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Assessing the Effect of Environmental Factors on Plant Diversity in Southern Rangelands of Golestan Province, Iran

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ABSTRACT

Aims: The present study aimed to investigate beta and alpha diversities in vegetation types and examine the relationship between the distribution of plant species and environmental factors in the rangelands of southern Golestan Province, Iran.
Materials & Methods: This study was conducted in four vegetation types, namely *Artemisia aucheri, Festuca ovina - Astragalus gossypinus, Bromus tomentellus,* and *Bromus tomentellus - Festuca ovina*. The vegetation was sampled using a systematic random sampling approach. Thirty plots measuring one m^2 were placed in each plant type along three 50-meter transects to measure the vegetation. In total, 120 plots were placed across the different plant types. Soil samples were collected from a depth of 0-30 cm. The soil depth was selected based on the mountainous terrain and the rooting depth of the plants. The Past software calculated plant species diversity and similarity indices between vegetation types and beta and alpha diversities. The Tukey test was used to compare the diversity indices of the plant functional groups.
Findings: The highest alpha diversity among annual plants was observed in the *F. ovina-A. gossypinus* type with a Shannon-Wiener index of 0.927 and a Simpson index of 0.554. At the same time, the most remarkable alpha diversity of shrub plants was associated with the same type with a Shannon-Wiener index of 1.316 and a Simpson index of 0.711. Across all four studied types, the highest richness of annual and perennial plants was observed in the *A. aucheri* type, with a Margalef index of 8.192 and a Menhinick index of 5.774. In contrast, the greatest richness of shrub species was observed in the *F. ovina-A. gossypinus* type, with a Margalef index of 3.734 and a Menhinick index of 2.677. In addition, beta diversity was calculated using the similarity index for vegetation types. The results indicated a Whittaker similarity index (beta diversity) of 0.3, 0.4, and 0.5 for annual, shrub, and perennial plants, respectively. Canonical Analysis (CA) was performed using the Canoco 4.5 software to examine the effect of environmental factors on plant species distribution. The analysis revealed that soil texture, N, organic carbon, pH, EC, and aspect were the most significant factors affecting the distribution of plant species.
Conclusion: This research provides valuable information about rangeland plant species for primary livestock grazing and soil protection in the studied vegetation types for better land management.

Keywords: Vegetation Types; Diversity; Richness; Plant Floristic List.

CITATION LINKS

[1] Zare Chahouki M. A., Shafizade M., ... [2] Koleff P., Gaston K. J., Lennon J. J. Measuring beta diversit ... [3] Jeffrey A. H., Van der ... [4] Ghorbani A., Moameri M., Dadjou F., Seyedi Kaleybar S. A., Pou ... [5] Battles J. J., ... [6] Dianati Tilaki G. A., Naderi ... [7] Miyashita T., Amano A., Yamakita T. Effects of Ecosystem Dive ... [8] Kargar M., Jafarian Z., ... [9] Samadi Khangah S., Ghorbani A., ... [10] She Y., Li X., Li Ch., Yang P., ... [11] Macarthur H. R.Pattern of species diversity. Biol. Rev. 1965; ... [12] Whittaker R. H. Evolution and measurement of species diversity ... [13] Erfanzadeh R., Kamali N., Ghelichnia H., Pétillon J. Effect of ... [14] Whittaker R. H. Vegetation of the Siskiyou Mountains, Oregon a ... [15] Ebrahimi M., Masoodipour A., Rigi ... [16] Azizi Kalesar M., ... [17] Jouri M. H., Patil D.N., Gavali ... [18] Zare Chahouki M.A., Esfanjani J. Predicting potential distribu ... [19] Rechinger K. H., Flora Iranica, Akademische Druck-u, Verlagsa ... [20] Black C. A Methods of soil ... [21] Jackson M. L., Soil Chemical ... [22] Tahmasebi, P., ... [23] Rocchini D., Andreini ... [24] Vellend M. Do commonly used indices of beta-diversity measure ... [25] Anderson M. J., ... [26] Wilson M. V., Shmida A. Measuring beta diversity with presence ... [27] Ayad M. The vegetation ... [28] He M.Z., Zheng J.G., Li X.R., Qian Y.L. Environmental factors ... [29] Vasquez H., Huam'an M., ... [30] Zare Chahouki M. A., Khojasteh F., Tavili A. Distribution of V ... [31] Sperry J. S., ... [32] Esfanjani J., ... [33] Boer B., Sargeant D. Desert ... [34] Zayed O., Hewedy O., ... [35] Zhao W.Y., Li J. L., Qij ... [36] Abbasi-Kesbi M., ... [37] Zare Chahouki M. A., KHalasi L., Azarnivand H. Environmental F ... [38] Flowers T.J., Halophytes. ... [39] Zhang Q., ... [40] Fattahi B., Ildoromi A. R. r ... [41] Jahantab J., Mahmoudi M. R., ...

Introduction

Recognizing essential variables such as climate, soil, vegetation, and biotic elements is necessary for effective rangeland management. Knowing the most important factors affecting the distribution of vegetation should carry out the best management measures in Rangelands [1]. Many methods have been proposed to evaluate diversity. These approaches fall into two categories: parametric and numerical indices. Numerical indices are the Margalef, Simpson, and Shannon-Wiener indices. These indices reveal the diversity of plant communities within a particular unit.

However, some studies on beta diversity have relied too heavily on a single criterion, whereas others have utilized the Whittaker index as the primary measure of beta diversity [2]. The diversity of plant species is a crucial indicator of the health and state of ecosystems, especially at the local or limited regional levels [3,4]. Numerous studies have established a correlation between species diversity and ecological system stability. However, disagreement exists regarding the appropriate use of diversity indices and models. Sensitive indicators can reveal damage to an ecological system. Also, they identify the best practices for restoring ecological systems [5-10].

