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Author(s): Behnam Bahrami, Ardavan Ghorbani, Mohammad Jafari, Fereidoun Rezanezhad, Abazar Esmali
* Corresponding author. Email: b.bahrami31@gmail.com

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The full retraction notice in PDF is preceding the original paper, which is marked "RETRACTED".

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Investigation of Relation Vegetation and Some Soil Physico-Chemical Characteristics in Three Rangeland Habitats

Behnam Bahrami[1*], Ardavan Ghorbani[2], Mohammad Jafari[3], Fereidoun Rezanezhad[4], Abazar Esmali[2]

[1]PhD Student of Rangeland Department, Mohaghegh Ardabili University, Ardabil, Iran
[2]Assosiated Professor of Rangeland and Watershed Management Department, University of Mohaghegh Ardabili, Ardabil, Iran
[3]Professor of Rangeland Department, Tehran University, Tehran, Iran
[4]Ecohydrology Research Group, Department of Earth and Environmental Sciences, University of Waterloo, Waterloo, Canada
Email:*ardavanica@yahoo.com

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Abstract

Knowledge of the effect of ecological factors on establishment of vegetation distribution is crucial in the management of rangeland ecosystem. The aim of this study is to investigate relation between soil factors and plant species to determine the most effective factors between in three rangeland habitats; grassland, grassland-shrubland and shrubland in the Khanghah watershed of Urmia (Iran). The present species were recorded in each habitat using a randomized-systematic sampling method. In each habitat canopy cover and density of plant species were estimated within 30 quadrates of 1 m^2 of located along 3 transect of 100 m. The soil samples were taken from the depth of 0 - 15 and 15 - 30 cm of the soil within 30 quadrates. Soil properties organic carbon, particulate organic matter-carbon, soil organic matter, clay, silt, sand, pH, EC, bulk density, phosphorus, potassium and $CaCO_3$ were measured. Relationships between soil factors and vegetation were determined using Multivariate techniques including Detrended Correspondence Analysis (DCA) and Canonical Correspondence Analysis (CCA). The results of the CCA showed that among soil factors, EC and Organic Matter are the most effective for describing the distribution of vegetation in three rangeland sites. In grassland habitat with reduction of nutrients, at first, grasses will replace the forbs and in the next stage, the grasses are replaced by shrubs. This trend is accompanied by decrease of organic matter, organic carbon, clay and silt. Ultimately the pH, EC, potassium, and $CaCO_3$ rate will increase in the shrub land.

Keywords

Grassland, Grassland-Shrubland, Habitat, Soil Factors

1. Introduction

Relationship between environmental parameter and vegetation cover is important to manage rangeland ecosystems and also helps to determine the main factors which can affect on vegetation cover changes. Vegetation is a main part of rangelands. Existence of each plants need to specific factors such as climate, topography and soil [1]. Investigating the relationship between plant species and environmental variables has been the aim of many ecological studies [2] [3].

Ecologists have documented that environmental variables may control plant species distribution and composition [4] [5]. Soil, is one of the most important environmental factors which affects the distribution and plant growths, and plays an important role in plant ecology [6]. The physical and chemical properties of soil, particularly in the rooting zone, play a very important role in shaping vegetation [7].

Thus, the distributions of vegetation more closely resemble to the changes in the soil characteristics [8]. Plants like animals and humans alike are attracted to locations where the site conditions are favourable to them, which suggest that differences in the distribution and abundance of plant species in any environment are an indication of the variation in soil properties [9] [10].

Several studies emphasized the influence of varying soil properties on the distribution and abundance of flora species in different locations [11] [12] [13] [14] [15].

Previous results, showed that the soil factors such as salinity, sand, sodium, potassium, magnesium and calcium, best correlated with distribution of vegetation in Failaka Island [16]. The results showed that the relationship of soil salinity with vegetation biomass, and that of soil salinity with available nitrogen were both negative [17]. Biomass was the main vegetation factor in indicating soil salinity.

