Shahid Beheshti University

Sustainable Earth Review

Journal homepage: http://sustainearth.sbu.ac.ir

Exploring the relationship between vegetation types and environmental factors in Mahdasht plain, Iran

Salman Zare[a*], Mohammad Jafari[a], Ali Tavili[a], Hamidreza Abbasi[b]

[a] Faculty of Natural Resource, University of Tehran, Tehran, Iran
[b] Research Institute of Forests and Rangelands

A B S T R A C T

Understanding laws of growth and development, the interaction between structures and natural factors, and evaluating potentials of ecosystems is the first step in providing a well-founded management to meet economic and social needs and help natural ecosystems to preserve their dynamism. The present study provides an analysis of soil, vegetation types as well as structure and species distribution in Mahdasht plain, Iran; and focuses on the environmental factors that control the species distribution. A data set including floristic vegetation and environmental variables (soil properties from two depths and topographic variable) were analyzed in order to describe the relationships between floristic composition and environmental variables. Classification of the vegetation was analyzed using two-way indicator species analysis (TWINSPAN) and Cluster Analysis techniques. Cluster Analysis showed results similar to TWINSPAN and resulted in the recognition of five vegetation groups. PCA was used to examine the relationship between the vegetation and studied environmental parameters. Analysis with PCA suggesting that there is a relatively high correspondence between vegetation and soil factors that explain 97% of the total variance in data set. PCA results showed that soil texture, salinity, PSS, effective soil depth, available nitrogen, potassium and soil moisture criteria were the major soil factors responsible for variations in the pattern of vegetation.

A R T I C L E   I N F O

Keywords:
Classification
Soil
TWINSPAN and PCA
Vegetation type

Article history:
Received: 10 Jan 2022
Accepted: 16 Mar 2022

*corresponding author
E-mail address:
zaresalman@yahoo.com
(S. Zare)

1. Introduction

Arid and semi arid regions are known as the most important natural ecosystems on the earth. In these environments, the risk of desertification through human activities such as overgrazing, early grazing (Rezaei, 2003) and climatic variations is very high. It occurs because dryland ecosystems are extremely vulnerable to over-exploitation and inappropriate land use. Well-planned land management of natural resources, which should be based on the assessment of inherent and current condition of this area, is therefore a major challenge for governments and land users (FAO, 1998). Assessments of the relationships between environmental variables and vegetation distribution are needed to enable sustainable management systems for these renewable resources Xu et al., 2008).

Plant growth and distribution are a function of environmental factors including climate, soil, topography, and microorganisms (Bindraban et al., 2000). Many soil properties affect plant growth and distribution in rangelands, but only some of them have a major impact (Herrick et al., 2002). Furthermore correlation of soils and vegetation are important for most investigations of plant habitats (Abd El-Ghani and Wafaa, 2003). Several ecological studies have provided quantitative assessments of the distribution of plant species and associations in relation to soil and other environmental factors in different areas. For example in the Egypt (Abd El-Ghani and Wafaa, 2003; Abd EI-Ghani, 1998; Abd El-Ghani and El-Sawaf, 2005); Iran (Jafari et al., 2003; Jafari et al., 2004; Tavili et al., 2009); China (Lu et al., 2006; Xu et al., 2008; He et al., 2007); Britain (Corney et al., 2004); USA (Kinucan et al., 1999) Worked in this direction.

Results of these studies generally indicated that the soil properties such as salinity gradient, moisture and available nutrient are the important factors in controlling the distribution of vegetation. During such environmental changes, the type and management of the vegetation as well as cultivation practices play an important role. These factors determine to a large extent the interaction between several soil physical and biological variables (Martinez-Fernandez et al., 1995). It is worthy to mention that the studied vegetations account for the dominant flora in arid and semi-arid regions as well they have not been investigated in detail at previous explorations, hence, the present research was done in order to analyze the factors that might be effective in their spatial distribution. The aim of this study was to get a better understanding of the relationships between soil, topography and vegetation that can be used as a reference for better management of natural resources and to find out the implications of the results from this study for restoration and management the arid and semi arid ecosystems. All information gained and the procedure proposed in this study would be very useful not only for our case study but also for other similar environments.

2. Material and Methods

2.1. Description of the study area

This study was carried out in an extension of approximately 3748 hectares between 35˚ 35′ 45″ to 35˚ 38′ 57″ N and 50˚ 44′ 03″ to 50˚ 52′ 27″ E, west marginal Mahdasht plain of Tehran, Iran (Fig. 1). The importance of the study area may be due to its position, which is located in the critical centers of wind erosion; therefore, desertification has been identified as a major problem in this area in recent years. The climate of the study area via Gaussen's method showed warm and dry Mediterranean with mean monthly temperatures ranging from -2.3$^{\circ C}$ in January to 35$^{\circ C}$ in July (Iranian Meteorological Organization, 2005). The annual mean precipitation is 240 mm, most of which falls during winter and spring seasons (March- April). The Ambrothermic curve showed six dry month including May, June, July, August, September and October.

