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Prioritizing Influential Criteria for Rangeland Suitability in Sistan, Iran: A DEMATEL-ANP Approach

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ABSTRACT

Aims: Land use planning based on ecosystem capacity plays a significant role in sustaining ecosystem service (ES) flows and preventing degradation. The present study aims to investigate the type and intensity of interaction between the effective criteria in evaluating the ecological capacity of rangelands using the DEMATEL-ANP approach in the Sistan Region, southeastern Iran.

Materials & Methods: The criteria influencing the land suitability evaluation of rangeland development were prepared based on scientific sources and expert opinions. Subsequently, a questionnaire method was utilized to assess the interactions among the criteria and their pairwise comparisons, leveraging the insights of seven experts. The final weight of the criteria was then calculated and analyzed using the DEMATEL-ANP approach.

Findings: The findings indicated that the criteria of elevation (0.117), slope (0.132), soil type (0.069), and soil erosion (0.088) exhibited the highest weights in determining the land suitability of the rangeland. These results show the critical impact of physical factors in evaluating the grazing capacity of rangelands.

Conclusion: The present study demonstrated that topographic and soil criteria significantly evaluate land suitability for rangeland development in the Sistan Region. Furthermore, it was ascertained that the DEMATEL-ANP approach enables incorporating the interactive effects of criteria in the prioritization of land suitability evaluation. This approach contributes to a more profound comprehension of the relationships between environmental criteria in evaluating land suitability for various uses.

Keywords: Land Suitability; Rangeland Development; Environmental Evaluation; Multi-Criteria Decision Making; Sistan Region.

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Introduction

Multi-criteria decision-making (MCDM) methods have recently gained popularity among researchers across various fields, including engineering, supply chain, and management. The analytic network process (ANP) is an advanced version of the analytic hierarchy process. It accommodates feedback and interactions within and between clusters and enhances its ability to assist decision-making. The ANP is recognized as one of the most commonly utilized MCDM methods, finding applications in numerous decision-making scenarios, including project management, risk evaluation, supplier selection, and product development [1]. While the ANP method functions as a technique for weighting, the DEMATEL method focuses on identifying the cause-and-effect relationships among different factors [2]. Hence, the DEMATEL approach is practical in analyzing intricate, multi-dimensional systems and generating graphical representations of relationships between factors. Consequently, it enhances the accuracy and reliability of decision-making processes [3, 4].

A significant challenge confronting the global community, particularly in numerous developing countries, including Iran, pertains to optimizing land use to satisfy the demands of a progressively expanding population [5]. In Iran, rangelands constitute 52% of the land, and the livelihood of over 916000 rural and tribal households depends on these lands. While livestock grazing in rangelands is the most common land use, they also provide various other services, such as those of other natural ecosystems. [6] This requires considering many factors interpreted as evaluation criteria [7]. Thus, the Rangeland Suitability Assessment (RSA), utilizing a new method such as the Analytical Network Process Decision-Making Trial and Evaluation Laboratory (ANP-DEMATEL), is a Successful step in identifying environmental constraints and represents one of the most essential stages in Effective rangeland management. This approach helps identify environmental constraints and allows managers to make better decisions for the sustainable preservation and use of natural resources. Overall, this assessment helps to improve rangeland management and ensure its sustainability [8,9]. DEMATEL-ANP facilitates the analysis of cause-and-effect relationships between criteria, concurrently enabling their simultaneous weighting. This method is adept at managing intricate and multi-dimensional systems. It concomitantly assists in developing graphical representations of relationships between factors. Consequently, it enhances the accuracy and reliability of decision-making processes. Classifying complex factors into cause-and-effect groups is the pivotal task and a primary rationale for extensively using the DEMATEL technique in problem-solving methodologies. This approach enables decision-makers to better understand the interrelationships among these factors by categorizing a diverse range of complex factors into cause-and-effect groups. This results in a deeper understanding of the factors' positions and roles in the mutual influence process [10]. In recent years, the analytic network process (ANP) and the Analytic Hierarchy Process (AHP) have contributed to decision-making in complex situations and possess widespread applications. AHP is a one-way process in which only the linear relationships between the criteria are noticed, and the dependence between them is ignored. Due to such limitations, ANP has been developed. In this method, issues with interdependence and feedback can also be noticed. For this reason, in recent years, the ANP has been used instead of the AHP in most fields [11]. Over the past twenty years, many advancements have been made in applying Multi-Criteria Decision Making (MCDM) methods for LSA, mainly through integrating GIS with MCDM

