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Research Article

DETERMINATION OF POTENTIAL FOREST AREAS IN THE ALTINAPA DAM LAKE

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Abstract

In this study, a suitability analysis has been conducted to assess the suitability of forest land use within the Altınapa Dam Lake basin, considering natural and cultural potentials, ecological structure, and forest resource values. Suitability analysis is recognized as a crucial tool for the conservation and sustainable utilization of natural and cultural resources. This analysis was carried out using Geographic Information Systems (GIS) and the Analytic Hierarchy Process (AHP). The result of this analysis is a suitability map, which indicates that approximately half of the basin is considered suitable for forest areas. This finding highlights the importance of forested areas in preserving and enhancing the ecological balance of the basin.

Keywords: *Analytic Hierarchy Process (AHP), Geographic Information Systems (GIS), Potential forest area, Weighting*

ALTINAPA BARAJ GÖLÜ HAVZASI POTANSİYEL ORMAN ALANLARININ BELİRLENMESİ

Özet

Bu çalışmada, doğal ve kültürel potansiyeller, ekolojik yapı ve orman kaynak değerleri göz önüne alınarak Altınapa Baraj Gölü havzası içindeki orman alanlarının uygunluğunu değerlendirmek için kullanılan uygunluk analizi, doğal ve kültürel kaynakların korunması ve sürdürülebilir kullanımı için önemli bir araç olarak bilinmektedir. Coğrafi Bilgi Sistemleri (CBS) ve Analitik Hiyerarşi Süreci (AHS) ile birlikte bu çalışma, uygunluk haritasını oluşturdu. Haritaya göre, havzanın yaklaşık olarak yarısı orman alanları için uygun olarak belirlenmiştir. Bu bulgu, havzanın ekolojik dengesini korumak ve artırmak için orman alanlarının önemini vurgulamaktadır.

Anahtar Kelimeler: *Analitik Hiyerarşi Süreci (AHS), Coğrafi Bilgi Sistemleri (CBS), Potansiyel orman alanı, Ağırlıklandırma*

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1. INTRODUCTION

The Industrial Revolution triggered a surge in the demand for resources, which has not slowed down as the world's population and consumption patterns have grown. The main sources of environmental degradation are the overuse of fossil fuels, land use changes, rapid urbanization, and industrialization, which all contribute to the emission of harmful gases into the atmosphere. These gases cause climate change, a global phenomenon that manifests as rising temperatures worldwide. Climate change has negative consequences for human life, such as droughts, reduced precipitation, melting glaciers, and rising sea levels.

Human activities require more efficient use of the limited natural resources available. Forests are vital for mitigating the negative impacts of environmental changes, as they help reduce greenhouse gases in the atmosphere. Therefore, deforestation is a major environmental threat, according to the United Nations, both for climate change and biodiversity (Orman Genel Müdürlüğü, 2015). Forests are considered a "Life Support System" for humanity, which highlights the importance of preserving and managing them sustainably (Mell, 2017; Hashim & Abdullah, 2022).

In this context, it is crucial that we use our existing lands wisely and effectively, adopting suitable approaches. Restoring and expanding forest cover is essential for maintaining environmental balance and supporting human well-being, especially in relation to challenges such as population growth, food security, and quality of life (Kalu, Edet & Chukwuenye, 2014). In the face of the rapid depletion of resources today, it is necessary to plan for the conservation and utilization of natural and cultural resource values in line with the principles of sustainability. Effective planning requires a precise analysis of the current situation and the evaluation of scenarios.

Forests play a vital role in conserving biodiversity and protecting essential resources, as evidenced by the fact that 13% of the world's forests are managed for these purposes, and another 31% are managed for soil and water conservation (Food and Agriculture Organization, 2016). Turkey has about 23.1 million hectares of forest land, but a large part of Konya province is still open and barren (Orman Genel Müdürlğü, 2020).

To enhance the forest cover and its benefits for humans and the environment, it is necessary to use Geographic Information Systems (GIS) and spatial data analysis tools to assess the current forest conditions and to locate suitable areas for afforestation. These tools enable the quantitative evaluation of forest resources and the identification of potential afforestation sites, as demonstrated by previous studies (Piran, Maleknia, Akbari, Soosani & Karami, 2013; Ateşoğlu, 2015).

Afforestation is a key strategy for managing land resources in a sustainable and beneficial way. It involves choosing the best sites for planting trees that can provide social and economic benefits to the countries. Site selection is crucial because forests cover a large area of land and different sites may have different suitability for afforestation.