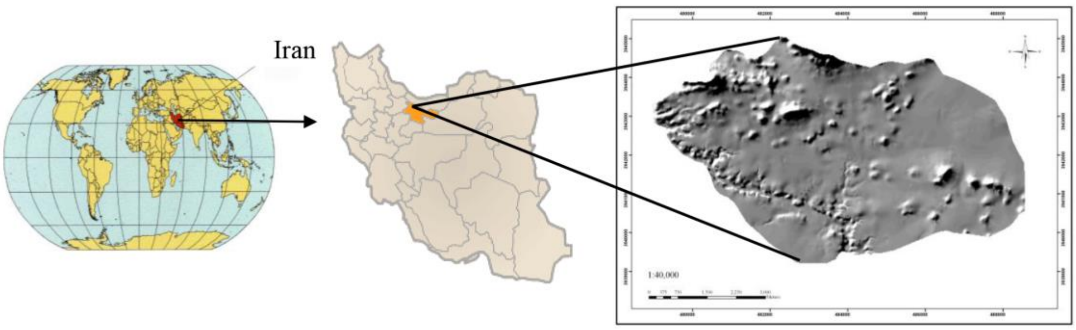

Fig. 1. Geographical situation of the study area

2.2. Data collection

After identifying the vegetation types, sampling was done in key area of each type. Within each key area 3-5 transects with 200-meter length, and containing 10 quadrates (1 square meter) were established. Environmental variables were collected when the plot was located. Sampling method was randomized-systematic. The optimum transects length, number of plots, and plot sizes have already been determined for this study area (Zare, 2009). The geographic location of each sampling point was recorded by Global Positioning System (GPS). The maps of slope, aspect and hypsometry provided using ArcGIS 9.2 software.

2.3. Soil sampling and laboratory analyses

Soil samples for determining soil properties were collected from 0-20 and 20-60 cm in starting and ending plot of a total of 18 transects within stratified vegetation types. Soil samples of each depth were mixed before analysis to reduce soil heterogeneity. Measured soil variables included physical, chemical and hydraulic properties. The samples were air dried at room temperature; then passed through a 2 mm sieve. The fine earth fraction (<2mm)

was retained for chemical analysis and subjected to the following chemical analyses:
pH in water 1:1 (McLean, 1982); Electrical conductivity (EC) in the saturated paste extract (Rhoades, 1982): Organic matter (OM) by the Walkley and Black's method (Nelson and Sommers, 1982); Total Nitrogen (N) by Kjeldahl method (Bremner and Mulvaney, 1982); and total phosphor (P) by the Olsen method (Olsen et al., 1982). Saturated moisture (SP) and effective soil depth (EP) determined by weighting method, Potassium (K) by flame photometry method (Knudsen et al., 1982); PSS by U.S. Salinity laboratory formula and the proportion of $CaCO_3$ by the Calsimeter method (Allison and Moode, 1962). To determine $CaSO_4$, the ammonium acetate extraction method was used (Knudsen,1982). Soil texture was determined by the Bouyoucous hydrometer method (Bouyoucos, 1962); hydraulical parameters such as field capacity (FC), wilting point (WP), available water (AW), saturation hydraulic conduct (Shc) and bulk density (Bd) estimated according to soil texture with application of CROPWAT 8.0 software.

2.4. Data analysis

Floristic analysis was performed with PC-ORD, V.4.17 package (McCune et al., 1999). The two-way indicator species analysis (TWINSPAN) was used to classify the vegetation samples in to groups based on untransformed Braun-Blanquet cover abundance scores. In addition, to confirm TWINSPAN, the floristic data were subjected to Cluster Analysis using Euclidian distance and the Ward group linking method (Hill, 1979). SPSS for windows (Ver.11.5) software package was used for multivariate statistical analysis. After classification of the vegetation, Principal component analysis (PCA) was applied to search for a general pattern in the measured environmental variables and to determine the most environmental effective factor in the distribution of vegetation.

3. Results and discussion

3.1. Classification

The TWINSPAN classification of 200 plots resulted in identifying of five site groups (Fig. 2), each site group will be referred here to as TWINSPAN vegetation group, and named after the leading dominant species that exert the local dominance or is distinctly important in a certain group of sites. These types are as follows:
1. *Artemisia sieberi – Atraphaxis spinosa*
2. *Zygophyllum eurypterum– Artemisia sieberi*
3. *Pteropyrum aucheri – Zygophyllum eurypterum*
4. *Tamarix sp. – Salsola kali*
5. *Artemisia sieber- Ephedra strobilacea*