In addition to species diversity, habitat diversity (beta diversity) is another measure of biodiversity. Beta diversity assesses habitat changes and species composition across environmental gradients and habitat fragments. It is a benchmark for measuring such changes [11-13]. Habitat diversity plays a crucial role in shaping species-specific patterns and determining changes in competition among plant communities [3, 14-16].

Jouri *et al.* [17] examined the role of plant richness and diversity in eco-balancing upland rangelands in the Alborz Mountains, located in the north of Iran. The findings revealed that neither the grassland nor the shrubland exhibited poor conditions. The study also established a correlation between plant diversity and richness, soil erosion, and rangeland conditions in both types. Additionally, certain vegetation factors impact habitat conditions and contribute to soil erosion.

Plant diversity is a crucial topic of interest for ecologists involved in applied ecological sciences. Reducing plant diversity can lead to ecosystem instability and a decreased ability to cope with pests and diseases. Consequently, protecting biodiversity within rangeland ecosystems is the ultimate goal of rangeland management.

Choosing the best rangeland management alternatives that support high plant diversity requires knowledge of the ecological conditions and the proper management techniques. Eventually, this can result in the development of more stable natural ecosystems, which will support and safeguard these ecosystems. The hazards that habitats face, the loss of biodiversity, the negative effect on system stability, the importance of habitat diversity, and its function in fostering biodiversity and environmental sustainability are just a few of the considerations that need to be considered [10].

Considering the importance of protecting plant species in the studied rangelands, soil protection and compliance with the standard of permissible exploitation limits will also be influential factors in maintaining vegetation cover because habitat diversity has been less studied in rangelands. Therefore, investigating the diversity and richness of vegetation in each type can help create the correct management for improving and restoring rangelands.

This study aimed to examine the diversity of plant species (beta diversity) between vegetation types and investigate the impact

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of environmental factors on vegetation types in the southern Golestan Province. The knowledge gathered from this study can be beneficial in making informed management decisions that would preserve and restore rangelands and improve fodder production on various plant species in the southern Golestan region.

Materials & methods

Study Area

The study area, located in the Alborz Mountains, is situated in the northwest of Shahroud County in Semnan Province and extended from 40° 00′ N to 28° 04′ E, 40° 50′ N to 27° 45′ E in the southern Golestan Province. The elevation of the study area ranged from approximately 2208 m to 2327 m. Geologically, the bedrock formations consist of dark-colored limestone lithology from the Cretaceous to Quaternary periods [18] (Figure 1.). The study identified four vegetation types in the area, labeled as type 1: *Artimisia aucheri* Boiss. type 2: *Festuca ovina* sub sp. guestfalica -*Astragalus gossypinus* Fisher. type 3: *Bromus tomentellus* Boiss. and type 4: *Bromus tomentellus* Boiss.-*Festuca ovina* sub sp. guestfalica.

Vegetation Sampling

The plant species were collected, identified through flora analysis, and dried and pressed. Plant species were identified using Flora Iranica [19], while the Raunkiaer system was employed to classify their life forms. Also, its importance in conservation and medicinal goals.

A systematic random sampling method was utilized to collect vegetation data. Specifically, 30 plots measuring one m^2 were placed within each vegetation type. The plots were arranged along three 50 m transects, extending from the bottom of the slope to higher altitudes, with a distance of 5 m between each adjacent plot [18]. One hundred twenty plots were established across all vegetation types, after which the density of plant species was determined for each plot.

Soil Sampling

Soil samples were collected from 0-30 cm depths based on the mountainous terrain and the rooting depth of the plants [18]. The soil properties that were assessed included texture (determined using Bouyoucos hydrometer to measure sand, silt, and clay content), organic carbon (determined using Walkley and Black rapid titration method) [21], pH (measured using a pH meter), electrical conductivity (EC, determined using a conductivity meter), lime (quantified using 1N HCl) [22] and N (measured through the Kjeldal apparatus and titration method).

The Past software calculates the similarity indices, β, and α diversities. Alpha diversity was estimated using the diversity index, focusing on the Shannon index. This index considers the number of individuals and taxa present, with values ranging from 0 (for communities consisting of a single taxon) to high values (for communities with multiple taxa, each with few individuals).

Shannon Wiener index (H) is calculated based on Eq. (1):

$$H = -\sum_{i}^{s} = p_i l_n p_i \qquad \text{Eq. (1)}$$

Simpson index (1-D): It measures the 'evenness' of the community from 0 to 1.

$$1 - D = \sum_{i=0}^{s} (p_i)2 = 1 - \sum_{i=0}^{n} [\frac{n_i(n_i - 1)}{N(N-1)}]$$

b) Richness index is calculated based on Eq. (2):

$$H = -\sum_{i}^{s} = p_i l_n p_i \qquad \text{Eq. (2)}$$

Menhinick and Margalef indices were used to assess the plant species richness.