According to previous results showed that distribution of communities is correlated with some soil variables (soil texture, soil moisture, organic matter, nitrogen and phosphorus [18]. Researches showed that the spatial distribution and densities tree/shrub species were selective with respect to varying soil properties [19].

The results, showed that the vegetation distribution was related to elevation, slope, and soil characteristics such as texture, organic matter, gypsum, acidity, lime, and gravity percentage [20].

Researcher reported that chemical properties such as organic matter and potassium and physical properties such as soil moisture and silt content caused increase soil fertility and consequently increased ecologic habitats in the soil [21].

The former results, Showed that Determination of the soil characteristics that are associated with each of xerophytic species can be used to determine which species is suitable for rehabilitating degraded sites in the study area [22]. Some results showed that soil texture, organic matter, gypsum, salinity, C/N ratio, and elevation greatly affected the distribution of vegetation [23].

To better understand and manage rangeland ecosystems, it is important to study the relationship between environmental factors and plants in these ecosystems. The effects of environmental factors on plant Communities have been the subject of many ecological studies in recent years. In addition, soil-plant relationships have been studied [24] [25].

Thus, determining which factors control the presence, number, variety, and relative abundance of plant species remains a central goal in ecology. The main purpose of this study was to investigate the relationship between soil factors with plant species to determine the most effective factors separating in three rangeland habitats.

2. Materials and Methods

2.1. Study Area

The study was conducted in Khanghah watershed between latitudes 37˚46'18"N and 37˚50'42"N and longitudes 44˚57'04"E and 45˚00'32"E. Mean annual precipitation and temperature are 393.9 mm and 9.87˚C, respectively. In this study, 3 sites including grass land, shrub land, and grass-shrub land with the same geographical elevation and aspect were selected as shown in **Figure 1**.

2.2. Data Collection

The sampling process was conducted during May of 2015, when most species were expected to be growing. The present species were recorded in each habitat using a randomized-systematic sampling method. Vegetation sampling in each site has been done in the key area. In each habitat canopy cover, density and frequency of each plant species were estimated quantitatively using the transect and quadrate methods.

Density of plant species were estimated with in 30 quadrates of 1 m^2 of located along 3 transect of 100 m. In the area sampled, elevation, slope and aspect were recorded. Soilsamples were taken from the depth of 0 - 15 and 15 - 30 cm in each quadrate. The soilsamples were transported to the laboratory and it characteristics were analyzed. Soil properties (Organic Carbon, POM-C[1], Soil Organic Matter, Clay, Silt, Sand, pH, EC, Bulk Density, Phosphorus, Potassium and CaCO3 were measured

2.3. Data Analysis

Relationships between soil factors and vegetation were determined using Multivariate techniques including Detrended Correspondence Analysis (DCA) and Canonical Correspondence Analysis (CCA).

DCA is an indirect gradient analysis technique; CCA is a direct gradient analysis. This technique greatly improves the power to detect specific effects of cross variable association and has been shown to be a robust model for detecting the relationship between species and their environment [26].

[1]particulate organic matter-carbon.