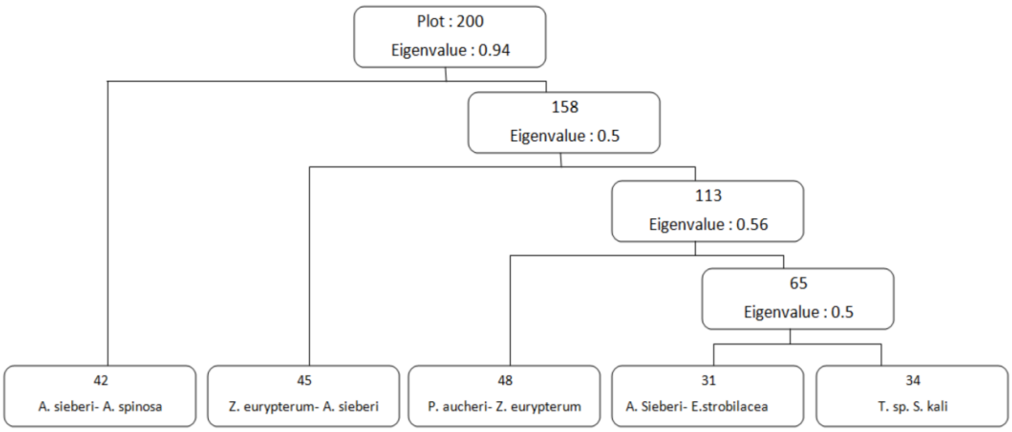

Fig. 2. Dendrogram of the TWINSPAN classification

The TWINSPAN results were compared with the classification produced from the Cluster Analysis using Euclidian distance and the Ward group linking method (Fig. 3); thereby, the results outputted from the two techniques were in accordance with each other. To examine whether the mentioned groups had significant difference or not, some factors like topographic and soil characteristics were analyzed using One-way ANOVA test (Table 1).

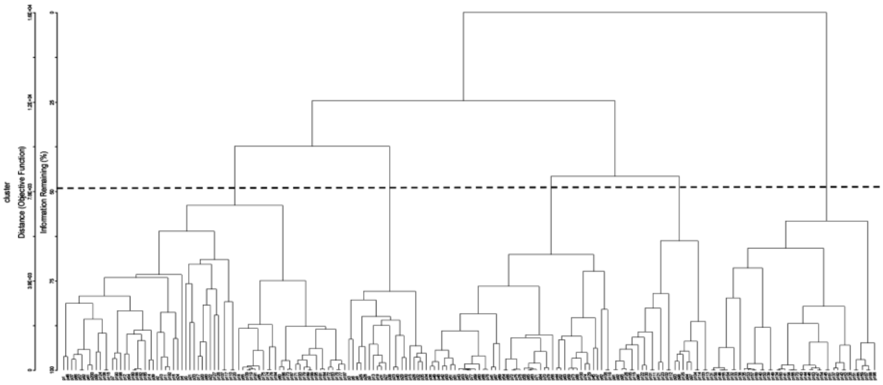

Fig. 3. Dendrogram of the Cluster Analysis classification

Table 1. Environmental factors of the five vegetation types of the study area

Statistical		Vegetation types					Types / Factor	Environmental variable
P-values	F-ratio	**A. se- E. st**	**T. sp- S. ka**	**P. au- Z. eu**	**Z. eu- A. se**	**A. se- A. sp**		
0.003	4.891	7.84	7.98	7.70	7.63	7.79	pH 1	Chemical properties
0.001	6.425	7.69	7.93	7.70	7.61	7.79	Ph 2	
0.00	7.628	0.41	1.92	0.37	0.40	0.45	EC 1	
0.00	16.396	0.53	2.01	0.32	0.41	0.31	EC 2	
0.001	5.608	0.34	0.81	0.43	0.28	0.55	OM 1	
0.028	3.114	0.14	0.30	0.34	0.28	0.35	OM 2	
0.00	8.315	0.04	0.06	0.02	0.02	0.03	N 1	
0.07	2.398	0.02	0.03	0.01	0.01	0.02	N 2	
0.001	6.543	32.35	25.05	18.51	10.50	23.95	P 1	
0.013	3.716	11.25	24.60	16.57	9.75	20.90	P 2	
0.004	4.785	13.03	18.56	8.07	6.82	12.62	K 1	
0.063	2.476	4.85	8.68	5.28	6.59	5.53	K 2	
0.019	3.43	8.26	10.94	8.66	8.05	12.55	$CaCo_3$ 1	
0.036	2.924	7.84	10.13	7.75	8.44	13.59	$CaCo_3$ 2	
0.00	10.286	11.72	20.92	39.77	42.65	3.57	$CaSo_4$ 1	
0.013	3.721	31.40	27.53	40.35	42.85	15.85	$CaSo_4$ 2	
0.003	5.065	0.01	0.03	0.01	0.01	0.01	PSS 1	
0.000	11.579	0.01	0.03	0.01	0.01	0.01	PSS 2	
0.002	5.323	26.57	42.80	29.60	22.00	50.88	Gravel 1	Physical properties
0.001	5.808	25.24	53.30	36.98	36.38	61.82	Gravel 2	
0.002	5.323	14.69	11.44	14.08	15.60	9.82	EP 1	
0.001	5.808	29.90	18.68	25.21	25.45	15.27	EP 2	
0.065	2.454	61.00	58.50	68.91	73.25	60.75	Sand 1	
0.296	1.282	68.75	67.75	76.13	77.00	70.50	Sand 2	
0.084	2.254	21.75	29.00	22.53	18.25	17.50	Silt 1	
0.83	3.67	18.25	18.00	17.19	15.50	16.00	Silt 2	
0.00	6.958	17.25	12.50	8.56	8.50	21.75	Clay 1	
0.347	1.157	13.00	14.25	6.69	7.50	13.50	Clay 2	
0.050	2.556	1.48	1.53	1.74	1.73	1.44	Bb 1	
0.103	2.102	1.92	1.45	1.78	1.89	1.54	Bb 2	
0.000	6.793	0.12	0.10	0.08	0.08	0.14	WP 1	Hydraulical properties
0.4	1.044	0.08	0.24	0.07	0.06	0.23	WP 2	
0.017	2.528	0.22	0.21	0.16	0.16	0.24	FC 1	
0.597	0.701	0.15	0.19	0.15	0.13	0.18	FC 2	
0.132	1.911	33.39	27.48	31.68	32.82	27.78	SP 1	
0.00	12.039	27.05	25.67	33.45	37.59	27.97	SP 2	
0.041	2.807	1.27	2.51	3.01	3.27	0.88	Shc 1	
0.402	1.039	1.44	2.10	3.55	3.73	2.36	Shc 2	
0.121	1.978	0.11	0.12	0.09	0.08	0.10	AW 1	
0.091	2.198	0.06	0.11	0.08	0.07	0.11	AW 2	
0.000	565.678	1164	1125	1158	1199	1195	Elevation	Topographical variable
0.014	3.646	1.48	2.58	7.53	7.41	6.93	Slope	
0.00	46.404	flat	North east	South west	west	South east	Aspect	