Margalef is calculated based on Eq. (3):

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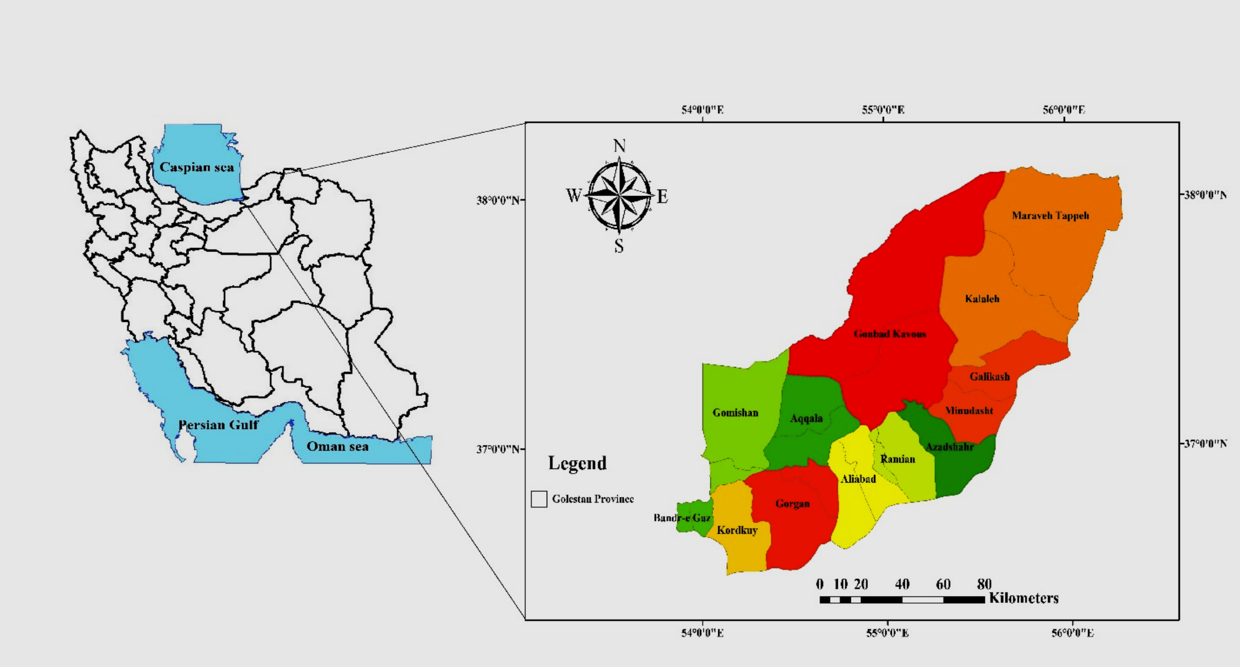

Figure 1) Location of the study area in the Golestan Province, Iran.

$$R_1 = \frac{s-1}{L_n(N)} \quad \text{Eq. (3)}$$

Menhenink (1999) is calculated based on Eq. (4):

$$R_2 = \frac{s}{\sqrt{N}} \; R_2 \quad \text{Eq. (4)}$$

In the above equations, 1-D is the Simpson index, S is the number of taxa, is the number of individuals of taxon I, N is the Total number of individuals, p_i is the Proportion of species I in the community of I, Ln is $\log_{10}$, R_1 is Margalef index, and R_2 is Menhenink index.

Beta diversity, or habitat diversity, was calculated using various indices, including those proposed by Wittaker, Harrison, Cody, Routledge, Wilson-Shmida, and Mourelle and Ezcurra [2]. The Past software can be utilized to estimate beta diversity from any number of samples, not just two.

Wittaker is calculated based on the Eq. (5):

$$b_{w=} \frac{s}{\bar{\alpha}} -1, \quad \text{Eq. (5)}$$

Harrison is calculated based on the Eq. (6):

$$b_{-1=} N-1 -1 / \frac{s}{\bar{\alpha}} \quad \text{Eq. (6)}$$

Cody is calculated based on the Eq. (7):

$$b_{c=} \frac{g(H)+l(H)}{2} \quad \text{Eq. (7)}$$

Routtledge is calculated based on the Eq. (8):

$$b_{1=} \log_{10} \alpha_i \; \sum_i \alpha_i \; -[\frac{1}{T}] \; . \sum_i e_i \; \log_{10} T -[\frac{1}{T}] \quad \text{Eq. (8)}$$

Wilson-Shmida is calculated based on the Eq. (9):

$$b_{t=} \frac{g(H)+l(H)}{2\bar{\alpha}} \quad \text{Eq. (9)}$$

Mourelle & Ezcurra is calculated based on the Eq. (10):

$$b_{me=} \frac{g(H)+l(H)}{2\bar{\alpha}(N-1)} \quad \text{Eq. (10)}$$

where S is the total number of species, α is the mean number of species in plots, N

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Table 1) Plant species and flora of the southern rangelands of Golestan Province, Iran.

Family and Plant Species	An (Annual)/ Pe (Perennial)/ Sh (Shrub)	Life Form	Importance
Asteraceae			
Artemisia aucheri Boiss.	Sh	Ch	Co
Cichorium intybus L.	An	He	Co
Taraxacum montanum Nutt.	An	He	Co
Tragopagon pratensis L.	An	Cr	Co
Anthemis cotula L.	An	Th	Me
Brassicaceae			
Alyssum linifolium Willd.	An	Th	Co
Cardaria draba L.	An	He	Co
Caryphyllaceae			
Acanthophyllum glandulosum Bunge ex Boiss.	Sh	Ch	Co
Minuartia lineate Boiss.	An	He	Me
Chenopodiaceae			
Eurotia ceratoides C.A.Mey.	Sh	Th	Co
Salsola kali L.	An	Th	Co
Colchicaceae			
Colchicum kurdicum Stef.	Pe	He	Me
Convulvolaceae			
Convolvulus arvensis L.	An	Th	Me
Cistaceae			
Helianthemum nummularium Guss.	An	He	Co
Clusiaceae			
Hypericum linoides A.St.-Hil.	Pe	He	Me
Euphorbiaceae		He	Co
Euphorbia rigida Loisel.	Pe	He	Co
Fabaceae			
Astragalus brevidens Rydb.	Pe	He	Me
Astragalus gossypinus Fisch. Rech.f.	Pe	He	Co
Colutea persica Boiss.	An	Ph	Co
Colutea porphyrogramma	An	Ph	Co
Onobrychis cornuta L.	Sh	Ch	Me
Medicago sativa L.	Pe	Th	Me
Medicago lupulina L.	Pe	He	Co
Poaceae			
Bromus tomentellus Boiss.	Pe	He	Co
Bromus tectorum L.	Pe	Th	Co
Festuca ovina L.	Pe	He	Co
Hordeum glaucum Steud.	Pe	Th	Co
Hordeum spontaneum K.Koch	Pe	Th	Co
Stipa barbata Michx.	Pe	He	Co
Lamiaceae		He	Co
Phlomis cuneata C.Y.Wu	An	He	Co
Nepeta persica Boiss.	An	He	Me
Stachys lavandulifolia Vahl	An	He	Me
Marrubium frasium L.	An	He	Me
Thymus kotschyanus Boiss.	Pe	Ch	Me
Lilliaceae			
Allium rubelum L.	An	Cr	Me
Plumbaginaceae			
Acantholimon bodeanum Bunge	Sh	Ch	Co
Rubiaceae			
Gallium verum Mill.	Pe	Cr	Me
Cupressaceae			
Juniperus commonis L.	Pe	Ph	Me

