

Hierarchy of Hiking Trails using the Analytic Hierarchy Process (AHP) to highlight the natural environment

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Abstract. Hiking on trails is an activity to improve the quality of human life, a strategy for the development of the tourist activity and highlighting the natural wealth of region. The present study deals with the hiking trails of the Municipality of Samothrace (Eastern Macedonia and Thrace, Greece). In this study, the trails were classified based on criteria with the contribution of the Analytic Hierarchy Process (AHP) method, which determined the weights of the criteria. Seven criteria (Starting Elevation, Summit Elevation, Slope, Degree of Difficulty, Length, Hiking Time, and Starting Point Distance from the City) which are considered important for the selection of a hiking trail by hikers were compared pairwise and based on the results the hiking trails classified. The Analytical Hierarchy Process can help and guide both managers and people who make decisions about the sustainable use and protection of the natural environment, and hikers who consider the criteria for trail selection. In this way, priorities can be set for the maintenance of existing trails and the design of new ones.

1 Introduction

Hiking is a popular activity, which improves people's health and can also contribute to tourism development in the area they are in [1]. Hiking is becoming more and more popular activity, because hikers through it improve their quality of life [2]. Health care professionals recommend hiking in nature, to reduce body weight, blood pressure and in general for human physical and mental health [3]. In many areas, hiking, in addition to sports, is a strategy for an alternative form of tourism [4].

Hiking trails are considered to be among the most ancient constructions of people, for their movement [5]. Hiking trails can contribute both to people's health and to the protection and management of natural environment [6]. Trails are infrastructures for tourism development, provide access to areas with natural and cultural resources [7], global leisure activity [8] as well as wildlife observations [9]. However, trampling can also have negative consequences, such as soil compaction and erosion [10-11], impact on fauna [12] and flora [13].

The lack of infrastructure and interference with nature for tourism development is an environmental concern [14]. This results in trails degradation which is influenced by various factors [15]. For this reason, the way trails function is of major importance for managers and decision-makers to meet the needs of both users and the protection of the trail [16]. When designing the trail, The research area was the Municipality of Samothrace (Eastern Macedonia and Thrace, Greece) (Figure 1),

sustainability and development potential should be taken into account [17]. The numbers of hikers as well as vegetation of trail are the most important factors that impacts soil degradation [18]. Thus, the continuous maintenance of trails can maintain the protection of natural and cultural resources and be a more attractive option leading to the local development of the area [19]. Another factor that managers should consider is easy access because it is considered more complex than some other tourist destinations [20].

In this study, the Analytic Hierarchy Process (AHP) was used to prioritize trails to improve the natural environment. In many scientific fields, the Analytical Hierarchy Process is applied to decision-making in problems [21]. The Analytic Hierarchy Process (AHP) provides quantitative problem-solving to decision makers by comparing criteria on a rating scale from 1 to 9 [22]. Al-Harbi [23] used the AHP method for project management. Anagnostopoulos and Vavatsikos [24] through the AHP method propose the selection of a construction project contractor to public authorities. Veisi et. al. [25] used the AHP method to select agricultural irrigation systems. Daoutis et. al. [26] prioritized the criteria with the contribution of the hybrid SWOT-AHP method for the design and construction of forest road network.

2 Study area

whose total area amounts to 178 km². The trails (Figure 2) which focused on in this study were made by the

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Evros Prefecture Forest Administration. Hiking trails characteristics (Table 1) in the Municipality of

Samothrace are presented below.