Code 1and 2 are related to the soil properties were measured in the first layer (0-20 cm) and the second layer (20-60 cm), respectively.

Result indicated that most of measured parameters showed highly significant differences among groups, meaning that TWINSPAN groups had significant differences. Soil characteristics of each of the five vegetation groups are summarized in Table 1. Of the measured soil parameters, soil texture, nitrogen and potassium of the second layer and the soil moisture factor show least significant differences between groups. A brief description of each type is coming as follow:

1. *Artemisia sieberi – Atraphaxis spinosa* type. Soil texture in the first and the second layer was Sandy clay loam and Sandy loam, respectively. This type was founded in the places with the highest percentage of gravel, lime, WP and FC and the lowest amount of EP and gypsum.

2. *Zygophyllum eurypterum– Artemisia sieberi* type. Soil texture in the first and the second layer was Sandy loam and loamy Sand, respectively. This type was found in the mountain and alluvial fan land unit. The amount of sand, gypsum, SP and Shc of this type is the highest of all the types while pH, P, N, OM, K and AW is the lowest.

3. *Pteropyrum aucheri – Zygophyllum eurypterum* type. Soil texture in the first and the second layer was Sandy loam and loamy Sand, respectively. the highest of Bd and the lowest of EC, clay, WP, FC and PSS was observed in this type.

4. *Tamarix sp. – Salsola kali* type. Soil texture in two layers was sandy loam. This type was found in the river trace land unit (low land) with the highest EC, pH, PSS, K, N, AW and OM and the lowest of content of sand, SP and Bd.

5. *Artemisia sieber- Ephedra strobilacea* type. Soil texture in two layers was Sandy loam. In this type the content of silt, EP and P was the highest compared with the other types but percentage of gravel was the lowest of all.

3.2. PCA

Principal component analysis (PCA) was performed for soil and vegetation analysis in order to determine the most effective soil parameters controlling the distribution of vegetation. Five plant types and 43 environmental factors were used in the analysis. The first three axes of the PCA ordination of soil samples accounted for 58.77%, 20.09% and 18.32% of the total variability, respectively. Therefore, the first three principal components together accounted for 98.19% of the total variance in data set (Table 2).

Table 2. PCA applied to the correlation matrix of the environmental factors in the study area