One of the methods that can help with site selection is using remote sensing (RS) and Geographic Information Systems (GIS). These are technologies that can collect and analyze spatial data about the land characteristics, land uses, and land changes. RS and GIS can help with ecological planning, which aims to balance the conservation and utilization of natural and cultural resources. Many studies have used these technologies to assess the current and future conditions of the landscape and to identify the optimal land uses (Cengiz, 2003; Güngör & Arslan, 2003; Zengin ,2007).

Another method that can help with site selection is using multi-criteria analysis (MCA). This is a technique that can support decision-makers in choosing the best alternative among many possible options, based on multiple criteria. MCA can save time, money, and energy by finding the most suitable solution. RS and GIS can provide the data needed for MCA, which can then be used to make land use decisions that are ecologically sustainable and consider the conservation and utilization of resources. These technologies are important for addressing the challenges of increasing resource demands, efficient resource use, and environmental problems that have emerged since the Industrial Revolution.

In this study, GIS and Analytic Hierarchy Process (AHP) method are employed to select suitable forest areas in the Altınapa Lake Dam region in Konya. AHP is a multi-purpose decision making method that is used to handle complex decision making processes in a more manageable and structured way. This method allows for

easier analysis of complex problems by transforming them into a hierarchical structure. AHP is especially used for multi-criteria decision analysis (MCDA).

2. MATERIAL AND METHOD

The selected research area, located within the boundaries of Konya province in the Central Anatolia Region of Turkey, is situated approximately 13 km northwest of the city center along the Konya-Beyşehir road, between the 37° 50' and 38° 07' north parallels and the 32° 05' and 32° 21' east meridians. The Altınapa Dam Lake Basin, which extends in a northwest-southeast direction, encompasses the districts of Meram, Selçuklu, and Derbent within Konya province, as well as the towns of Tepeköy and Başarakavak, along with local administrative areas such as Küçükmuhsine, Ulumuhsine, Güneyköy, Akpınar, Dağdere, Mülayim, and Selahattin villages (Figure1).

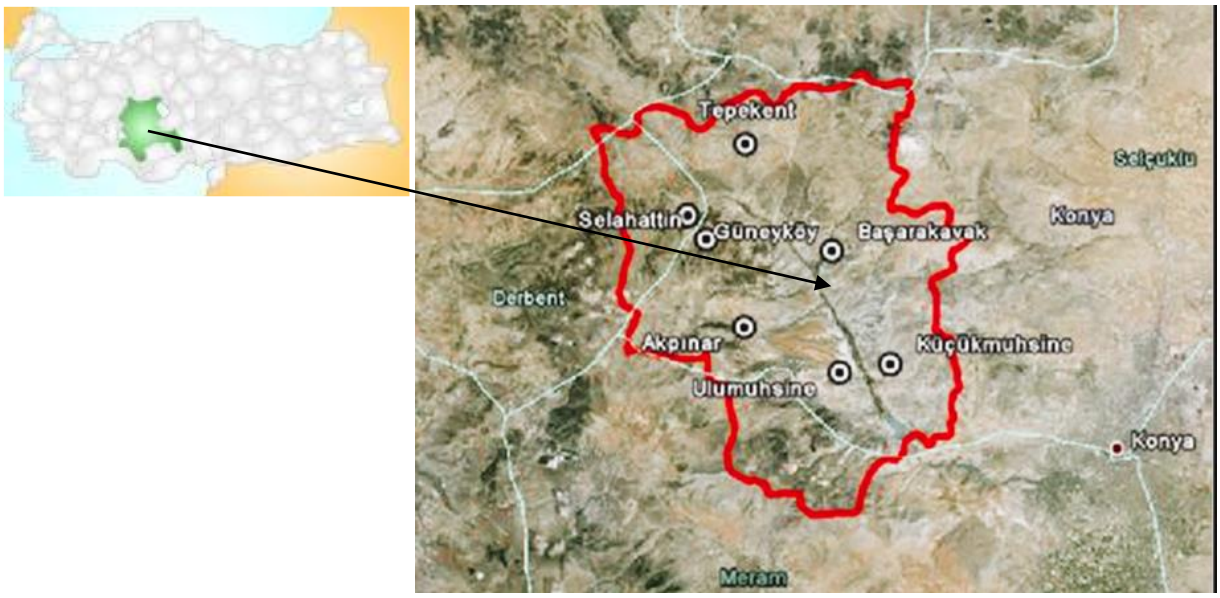

Figure1. Study area

In general, one of the most significant applications of GIS is land use suitability mapping and analysis (Malczewski, 2004). To implement a decision-making process based on MCA, it is necessary to identify alternatives and rank these alternatives according to their impact values (Jansen & Rietveld, 1990). Integrating analytical techniques with GIS within the context of multi-criteria analysis provides users with a more functional infrastructure (Carver, 1991).