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techniques[12].
Monavari et al. [13] assessed the ecological capacity of East Azerbaijan Province for industrial development by applying Geographic Information Systems (GIS) and the Analytic Hierarchy Process (AHP). This study aimed to assess the region's potential for industrial growth while considering ecological factors, utilizing GIS for spatial analysis and AHP for structured decision-making. According to the results, East Azerbaijan Province has relative limitations. It does not have first-order capacity, while 21% of the province can develop a secondary industry. Reshmidevi et al. [14] employed a GIS-integrated fuzzy rule-based inference system to evaluate the agricultural capacity of the western Senegal watershed. The findings from this system underscore its capacity to process substantial information volumes and its efficacy in assessing the ecological capacity of agriculture. Rabia and Terrible [15] proposed a novel parametric concept employing three distinct methodologies to enhance the outcomes of land suitability evaluation. Their analysis indicated that the natural environment's inherent characteristics emerged as the primary constraint on the study outcomes. Zoleka and Bhagat conducted a thorough analysis of land suitability for agronomic in the Mala and Pravera basins in India, using a multi-criteria decision-making (MCDM) approach and Indian Remote Sensing (IRS) Satellite images. Their method involved expert opinions and correlation analysis to rank different criteria, and the effectiveness of these criteria was assessed through pairwise comparisons using Super Decisions software [16]. In a related study, Villacreses et al. investigated the suitability of locations for wind farms in Ecuador by employing GIS and a multi-criteria decision-making (MCDM) approach. The analysis showed that four different MCDM methods yielded similar results, with optimal locations identified as those achieving 75% or more of the maximum score. This finding demonstrates the effectiveness of MCDM methods as essential tools for determining ideal wind farm sites [17]. In general, the studies showed that In recent years, specifically since 2008, there has been an increase in the number of publications focusing on the joint hybrid mathematical modeling of the DEMATEL and ANP techniques [18].
Given the severe exploitation of Iran's rangelands and their unfavorable location, it is imperative to consider their environmental capacity in range development and utilization [19]. In recent years, the Natural Resources and Watershed Management Organization, in collaboration with relevant experts, has concluded that the development, maintenance, improvement, and revival of these rangelands can only be achieved through the engagement of users and local communities, the application of expert methods based on scientific and technical principles, and the development of integrated management, which involves the preparation and implementation of grazing plans.
The Sistan Region's rangelands are going through a significant change. Environmental challenges include frequent droughts and desertification. These challenges have led to water scarcity and soil erosion, resulting in the degradation of rangelands. This had two main consequences: first, it led to overgrazing, and second, it contributed to the loss of land fertility. The resulting situation has had a detrimental effect on the livelihoods of local farmers and herders, underscoring the urgent need for sustainability, management, and conservation of natural resources in the region. The present research aims to determine the effectiveness, impressibility, intensity of interaction, and cause-and-effect relationships between the criteria and their importance for rangeland management

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using the ANP-DEMATEL approach in the Sistan Region.

Materials & Methods

Study Area

The Sistan Plain is located north of Sistan and Baluchestan Province in eastern Iran (Figure 1). The region's flat, blocked basin is formed by the alluvium of the Hirmand River delta, which is located at 30°18' to 31° 20' N and 61°10' to 61°50' E. The alluvial fan of the Hirmand River extends from north to south. The Sistan Region is bordered by South Khorasan Province to the north, Dashtak to the south, Afghanistan to the east, and the Kerman Desert to the west. It covers an area of 15,917 square kilometers, with 5,560 square kilometers occupied by Hamun Lake and the surrounding lands.

Extreme aridity, intense wind, continuous dust storms, and low precipitation distinguish the climate of the Sistan Plain. The region experiences a bimodal seasonal pattern, marked by a protracted hot summer spanning from May to October and a cold winter from November to April. The Köppen climate classification puts the region in a desert or arid zone. Precipitation is very low and varies yearly, with a mean of 50-100 mm, an mean temperature of 29.23 °C, and a maximum wind speed of 334.40% [20]. The basalt hill of Khajeh Mountain, in the western region of Zabul, is the sole elevated land formation in the context of Hamun Lake at an mean elevation of 900 m above sea level. The Helmand River, which originates from the Koh-e Bābā heights of the Hindu Kush Mountains, supplies water to the Sistan Plain. The river's 1,050-kilometer course begins at the Iranian border, crosses the Parian Marzi (the common border between Afghanistan and Iran), and enters the Sistan Region before reaching Hamun Lake. The Sistan Region is known for an extended period of dryness, marked by low rainfall, high evaporation, low humidity, and strong winds that last about 120 days a year. These conditions are unfavorable for animal and plant life. The rural residents, primarily farmers, depend on agriculture and animal husbandry for their livelihoods.

