DOI: 10.26650/JGEOG2019-0004

COĞRAFYA DERGİSİ
JOURNAL OF GEOGRAPHY
2019, (38)
http://jgeography.istanbul.edu.tr

İSTANBUL UNIVERSITY PRESS

Determination of Paragliding Fields with GIS-based Analytic Hierarchy Process*

CBS tabanlı Analitik Hiyerarşi Süreci ile Yamaç Paraşütü Sahalarının Belirlenmesi

Çağdaş KUŞÇU ŞİMŞEK[1], Tarık TÜRK[1], Halime ÖDÜL[1]

[1]Cumhuriyet University, Department of Geomatics Engineering, Faculty of Engineering, Sivas, Turkey

ORCID: Ç.K.Ş. 0000-0002-3161-6508; T.T. 0000-0002-2671-7590; H.Ö. 0000-0003-0879-7395

ÖZ

Günümüzde kentte yaşayan insanlar şehirden uzaklaşma eğilimindedir. Bu durum her geçen gün doğa turizmine olan ilgiyi ve doğa sporlarına olan yönelimi arttırmaktadır. En gözde doğa sporlarından biri de yamaç paraşütüdür.

Bu çalışmada Coğrafi Bilgi Sistemi (CBS) tabanlı Analitik Hiyerarşi Süreci (AHP) yaklaşımı ile yamaç paraşütü alanları otomatik olarak belirlenmiştir. Model ölçütleri, uçuş için uluslararası teknik gereklilikler ve deneyimli pilotun uzman görüşleri yardımıyla belirlenmiştir. Kolay ve orta seviyeli uçuş alanların tanımlanmasında uluslararası koşullar dikkate alınırken, zor dereceli uçuş alanların belirlenmesinde ise deneyimli yamaç paraşütü pilotunun görüşleri hesaba katılmıştır. Oluşturulan CBS tabanlı sistemin sonuçlarına göre, belirlenen hedef noktalardan rastgele seçilen 10'u ziyaret edilmiştir. Bu sahada tecrübeli pilot lisansına sahip profesyonel yamaç paraşütü pilotu tarafından test uçuşu gerçekleştirilmiştir. Elde edilen sonuçlara göre; uçuş alanı olarak 9 saha belirlenmiştir. Sonuç olarak, alternatif yamaç paraşütü alanlarının belirlenmesine yardımcı olmak amacıyla bir yöntem geliştirilmiştir.

Anahtar kelimeler: Analitik Hiyerarşi Süreci, Coğrafi Bilgi Sistemi, yamaç paraşütü

ABSTRACT

Nowadays, people living in the city tend to want to get away from the city. This situation is leading to an ever increasing interest in nature tourism and an orientation to outside sports. One of the most popular nature sports is paragliding.

In this study, paragliding fields were automatically determined with the Analytic Hierarchy Process (AHP) approach based on Geographical Information Systems (GIS). Model criteria were decided with the help of international technical requirements for flying and the expert opinions of an experienced pilot. While international conditions were used for the definition of easy and moderate fields, difficult conditions were defined with the guidance of the experienced paragliding pilot. According to the results of the GIS-based system created, 10 out of the designated target points were randomly visited. The test flight was performed in the field by a professional paragliding pilot with an experienced pilot license. According to the results obtained, 9 fields were determined as flight areas. Consequently, a method has been developed in order to help determine alternative paragliding fields.

Keywords: Analytic Hierarchy Process, Geographical Information Systems, paragliding

*Abstract of this study was presented at IWACT'18 International West Asia Congress of Tourism Research between 27th Sept – 30th Sept 2018 in Van – Turkey.

Submitted/Başvuru: 28.01.2019 • **Revision Requested/Revizyon Talebi:** 11.02.2019 • **Last Revision Received/Son Revizyon:** 24.03.2019 • **Accepted/Kabul:** 02.04.2019 • **Published Online/Online Yayın:** 15.04.2019

Sorumlu yazar/Corresponding author: Tarık TÜRK / tarikturk@gmail.com

Atıf/Citation: Kuscu Simsek, C., Turk, T., Odul, H. (2019). Determination of paragliding fields with GIS-based Analytic Hierarchy Process. *Cografya Dergisi, 38*, 1-10. https://doi.org/10.26650/JGEOG2019-0004

1. INTRODUCTION

1.1. Literature Review

Nowadays, people living in the cities are directing themselves to nature due to the fact that there are limited recreational areas in the cities (Koçak, 2010; Kienast et al., 2012). People want to integrate with nature to keep themselves away from stress and to be healthy (Kaplan and Ardahan, 2012; Ardahan and Yerlisu Lapa, 2011). Easily accessible natural areas close to the city has become more popular owing to the fact that the fast and busy nature of city life has been overwhelming people. In spite of this demand, the existence of a very limited number of functional rural recreational areas with natural qualities within the city and the gradual decrease in these existing areas make it necessary for people to go to recreational tourism areas in far away areas for recreational purposes in accordance with their economic opportunities and time (Ardahan and Yerlisu Lapa, 2011). This situation, which requires time together with the financial burden, decreases the practicability of nature sports for everyone and causes them to appeal to a certain population (Ekinci et al., 2012).

Moreover, these kinds of sports activities and the increased demand for ecotourism have also increased the pressure on nature, which itself is delicately balanced (Sezgin and Gümüş, 2016). In this respect, the adoption of a sustainability approach in natural areas and the protection of the natural environment require comprehensive planning and the proper management of the resources in the planned area (Koçak, 2010; Bunruamkaew and Murayama, 2011). The symbiotic relationship between human and nature necessitates a rational planning approach (Fung and Wong, 2007).

