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The Effect of Ecological Factors on Vegetation in Hamedan Alvand Region (Iran)

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ABSTRACT: The objective of this research was to study the relationships between environmental factors and vegetation in order to find the most effective factors in the distribution of plant species in Hamedan Alvand region. Sampling of soil and Floristic composition were performed with Eco-phytosociology method with emphasis on physiognomic-floristic-ecologic criteria. The data analysis was performed by using Anaphyto Software in F.C.A. and A.H.C. Method. In this survey, 143 special stations (releve) were studied. Floristic and ecological data were estimated quantitatively within each releve. Results showed that the effective ecological factors of the region were classified as the principal, determinant and differential ecological factors. Obtained data showed that the elevation factor of the region was the principal ecological factor, the factors of elevation, slope as well as the aspect is the determinant ecological factors and the factors of pH, EC and texture of soil were effective as the differential ecological factors.

***Keywords*:** : Ecological factor, Soil characteristics, Eco-phytosociology, F.C.A, Hamedan Alvand, Iran

INTRODUCTION

Establishment of plant species depend on climatic, edaphic and biologic conditions which is not a random phenomenon. Due to important role of plants in ecosystem equilibrium as well as direct and indirect utilization of plants by human, it is necessary to define the relation between plants and environmental factors in order to improve natural resources.

In order to better understand and manage rangeland ecosystems, it is important to study the relationship between environmental factors and plants in these ecosystems. One of the main components of rangelands is vegetation, the absence and presence of which is controlled by environmental variables such as climate, soil and topography. Among different environmental factors, soil is of high importance in plant growth, and is a function of climate, organisms, topography, parent material and time (Hoveizeh, 1997). Topography(elevation, slope, and aspect) affects soil and climate, in addition to affecting temperature and evapo-transpiration (as elements of climate), makes deeper soil and higher content of organic matter, that result in intensive vegetation in the northern aspects in comparison to the southern ones (Jenny, 1980).

Many studies have shown that abiotic environmental factors, such as topographic parameters, can be important sources of variation of plant diversity (Bennie, 2006; Marini Lorenzo, 2007). Grassland diversity is strongly affected by environmental factors; e.g. soil and topography (Cristofoli, 2010; Marini Lorenzo, 2007). Some theoretical studies have suggested that there is a direct positive relationship between species evenness and species richness; recent empirical studies reveal that the relationship between species richness and evenness is not always positive (Triin Reitalu, 2009). Species evenness and richness also differ in their responses to local habitat factors (Wilsey and Stirling, 2007)

Chemical and physical soil properties are related to natural soil characteristics, and influence both species richness and evenness of vascular plants (Marini Lorenzo, 2007).

Plant growth and development are controlled by internal regulators, which are modified according to environmental conditions. Plants reflex a complex of environmental properties, including climate and soil variables.

Determining which factors control the presence, number, identity, and relative abundance of plant species remains a central goal in ecology. The main purpose of this research was to study the relationship between topographic and edaphic factors with plant species. Understanding relationships between ecological variables in a given ecosystem helps us to apply these findings in management, reclamation, and development of similar regions.

MATERIALS AND METHODS

Study area

Alvand region is located in the west of Iran, and Hamedan, Asad abad and Touyserkan cities surround it. This region is located between western longitudes 48° 10´ to 48° 40´and orthern latitudes 34° 30´ to 34°50´. The precipitation ranges between 206.1 and 420.7 mm, respectively. Its maximal elevation is 3428 m. The main sites of this region are the Ganjnameh, Takhteh-Nader, Meydan Mishan and Kivarestan due to attract tourist. The climate of the study area is considered to be semi-arid, the annual precipitation being approximately 300 mm. Rainfall occurs from October to May, with a maximum during November and February of each year. Another feature characterizing the precipitation in the study site is its irregular yearly distribution. The mean monthly temperatures vary between 1.91 and 23.45^{0}C, the mean annual value being 10.88^{0}C. The annual potential evaporation far exceeds the annual rainfall with a mean annual amount of 1,505 mm, approximately estimated (Yavari, 2010, 2011).

The aim of this study was to determine floristic composition and plant species diversity in the Hamedan Alvand region of Iran.