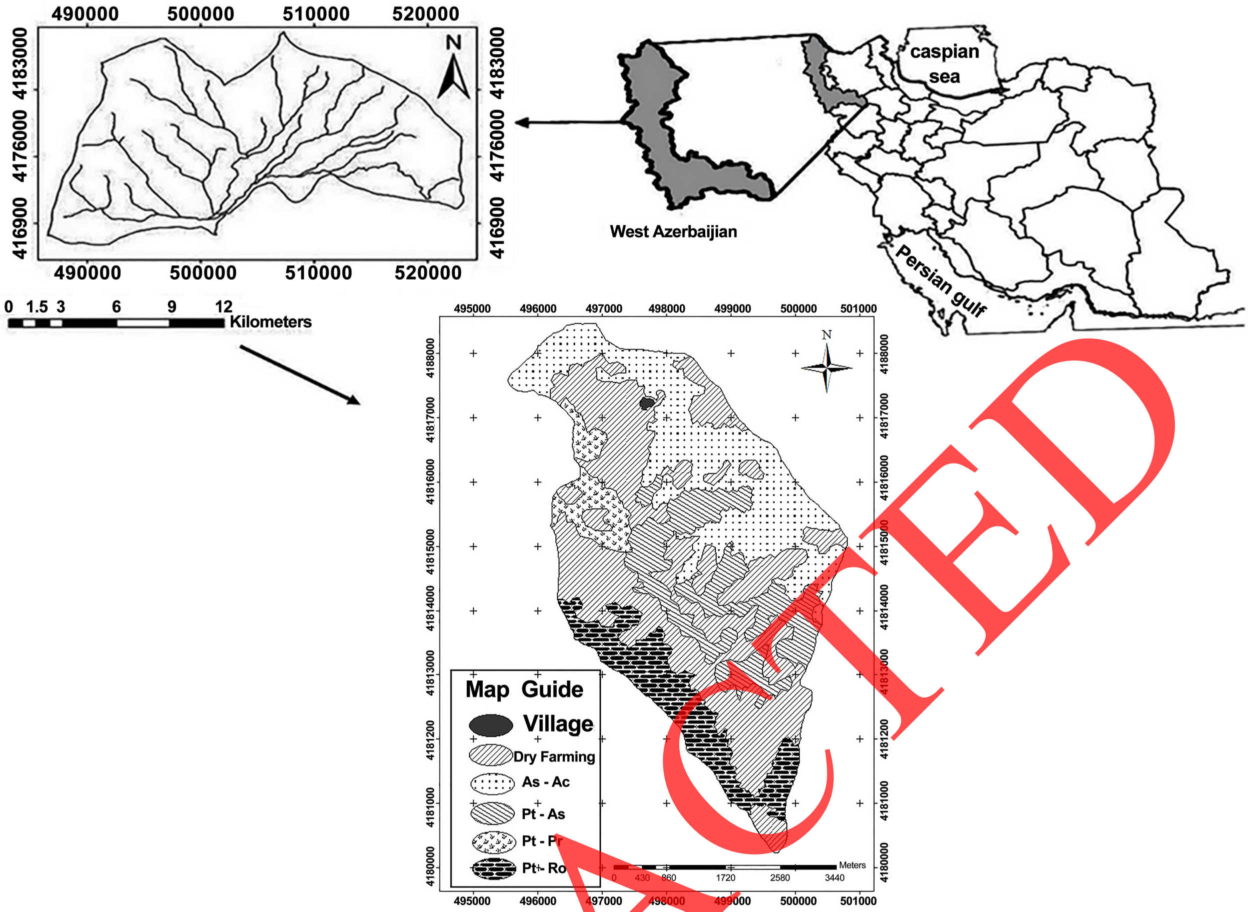

Figure 1. Geographical position of study area.

In the present study, Preliminary DCA analysis was made to check the magnitude of change in species composition along the first ordination axis (*i.e.*, gradient length in standard deviation (SD) units). A gradient length greater than 4 SD indicates a strong unimodal response and the appropriateness of CCA.

CCA analysis was used to determine the relationships between the floristic compositions and the soil variables in the study area. Distribution-free Monte Carlo test permutation (1000 permutations) was used to analyze signification of species-soil correlation and Eigen values of first canonical axis. Prior to analysis all variables were assessed for normality and appropriate transformations were performed. All ordinations, including DCA and CCA, were performed using CANOCO version 4.5 [27].

3. Resulte

3.1. Detrended Correspondence Analysis

The results of the DCA ordination are presented in Table 1. The eigenvalue of the strong first axis was 0.74 and of the second axis 0.50. As shown in Table 1, the first axis (eigenvalue = 0.74) accounted for 10.6% of the variation in vegetation factors is by far the most important. Also gradient length estimated greater than 4 SD, which showed a modest unimodal response and thus the appropriateness of CCA.

3.2. Canonical Correspondence Analysis

There was high correlation between some soil factors, because of that in this study, they were not entered in the analysis CCA. This correlation was observed between carbon and organic matter, thus organic carbon was removed from the calculations. Also was found a high correlation between the %sand with %clay and %silt, that the %sand was not entered in the calculations.