Methodology

Ecological factors, including physical factors (e.g., erosion, landform, soil, and climate change), biological factors (e.g., vegetation), and economic factors (e.g., land, infrastructure,

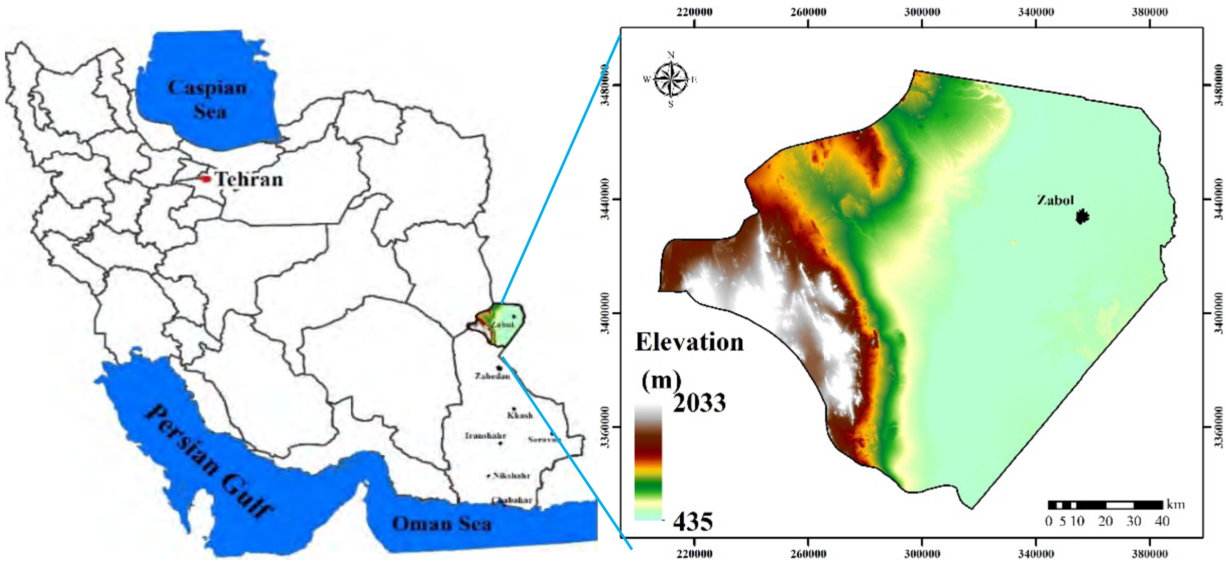

Figure 1) Map of the study area and its location in the northern part of Sistan and Baluchestan Province in eastern Iran.

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and energy sources) were specified through literature review, library studies, and expert's opinions (Table 1) [21-23]. Questionnaires were designed and completed by seven local experts (e.g., faculty members and various specialists in relevant research areas, including rangeland management, natural resources, and environmental sciences) to determine the intensity of mutual relations between the criteria and their weighting [24]. Following the collection, correction, and adjustment of the judgments and experts' personal opinions concerning factor weights, the mutual relations of the criteria were determined using the Decision-Making Trial And Evaluation (DEMATEL) technique. Subsequently, the criteria were weighted through the Analytical Network Process - Decision Making Trial And Evaluation (ANP-DEMATEL) approach [2].

Table 1) Criteria for evaluating grazing capacity utilized in this study were specified through a literature review [17-19].

Criteria	Sub-criteria	Decision-making index
Physical Criteria	Landform	Elevation
		Slope
	Soil	Soil texture
		Soil structure
		Soil depth
		Soil moisture
	Geology	Bedrock type
		Rocks' sensitivity to erosion
		Landslide
	Erosion	Erosion (water, wind)
		Intensity of erosion
		Form of erosion (surface, channel, rill, and gully)
		Sensitivity to erosion
	Climate	Climate type
		Mean annual rainfall
		Mean annual temperature
		Evaporation
Biological Criteria	Vegetation	Plant type
		Plant density
		Canopy cover percentage
		Pasture condition
		Pasture orientation
Economical Criteria	Lands	Current land use
	Infrastructures	Distance to roads
		Distance to Residential area
	Energy resources	Distance to water resources

Decision-Making Trial and Evaluation

This technique is a methodical process that is generally executed in five steps:

(i) Construction of the direct correlation matrix (M) by taking the simple average of the multiple experts' viewpoints.

(ii) Normalizing the direct correlation matrix N=K×M:

$$k = \frac{1}{\max \sum_{j=1}^{n} a_{ij}} \quad \text{Eq. (1)}$$

where k is calculated as Eq. (1): α_{ij} is the sum of all rows and columns. k equals the inverse of the most significant number of rows and columns.

(iii) Calculating the total correlation matrix through Eq. (2):

$$T = N \times (1 - N)^{-1} \quad \text{Eq. (2)}$$

(iv) Construction of causal diagram [25]:

The sum of the elements in each row (D) for a given factor indicates the influence of that factor on other factors in the system, thus quantifying its outgoing influence. Conversely, the sum of the column elements (R) for each factor measures its incoming influence, indicating how other factors impact it. Consequently, the horizontal vector (D+R) signifies a factor's overall effectiveness or centrality within the system [26]. The higher the D+R value of a factor, the more interaction that factor would have with other factors in the system [26].

The vertical vector (D-R) shows how each factor affects the other. Generally, when D-R is positive, it is viewed as a causal factor; if it is negative, it is seen as an effect. A Cartesian coordinate system is created, where the vertical axis shows the D+R values and the horizontal axis shows the D-R values [26]. Figure 2 shows this coordinate system and its components.