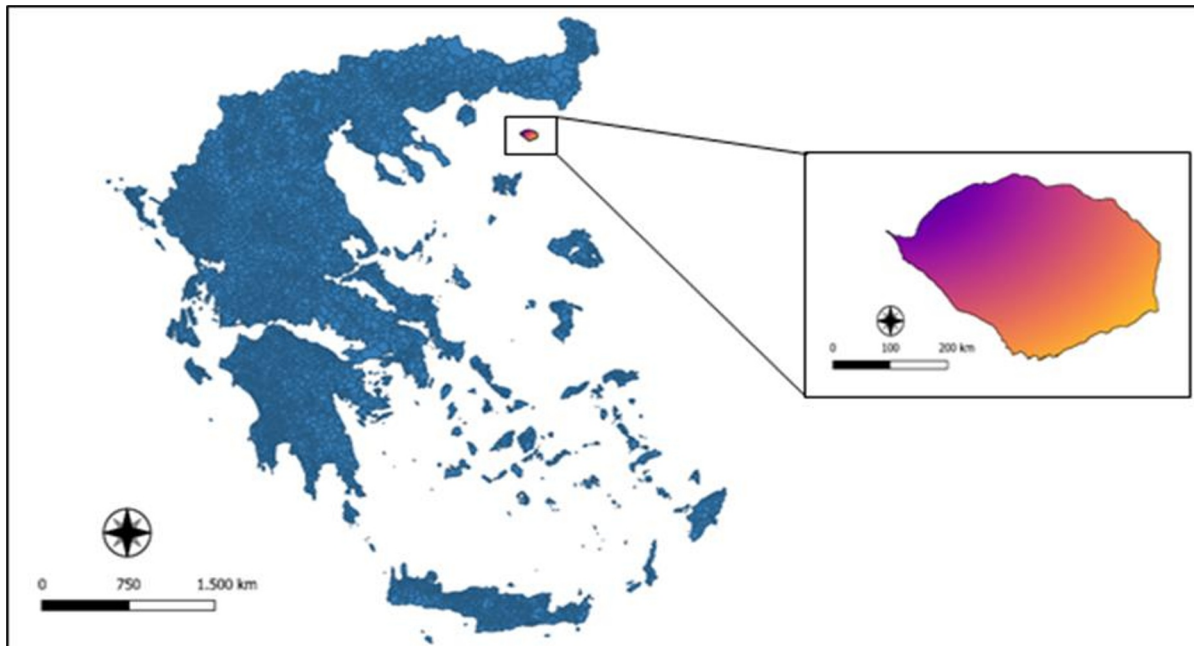


Fig. 1. Study area, Municipality of Samothrace (Eastern Macedonia and Thrace, Greece).

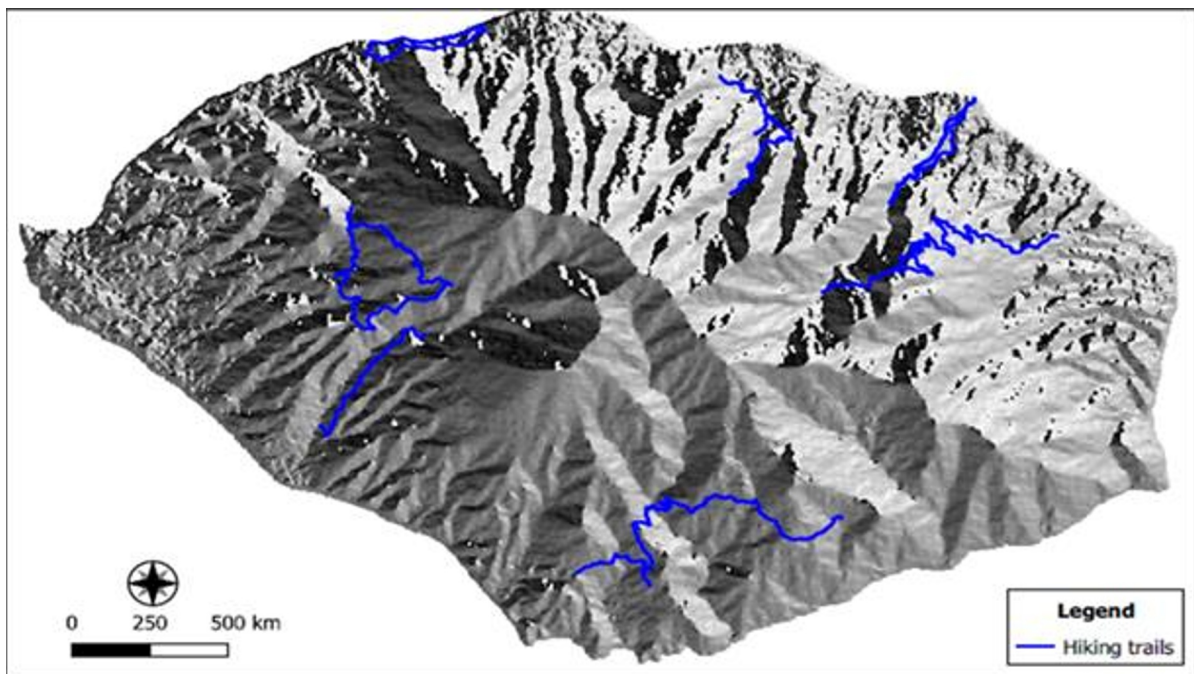


Fig. 2. Hiking trails in the Municipality of Samothrace.