In this context, the ability of GIS to associate information with geographical location provides significant contributions to the development and management of tourism (Bishop and Hulse, 1994; Boyd et al., 1995; Miler et al., 1998; Hai-ling et al., 2011; Tseng et al., 2013; Parladır, 2013). The fact that the economic, social and environmental demands of sustainable development should be evaluated together makes the decision-making process difficult in tourism planning (Bahaire and Elliott-White, 1999; Chen, 2007; Fung and Wong, 2007; Hai-ling et al., 2011; Zhang, 2012; Carreta et al., 2016). In this respect, GIS plays a role in the supervision of environmental conditions, the examination of the suitability of places, the evaluation of conflicting interests and the modeling of relationships (Bahaire and Elliott-White, 1999; Kliskey et al., 1999; Kliskey, 2000; Boers and Cottrell, 2007; Chhetri and Arrowsmith, 2008; Bunruamkaew and Murayama, 2012).

As one of the alternative nature sports, paragliding appeals to the adrenaline junkies. It is necessary to find the right answers to the questions of “when and where” when undertaking a safe flight due to the risks associated with this sport. Apart from the pilot experience, the flying field should meet the technical requirements to ensure a safe flight. Additionally, in conjunction with meteorological conditions, the selection of locations of sport fields are also of great importance. Firstly, suitable flight hills are required in order to be able to paraglide. The land structure of the front of the hill and the climatic conditions should be investigated in depth. Furthermore, these components should be analyzed by experienced pilots in terms of conformity and risk. The predominant wind direction, slope, and altitude of the take-off field are the most important features that should be primarily evaluated for the safety of the take-off field. Another feature that is essential for the safety of the take-off field is that there should be no barriers in areas within a certain distance that might endanger the take-off, flight and landing safety. Landing areas should be a flat area away from anything that can cause turbulence (Topay, 2003).

One of the major constraints of the paragliding sport is meteorological conditions (Falavarjini, 2015). Paragliding accidents mainly occur due to sudden fluctuations in wind and thermal design. These sudden fluctuations in weather conditions can cause flyers to run into the rocky and woody etc. areas in conjunction with hard landing (Krüger-Franke et. al.; 1991; Ceyhan et. al., 2014). Therefore, to provide safety in paragliding, the wind speed and direction must be taken into consideration along with the physical conditions of the take-off and landing areas. The determination of flying hills and landing areas with appropriate conditions in large geographies is difficult. Moreover, the examination of all fields by pilots is also impossible. At this stage, GIS-based studies are crucial for determining potential flying fields. Finding suitable sites for paragliding is a complex decision-making problem, with different, inconsistent criteria and various objectives. Concordantly, Multi Criteria Decision Making (MCDM) methods allow a logical structure to investigate, analyze and solve such problems (Höfer et. al., 2016). One of the most frequently used MCDM methods is the AHP method. It states the precedencies of each alternative with the assigned weight for each alternative by analyzing the judgmental matrices using the advanced mathematical theory of eigenvalues and eigenvectors. (Tiwari et. al., 1999). This method is an indirect mapping technique, different variables are evaluated with different significance ratings by using specific decision making rules and factors selected by expert experiences (Feizizadeh et. al., 2014). Therefore, it is successfully used as a decision making tool to solve the problems of many disciplines including public administration and politics. (Pereira and Duckstein, 1993; Tiwari, 1999; Nekhay, 2009; Tegou, 2010). In literature, there is one study available related to the determination of the most suitable paragliding sites with GIS (Kuşçu et al, 2018). The most important difference of this study is that it is performed using the AHP method.

The aim of this study is to help identify alternative paragliding fields. In this process, a new method has been developed in order to assist with detecting the most suitable paragliding fields in any city with the help of AHP based on GIS and user interface program. AHP is a holistic multi-criteria decision method based on topographic, geographic and physical standards. Previously, paragliding fields were decided by observational and experimental methods. In this study, paragliding fields were determined according to scientific criteria. Thus, this study contributes to tourism activities in the region and recommends new suitable fields for paragliding lovers.

1.2. The AHP Method

AHP, which was developed by T.L. Saaty in 1971-1975 (Saaty, 1987), has been increasingly applied and is used as multi-criteria decision analysis in planning. It is applied to solve a wide range of problems involving complex criteria at different levels (Siddiqui et. al., 1996; Feizizadeh et. al., 2014).

AHP is part of the more comprehensive category of pair-wise comparison techniques in which attributes are ranked against each other to evaluate their relative importance. (Tegou et. al., 2010). The method consists of four axioms; decomposition, comparative judgments, synthesis and expectations. The first three principles guide the problem solution using the AHP and the last axiom ensures that the ideas are adequately represented in the model. (Saaty, 1987).

In order to hierarchically weigh the criteria used in this method, each criterion is compared with other criteria. For this, a reciprocal judgment matrix is created where the number of rows and the number of columns are defined according to criteria. In the creation of this matrix, the scaling method developed by Saaty (1977) is used. According to this method, a fundamental scoring system of definitions (from 1 to 9) is used to express the expert opinions and judgments (**Table 1**) (Saaty, 1990).

Table 1: The fundamental scale according to Saaty (1977).

Intensity of Importance	Definition
1	Equal importance
3	Moderate importance of one over another
5	Essential or strong importance
7	Very strong importance
9	Extreme importance
2, 4, 6, 8	Intermediate values

A comparison of the criteria in the reciprocal judgment matrix is made both one to one and reciprocal to each other by considering the importance of the values. In the reciprocal judgment matrix formed according to **Table 1** given below (Eqs. 1); a_{ij} shows the relative importance of criterion a_i over criterion a_j.

$$A=\begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} \qquad a_{ji}=\frac{1}{a_{ji}} \qquad (1)$$

The components of the diagonal of the square matrix (*n x n)* take a value of 1 when $i = j$. If the importance of criteria a_i over criteria a_j is k, then the relative importance of a_j over a_i is 1/k.