*He: Hemicryptophytes, Th: Therophytes, Cr: Cryptophytes, Ch: Chamaephytes, Ph: Phanerophytes, Co: Conservation plant species, Me: medicinal plant species is the number of samples, g(H) is the total gain of species along the gradient (samples ordered along columns), l(H) is the total loss of species, e_i is the number of samples containing species I, and T is the total number of occurrences [2].

Diversity indices were compared using the Tukey test method in the SPSS software. Data analysis was conducted using the Canoco 4.5 software to assess the influence of environmental factors on species diversity. Given that the gradient in the Detrended Correspondence Analysis (DCA) method was equal to 6.013, which is greater than 4, the Canonical Analysis (CA) method was employed to establish a relationship between environmental factors and plant species diversity and richness [23].

Findings

Identified Plant Life Forms

A total of 40 plant species from 16 families were identified in the study area. The Poaceae family had the highest species richness, while the Chenopodiaceae, Euphorbiaceae, Convolvulaceae, Cistaceae, Colchicaceae, Lilliaceae, Plumbaginaceae, and Rubiaceae families had the lowest species richness. The life form distribution in the region revealed that hemicryptophytes were the most abundant, followed by therophytes, cryptophytes, and chamaephytes, as shown in Table 1.

Alpha Diversity

Regarding alpha diversity, the *B. tomentellus-F. ovina* type had the highest perennial plant species diversity, with a Shannon-Wiener index of 1.965 and a Simpson index of 0.815. The *F. ovina-A. The gossypinus* type had the highest diversity of annual plant species, with a Shannon-Wiener index of 0.927 and a Simpson index of 0.554. For shrub species, the *F. ovina-A. The gossypinus* type had the highest diversity, with a Shannon-Wiener index of 1.316 and a Simpson index of 0.711. Regarding annual plant species richness, the *A. aucheri* type had the highest Margalef index (3.059) and Menhinick index (2.449). At the same time, the *A. aucheri* type also had the highest richness of perennial plant

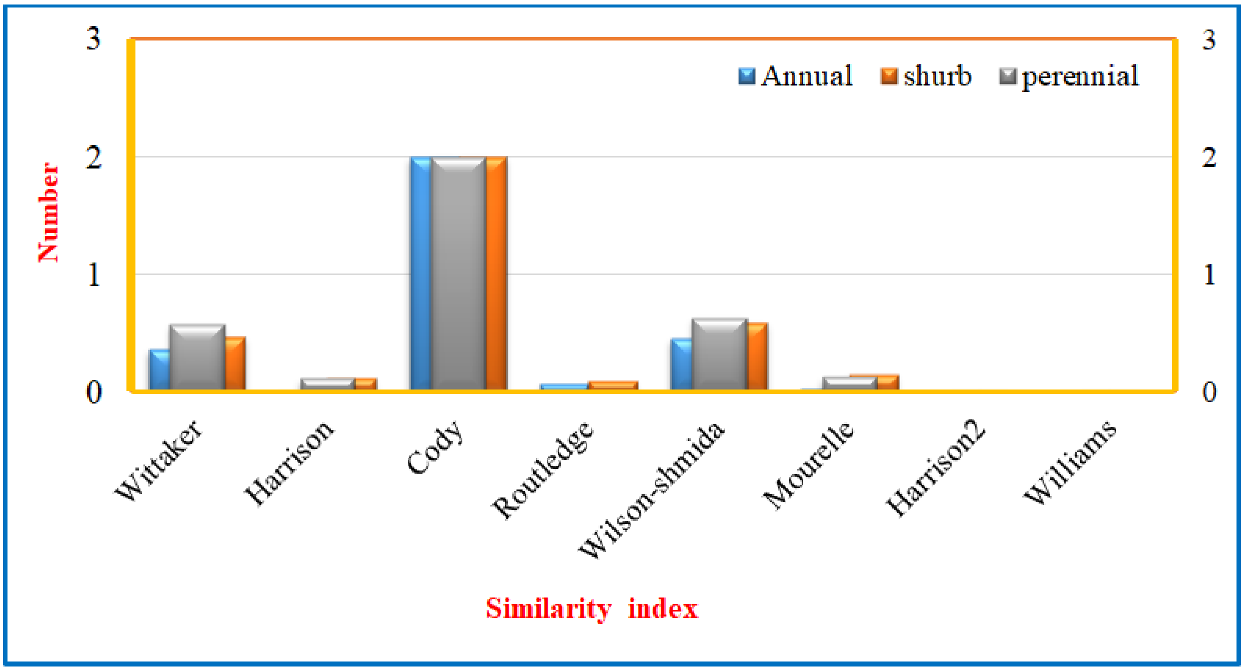

Figure 2) Beta diversity indices in four vegetation types (Type 1: *A. aucheri*, Type 2: *F. ovina - A. gossypinus*, Type 3: *B. tomentellus*, Type 4: *B. tomentellus - F. ovina*).