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Table 1. Hiking trails in the Municipality of Samothrace.

Alternatives & Criteria	Degree of difficulty	Length (m)	Start elevation (m)	Summit elevation (m)	Hiking time (min)	Slope (%)	Starting point distance from the city (m)
Chora (Health Center) -Korakia - Askamnes - Agianemi - Koufopetro - Chora (Health Center)	2	9276	199	593	240	3.0	45
Makrylies - Xiropotamou Waterfall	1	3503	40	230	75	3.0	8100
Paleapolis tour trail	1	5080	10	80	105	2.0	4260
Therma - Gria	1	1989	52	154	60	4.9	11433
Vathra - Christos							
Gria Vathra - 7th - 8th Vathra	3	573	50	154	45	15.0	13256
Christos - Kouriat	3	2773	152	613	225	15.8	13308
Panagia	3	10067	180	795	330	4.6	15200
Krimmiotissa - Agia Thekla							
The hiking trail of Fonias	2	3550	9	257	150	6.8	15220
Parakampsi Fonia trail to return via the ancient city of Zerinthion	1	1781	9	160	50	8.9	12925
Parking - Pyrgos tou Fonia	1	361	2	10	15	2.1	15430
Ano Meria - Koufouklio - Karya - Piges Fonias	3	10509	104	833	270	5.5	15430
Parakampsi keraion	3	431	724	823	25	23.9	15553

3 Methodology

For collecting data, a structured questionnaire was constructed, and 100 closed-ended questionnaires were distributed to hikers for the pairwise comparison of the seven trail selection criteria. Information derived from pairwise comparisons can be summarized in a table of weights, where the relative weight enters the array as element a_{ij} and the inverse of the preference ratio $1/a_{ji}$ goes to the opposite side of the main diagonal.

$$A = (a_{ij}) = \begin{bmatrix} W_1/W_1 & W_1/W_2 & \dots & W_1/W_n \\ W_2/W_1 & W_2/W_2 & \dots & W_2/W_n \\ \vdots & \vdots & \ddots & \vdots \\ W_n/W_1 & W_n/W_2 & \dots & W_n/W_n \end{bmatrix} \quad (1)$$

To check the consistency of the weights, called Consistency Ratio (CR), the Consistency Index (CI) given by the formula should first be calculated:

$$CI = \frac{(\lambda \max - n)}{(n - 1)} \quad (2)$$

The consistency ratio CR is the remainder of the division of the consistency index (CI) and the random consistency index (RI) and is calculated by the formula [27]. The consistency ratio CR must be ≤ 0.1 to be consistent.

$$CR = \frac{CI}{RI} \quad (3)$$

4 Results

Seven criteria (Starting Elevation, Summit Elevation, Slope, Degree of Difficulty, Length, Hiking Time, and Starting Point Distance from the City) were rated by hikers using questionnaire. From the questionnaires results, the criteria that occupy the first three positions are the Degree of Difficulty (19.44%), the Length (15.18%) and the Summit Elevation (14.60%), while in the last position rank the "Starting Elevation" criterion with a rate of 11.81% (Figure 3). According to the

criteria weights, the hiking trails were prioritized (Table 2) and ranked according to the AHP method (Figure 4).