The number of judgments required for this matrix is *n (n-1)/2* (Saaty, 1987). To determine the importance distributions of the criteria against each other, n number and n-component (Eqs. 2) vectors which form the comparison matrix were created. The sum of the components of the obtained column vector must be 1.

$$b_{ij}=\frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \qquad (2)$$

A new C matrix was formed from the combination of n-column vectors obtained. The *w* column vector called eigenvector was created from the arithmetic mean of the row components of the *C* matrix (Eqs. 3).

$$C=\begin{bmatrix} c_{11} & c_{12} & \dots & c_{1n} \\ c_{21} & c_{22} & \dots & c_{2n} \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ c_{n1} & c_{n2} & \dots & c_{nn} \end{bmatrix} \qquad w_i=\frac{\sum_{j=1}^{n} c_{ij}}{n} \qquad W=\begin{bmatrix} w_1 \\ w_2 \\ \cdot \\ \cdot \\ \cdot \\ w_n \end{bmatrix} \qquad (3)$$

Subsequently, so as to check the consistency of the matrix, the consistency index *(CI)* and the consistency ratio *(CR)* have to be calculated. The *CR* is obtained by dividing the *CI* by the random value *(RI)* for the consistency index. *RI* is obtained from the random consistency index table which is given by Saaty (1987) as a function of n. To consider the matrix consistent, CR must be smaller than the 0.1 threshold value (Saaty, 1977).

2. THE STUDY AREA

The Sivas provincial border was selected as the study area (**Fig. 1**). The provincial area, which starts on the high plateaus of Central Anatolia of Turkey and rises to the east, ends with a mountainous and steep section in the north, east, and south-east. The average altitude is greater than 1000 meters. The region with a rugged structure is also open to northern winds. The winds blowing in the Sivas region consist of the northwest wind blowing from the northwest by 19.3%, the north-east wind blowing from the north-east by 16.8%, the north wind blowing from the north by 18.1%, and the remaining part consists of various winds (Governorship of Sivas, 2017).

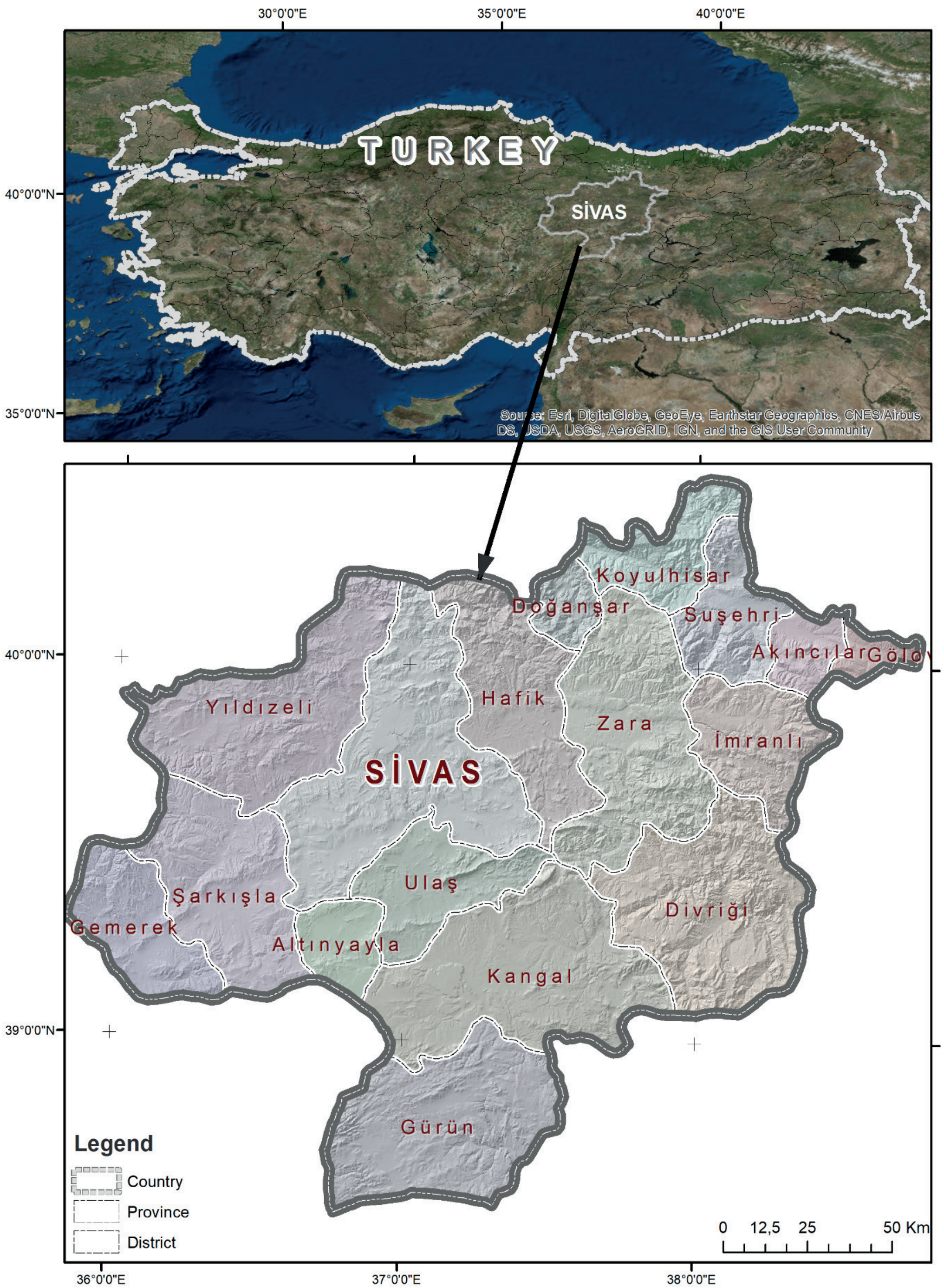

Figure 1: Study Area.

When the tourism structure of the Sivas province is examined, it is observed that thermal tourism along with cultural tourism mainly comes to the forefront. Mountaineering and trekking attract a lot of attention when the nature sports done in the region are examined (Governorship of Sivas, 2011). However, the city has enough wind potential for paragliding, and it is necessary to determine suitable flying fields in the city to evaluate this feature.

3. METHODOLOGY

In this study; the AHP was used as an analysis and evaluation method. The methodological framework of the study is shown in **Figure 2**. Analyses were performed on 250 m x 250 m grids.