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Table 2) Levels of species richness and evenness in the vegetation types in the study area.

Type		Shannon Wiener	Simpson	Margalef	Menhenink
Artemisia aucheri	Perennial	1.862	0.803	8.192	5.774
	Shrub	0.706	0.403	2.465	2.221
	Annual	0.864	0.477	3.059	2.449
Festuca ovina - Astragalus gossypinus	Perennial	1.164	0.469	4.505	2.728
	Shrub	1.316	0.711	3.734	2.677
	Annual	0.927	0.554	1.553	1.199
Bromus tomentellus	Perennial	1.884	0.777	3.333	2.149
	Shrub	0.436	0.265	1.076	1.257
	Annual	0.500	0.32	0.343	0.476
Bromus tomentellus - Festuca ovina	Perennial	1.965	0.815	4.127	2.898
	Shrub	0.474	0.297	0.012	3.303
	Annual	0.668	0.444	0.78	0.833

Table 3) Tukey test results for comparing the averages of diversity and richness indices.

Indices	Mean Difference ± Std. Error	F
Shannon Weiner	0.979*±0.238	11.296
Simpson	0.267±0.114	4.104
Margalef	3.605* ± 1.205	5.394
Menhenink	2.148±0.828	3.367

*The mean difference is statistically significant at the 0.05 level.

species, with a Margalef index of 8.192 and a Menhinick index of 5.774. Finally, the *F. ovina-A. gossypinus* type had the highest shrub species richness, with a Margalef index of 3.734 and a Menhinick index of 2.677 (Table 2).

Beta Diversity

Beta diversity was estimated using a similarity index, with the Whittaker similarity index being employed for annual, shrub, and perennial plants. The results indicated that the Whittaker similarity index was 0.3 for annual plants, 0.4 for shrub plants, and 0.5 for perennial plants (as depicted in Figure 2.).

Ordination and Comparison of Diversity Indices in the Studied Vegetation Types

The gradient value obtained through the Detrended Correspondence Analysis (DCA) method was 6.013, indicating that the Canonical Analysis (CA) method would be more appropriate for data analysis [23]. Tables 6. and 7. present the eigenvalues obtained from the DCA and CA methods. The results, as depicted in Table 4, reveal that the first axis had a variance of 24.3%, while the second, third, and fourth axes had variances of 44%, 59.5%, and 44.6%, respectively. Specifically, axis 1 accounted for 80% of the total variance, followed by the second, third, and fourth axes with 71%, 67%, and 55%, respectively. The first component was determined by the absolute values of coefficients for N, organic carbon,

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Table 4) Variance analysis for different diversity and species richness measures.

Indices		Sum of Squares	df	Mean Square	F	Sig.
Shannon Weiner	Between Groups	2.574	2	1.287	11.296	0.004
	Within Groups	1.025	9	0.114		
	Total	3.599	11			
Simpson	Between Groups	0.214	2	0.107	4.104	0.049
	Within Groups	0.235	9	0.026		
	Total	0.449	11			
Margalef	Between Groups	31.337	2	15.668	5.394	0.029
	Within Groups	26.143	9	2.905		
	Total	57.480	11			
Menhenink	Between Groups	9.235	2	4.617	3.367	0.041
	Within Groups	12.342	9	1.371		
	Total	21.577	11			

and aspect, while the second component was influenced by sand, silt, clay, pH, and EC. Additionally, the third component was primarily affected by Caco3, while the fourth component was influenced by slope and elevation. Figure 3 depicts the plant species ordination based on these components, and the correlation between environmental factors and plant species was determined along the corresponding axes.

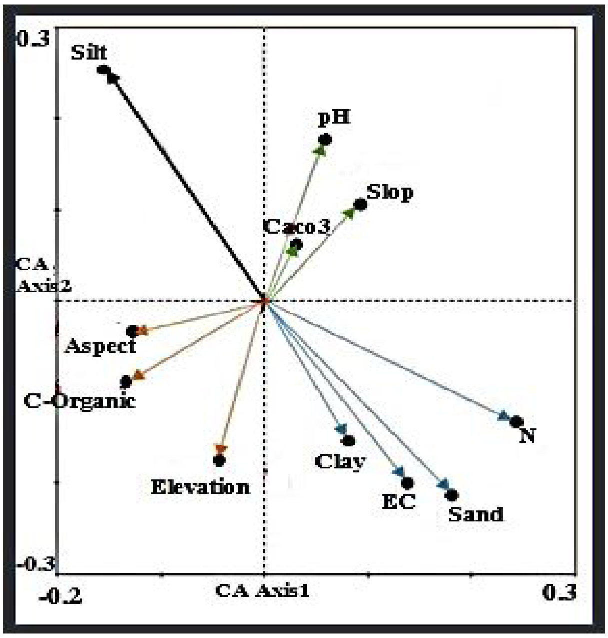

Figure 3) Ordination Diagram of Plant Species Based on Components Using the CA Method.

Table 2 provides the results of variance analysis for different indices of plant species diversity and richness. The significance level is less than 0.01 and 0.05, indicating a 95% confidence interval for the entire numerical index of plant species richness and diversity, except for the Shannon-Wiener index. The Tukey method was utilized to compare the different levels (as shown in Table 3). As per the data displayed in Table 2. although there is a significant relationship at the 5% level between perennial and annual plants using the Shannon-Wiener index and Margalef index, there is no significant relationship between the groups in other indices.