Eigenvector						Axis / Factor	variable
6	5	4	**3**	**2**	**1**		
0/00	0.00	1.208	7.880	8.639	25.273	Eigenvalue	PCA
2.067	2.267	2.517	2.850	3.350	4.350	Broken-stick	
0.00	0.00	2.810	18.326	20.090	58.774	%of Variance	
100	100	100	**97.190**	78.864	58.774	Cum.% of Var.	
-0.0053	**-0.5284**	-0.0489	0.1422	0.0358	-0.1809	pH 1	Chemical properties
-0.0711	**0.7895**	-0.0962	-0.0113	0.1099	-0.1870	Ph 2	
0.0122	-0.0026	0.1524	0.0717	**0.2129**	-0.1462	EC 1	
0.0605	0.0005	0.1775	0.1167	**0.2086**	-0.1376	EC 2	
-0.0912	-0.0589	-0.0912	-0.0338	0.1462	**-0.1775**	OM 1	
0.1303	-0.0445	-0.2229	**-0.3158**	0.1293	-0.0196	OM 2	
0.0580	0.0043	0.0999	0.1198	0.0849	**-0.1793**	N 1	
0.0203	0.0383	**0.2011**	0.0688	-0.0097	-0.1901	N 2	
0.0131	0.0305	**-0.2441**	0.1934	-0.1668	-0.1247	P 1	
-0.1746	-0.0585	**-0.2323**	-0.1116	0.1106	-0.1701	P 2	
0.1240	-0.0275	0.0556	0.1083	0.0325	**-0.1882**	K 1	
-0.1077	-0.0189	**0.3851**	0.0004	0.2595	-0.0972	K 2	
-0.1322	0.0051	-0.0211	**-0.2051**	-0.0458	-0.1604	$CaCo_3$ 1	
0.0751	-0.0076	0.1375	**-0.2446**	-0.1023	-0.1282	$CaCo_3$ 2	
-0.0113	-0.0174	-0.0088	-0.0059	**0.2288**	0.1472	$CaSo_4$ 1	
0.0457	-0.0138	0.0006	0.1094	0.1606	**0.1644**	$CaSo_4$ 2	
0.1710	-0.0140	0.1622	0.0793	**0.2173**	-0.1422	PSS 1	
0.1185	-0.0111	0.2203	0.1127	**0.2290**	-0.1240	PSS 2	
0.0809	-0.0566	-0.1164	**-0.1802**	-0.0401	-0.1681	Gravel 1	Physical properties
-0.0995	-0.0098	0.0581	**-0.2577**	0.0378	-0.1350	Gravel 2	
0.0018	-0.0152	0.1164	**0.1802**	0.0401	0.1681	EP 1	
0.0101	-0.0055	-0.0581	**0.2577**	-0.0378	0.1350	EP 2	
0.0744	0.0693	0.1052	-0.0863	0.0857	**0.1850**	Sand 1	
-0.0614	-0.0751	-0.0523	-0.1407	0.0847	**0.1755**	Sand 2	
0.0806	-0.0544	-0.1812	0.1819	**0.2203**	-0.1054	Silt 1	
0.0624	-0.0774	**-0.3649**	0.2873	0.0244	-0.0852	Silt 2	
-0.0056	0.0063	0.0289	-0.0501	**-0.2687**	-0.1186	Clay 1	
0.1016	0.0220	**0.1848**	0.0705	-0.1088	-0.1798	Clay 2	
0.0019	0.0114	-0.0964	-0.04144	**0.1989**	0.1583	Bb 1	
-0.0145	0.0133	0.0537	0.1468	-0.1022	0.1707	Bb 2	
-0.0704	0.0503	0.0379	-0.0414	**-0.2507**	-0.1322	WP 1	Hydraulical properties
0.0121	0.0187	0.0999	-0.1216	0.0096	**-0.1856**	WP 2	
-0.0387	-0.0313	0.0465	0.0257	**-0.1941**	-0.1624	FC 1	
-0.0477	-0.700	-0.710	-0.0849	0.0201	**-0.1922**	FC 2	
-0.1457	0.0834	0.0237	**0.1736**	-0.0724	0.1684	SP 1	
-0.0154	0.0355	0.1502	-0.1126	0.0846	**0.1791**	SP 2	
-0.0145	-0.0145	0.0522	0.0024	**0.2848**	0.1082	Shc 1	
-0.0324	-0.0047	-0.0254	**-0.1887**	0.1632	01391	Shc 2	
0.0305	-0.0046	0.0398	0.1184	-0.0186	**-0.1871**	AW 1	
0.0136	-0.0490	-0.0596	-0.1656	0.0939	**-0.1668**	AW 2	
-0.2832	-0.1823	**0.3220**	-0.1919	-0.1887	0.1047	Elevation	Topographical variable
0.5716	-0.0490	-0.1071	-0.2970	0.0400	0.1047	Slope	
0.5622	0.0721	0.1995	0.0771	-0.2869	0.0876	Aspect	

Code 1and 2 are related to the soil properties were measured in the first layer (0-20 cm) and the second layer (20-60 cm), respectively.

PCA axis 1 showed significant correlation with Sand% and AW of two layers; OM, K and N of first layer and CaSo4, SP, WP and Fc of second layer. PCA axis 2 represents significant correlation with EC, PSS and AW of two layers; silt%, clay, CaSo4, WP and Fc, Bd and Shc of the first layer and finally PCA axis 3 includes $CaCo_3$, gravel% and EP of two layers, SP of the first layer and OM and Shc of the second layer. Spatial distribution of vegetation types are shown in Fig 4 and 5.