The analysis criteria to be used in the determination of the fields were determined based on the "Flying Altitudes, Conditions and Hill Features" specified in the Turkish Aeronautical Association Flight Training Directive, supported by the International Aviation Federation. Furthermore, the criteria applied with experiential knowledge of safe flights were extended with the help of experienced pilots (flight instructors with experienced pilot license).

In the light of this information, energy transmission lines, stands, highways, streams, lakes/ponds, dams, Coordination of Information on the Environment (CORINE) land use, protected areas, military areas, airports, digital elevation model (DEM), valleys and wind direction data was used. The analyses were performed separately for taking off and landing fields. The

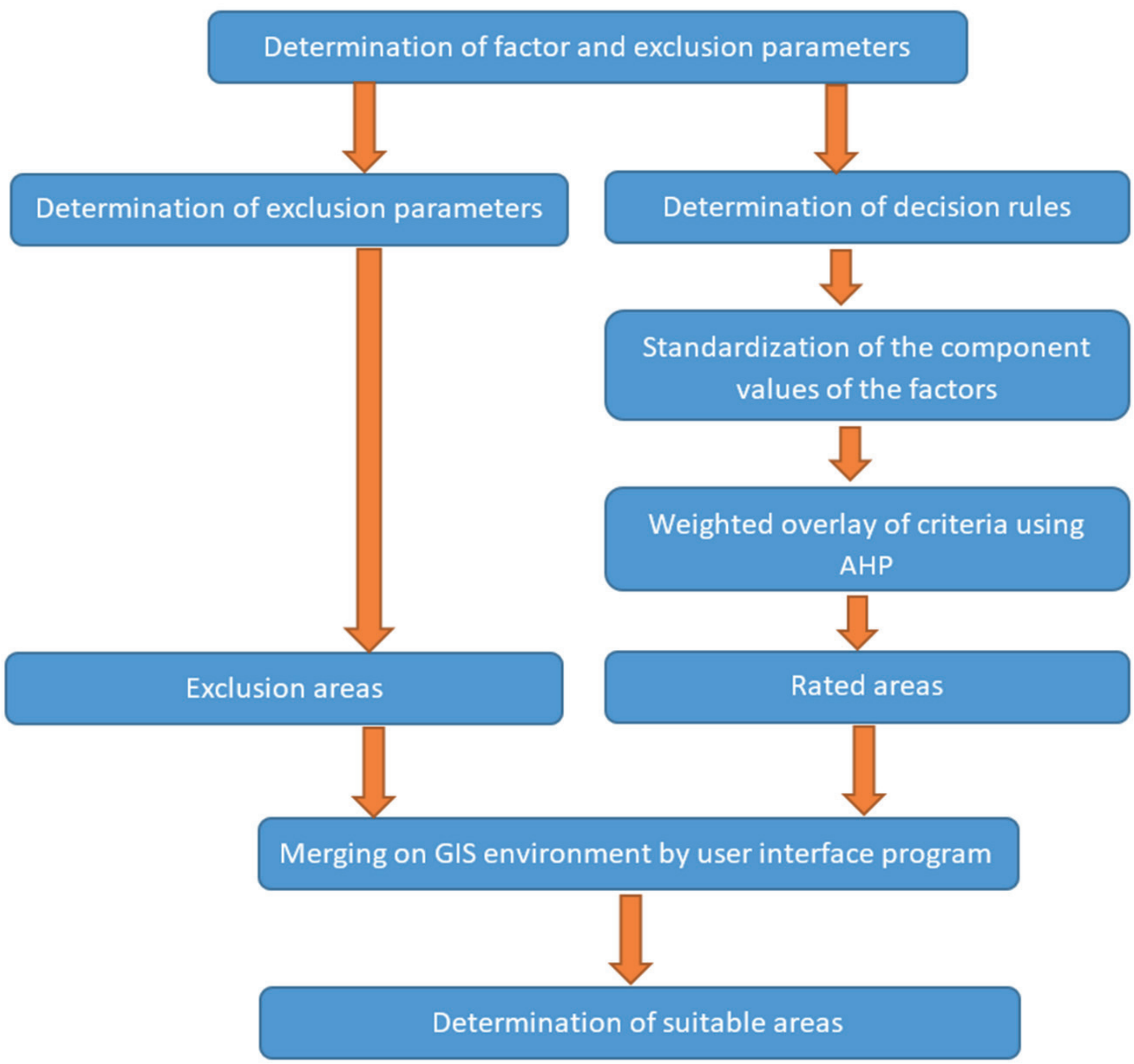

Figure 2: Methodological framework.

Table 2: Exclusion parameters.

Exclusion Parameters			
Code	**Factor**	**Exclusion Parameter (Taking off / Landing)**	**Exclusion criteria**
E1	Road	Taking off / Landing	≥400 m
E2	Airport	Taking off / Landing	≥ 6 km
E3	Power line	Taking off / Landing	≤ 500 m
E4	Stream	Taking off / Landing	≤ 300 m
E5	Dam – Pond	Taking off / Landing	≤ 750 m
E6	Lake	Taking off / Landing	≤ 300 m
E7	Stand	Taking off / Landing	≤ 200 m
E8	Valleys	Taking off	≤ 1500 m
E9	Protected sites	Taking off / Landing	= 0 m
E10	Marsh	Taking off / Landing	= 0 m
E11	Naked rocky	Taking off / Landing	= 0 m
E12	Thana	Taking off / Landing	= 0 m
E13	Slope*	Taking off	≤ 18° and ≥30° (≥ 38°)
		Landing	0° - 5°
E14	ΔH*	= taking off - landing	≤ 60 m and ≥ 350m (≥600)
E15	Visibility analysis	Between taking off and landing areas	Out of visible areas
E16	Flight distance	Between taking off and landing areas	≤ 300 m and ≥ 8 km

* International standards require a maximum slope of 30° and a height difference of 60 to 350 m. However, difficult fields can exceed the standards due to the professionalism of the pilots. With the approval of expert pilots, the inclination of 38° and a height difference up to 600 m criteria were considered for difficult fields.

Table 3: AHP criteria and value scores.