As for the method used in this study, under the light of the obtained data, natural factors and their sub-factors were determined for forested areas as the land use type. The selected natural factors and sub-factors were combined in a method that suits the research purpose, drawing from optimal land use recommendations and landscape assessment methods developed by Ortaçeşme (1996), Mansuroğlu (1997), Zengin (2007) and Akten (2008) based on the ecological structure and characteristics of the Altınapa Dam Lake. To determine ecological suitability, an inventory of natural potential was created, considering the landscape assessment and priority land use recommendations by McHarg (1992) and Lyle (1985). Potential forested areas compatible with the ecological structure were sought based on the collected data. CBS techniques were utilized for the applicability of the method. The evaluation factors included Soil Capability Classes, Slope, Erosion, Soil Depth, Aspect, and Limiting Soil Properties. Evaluation factors were assigned scores ranging from 1 to 4 for their subunits, and suitability values were established. Subsequently, these sub-criteria scores were multiplied by the weight value of their corresponding criteria. This process aligns the criteria on the same scale, allowing them to be combined or aggregated together. Consequently, the suitability degree of a specific area for a given land use type is obtained by summing the results of multiplying the scores by their respective weight values. This operation mathematically constitutes a linear combination.

After finding the Suitability Value (SV) for each use of the land, an evaluation was conducted considering the percentage of each factor's subunits in the land use. For each land use, Suitability Points (SP) were obtained

by multiplying the SV of each factor by its Suitability Coefficient (SC). The Total Suitability Points (TSV) were then calculated by summing SV values.

In the evaluation, suitability values are ranked as follows: 4-Class I suitability, 3-Class II suitability, 2-Class III suitability, and 1-Not suitable. In cases where multiple subunits have an equal impact, both subunits can receive the same value

3. FINDINGS

Forest areas was selected as the land use type for The Altınapa Dam Lake basin. Based on data acquisition, suitability values and suitability coefficients were determined for the forest land use type, taking into account the factors created for this land use type and the assigned weight values for each factor. These suitability values and coefficients, along with the criterion scores obtained, are presented in Table 1.

Table 1. The selected evaluation criteria, sub-criteria, and suitability values for determining potential forest areas

LAND USE TYPE	CRITERIA	SUB-CRITERIA	SUITABILITY VALUES (SV)	SUITABILITY COEFFICIENT (SC)
Forest	Land use capability classes	I, II, III	1	0.458
		IV	2	
		V	3	
		VI, VII, VIII	4	
	Erosion	Very low	4	0.132
		Low	3	
		Moderate	2	
		Severe	1	
		Very severe	1	
		Extremely severe	1	
	Slope	0-2%	4	0.141
		2-6%	3	
		6-12%	2	
		12-20%	1	
		20>%	1	
	Elevation	1200-1400	4	0.081
		1400-1600	3	
		1600-1800	2	
		1800-2000	1	
		2000-2200	1	
		2200<	1	
	Aspect	S, SE, SW	4	0.034
		E, W	3	
		NE, NW	2	
		N	1	
	Soil depth	Deep (90-+cm)	4	0.188
		Moderate deep (50-90cm)	3	
		Shallow (20-50cm)	2	
		Very shallow (0-20cm)	1	
	Limiting soil property	Present	1	0.045
		Absent	4	

In the study, soil capability classes, erosion, slope, and soil depth suitability coefficients have been found to be higher compared to other factors. It is understood that these criteria have a high level of importance for forests.

According to the analysis results conducted to determine potential forest areas in the study area, it is observed that the areas classified as class I suitability cover the least extent, while areas classified as Class III cover the largest extent. According to the analysis results conducted to determine potential forest areas in the research area, the area has been categorized as follows: 0.94 km² (0.17%) falls under the category of Class I suitability, 54.97 km² (9.75%) falls under Class II suitability, and 486.62 km² (86.28%) falls under Class III suitability. These types of areas are characterized by predominantly including VII. and VIII. class lands, having a slope greater than 12%, experiencing severe or very severe erosion, and having reduced soil depth (Figure 2).