3.3. CCA in First Layer (0 - 15)

The results of CCA ordination in first layer (0 - 15 cm) are presented in Table 2 and Figure 2. The eigenvalue of the strong first axis was 0.57 and of the second axis 0.48. As shown in Table 2, the first axis (eigenvalue = 0.57) accounted for 8.2% of the variation in soil factors and 95 % coefficient of correlation of the environment-species is by far the most important (Table 2).

From the intra-set correlations of soil factors with the first three axes of CCA, it can be noted that CCA axis 1 was correlated to pH (r = 0.69), EC (r = 0.73), Bulk Density (r = 0.65), Gypsum (r = 0.62), POM-C (r = −0.45), Organic Matter (r = −0.41) and Silt (r = −0.38). While the CCA axis 2 was Correlated to potassium (r = −0.55), phosphorus (r = −0.37) and Clay (r = −0.13) (Table 3).

The results of Monte Carlo test showed that, in first layer (0 - 15) among all soil factors, EC ($P < 0.01$) was the most influential features on the distribution of plants for this area. Also soil characteristics such as pH, Gypsum and Bulk Density are the most effective for describing the distribution of vegetation in the study area. Also this factor (EC) showed a significant positive correlation with *Astragalusgossypinus, Alyssumbracteatum* and significant negative correlation with *Trifoliumrepens, Chenopodiumalbum, Asperulaodorata*, *Coronillavaria, Campanula simplex* and *Bupleurumrotundifolium* (Figure 2).

Table 1. Results of DCA analysis for vegetation factors in the study area.

Axes	DCA_1	DCA_2	DCA_3	DCA_4
Eigenvalue	0.74	0.50	0.31	0.23
Lengths of gradient	4.85	3.92	2.85	2.18
Percentage of variance explained	10.6	7.1	4.5	3.3
Cumulative Percentage variance of species data	10.6	17.7	22.2	25.5

Table 2. Results of CCA analysis for soil factors in depth 0 - 15 cm.

Axes	CCA_1	CCA_2	CCA_3	CCA_4
Eigenvalue	0.57	0.48	0.39	0.32
Species-environment correlations	0.95	0.91	0.86	0.85
Cumulative percentage variance of species data	8.2	14.4	20.0	24.6
Cumulative percentage variance of species-environment relation	21.2	37.0	51.4	63.4

Figure 2. CCA-ordination of species in relation to Soil factors in first layer (0 - 15 cm).

Table 3. Results of Monte Carlo test for species-soil correlations in first layer (0 - 15).

Soil factors	Axis1	Axis2	Axis3
pH	**0.69**	−0.51	−0.13
EC	**0.73**	−0.42	−0.09
OM	**−0.41**	−0.11	−0.08
POMC	**−0.45**	0.19	0.05
BD	**0.65**	−0.19	−0.16
Gyp	**0.62**	−0.25	0.16
$CaCo_3$	0.21	0.14	**−0.26**
P	−0.05	**−0.37**	0.05
K	0.40	**−0.55**	−0.01
Clay	0.04	**−0.13**	0.12
Silt	**−0.38**	0.21	0.24

Abbreviations are defined in Appendix A.

3.4. CCA in First Layer (15 - 30)

The results of CCA ordination in depth 15 - 30 cm are presented in Table 3 and Figure 3. Results of CCA analysis for soil factors in depth 15 - 30 cm are shown in Table 4 and the eigenvalue of the strong first axis was 0.59 and of the second axis 0.48. As shown in Table 4, the first axis accounted for 8.5% of the variation in soil factors and 96% coefficient of correlation of the environment-species is by far the most important (Table 4). From the intra-set correlations of soil factors with the first three axes of CCA, it can be noted that CCA axis 1 was correlated to Organic Matter (r = −0.82), EC (r = 0.44), pH (r = 0.25), Clay (r = −0.21) while the CCA axis 2 was Correlated to Potassium (r = −0.41), Bulk Density (r = −0.25), $CaCO_3$ (r = 0.24) and POM-C (r = -0.08). The results of Monte Carlo tests shown in Table 5 and that showed, in first layer (15 - 30) among all soil factors, Organic Matter ($P < 0.01$) was the most influential features on the distribution of plants for this area (Table 5).