Code	**AHP criteria and value scores**	**Components**		
		easy	**moderate**	**difficult**
C1	Elevation difference between taking off and landing areas	60m - 350m (50)	350m – 600m (80)	600 m (100)
C2	Visibility distance between landing and taking off sites	2000 m (60)	1750 m (80)	1500 m (100)
C3	Distance between taking off and landing	2000 m (50)	5000 m (70)	8000 m (100)
C4	Slope in landing and taking off	18° - 30° (85)	30° - 35° (90)	35° - 38° (100)

analysis exclusion criteria and decision rules created in this context are presented in **Table 2** and **Table 3**.

After the elimination of exclusion areas, weights were calculated using **Table 3** and the remaining regions associated with the weights and the paragliding fields were determined according to difficulty level as: difficult, moderate and easy. By relating the aspect attributes of determined taking off fields with wind directions, suitability for the weather conditions was provided. The generated relationship between wind direction and aspect is shown in **Figure 3**. In this way, by allowing the user to input the wind direction to the interface program, determinations of suitable flight fields were provided.

In this study, although the criteria given in **Table 2** were used, the relative criteria that may vary according to the flight pilot's professionalism were presented as parameters that the user can enter in the user interface program depending on his/her preference. The variable parameters which can be changed by the user in this user interface program are given in **Table 4**. Furthermore, the user interface program was developed with the

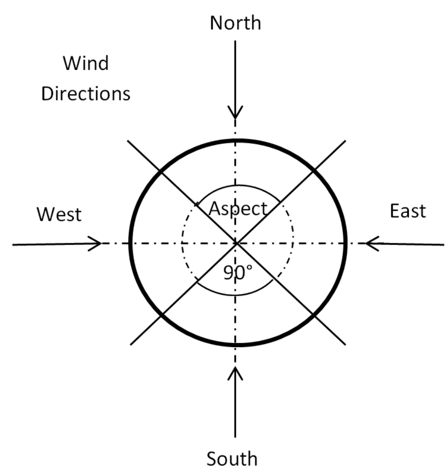

Figure 3: Relationship between wind direction and aspect.

Table 4: Criteria changeable by the user in the user interface program.

Changeable criteria by the user	
Province Border	Distance from lake
Distance from valley	Distance from dam / pond
Distance from road	Distance from power transmission line
Distance from stream	Distance from stand
Distance from Airport sites	Wind direction

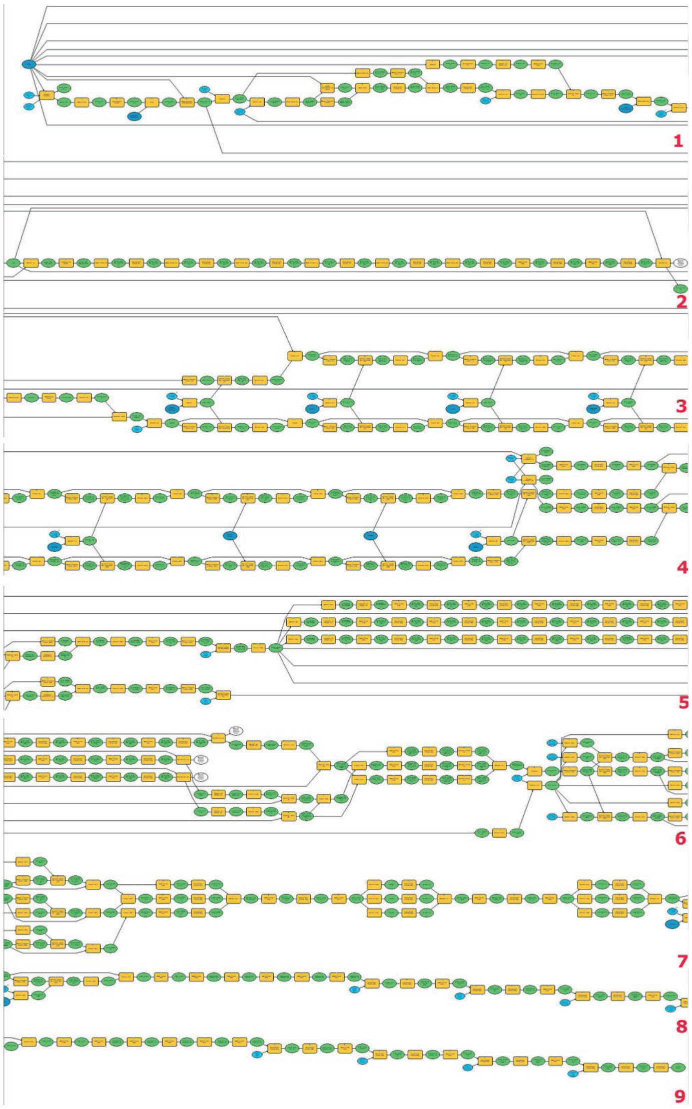

Figure 4: Model builder flowchart.