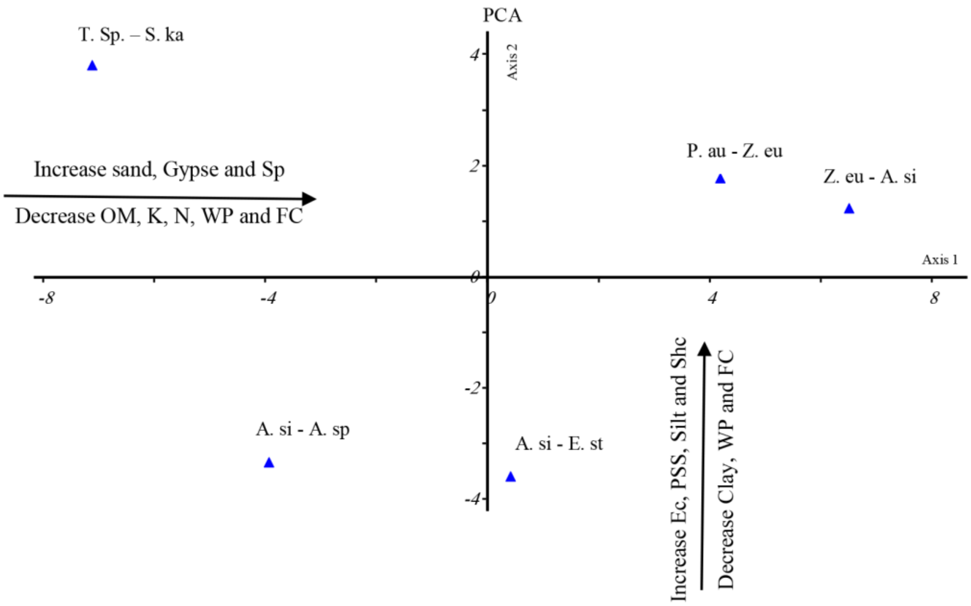

Fig. 4. Axis 1 and 2 of the PCA diagram of the vegetation types related to the environmental factors in the study area

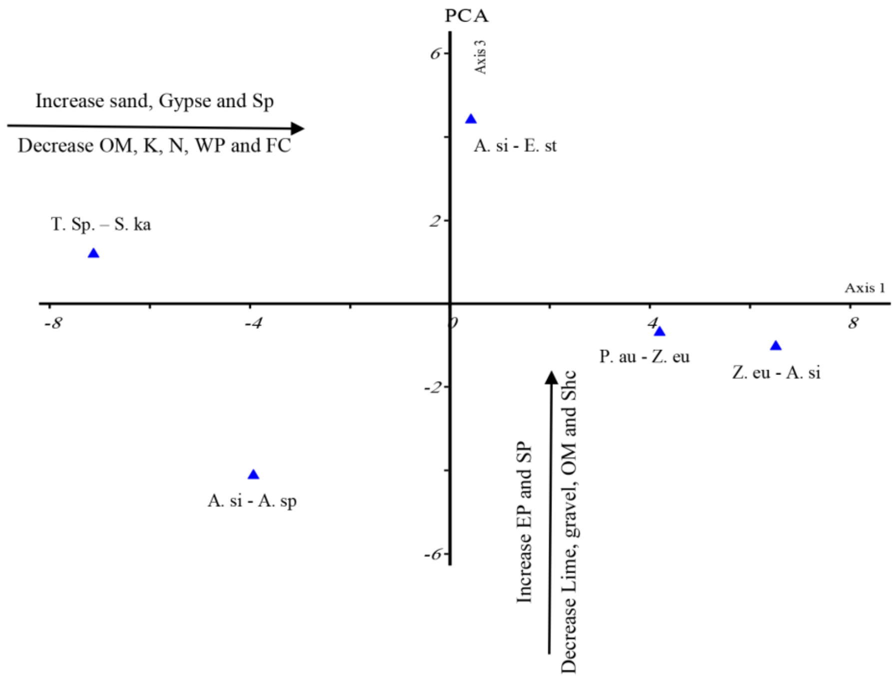

Fig. 5. Axis 1 and 3 of the PCA diagram of the vegetation types related to the environmental factors in the study area

Z. eurypterum – *A. sieberi* and *P. aucheri* – *Z. eurypterum* types comforted in the first quarter of the PCA axes 1 and 2. According to the diagram, axes 1 factors have the most role in distribution of these types, as they have a positive relationship with sand% of two layers, $CaSo_4$ and SP of the second layer and inverse relation with OM, K, N, WP and FC.

In related to *A. sieber*- *E. strobilacea* type according to the Figs 4 and 5 it has a high correlation with the second and third axes. Therefore, this type has the most negative relation with variables of the second axis and most positive relation with variables of the third axis. Increase in the EP, clay, WP and FC in two layers and SP in first layer in one hand and decrease in the $CaCo_3$, EC, PSS and gravel in two layers and silt and Shc in the first layer in other hand controlling the distribution of this type.

T. sp. – S. kali type situated in second quarter of the PCA axes and environmental characteristics are approximately similar in axes 1 and 2. This type represents high correlation with the EC, PSS in two layers, OM, K, N, silt, $CaCo_3$, Bd and Shc in first layer and WP and FC in second layer. With attention to the position of *A. sieberi – A. spinosa* type in the third quarter of the diagram, it has a correlation approximately similar in negative part of axes 1 and 2 or 1 and 3. Therefore, this type has the most relation with variables such as OM, K, N and clay in first layer and WP and FC in two layers. This type has inverse position compare to *P. aucheri – Z. eurypterum* type, it means that decrease in factors which explain distribution of this type lead to present of *P. aucheri – Z. eurypterum* type.