There are significant differences between annual, perennial, and shrub plants. Shannon Wiener index is significant differences (99%) in the vegetation types (Table 4): Table 5 shows a substantial association at the 5% level between the Shannon-Wiener and Margalef indices for perennial and annual plants. However, the groups have no significant relationship according to other indices.

Discussion

It is critical to comprehend the relationship between diversity and features of plant

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Table 5) Tukey test results to compare the average of the indicators of diversity and richness.

Dependent Variable		(I) Fisher	(J) Fisher	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Shannon Weiner	Dunnett t (2-sided)[a]	1.00	3.00	0.979*	0.238	0.005	0.3552	1.602
		2.00	3.00	-0.007	0.238	0.999	-0.630	0.617
Simpson	Dunnett t (2-sided)[a]	1.00	3.00	0.267	0.114	0.077	-0.310	0.565
		2.00	3.00	-0.029	0.114	0.952	-0.328	0.268
Margalef	Dunnett t (2-sided)[a]	1.00	3.00	3.605*	1.205	0.027	0.455	6.755
		2.00	3.00	0.388	1.205	0.928	-2.762	3.538
Menhenink	Dunnett t (2-sided)[a]	1.00	3.00	2.148	0.828	0.052	-0.016	4.312
		2.00	3.00	1.125	0.828	0.337	-1.039	3.289

a. Dunnett t-tests treat one group as a control and compare all other groups against it.
*. The mean difference is significant at the 0.05 level.

Table 6) Eigenvalues for diversity and richness species of plant ordination with environmental factors using the DCA method.

Axes	**1**	**2**	**3**	**4**	**Total Inertia**
Eigenvalues	0.805	0.479	0.423	0.267	8.094
Lengths of Gradient	6.013	3.727	4.643	3.473	
Species-Environment Correlations	0.807	0.661	0.673	0.586	
Cumulative Percentage Variance:					
of Species Data	9.9	15.9	21.1	24.4	
of Species-Environment Relation	22.1	33.6	0	0	
The Sum of All Eigenvalues					8.094
The Sum of All Canonical Eigenvalues					1.965

communities because species diversity is lost due to various natural and human stressors, including severe grazing, drought, and similar situations.

Based on the findings, the Poaceae, Fabaceae, and Asteraceae families were dominant in the southern rangelands of Golestan Province. The study area's climate is cold and mountainous, and Hemicyptophytes dominated the plant life in the rangeland. Consequently, the study area is well-suited for hemicryptophyte plants. This plant life form prefers cold and mountainous climates [18]. The study area's second most prevalent plant life form was therophytes, adapted to various environmental conditions. The third life form was identified as cryptophytes and chamaephytes. While the Shannon-Wiener and Margalef indices showed a significant relationship at the 5% level, there was no significant relationship between the groups in other indices. The similarity of vegetation type was measured using common plant species between them. Similar plant species suggest a lower dissimilarity between the plant communities and the habitat [24]. Beta

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Table 7) Eigenvalues for diversity and richness species of plant ordination with environmental factors using the CA method.

Axes	1	2	3	4	Total Inertia
Eigenvalues	0.805	0.713	0.676	0.555	8.094
Species-environment Correlations	0.769	0.738	0.131	0.724	
Cumulative Percentage Variance:					
of Species Data	9.9	18.8	27.1	34	
of Species-Environment Relation	24.3	44	44.6	59.5	
The Sum of All Eigenvalues					8.094
The Sum of all Canonical Eigenvalues					1.965

Table 8) The correlation coefficient between the axes of plant species and environmental factors in rangeland study by the CA method.

	Axes1	Axes2	Axes3	Axes4
Sand	0.578	<u>-0.640</u>	0.118	0.173
Clay	0.285	<u>-0.474</u>	-0.058	-0.263
Silt	-0.534	<u>0.764</u>	-0.107	-0.092
Caco3	0.125	0.195	<u>-0.545</u>	-0.248
N	<u>0.807</u>	-0.397	-0.36	0.165
C-organic	<u>-0.464</u>	-0.230	0.405	0.442
pH	0.176	<u>0.547</u>	-0.531	-0.234
EC	0.463	<u>-0.608</u>	-0.364	0.066
Elevation	-0.114	-0.528	0.383	<u>0.816</u>
Slop	0.300	0.340	-0.528	<u>-0.770</u>
Aspect	<u>-0.444</u>	-0.049	0.405	-0.109

diversity indices involve arithmetic operations to combine species richness and evenness in each community [25, 26]. This study used six indices to compute beta diversity, and the Whittaker index [27] was employed to measure beta diversity. The results indicated a low level of similarity between habitats of vegetation types, with values of 0.3, 0.4, and 0.5 for annual, shrub, and perennial plants, respectively.