Figure 3. CCA-ordination of species in relation to Soil factors in second layer (15 - 30 cm).

Table 4. Results of CCA analysis for soil factors in depth 15 - 30 cm.

Axes	CCA_1	CCA_2	CCA_3	CCA_4
Eigenvalue	0.59	0.48	0.44	0.39
Species-environment correlations	0.96	0.94	0.89	0.87
Cumulative percentage variance of species data	8.5	15.5	21.8	27.5
Cumulative percentage variance of species-environment relation	17.1	31.2	43.9	55.3

Table 5. Results of Monte Carlo test for species-soil correlations in first layer (0 - 15).

Soil factors	Axis1	Axis2	Axis3
Ph	**0.25**	0.07	−0.15
EC	**0.44**	0.12	−0.03
OM	**−0.82**	−0.23	−0.27
POMC	0.03	**−0.08**	−0.07
BD	−0.18	**−0.25**	0.17
Gyp	−0.12	−0.24	**0.39**
CaCo3	0.23	**0.24**	−0.11
P	0.17	−0.06	**0.26**
K	−0.12	**−0.41**	0.11
Clay	−0.21	0.01	−0.07
Silt	−0.27	0.01	**0.34**

Abbreviations are defined in Appendix A.

The results of Monte Carlo test showed that, in second layer (15 - 30) among all soil factors, Organic Matter ($P < 0.01$) was the most influential features on the distribution of plants for this area. Also this factor (OM) showed a significant positive correlation with *Phleumpaniculatum*, *Poabulbosa*, *Ttifoliumpretense*, *Centaureacyanus*, *Malvasylvestris*, *Veronicabiloba* and significant negative correlation with *Rosaconina* (Figure 3).

4. Discussion

Phytosociological and soil studies help us to understanding the formation of plant communities and relationships. These are important because generally when we relate each other to underlying factors, make a better picture of the relationships results. The distributions of vegetation more closely resemble to the changes in the soil characteristics [8]. In this study, the relationship between soil factors with plant species was investigated to determine the most effective factors separating in three rangeland habitats; grassland, grassland-shrubland and shrubland using Canonical Correspondence Analysis (CCA).

Using multivariate analysis methods is useful in determination of relationships between species and environmental factors, because CCA was used commonly by many researchers to investigate this relationship concurrently [2] [5] [28].

Results of CCA showed that distribution of communities is correlated with some soil factors. Also among soil factors, EC (in first layer) and Organic Matter (in second layer) was the most influential features on the distribution of vegetation in three rangeland sites in the study area. In addition, soil characteristics such as pH, Gypsum and Bulk Density were the most effective for describing the distribution of vegetation in the study area.

The relation between species distribution and the characteristics of the upper mineral soil layer(s) has been reported in many scientific documents. Some researcher reported a close relationship between plant species composition and soil chemistry (pH, calcium and organic carbon) [30]. Also some researchers showed that the EC (Electrical Conductivity) was the most influential features on the distribution of vegetation Which were consistent with the results of the present study [29] [30] [31] [32] [33].

Organic matter content as a pivotal soil fertility factor can affect plant diversity. The increases in soil nutrients (OM), improvement in site conditions and decrease in soil bulk density, EC and pH indicated, that this condition was observed in grassland habitat. The changes were mainly attributable to the development of vegetation and interaction between soil and vegetation [34]. The results showed that organic matter content has an important role in the improvement and increasing of the soil cationic capacity [31]. Also, [35] have mentioned the important role of the organic matter in the soil improvement.

According to the results, soil characteristics such as pH, Gypsum and Bulk Density were the most effective for describing the distribution of vegetation in the study area, that this condition was observed in shrubland habitat, because the soil is poor in this habitat and most importantly, the canopy cover is the shrub and grasses are rarely in between the shrubs. The trend of decreasing the soil fertility from grassland to grass-shrub land and shrub land is like the range destruction. When soil fertility decreases, the amount of the shrub increases in the rangeland and vice versa [36] [37] [38] [39].