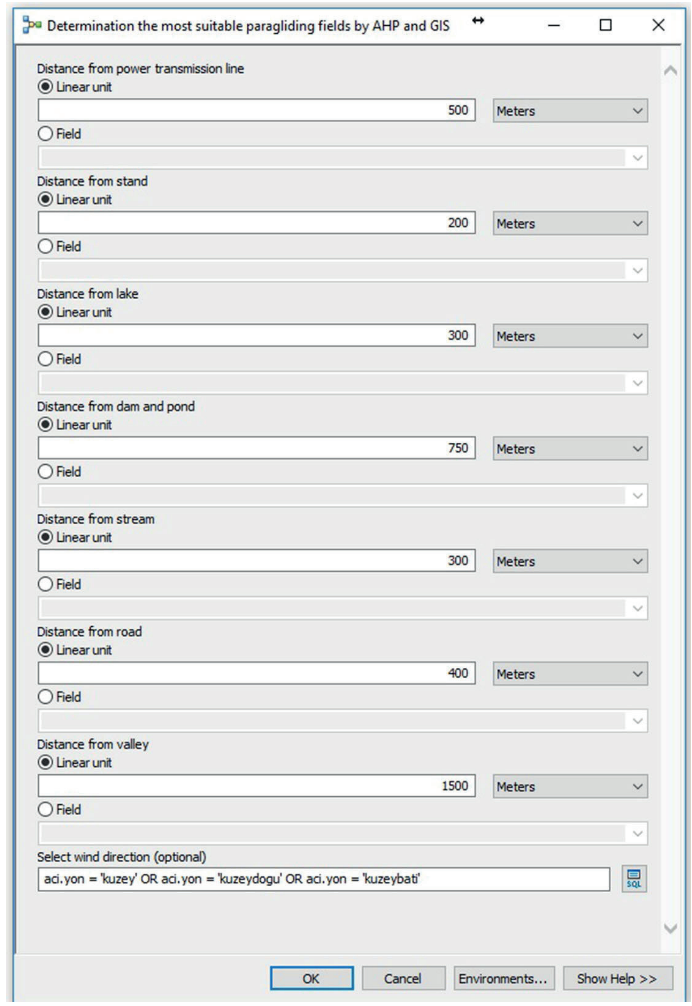

Figure 5: The developed user interface program.

Model Builder in ArcGIS 10.1 software environment so that it could be used anywhere in the world (**Fig. 4** and **Fig. 5**).

At the end of these processes, grid areas of 250 m x 250 m in suitable size for the flight were determined within the provincial borders of Sivas. Then, the generalization process was performed to eliminate the unfavorable targets determined as individual cells in the entire study area. According to the results obtained, the regions having more targets than a certain field width within the boundary to be decided (1 km x 1 km) were accepted as the suitable regions for flying.

4. RESULTS AND DISCUSSION

The reciprocal judgement matrix (**Table 5**), eigen vector, weights and consistency index values (**Table 6**) were calculated

Table 5: Reciprocal judgment matrix.

	C1	C2	C3	C4
C1 (elevation difference)	1	3	4	7
C2 (visibility)	1/3	1	3	4
C3 (flight distance)	1/4	1/3	1	3
C4 (slope)	1/7	1/4	1/3	1
$\sum_{i=1}^{n} a_{ij}$	1,72619	4,583333	8,333333	15

Table 6: Eigen vector.

$b_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}}$	C1	C2	C3	C4	$\sum_{j=1}^{n} c_{ij}$	$w_i = \frac{\sum_{j=1}^{n} c_{ij}}{n}$
C1	0,57931	0,654545	0,48	0,466667	2,180522	0,545131
C2	0,193103	0,218182	0,36	0,266667	1,037952	0,259488
C3	0,144828	0,072727	0,12	0,2	0,537555	0,134389
C4	0,082759	0,054545	0,04	0,066667	0,243971	0,060993

CI = 0,04047 RI= 0,9 CR= 0,044967 < 0,1

in the AHP process. The results were validated by consistency ratio calculations. Since CR <0.1, the reliability of the weights were accepted.

We proceeded to the final stage of the study after automatically determining the suitable fields for taking off in the GIS environment by the user interface program developed (**Fig.4** and **Fig. 5**). Following this, the user interface program created was run to determine the paragliding fields by using weights (**Fig.5**). As a result of this process, the paragliding fields were automatically obtained according to their difficulty level (**Fig. 6**).

45 fields were detected as suitable fields for paragliding by GIS-based AHP and the user interface program was developed. 10 of these fields were randomly visited and test flights were performed in these fields by the professional paragliding pilot with an EP license. According to the results obtained from these flights; 9 of these fields were confirmed as suitable flight fields for paragliding. Thus, the study was concluded with 90 % accuracy.

5. CONCLUSIONS

Land suitability assessment should be handled as the creation of a suitability index which covers the whole of the study area, not just the selection of most suitable areas. At this point, the combination of AHP with GIS provides a strong approach to the suitability analysis. GIS enable computation of the criteria while a MCDA can be used to group them into a suitability index (Joerin et. al., 2001). The role of GIS in applying the procedurally-

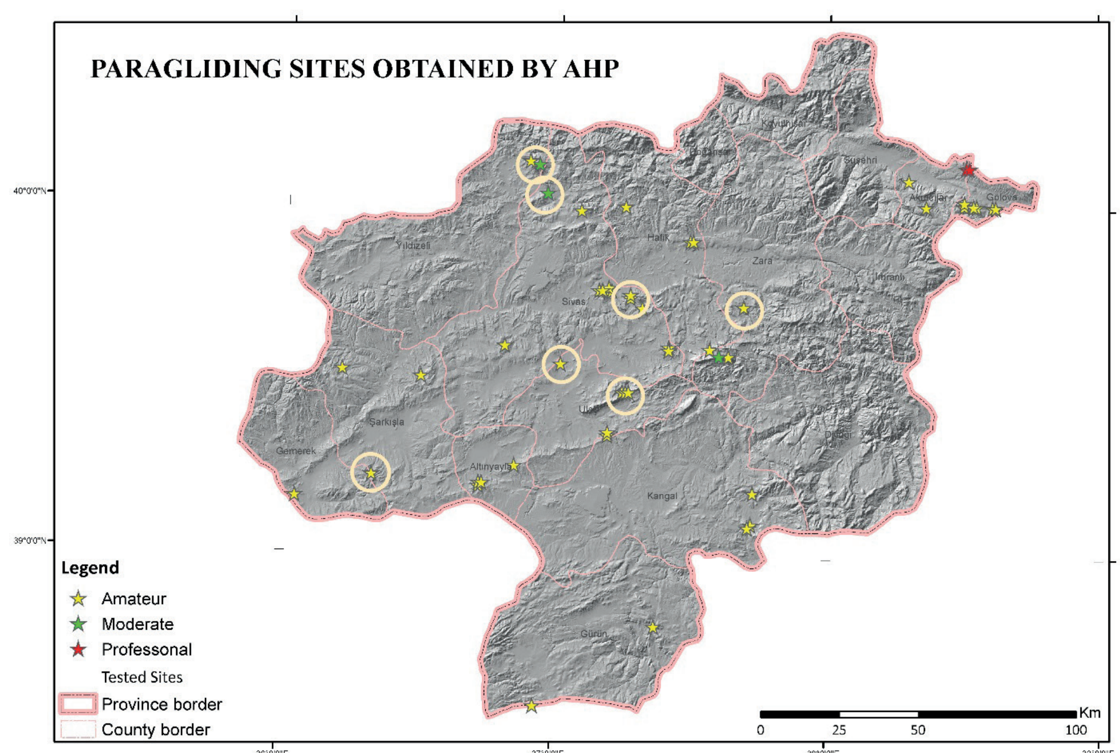

Figure 6: Suitable paragliding fields map.