The present study revealed that soil factors (such as soil texture, N, organic carbon, pH, and EC) and physiographic factors (such as aspect) had the most significant impact on the distribution of plant species. These findings are consistent with those reported in other studies, such as Ayad [28], He *et al.* [29], and Vasquez *et al.* [30], which demonstrated the significant influence of soil factors on plant species distribution [31]. According to the results obtained from this research, soil texture plays a crucial role in infiltration, water retention, and plant access to water and nutrients. In addition to determining plant groups, soil texture is also a significant factor in the distribution of plant species [32, 33]. Boer and Sargeant [34] established a relationship between vegetation and soil texture. Nitrogen, one of the soil factors, played a significant

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role in the distribution of plant species in the studied rangelands. Nitrogen is a crucial element for plant growth, and increased vegetative growth leads to increased plant photosynthesis, which produces hydrocarbon substances [35]. Consequently, hydrocarbon substances also play a significant role in protein synthesis. Zhao *et al.* [36] analyzed changes in species diversity and production concerning soil characteristics in the northern Tianshan Mountains. The analysis revealed that soil nutrients are the primary factors determining the distribution and pattern of the main plant types in the region. They also reported that soil nutrients, available water, pH, and EC influence species diversity and production changes. The analysis of this research revealed that organic matter is one of the soil factors that affect plant species distribution, and these results are consistent with those reported in other studies [28, 29, 31, 37]. Organic matter significantly affects soil-building and soil-holding capacity. The present study revealed that EC played a crucial role in the distribution of plant species, which is consistent with the findings of Zare Chahouki *et al.* [38], Flowers [39], and Zhang *et al.* [40]. Thus, once the plant species in an area are identified, it is crucial to understand their ecological requirements and the environmental and management factors that affect their distribution. This understanding should inform the investigation of all possible management methods, followed by detailed planning and integrated use of suitable methods. Additionally, the aspect was found to be a significant factor in the distribution of plant species, which is consistent with the findings of Fattahi and Ildoromi [40] and Jahantab *et al.* [41].

Conclusions

The results of this study indicate a diverse range of taxonomic levels, families, and biological forms in the study area, which contribute to soil conservation and livestock forage. It is, therefore, crucial to identify the most critical environmental factors affecting the distribution of plant species, as it can significantly impact plant species diversity and richness in rangelands. The current study aids in predicting the existence of plant species that share traits; put another way, it makes it feasible to identify which group of plants is concurrently present in the monitoring area in the event of any perturbations in the area. Additionally, by considering the adaptation and resilience of plants, we can select suitable plant species for the improvement and regeneration of the region. In conclusion, the findings of this study can aid in the conservation, management, and rehabilitation of rangeland resources. Despite the results mentioned above, the importance of diversity in rangeland ecosystems is emphasized. Habitat diversity can be calculated to achieve sustainable rangeland management, which can help protect plant species, ensure stability, and prevent degradation. Ranchers, farmers, and tourists must care for the rangeland to ensure its long-term health and productivity.

Author Contributions
Javad Esfanjani, Mohammad Ali Zare Chahouki, and Shirin Mahmoodi conceived the work, performed the experiments and analyses, contributed analysis tools, wrote and revised the paper, and edited the English text. All authors approved the final paper.
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References

1. Zare Chahouki M. A., Shafizade M., Environmental effective factors on distribution of (Case study: Chahbyki region of Yazd Province). IJRDR. 2008; 15(3):403-414.
2. Koleff P., Gaston K. J., Lennon J. J. Measuring beta diversity for presence-absence data. J. Anim. Ecol. 2003; 72(3): 367-382.
3. Jeffrey A. H., Van der Putten W. H., Turin H., Wagenaar R., Bezemer T. M. Effects of changes in plant species richness and community traits on carabid assemblages and feeding guilds. Agric. Ecosyst. Environ. 2008; 127(2): 100–106.
4. Ghorbani A., Moameri M., Dadjou F., Seyedi Kaleybar S. A., Pournemati A., Asghari S. Determinization of environmental factors effects on plants production in QezelOzan-Kosar rangelands, Ardabil Province factors effect on rangelands production. ECOPERSIA 2020; 8(1): 47-56.
5. Battles J. J., Shlisky A. J., Barrett R. H., Heald R. C. Allen-Diaz B.H. The effects of forest management on plant species diversity in a Sierran conifer forest. Range. Ecol. Manag. 2001; 146(1-3): 211-222.
6. Dianati Tilaki G. A., Naderi Nasrabad H., Abdollahi J. Investigation of relationship between vegetation, topography and some soil physico-chemical characteristics in Nodoushan rangelands of Yazd Province (Iran). ECOPERSIA 2011;2:147-156.
7. Miyashita T., Amano A., Yamakita T. Effects of Ecosystem Diversity on Species Richness and Ecosystem Functioning and Services: A General Conceptualization. J. Int. Obser. Assess. 2014; 1:29-47.
8. Kargar M., Jafarian Z., Tamartash R., Alavi, S. J. Prediction of Spatial Distribution of Plant Species Richness in the Valdarreh Rangelands, Mazandaran by Macroecological Modelling and Stacked Species Distribution Models. ECOPERSIA 2018; 6(2):139-145.
9. Samadi Khangah S., Ghorbani A., Moameri M. Relationship between ecological species groups and environmental factors in Fandoghlou rangelands of Ardabil, Iran. ECOPERSIA 2021; 9(2):131-138.
10. She Y., Li X., Li Ch., Yang P., Song Z., Zhang J. Relationship between Species Diversity and Community Stability in Degraded Alpine Meadows during Bare Patch Succession. J. Plant 2023;12(20):1-16.
11. Macarthur H. R.Pattern of species diversity. Biol. Rev. 1965; 40(4): 510-533.
12. Whittaker R. H. Evolution and measurement of species diversity. J. Taxon 1972; 21(2-3):213-380.
13. Erfanzadeh R., Kamali N., Ghelichnia H., Pétillon J. Effect of grazing removal on aboveground vegetation and soil seed bank composition in sub-alpine grasslands of northern Iran. J. Plant Ecol. Diver. 2016; 9(3):309-320.
14. Whittaker R. H. Vegetation of the Siskiyou Mountains, Oregon and California. Ecol. Monogr. 1960; 30(3):279-338.
15. Ebrahimi M., Masoodipour A., Rigi M. Role of soil and topographic features in distribution of plant species (Case study: Sanib Taftan Watershed). ECOPERSIA 2015; 3(1):917-932.
16. Azizi Kalesar M., Moameri M., Ghorbani A. Ecological parameters affecting the distribution of Vaccinium arctostaphylos L. in ecotone rangelands of Namin County, Iran. ECOPERSIA 2022; 10(2): 153-164.
17. Jouri M. H., Patil D.N., Gavali R.S., Safaiean N. The function of plant richness and diversity on eco-balancing of upland rangeland on Alborz Mountains (North of Iran). J. Biodivers. Environ. Sci. 2011; 2: 133.
18. Zare Chahouki M.A., Esfanjani J. Predicting potential distribution of plant species by modeling techniques in southern rangelands of Golestan, Iran. Range Manag. Agrofor. 2015; 36(1):66-71.
19. Rechinger K. H., Flora Iranica, Akademische Druck-u, Verlagsanstalt, Graz 2001; Vols. 1-171.
20. Black C. A Methods of soil analysis. America. Soc. Agron. 1979; 2(1):771-1572.
21. Jackson M. L., Soil Chemical Analysis. Prentice-Hall of India, NewDehli 1967; 498p.
22. Tahmasebi, P., Ecological analysis of grassland ecosystems. Pelk Publications 2011; 274p.
23. Rocchini D., Andreini S. B., Chiarucci A. Maximizing plant species inventory efficiency by means of remotely sensed spectral distances. Glob. Ecol. Biogeogr 2005; 14(5):431–437.
24. Vellend M. Do commonly used indices of beta-diversity measure species turnover? J. Veg. Sci. 2001; 12: 545–552.
25. Anderson M. J., Crist T. O., Chase J. M., Vellend M., Inouye B. D., Freestone A.L. Navigating the multiple meanings of β diversity: a roadmap for the practicing ecologist. J. Ecol. 2011; 14(1):19–28.
26. Wilson M. V., Shmida A. Measuring beta diversity with presence-ansence data. J. Ecol. 1984; 72(1):1055-1064.
27. Ayad M. The vegetation and environment of the western Mediterranean coastal land of Egypt. IV. The habitat of non-saline depressions. J. Ecol. 1976; 64:713–722.
28. He M.Z., Zheng J.G., Li X.R., Qian Y.L. Environmental factors affecting vegetation composition in the