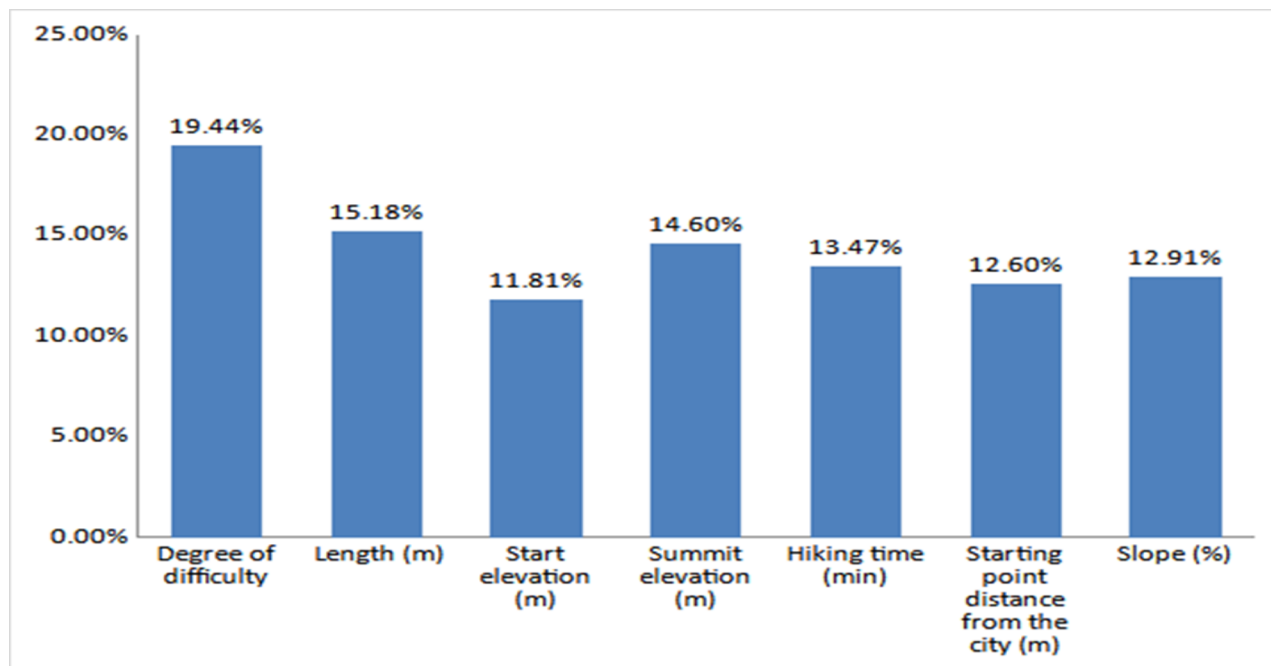


Fig. 3. Ranking of weights.

Table 2. Ranking of hiking trails with the application of the AHP Method.

Alternatives	Rank
Chora (Health Center) -Korakia - Askamnes - Agianemi - Koufopetro - Chora (Health Center)	3
Makrylies - Xiropotamou Waterfall	7
Paleapolis tour trail	4
Therma - Gria Vathra - Christos	8
Gria Vathra - 7th - 8th Vathra	12
Christos - Kouriat	6
Panagia Krimniotissa - Agia Thekla	2
The hiking trail of Fonias	5
Parakampsi Fonia trail to return via the ancient city of Zerinthion	9
Parking - Pyrgos tou Fonia	11
Ano Meria - Koufouklio - Karya - Piges Fonias	1
Parakampsi keraion	10

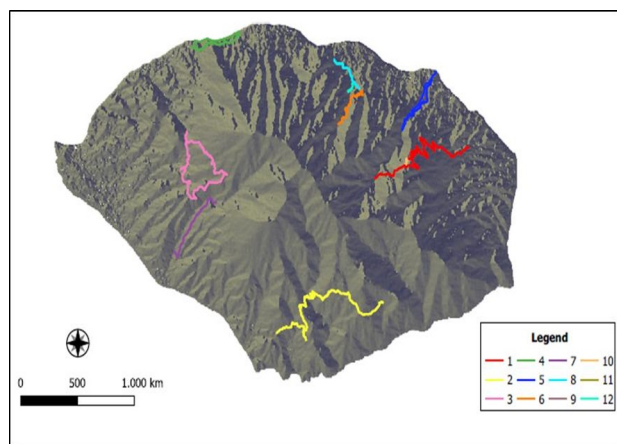


Fig. 4. Ranking of hiking trail according to the AHP method.

5 Conclusions

The construction of hiking trails can help the local community improve their income and contribute to the improvement of the natural environment as well as human health and recreation. During their construction, the negative consequences that may arise from hiking both on vegetation and on wildlife should also be considered. In this study, the Analytic Hierarchy Process (AHP) was used to prioritize trails of the Municipality of Samothrace. The criteria that occupy the first three positions are the Degree of Difficulty (19.44%), the Length (15.18%) and the Summit Elevation (14.60%), while in the last position rank the "Starting Elevation" criterion with a rate of 11.81%. The results of the research can be used by managers and decision-makers when constructing hiking trails to attract hikers and help the area's development.

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