rational model of decision making in land use allocation, site, and route selection problems is extremely important. In addition to this, it helps the decision makers to assign precedence weights to decision criteria, evaluate the suitable alternatives, and visualize the results of choice (Jankowski, 1995). In this study, suitable paragliding fields were detected on the basis of AHP and GIS methods. The accuracy and reliability of the study was increased thanks to the support received in determining the criteria with opinions of the experts. In addition, this study reveals that while wide areas cannot be analyzed by observations, they can be analyzed scientifically by GIS techniques.

The outcomes of the study have indicated potential new tourism areas by bringing many fields that have not yet been discovered by paragliders to the agenda. It is thought that these fields that could potentially be transformed into attraction centers with various promotional and demonstration flights will, over time, make positive contributions to the socio-economic development of the region. Of course it should not be ignored that there should be some other crucial conditions such as accommodation capacity and facilities, means of transportation, entertainment facilities and overall infrastructures and superstructures for transforming these fields to a tourism destination. In addition, the outcomes of the study suggest new alternative flying fields that can be reached more easily and quickly by paragliding lovers. This will provide economic benefits by reducing the time and cost that participants spend to be able to paraglide and also allow the sports branch to reach larger populations.

Publishing the potential paragliding fields on web-based GIS is extremely important in terms of reaching more users. As a result of publishing this study on the web, it will be more beneficial for paragliding lovers in the future. Thus, paragliding which is one of many nature-based sports will stand out further. Consequently, it will be easier to advertise not only paragliding but also other nature-based sports by GIS.

Acknowledgements: We would like to express our thanks to Dr. Hakan ULUDAĞ, paragliding pilot with the license of Experienced Pilot (EP), who supported the study with his knowledge and flight tests.

Grant Support: Scientific Research Project Fund of Sivas Cumhuriyet University with the project number CUBAP M 710 was received for this study.

REFERENCES

Ardahan, F., & Yerlisu Lapa, T. (2011). Açık alan rekreasyonu: bisiklet kullanıcıları ve yürüyüşçülerin doğa sporu yapma nedenleri ve elde ettikleri faydalar. *Uluslararası İnsan Bilimleri Dergisi*, 8(1), 1327-1341.

Bahaire, T., & Elliott-White, M. (1999). The application of geographical information systems (GIS) in sustainable tourism planning: a review. *Journal of Sustainable Tourism*, 7(2), 159-174.

Bishop, I. D., & Hulse, D. W. (1994). Prediction of scenic beauty using mapped data and geographic information systems. *Landscape and Urban Planning*, 30(1-2), 59–70.

Boers, B., & Cottrell, S. (2007). Sustainable tourism infrastructure planning: a gis-supported approach. *Tourism Geographies*, 9(1), 1-21.

Boyd, S. W., & Butler, R. W., & Haider, W. (1995), *Identifying Criteria And Establishing Parameters For Forest-Based Ecotourism In Northern Ontario Canada*, 15 Aralık 2016 tarihinde Noda Note No:7: http://www.cfs.nrcan.gc.ca/pubwarehouse/pdfs/9501.pdf adresinden alındı.

Bunruamkaew, K., & Murayama, Y. (2012). Land use and natural resources planning for sustainable ecotourism using gis in surat thani, thailand. *Sustainability*, 4(3), 412-429.

Bunruamkaew, K., & Murayama, Y. (2011). Site suitability evaluation for ecotourism using GIS & AHP: a case study of surat thani province, thailand. *Procedia Social and Behavioral Sciences*, 21, 269–278.

Cerreta, M., & Inglese, P., & Manzi, M. L. (2016). A multi-methodological decision-making process for cultural landscapes evaluation: the green lucania project. *Procedia - Social and Behavioral Sciences*, 216, 578-590.

Ceyhan, İ., & Çakın, A., & Temiz, C., & Yavuz, V., & Koçak, K., & Kahya, C. (2014), Analysis Of The Wind Persistence In Southwest Anatolia In Terms Of Paragliding, OSTIV XXII. Congress, Leszno, Poland.

Chen, R. J. (2007). Geographic information systems (GIS) applications in retail tourism and teaching curriculum. *Journal of Retailing and Consumer Services*, 14(4), 289-295.

Chhetri, P., & Arrowsmith, C. (2008). GIS-based modelling of recreational potential of nature-based tourist destinations. *Tourism Geographies*, 10(2), 233–257.

Ekinci, E., & Yenel, F., & Sarol, H. (2012). *Doğa Yürüyüşlerine Katılım Motivasyon Ölçeği: Geçerlik Ve Güvenirlik Çalışması,* 16 Aralık 2016 tarihinde Anatolia Turizm Akademisi: http://www.anatoliajournal.com/atad/depo/bilgibankasi/Kitap_10011.pdf adresinden alındı.

Feizizadeh, B., & Jankowski, P. & Blaschke, T. (2014). A GIS based spatially-explicit sensitivity and uncertainty analysis approach for multi-criteria decision analysis. *Computers & Geosciences*, 64, 81-95.

Falavarjani, N. G. (2015). Wind to select the recreation flying site. *International Journal of Geography and Geology*, 4(3), 57-67.

Fasching, G., & Schippinger, G., & Pretscher, R. (1997). Paragliding accidents in remote areas. *Wilderness & Environmental Medicine*, 8(3), 129-133.

Fung, T., & Wong, F. K. K. (2007). Ecotourism planning using multiple criteria evaluation with gis, Geocarto International, 22(2), 87-105.