Each factor's position is determined by a point with coordinates (D+R, D-R) within this system, resulting in a graphical representation of the factors' relationships. This setup enables the positioning of each factor based on its overall influence (D+R) and its causal or effectual nature (D-R). By plotting these values, key factors that exert significant influence and those primarily affected by other factors can be identified.

(v) Calculating the relations threshold is imperative for determining the network

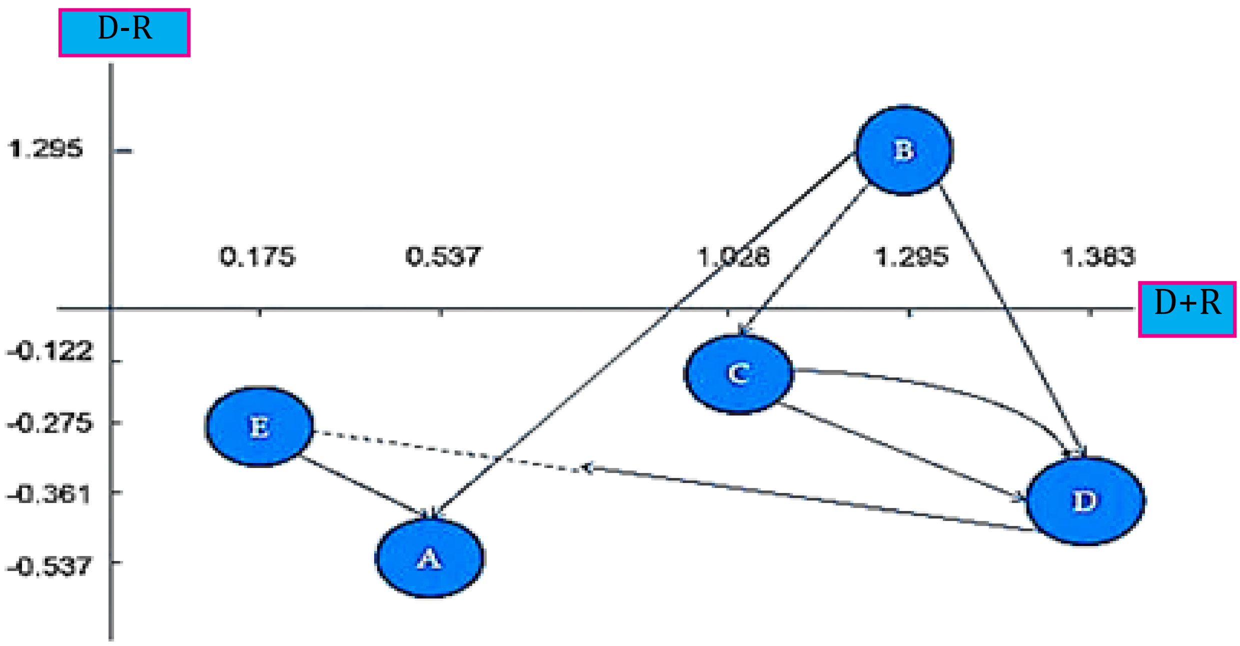

Figure 2) Causal diagram. D+R signifies the degree of the desired factor’s effectiveness in the system. D-R illustrates the influence of each factor.

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relationship map (NRM). This method facilitates disregarding partial relations, thereby enabling the delineation of the network of significant relationships [24]. The NRM exclusively depicts relations whose values in the T matrix exceed the threshold value. Calculating the threshold value for relationships entails determining the mean values of the matrix T. After determining the threshold intensity effect, all values in the matrix T that are less than the threshold value are set to zero. This results in excluding the previously mentioned causal relation [27].

Analytical Network Process

ANP can be divided into two distinct components. The first component is the control hierarchy, which comprises network relationships between the goal, criteria, and Sub-criteria. The second component is the network hierarchy, which comprises network relationships between elements and clusters [28, 29]. This method considers relations between decision elements by replacing the traditional hierarchical structure with a network structure. This shift enables the examination of complex interdependencies and feedback loops among system components, thereby providing a more nuanced and comprehensive framework for decision-making [30].

(i) Developing the network model: In this step, the criteria effective in the final decision and determined by the DEMATEL method, along with the opinion of experts, are linked to each other and form a network structure.

(ii) Creating a matrix for pairwise comparisons and determining weight vectors [31] Pairwise comparison matrices are made to evaluate the impact of criteria and Sub-criteria concerning the upper levels of the network and their interrelations. These matrices allow calculating weight vectors for the related elements [31].

After completing the pairwise comparison, the weight vector (W) is computed [24] using Eq. (3).

$$AW = \lambda_{max} W \qquad \text{Eq. (3)}$$

where λmax represents the maximum value of matrix A.

The vector w is normalized using $a = \sum_{i=1}^{n} w_i$ [2]. To determine the compatibility and validity of the comparisons [24], the compatibility index of the criteria weight is used, which is calculated using the Eq. (4):

$$CI = \frac{\lambda_{max} - n}{n - 1} \qquad \text{Eq. (4)}$$

The comparison is generally confirmed if the CI is less than 0.1.