4. Conclusion

The PCA results have indicated that, the spatial distribution of vegetation type seems to be controlled by a number of soil characteristics such as soil texture, EC, OM, K, N, Bd, EP, CaCo3, $CaSo_4$ and soil moisture content. In other words, the spatial distribution of the vegetation types are related to three characteristics including soil texture, soil fertility and soil moisture content. For example the species composition of *A. sieber- E. strobilacea* seems to be more influenced by effective soil depth than the other vegetation types, because it was found on flat sites with deep soil, whereas other vegetation types were observed on rocky sites. Kinucan et al. (Kinucan,1999) in an investigation in an alpine rangeland in USA found that the type of vegetation present on a particular site controlled by soil depth. They considered that this variation was due to difference in total water storage capacity, which is a function of soil depth. Available soil nitrogen in the area was another important soil factor in the distribution of vegetation types. With an increase in soil salinity, the available nitrogen decreased significantly. For example, *T. sp. – S. kali* type was different from other types in soil salinity and available nitrogen. Our results were similar to those reported previously by Jafari et al. (2003), 2004; Abd El-Ghani et al. (2003) and He et al. (2007) that showed strong relationships between vegetation pattern and soil moisture–salinity gradient. In addition, most ecologists believe that nitrogen availability and plant community structure are related and it is likely that nitrogen availability can acts as a good indicator of current and historic soil conditions and plant populations (Bauer and Black, 1994; Wedin, 1999; Wedin and Tilman, 1990) Soil texture and $CaSo_4$ are other effective factors in the distribution of *Z. eurypterum – A. sieberi* and *P. aucheri – Z. eurypterum* types. *Z. eurypterum* is the gypsophyte plant that grows in the gypsious lands and indicates soils with high gypsum. These results were in conformity with the results reported by Jafari et al. (2004) and He et al. (2007). They recommended that Soil texture and $CaSo_4$ controls distribution of plant species. He et al. (2007) mentioned that the soil texture plays a significant role in regulating vegetation pattern, including vegetation composition, functional group, and structure. Furthermore, soil texture influences infiltration and moisture retention and the availability of water and nutrients to plants (Sperry and Hacke, 2002). Based on the results obtained in the study area, the distribution of vegetation types was more correlated with soil characteristics than the topographic variables. Understanding the relationships between environmental variables and vegetation distribution in this area helps us to apply these findings in sustainable and integrated management, reclamation, and development of arid and semi-arid ecosystems. It is expected that this finding could be used as a tool for vegetation distribution pattern in rangeland within similar ecosystems.

References

Abd El-Ghani, M.M. & Wafaa, M.A., 2003. Soil–vegetation relationships in coastal desert plain of southern Sinai, Egypt. *Journal of Arid Environment*, 55, 607-628.

Abd EI-Ghani, M.M., 1998. Environmental correlations of species distribution in arid desert ecosystems of