5. Conclusion

Determining the relationship between soil and plants is a useful way to better understand the ecosystem condition and can help to manage the rangeland ecosystem. In this study, three rangeland sites including grassland, grassshrub land, and shrub land were selected to determine the Relation Vegetation and some soil Physico-chemical characteristics. To remove other parameter which can affect this issue due to different elevation and aspect, three sites were placed in the same elevation and aspect. Results showed that, trend of soil factors form grassland to grass-shrub land and to shrub land is decreasing the organic matter, %-Clay and Silt also increasing the EC, pH, Gypsum and sand. Finally, changes were in rangeland ecosystems function (nutrient cycling in the soil) because of the loss of nutrients, that result in three habitats were separated from the other.

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Abbreviations

Abbreviations of the plant species and Soil factors in the tables and figures.

Achiwilh	*Achilleawilhelmsii*	*Galiver*	*Galiumverum*	*Rha Pall*	*RhamnusPallasii*
Aetharab	*Aethionemaarabicum*	*Helinum*	*Helianthemumnummularium*	*Ros can*	*Rosa canina*
Alys bra	*Alyssum bracteatum*	*Helicplic*	*Helichrysumplicatum*	*Salvaeth*	*Salvia aethiopis*
Aspe odor	*Asperulaodorata*	*Juni com*	*Juniperuscommunis*	*Salvoffi*	*Salvia officinalis*
Astraego	*Astragalusaegobromus*	*Lyco euro*	*Lycopuseuropaeus*	*Scro sp.*	*Scrophularia sp.*
Astrstrib	*Astragalustribuloides*	*Mal syl*	*Malvasylvestris*	*Scut tour*	*Scutellariatournefortii*
Asynampl	*Asyneumaamplexicaule*	*Matt fari*	*Matthiola farinose*	*Sedualb*	*Sedum album*
Bro tom	*Bromustomentellus*	*Ment spic*	*Menthaspicata*	*Stacbyz*	*Stachysbyzanthina*
Buprotu	*Bupleurumrotundifolium*	*Musneg*	*Muscarineglectum*	*Stac lava*	*Stachyslavandulifolia*
Camp simp	*Campanula simplex*	*Nep cra*	*Nepetacrassifolia*	*Teucpoli*	*Teucriumpolium*
Caps burs	*Capsella bursa-pastoris*	*Phle pan*	*Phleumpaniculatum*	*Thal tum*	*Thalictrumtumens*
Cent cya	*Centaureacyanus*	*Phle pre*	*Phleum pretense*	*Traggra*	*Tragopogongraminifolius*
Cent vir	*Centaureavirgata*	*Phlo can*	*Phlomiscancellata*	*Trifpra*	*Trifolium pretense*
Chen alb	*Chenopodium album*	*Plan atr*	*Plantagoatrata*	*Trif rep*	*Trifoliumrepens*
Cirsvul	*Cirsiumvulgare*	*Poabul*	*Poabulbosa*	*Verb tha*	*Verbascum Thapsus*
Coro var	*Coronillavaria*	*Poa tri*	*Poatrivalis*	*Vero ana*	*Veronica anagalis*
Cous com	*Cousinia commutate*	*Pota spec*	*Potentillaspeciosa*	*Vero auc*	*Veronica aucheri*
Cous com	*Cousinia commutate*	*Pote rec*	*Potentilla recta*	*Vero bilo*	*Veronica biloba*
Dian orie	*Dianthus orientalis*	*Prihete*	*Primulaheterochroma*	*Vici per*	*Viciapersica*
Fes ovi	*Festucaovina*	*Prunvul*	*Prunella vulgaris*		
pH	Acidity	POMC	particulate organic matter-carbon	$CaCo_3$	Calcium carbonate
EC	Electrical conductivity	BD	Bulk Density	P	Phosphorus
OM	Organic matter	Gyps	Gypsum ($CaSo_4$)	K	Potassium