(iii) Forming the initial supermatrix [24]: In this step, the pairwise comparison from the previous step, several matrices are made, and their relative weight is calculated. Then, the obtained weights are entered into the supermatrix, which illustrates the connections among the elements of the system.

(iv) Creating the weighted supermatrix [24]: Each column of the matrix is standardized to normalize the elements of the primary supermatrix column regarding their relative weights, ensuring that the sum of the columns satisfies Eq. (1). As a result, a new matrix is obtained where the sum of each column conforms to Eq. (1).

(v) Calculating overall priorities [2, 24, 30]: The weighted supermatrix transforms the limit capacity so that the elements of the convergent matrix and its row values are equal. In this case [24], the row sum of the weighted supermatrix converges to satisfy Eq. (5), Thus establishing a stable and consistent state for the matrix.

$$\lim_{k \to \infty} w^k \qquad \text{Eq. (5)}$$

Figure 3 depicts the DEMATEL-ANP approach. Finally, considering this weighting process, a specific weight is allocated to each criterion [30].

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Findings

DEMATEL Analysis

The DEMATEL approach was used to determine the effectiveness (D), impressibility (R), strength of interaction (D+R), and nature of the cause-and-effect link (D-R) concerning the criteria and Sub-criteria [24]. The findings are shown in Tables 2 and 3. Among the criteria [24], vegetation was determined to have the highest effectiveness (D=1.22), while distance from environmental elements was determined to have the lowest effectiveness (D=0.37). Additionally, vegetation and landform were determined to have the highest and lowest impressibility, with R values of 1.4 and 0.31, respectively. The intensity of interaction (D+R) revealed that vegetation and geology exhibited the highest (2.62) and lowest (1.09) interaction with other criteria, respectively [1,2,7,10]. Furthermore, the D-R values indicated that landform, soil, and climate are causal criteria. In contrast, the remaining criteria were classified as effect criteria (Table 2).

Among the sub-criteria, slope demonstrated the highest effectiveness (D=1.3), while distance to road and residential areas exhibited the lowest impact (D=0.14). Additionally, soil erosion and slope exhibited the highest and lowest impressibility, with R values of 1.01 and 0.24, respectively [1,10]. Regarding interaction intensity (D+R), land use exhibited the highest interaction with other criteria (D+R = 1.75). At the same time, the distance to fault, road, and residential areas clarified the lowest (D+R = 0.53). The D-R values further delineated that slope, elevation, land use, rainfall, pasture type, and temperature functioned as causal sub-criteria. At the same time, the remaining factors constituted effect sub-criteria (Table 3). Figure 4 presents the network relationship map (NRM), indicating that slope was the most significant causal sub-criterion. At the same time, evaporation was the most