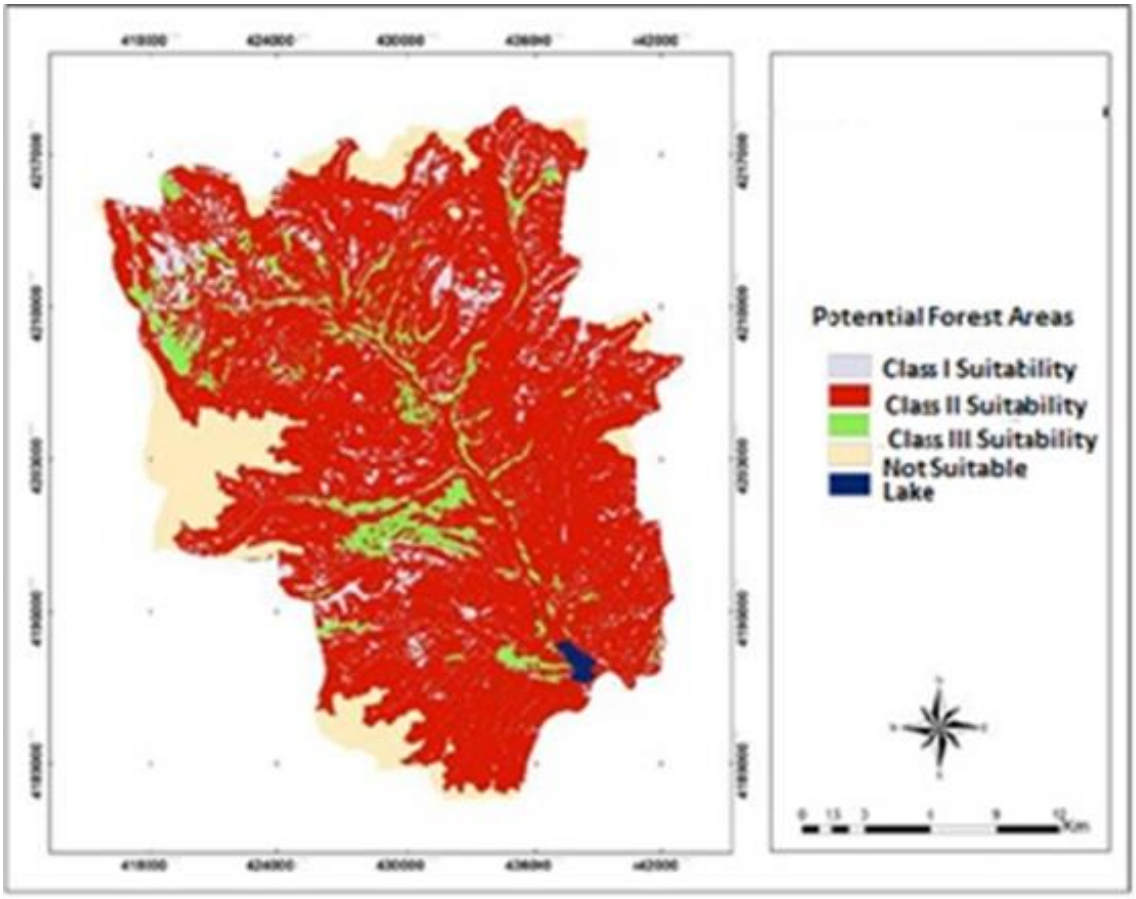

Figure 2. Forest suitability map

4. CONCLUSION

In Turkey, one of the primary issues related to land use is the lack of consideration for scientific and technical criteria when planning which areas will be used for what purposes and which land uses will be included. In the assessment of land suitability and land use planning, it is essential to establish criteria that will ensure the conservation of natural resources for the most suitable land use.

An analysis was conducted to determine potential forest areas in the Altınapa Dam Lake basin. GIS techniques were used to create digital maps and conduct analyses to identify these potential forest areas. The results of the analysis showed that there is a substantial area with high ecological suitability for potential forest lands in the Altınapa Dam Lake basin. This utilization of GIS technology provided precise information, allowing for the identification of suitable forested areas and the development of a comprehensive resource management plan.

The study revealed that the soils contributing to forest potential exhibit a high degree of ecological suitability. While the current forest area covers 29.83% of the region with 168.04 km², the study indicated that 49.5% of the area could be ecologically suitable for forests.

In these potential areas, it is essential to establish the necessary legal regulations and conduct afforestation and reforestation efforts that align with the climate and soil conditions to prevent different and improper land uses and soil erosion.

The study identified contradictions between the existing forest areas and the optimal forest presence in the research area. The current forest area is 128.08 km², whereas it should be 266.48 km². In addition to afforestation, it is crucial to take measures and implement efforts to protect forests, which serve as significant resources by regulating the water regime, preventing natural disasters like floods and landslides, erosion control, climate moderation, oxygen production, meeting recreation needs, supporting wildlife and ecological balance, and contributing economically. This includes addressing issues such as illegal logging, animal grazing, and land clearing that cause substantial damage to forests. More efforts are needed to protect and preserve these vital forested areas.

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