Alxa Plateau, China. J. Arid Environ 2007; 69(3): 473–489.

29. Vasquez H., Huam'an M., Bobadilla L., Zagaceta H., Valqui L., Maicelo J., Lopez S. Evaluation of pasture degradation through vegetation indices of the main livestock micro-watersheds in the Amazon region (NW Peru). J. Environment. Sus. Indica 2023; 20:1-9.
30. Zare Chahouki M. A., Khojasteh F., Tavili A. Distribution of Vegetation Type according to Edafic Properties and Topography in Iran. Pol. J. Environ. Stud. 2012; 21(4): 1071-1077.
31. Sperry J. S., Hacke U.G. Desert shrub water relations with respect to soil characteristics and plant functional type. J. Function. Ecol. 2002; 16(3): 367-378.
32. Esfanjani J., Ghorbani A., Moameri M., Zare Chahouki M.A., Esmali Ouri A., Mirzaei Mossivand A. Prediction of Distribution of Prangos uloptera DC. Using Two Modeling Techniques in Southern Rangelands of Ardabi Province, Iran. J. Range. Sci. 2020; 10(2):137-148.
33. Boer B., Sargeant D. Desert perennials as plant and soil indicators in Eastern Arabia. Plant Soil 1988; 199(2):261–266.
34. Zayed O., Hewedy O., Abdelmoteleb A., Ali M., Youssef M., Roumia M., Seymour D., Yuan Z. Nitrogen Journey in Plants: From Uptake to Metabolism, Stress Response, and Microbe Interaction. Biomolecules 2023; 13(10):1443.
35. Zhao W.Y., Li J. L., Qij G. Changes in vegetation diversity and structure in response to heavy pressure in the northern Tianshan Mountains, China. J. Arid Environments 2007; 68(3): 465–479.
36. Abbasi-Kesbi M., Tatian M.R., Tamartash R., Fattahi B. Relationships between Soil Properties and Plant Diversity Indices (Case Study: Lashgardar Protected Rangeland, Malyer, Iran). J. Range Sci. 2017; 7(1):79-89.
37. Zare Chahouki M. A., KHalasi L., Azarnivand H. Environmental Factors Affecting Distribution of Vegetation Communities in Iranian Rangelands. Int. J. Plant Res. 2010; 23:1-15.
38. Flowers T.J., Halophytes. In: Barker, D.A., Hall, J.L. (Eds.), Ion Transport in Cells and Tissues. 1975; North-Holland, Amsterdam, (309 pp).
39. Zhang Q., Wang J., Wang Q. Effects of abiotic factors on plant diversity and species distribution of alpine meadow plants. Ecol.Infor. 2021; 61:1-8.
40. Fattahi B., Ildoromi A. R. Effect of Some Environmental Factors on Plant Species Diversity in the
41. Mountainous Grasslands (Case Study: Hamedan - Iran). ECOPERSIA 2011; 1: 45-52.
42. Jahantab J., Mahmoudi M. R., Sharafatmandrad M., Karimian V., Sheidai-Karkaj E., Khademi A., Morshedloo M.R., Hano Ch., Lorenzo J. Determining Effective Environmental Factors in the Distribution of Endangered Endemic Medicinal Plant Species Using the BMLR Model: The Example of Wild Celery (Kelussia odoratissima Mozaff., Apiaceae) in Zagros (Iran). J. Plant. 2022; 11(21):1-12.

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