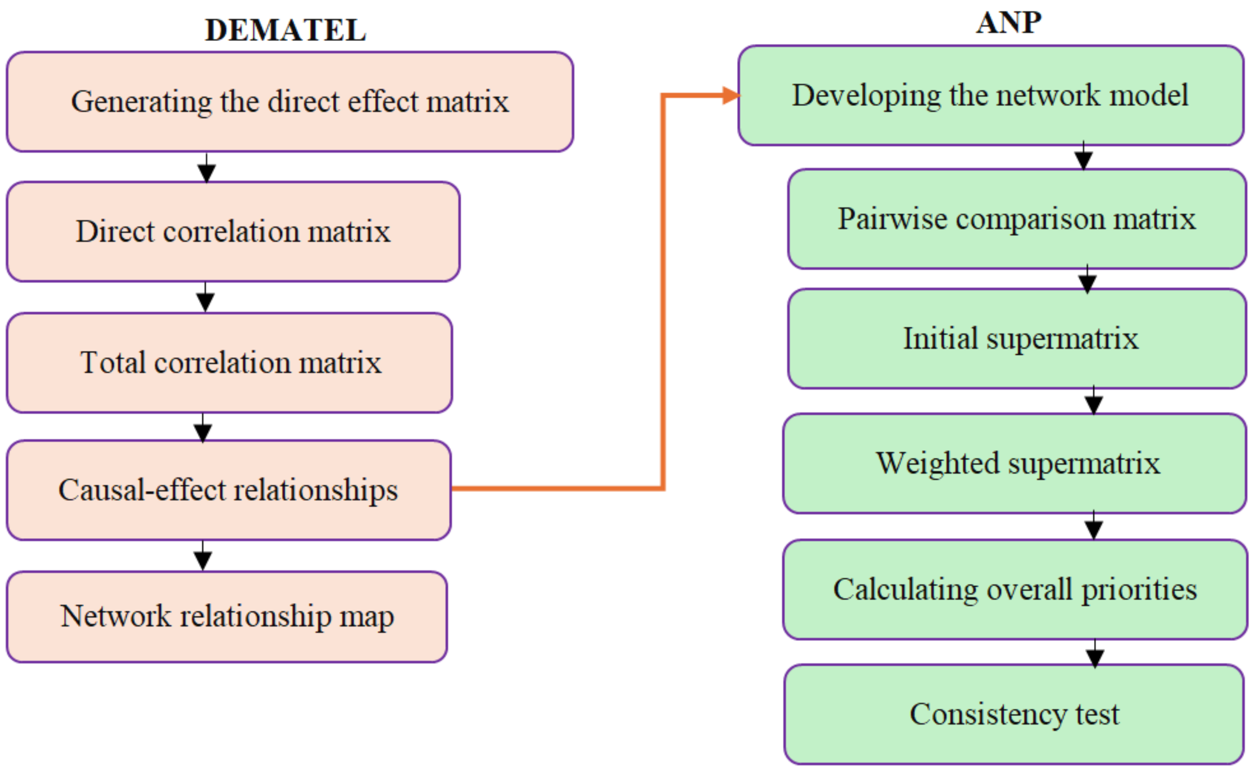

Figure 3) Flowchart of DEMATEL-ANP approach for prioritizing influential criteria for Sistan rangeland suitability.

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Table 2) Results of DEMATEL Analysis for Determining influential criteria for Sistan rangelands suitability.

Study variable	D	R	D + R	D - R
Landform	1.16	0.31	1.47	0.85
Soil	0.65	0.94	1.59	-0.29
Geology	0.47	0.62	1.09	-0.15
Climate	0.99	0.56	1.55	0.43
Vegetation	1.22	1.40	2.62	-0.18
Land-use	0.93	1.10	2.03	-0.17
Distance from environmental elements	0.37	0.86	1.23	-0.49

Table 3) Results of DEMATEL analysis of sub-criteria for determining the suitability of Sistan rangelands.

Study variable	Name	D	R	D + R	D - R
Slope	C2	1.30	0.24	1.54	1.06
Elevation	C1	1.19	0.47	1.66	0.72
Land-use	C11	1.00	0.75	1.75	0.25
Rainfall	C7	0.59	0.49	1.08	0.1
Type of pasture	C10	0.86	0.80	1.66	0.06
Temperature	C8	0.54	0.53	1.07	0.01
Geology	C5	0.30	0.35	0.65	-0.05
Distance to the water body	C13	0.24	0.38	0.62	-0.14
Distance to river	C12	0.23	0.43	0.66	-0.20
Distance to fault	C6	0.16	0.37	0.53	-0.21
Distance to road	C15	0.14	0.38	0.52	-0.24
Distance to the residential areas	C14	0.14	0.38	0.52	-0.24
Soil erosion	C4	0.72	1.01	1.73	-0.29
Soil type	C3	0.50	0.82	1.32	-0.32
Evaporation	C9	0.21	0.71	0.92	-0.5

substantial effect sub-criterion.

Criteria Weighting

The final importance of sub-criteria was determined based on the integrated ANP-DEMATEL approach. The results are presented in Table 4, and their comparison is depicted in Figure 5. It was clarified that the land use, slope, pasture type, and elevation were prioritized with 0.142, 0.132, 0.125, and 0.117, respectively [7,2]. These results determined the potential and suitability of the land for rangeland development in the

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Sistan Region. Additionally, it was determined that the current land use patterns, landform characteristics, and vegetation cover are essential to develop effective rangeland management strategies. Distances to water bodies, rivers, faults, residential areas, and roads were found to be least significant, with values of 0.031, 0.027, 0.02, 0.017, and 0.017, respectively [1,2,7,10].

Discussion

This study assessed the capacity of the Sistan Region for rangeland development, utilizing an ecological, socio-economic, and multi-criteria framework. A comprehensive set of 15 environmental and socio-economic criteria was established, and their interrelationships were examined through the DEMATEL method. The relative importance of these criteria was subsequently determined using the ANP-DEMATEL approach.

The DEMATEL method yielded four parameters: effectiveness (R), impressibility (J), intensity of interaction (R + J), and cause-and-effect relationship (R - J) for each criterion. The results indicated that slope, elevation, and land use had the most significant impact on other parameters, with erosion, soil type, and pasture type being more affected than the different criteria. According to the

Table 4) Final weights of Sistan rangeland development criteria based on the integrated ANP-DEMATEL approach

Row	Index	Weight
1	Elevation	0.117
2	Slope	0.132
3	Soil type	0.069
4	Soil erosion	0.088
5	Geology	0.041
6	Distance to fault	0.020
7	Rainfall	0.072
8	Temperature	0.070
9	Evaporation	0.033
10	Type of pasture	0.125
11	Land use	0.142
12	Distance to river	0.026
13	Distance to the water body	0.031
14	Distance to the residential area	0.017
15	Distance to roads	0.017
Inconsistency ratio = 0.07		