Hai-Ling, G., & Liang-Qiang, W., & Yong-Peng, L. (2011). A GIS-based approach for information management in ecotourism region. *Procedia Engineering*, 15, 1988-1992.

Höfer, T., & Sunak, Y., & Siddique, H. & Madlener, R. (2016). Wind farm siting using a spatial analytic hierarchy process approach: a case study of the städteregion aachen. *Applied Energy*, 163, 222-243

Hwang, C. L. & Yoon, K. (1981). *Multiple attribute decision making methods and applications: A state of the art survey*. Berlin Heidelberg: Springer Verlag.

Jankowski, P. (1995). Integrating geographical information systems and multiple criteria decision-making methods. *Int. Journal of Geographical Information Systems*, 9:3, 251-273.

Joerin, F., & Thériault, M., & Musy, A. (2001). Using gis and outranking multicriteria analysis for land-use suitability assessment, int. *Journal of Geographical Information Science*, 15:2, 153-174.

Kaplan, A., & Ardahan, F. (2012). Doğa sporlari yapan bireylerin profilleri, doğa sporu yapma nedenleri ve elde ettikleri faydalar: Antalya örneği. *Karadeniz Sosyal Bilimler Dergisi*, 5(8), 93-114.

Kienast, F., & Degenhardt, B., & Weilenmann, B., & Wäger, Y., & Buchecker, M. (2012). GIS-Assisted mapping of landscape suitability for nearby recreation. *Landscape and Urban Planning*, 105, 385– 399.

Kliskey, A. D. (2000). Recreation terrain suitability mapping: A spatially explicit methodology for determining recreation potential for resource use assessment. *Landscape and Urban Planning*, 52(1), 33-43.

Kliskey, A. D., & Lofroth, E. C., & Thompson, W. A., & Brown, S., & Schreier, H. (1999). simulating and evaluating alternative resource-use strategies using gis-based habitat suitability indices. *Landscape and Urban Planning*, 45, 163-175.

Koçak, F., & Balcı, V. (2010). Doğada yapılan sportif etkinliklerde çevresel sürdürülebilirlik. *Ankara Üniversitesi Çevre Bilimleri Dergisi*, 2(2), 213-222.

Krüger-Franke, M., & Siebert, C. H., & Pförringer, W. (1991). Paragliding injuries. *British Journal of Sports Medicine*, 25(2), 98-101.

Kuşçu Şimşek, Ç., & Türk, T., & Ödül, H., & Çelik, M. (2018). Detection of paragliding fields by GIS. *International Journal of Engineering and Geosciences*, 3(3), 119-125. DOI: 10.26833/ijeg.413833.

Miller, W., & Collins, M. G., & Frederick, R. S., & Cook, E. (1998). An approach for greenway suitability analysis. *Landscape and Urban Planning*, 42, 91-105.

Nekhay, O., & Arriaza, M., & Guzmán-Álvarez, J. R. (2009). Spatial analysis of the suitability of olive plantations for wildlife habitat restoration. *Computers and Electronics in Agriculture*, 65, 49-64.

Parladir, M. Ö. (2013). *Isparta ili'nde yapılacak alternatif turizm türlerinin ve yerlerinin gis araçları ile belirlenmesi*. Yüksek Lisans Tezi. Isparta: Süleyman Demirel Üniversitesi Fen Bilimleri Enstitüsü.

Pereira, J. M. C, & Duckstein, L. (1993). A multiple criteria decision-making approach to GIS-based land suitability evaluation. *International Journal of Geographical Information System*s, 7:5, 407-424.

Saaty, R. W. (1987). The analytic hierarchy process, what it is and how it is used. *Math Modelling*, 9: 3-5, 161-176.

Saaty, T. L. (1977). A scaling method for priorities in hierarchical structures. *Journal of Mathematical Psychology*, 15, 234-281.

Saaty, T. L. (1990). How to make a decision: the analytical hierarchy process. *European Journal of Operational Research*, 48, 9-26.

Sezgin, M., & Gumus, M. (2016). The evaluation of beysehir lake national park (konya-turkey) in the framework ecotourism. *Journal of Advanced Management Science*, 4(4), 342-346.

Siddiqui, M., & Everet, J., & Vieux, B. (1996). Landfill siting using geographical information systems: a demonstration. *Journal of Environmental Engineering*, 122, 515-523.

Sivas Valiliği. *Sivas 2011 Çevre Durum Raporu*. 23 Aralık 2016 tarihinde http://www.csb.gov.tr/turkce/dosya/ced/icdr2011/sivas_icdr2011.pdf adresinden alındı.

Sivas Valiliği. 20 Mayıs 2017 tarihinde http://www.sivas.gov.tr/ilimiz-hakkinda-genel-bilgiler adresinden alındı.

Tegou, L., & Polatidis, H., & Haralambopoulos, D. A. (2010). Environmental management framework for wind farm siting: Methodology and case study. *Journal of Environmental Management*, 91, 2134-2147.

Tiwari, D. N., & Loof, R., & Paudyal, G. N. (1999). Environmental-economic decision-making in lowland irrigated agriculture using multi-criteria analysis techniques. *Agricultural Systems*, 60, 99-112.

Topay, M. (2003). *Bartin-uluyayla peyzaj özelliklerinin rekreasyon-turizm kullanımları açısından değerlendirilmesi üzerinde bir araştırma*. Doktora Tezi. Ankara: Ankara Üniversitesi Fen Bilimleri Enstitüsü Peyzaj Mimarlığı Anabilim Dalı.

Tseng, T. A., & Ding, T. J., & Collins, J. R., & Su, W. Y. (2013). Site Selection Model of Potential Ecotourism Development Area: from the Resources Aspect. In AT Tseng (Chair), ISSRM 2013 Conference, Estes Park Center Co.

Zhang, Y. J., & Li, A. J., & Fung, T. (2012). Using gis and multi-criteria decision analysis for conflict resolution in land use planning. *Procedia Environmental Sciences*, 13, 2264 – 2273.