eastern Egypt. *Journal of Arid Environment*, 38, 297-313.
Abd El-Ghani, M.M. & El-Sawaf, N.A., 2005. The coastal roadside vegetation and environmental gradients in the arid lands of Egypt. Community *Ecology*, 6, 143-154.
Allison, L.E. & Moode, C.D., 1965. *Methods of Soil Analysis.* Part 2. Agronomy Series, vol. 9, American Society of Agronomy, Wisconsin Series: 1379-1396.
Bauer, A. & Black, A.L., 1994. Quantification of the effect of soil organic matter content on soil productivity. *Soil Science Society of America Journal*, 58, 185-193.
Bindraban, P.S., Stoorvogel, J.J., Jansen, D.M., Vlaming, J. & Groot, J.J.R., 2000. Land quality indicators for sustainable land management: proposed method for yield gap and soil nutrient balance. *Agriculture, Ecosystems & Environment*, 81, 103-112.
Bouyoucos, G.J., 1962. Hydrometer method improved for making particle size analyses of soils. *Agronomy Journal*, 54, 464-465.
Bremner, J. M. & Mulvaney, C.S., 2004. Nitrogen—total. In: Page, A.L. (Ed.), Methods of Soil Analysis, vol. 2. American Society, Corney, P. M., Le Duc, M. G., Smart, S. M., Kirby, K. J., Bunce, R. G. H., Marrs, R. H. The effect of landscape-scale environmental drivers on the vegetation composition of British woodlands. *Biological Conservation*, 120, 491-505.
FAO. Land Evaluation for Development FAO, Rome, Italy, 1980.
He, M.Z., Zheng, J.G., Li, X.R. & Qian, Y.L., 2007. Environmental factors affecting vegetation composition in the Alxa Plateau, China. *Journal of Arid Environments*, 69, 473-489.
Herrick, J.E., Brown, J.R., Tugel, A.J., Shaver, P.L. & Havstad, K.M., 2002. Application of soil quality to monitoring and management: paradigms from rangeland ecology. *Agronomy Journal*, 94, 3-11.
Hill, M.O., 1979. TWINSPAN-a FORTRAN program for arranging multivariate data in an ordered two- way table by classification of the individuals and attributes. Ecology and Systematics. Cornell University, Ithaca, New York, USA.
Iranian Meteorological Organization, 2006. Climatic Data. Karaj Station, Tehran Province, Iran. 2005Lu, T., Ma, K. M., Zhang, W.H., Fu, B. J. Differential responses of shrubs and herbs present at the Upper Minjiang River basin (Tibetan Plateau) to several soil variables, *Journal of Arid Environments*, 67, 373-390.
Jafari, M., ZareChahouki, M.A., Tavili, A., Azarnivand, H. & Tavili, A., 2003. Soil – vegetation relationships in Hoz-e-soiltan region of Qom Province, Iran, *Pakistan Journal of Nutrition*, 2(6), 329-334.
Jafari, M., ZareChahoukib, M.A., Tavili, A., Azarnivand, H. & ZahediAmiri, GH., 2004. Effective environmental factors in the distribution of vegetation types in Poshtkouh rangelands of Yazd Province (Iran). *Journal of Arid Environments*, 56, 627-641.
Kinucan, R., Loomis, L., Warnock, B. & Cearley, K., 1999. Banded vegetation and soil patterns in the Stockton Plateau, west Texas, USA, 122-123, In D. J. Eldridge and D. Freudenberger (ed.) 1999. People and rangelands: building the future. *Proceedings of the VI International Rangeland Congress*, Townsville, Queensland, Australia, Townsville, Queensland, Australia. Aitkenvale, Australia.
Knudsen, D., Peterson, G.A. & Pratt, P., 1982. Lithium, sodium, and potassium. In: Page, A.L. (Ed.), *Methods of Soil Analysis. Part, American Society of Agronomy*, vol. 2. Soil Science Society of America, Madison, Wis., 225-246.
Martinez-Fernandez, J., Lopez-Bermudez, F. & Romero-Diaz, A., 1995. Land use and soil-vegetation relationships in a Mediterranean ecosystem: E1 Ardal, Murcia, Spain. *Catena*, 25, 153-167.
McCune, B. & Mefford, M.J., 1999. Multivariate Analysis of Ecological Data. Ver 4. MjM Software Design, Gleneden Beach, Oregon, USA.
McLean, E.O., 1982. *Soil pH and lime requirement*. In: Page, A.L. (Ed.), Methods of Soil Analysis. Part, American Society of Agronomy, vol. 2. Soil Science Society of America, Madison, Wis., 199-224.
Nelson, D.W. & Sommers, L.E., 1982. *Total carbon, organic carbon, and organic matter*. In: Page, A.L. (Ed.), Methods of Soil Analysis, American Society of Agronomy, vol. 2. Soil Science Society of America, Madison, Wis.: 539-579.
Olsen, S.R. & Sommers, L.E., 1982. Phosphorus. In: Page, A.L. (Ed.), *Methods of Soil Analysis*, American Society of Agronomy, vol. 2. Soil Science Society of America, Madison, Wis., 403-430.
Rezaei, S.A., 2003. The use of a soil quality index in site capability assessment for extensive grazing. PhD Dissertation, University of Western Australia, Perth, Australia.
Rhoades, J.D., 1982. Soluble salts. In: Page, A.L. (Ed.), *Methods of Soil Analysis*, American Society of Agronomy, vol. 2. Soil Science Society of America, Madison, Wis,: 167-179.
Soleimani, K., Kordsavadkooh, T. & Muosav, S.R., 2008. The Effect of Environmental Factors on Vegetation Changes Using GIS (Case Study: Cherat Catchment, Iran). *World Applied Sciences Journal*, 3(1), 95-100.
Sperry, J.S. & Hacke, U.G., 2002. Desert shrub water relations with respect to soil characteristics and plant functional type. *Functional Ecology*, 16, 367-378.
Tavili, A., Rostampoyr, M., ZareChahouki, M.A. & Farzadmehr, J., 2009. CCA application for vegetation-environment relationship evaluation in arid environments (southern Khorasan rangelands). J. *Desert*, 14(1), 101-111.
Wedin, D.A., 1999. *Nitrogen availability, plant-soil feedbacks and grassland stability*, 193-197, In D. J. Eldridge and D. Freudenberger (ed.) People and rangelands: building the future. Proceedings of the VI International Rangeland Congress, Townsville, Queensland, Australia, Townsville, Queensland, Australia. Aitkenvale.
Wedin, D.A. & Tilman, D., 2008. Species effects on nitrogen cycling: a test with perennial grasses. *Oecologia*, 84, 433-441.
Xu, X.L., Ma, K.M., Fu, B.J., Song, C.J. & Liu, W., 2008. Relationships between vegetation and soil and topography in a dry warm river valley, SW China. *Catena*, 75(2), 138-145.
Zare, S., 2009. *Study of some dry land vegetation-soil characteristics relationships (case study: Chaharbagh rangelands of Shahriyar, Iran)*, M.Sc. Thesis, University of Tehran, Tehran, Iran, 120 P. (in Persian).