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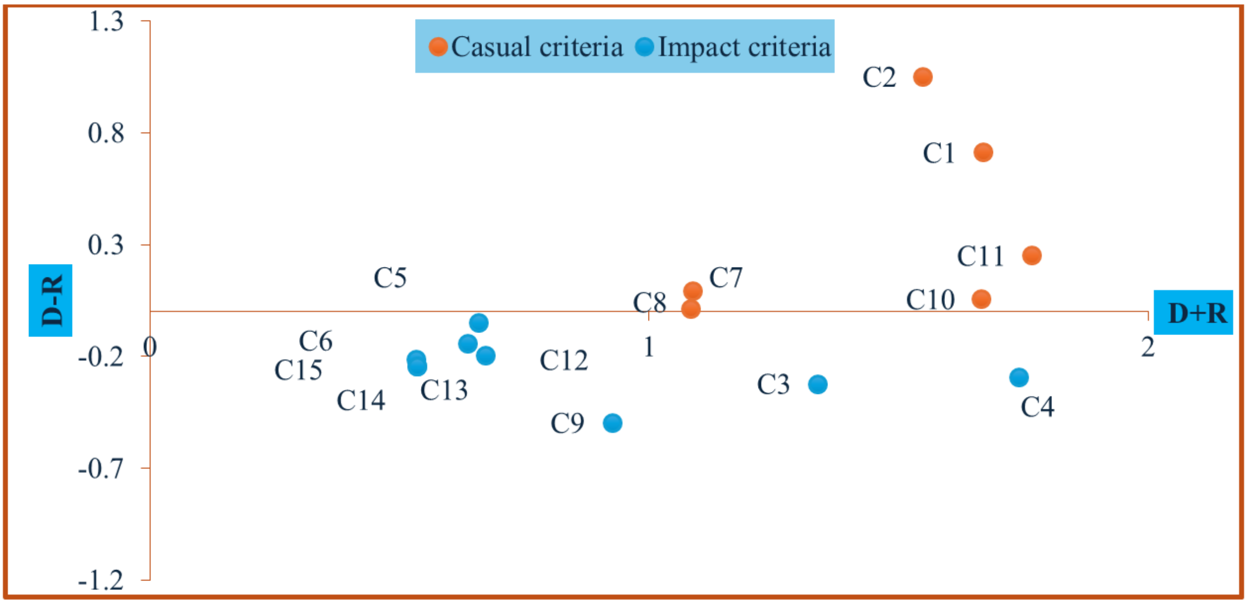

Figure 4) Causal diagram of Sub-criteria for determining the suitability of Sistan rangelands.

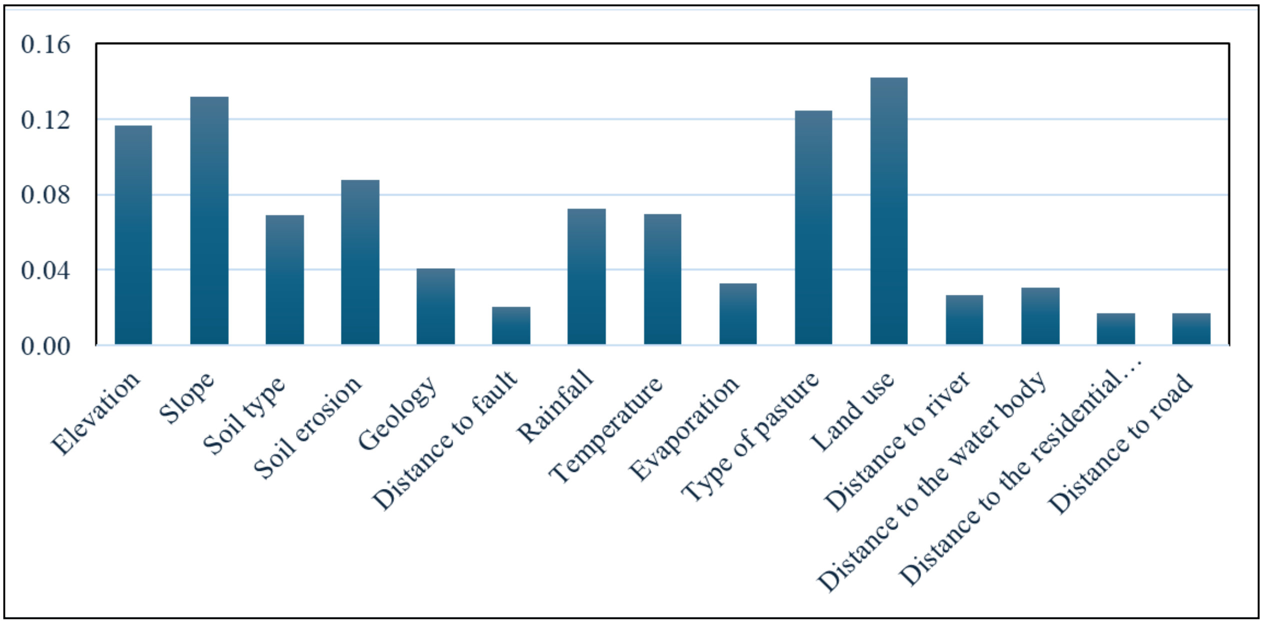

Figure 5) Final weight diagram of Sistan rangeland development criteria based on the integrated ANP-DEMATEL approach.

