyses, and site selection and has compared the AHP and fuzzy methods' ability to evaluate in an erosion risk analysis of Gaziantep Province in Turkey. As a result, the AHP and fuzzy methods have been determined to be compatible with each other. Therefore, the FUZZY method has been scientifically proven to be able to be used in erosion risk analysis studies just as effectively as the AHP method in regions with semi-arid climate characteristics such as Gaziantep. Also, areas with physical conditions such as Gaziantep will suffer no inconvenience when simply using the fuzzy method to output erosion risk maps.

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