intensity of interaction, land use, soil erosion, and elevation were prioritized, while the distances to faults, residential areas, roads, and water bodies were ranked last. The slope, elevation, land use, rainfall, pasture type, and temperature are classified as cause criteria. In contrast, geology, distance to water sources, distance to roads, distance to fault, distance to residential areas, soil erosion, soil type, and evaporation are included in the effect criteria. It is acknowledged that in terms of relationships and mutual effects, slope, elevation, and land use were prioritized for rangeland development, and their variability affects the conditions and status of other criteria and environmental parameters. This

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is because the ecological status of the region is strongly influenced by the characteristics of the topography (slope and elevation), and other environmental factors also change with alterations in topography and landform. Furthermore, the vegetation conditions, land use, rainfall, and temperature greatly influence the formation of local microclimates and increase ecosystem diversity [32,33].

The findings underscore the significance of the integrated ANP-DEMATEL approach in determining the final importance of evaluation indicators. The results of this study indicate that the criteria of land use, slope, pasture type, and elevation are prioritized for assessing the potential and suitability of land for rangeland development in the Sistan Region. These findings emphasize the importance of considering current land use patterns, landform characteristics, and vegetation cover in rangeland development, particularly in the study area. These criteria, in addition to fostering diversity and enhancing the quality of natural ecosystems, are effective in mitigating and reducing natural hazards and environmental resource degradation. Previous research has emphasized the significance of specific ecological factors in assessing the environmental potential for rangeland development. In contrast to the findings of this study, Minaei and Kainz [34] reported that water erosion and rock outcrop were the primary criteria for rangeland development in the Halaijan-Izeh watershed. Jozi and Ebadzadeh [35] observed that sub-basins near rural areas, access roads, and livestock traffic exhibited reduced potential for rangeland development. Shahbazi et al. [36] It was also observed that the slope plays an essential role in rangeland development, supporting the findings of this research.

The ANP-DEMATEL approach, when utilized for weighting criteria in this study, demonstrated that it can provide a suitable solution for determining internal relationship dependencies, interactions, and their relative importance. This approach facilitates the determination of the final weight of criteria based on expert opinions, thereby supporting the prioritization of evaluation criteria. Additionally, it enables the identification of essential and influential criteria in the decision-making environment, allowing for a more focused approach to these criteria. In addition, Pourkhbaz et al. [37] noted that the combined ANP-DEMATEL approach facilitates the identification of suitable solutions for group decision-making, thereby determining the final weight of the criteria. Taheri et al. [27] further emphasized the efficacy of this approach, not only in quantifying the influence between diverse groups of factors but also in normalizing the effect set matrix within the supermatrix. The absence of weight recording in this process enables calculating the dependency levels of different factors in ANP. The significance of employing the ANP approach for decision-making in land assessment has been acknowledged by numerous researchers [30, 38, 39, 40, 41, 17].

Numerous limitations hindered the determination of criteria and collection of data in this research. The process of determining criteria involved the time-consuming solicitation of expert opinions and their integration, which introduced variability in the results due to conflicting expert views. Additionally, the lack of a comprehensive guide to rangeland development in Iran led to the assessment framework being informed by expert opinions or sources beyond Iran, potentially compromising the validity of the study's results. Furthermore, the absence of a suitable database for the study area necessitated the use of data collected on disparate scales, which introduced potential biases and compromised the accuracy and validity of the findings.

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This study's findings indicate that establishing a comprehensive rangeland management plan for the study area is imperative. This necessity arises from the environmental challenges faced by the region, including drought, climate change, and changes in land use, which have led to the deterioration of the region's rangelands. Without adequate planning and management, the degradation of rangelands is projected to have detrimental environmental, economic, and social consequences for the local population and other regional inhabitants.

Conclusions

The ANP-DEMATEL technique was employed in this research to evaluate the region's capacity, and the results suggest that this method enhances the accuracy of the evaluation process by determining the importance of each index through its weighting. Despite its greater complexity compared to sieve mapping, it is evident that some indicators have a more significant impact, while others have less influence in assessing the land's capacity for various types of land use. A notable advantage of the ANP-DEMATEL approach is its considerable flexibility, which allows for the inclusion of any necessary criteria and indicators in the evaluation process. This flexibility facilitates the investigation of the internal effects of these criteria, thereby improving the accuracy and comprehensiveness of the evaluation process. The findings highlight the importance of the ANP-DEMATEL approach in enhancing the accuracy of land suitability assessments for grazing. This method aids in comprehending the interactions among different criteria and supports improved decision-making in rangeland management. Consequently, using multi-criteria decision-making methods in selecting the type and location of pastures is recommended to reduce wasted time and costs.

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