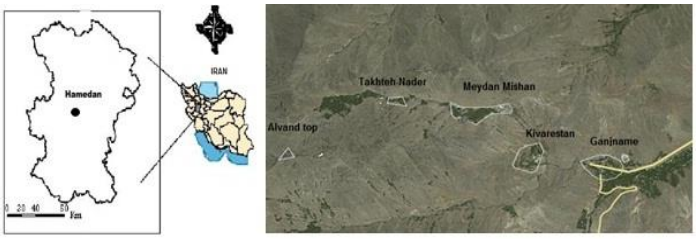

Figure 1. Topographic map of Hamedan Alvand region showing position of the area in Iran

Data collection

Ecologic data were collected from each endogenous milieu (each releve representing endogenous milieu). Total of 143 endogenous milieu were selected for investigation in study area. To determine the placement of the releves, the eco-phytosociological method was used. To determine the minimal area of each releve, the Area-Species Method on the basis of area-species curve and Cain Method were applied (Cain, 1959). All ecologic-floristic data were collected of each special station. Plant specimen deposited in the Herbarium, of Bu-Ali Sina University in Hamadan, Iran. Studies ecological factors included: elevation, aspect, slop and pH, EC, texture of soil in each special station

Data analysis methods

Data obtain were analyzed by Anaphyto software by a series of multivariate techniques such as Factorial Correspondence Analysis (FCA) and Ascendant Hierarchical Classification (A.H.C).

The ranking of the groups obtained through F.C.A. was performed by employing H.C.A. The results obtained by data analysis in F.C.A. Method were presented on the multiplex coordinate axes with various compositions, such as (1, 2), (1, 3), (1, 4), (3, 4)… axes. In this grouping, since the releves are located near or far from each other based on their similarity or dissimilarity in the floristic compositions and with respect to the fact that each endogenic milieu has particular ecological factors and subsequently, its own floristic composition; by placing exclusive marks on the coordinate axes for each ecological factors, it became possible to determine the effective factor(s) on the groups as specified in differential duplex compositions. In this approach, on the multiplex coordinate axes, those factors in the region which cause separation and categorizing the principal formations have been considered as the principal ecological factors; however, the factors that cause separation and categorizing the floristic composition in a formation are considered as determinant ecological factors and those factors that cause division and differentiation

of a part of floristic composition of a formation were considered as differential ecological factors. In this manner, the ecological factors were specified as principal, determinant and differential ecological factors in the region (Nazarian, 2004, Yavari, 2010, 2011).

RESULTS AND DISCUSSION

Results

By comparing the results obtained from F.C.A. on multiplex coordinate axes through placing the ecological factors, we were led to select one or more coordinate axes for each one of the ecological factors subject of study and present the quality of the effect of those factors on vegetation of the region. Among the obtained axes, only a few of the coordinate axes have been selected as sample to be presented.

Elevation

This factor has been effective as principal and determinant factor in the region. Elevation has been able to divide the special stations of the region into three groups. Group I has 2000-2400 meters, group II has 2400-3000m and group III has 3000-3500 elevation. (Fig. 2) Group I includes the determined releves and dominant species such as:

Mentha longifolia, Phragmites australis, Cichorium intybus, Centaurea iberica, Lotus corniculatus, Brunela vulgaris, Juncus infelaxus, Uctica dioica, Rubia tinctoria, Euphorbia bossieria, Rosa canina,, Galium verum, Ononis spinosa, Sangiosorba minor, Inula helenium, Trifolium repens, Plantago lanceolata, Circium hygrofilum, Agrapyron tauri.

Group II includes the determined releves and dominant species such as:

Phlomis olivieri, Gundelia tourneforti, Eremopoa persica, Cleome ibrica, Poa bolbusa, Agropyron tricophorm, Astragalus glaucops, Bromus tomentelus, Circium lapaceum, Festuca ovina, Centaurea virgata, Cerasus microcarpa, Ziziphora clinopodioides, Asyneuma persicum, Verbascum speciosum.

Group III includes the determined releves and dominant species such as:

Euphorbia chierandenia, Phlomis persica, Bromus tomentelus, Tanacetum polycephalum, Arenaria insignis, Bupleurum falcatum, Agropyron tauri, Festuca ovina, Silene bupleuroides, Acantholimon bromifolium, Poa bulbusa, Alchemila kurdica, Pimpinella tragidum, Valerania sisymbriifolia, Scutellaria nepetifolia, Nepeta crispa, Polygonum polychnemoides.

Aspect

This factor has also been effective as determinant and differential ecological factor in the region. Four groups could be separated in the range formation (Fig.3). Group I includes northern slope with dominant species: Astragalus glaucops, Bromus tomentelus, Cirsium lappaceum, Festuca ovina, Centaurea virgata, Cerasus microcarpa, Ziziphora cilinopoides, Asyneuma persicum, Eryngium pyramidal, Verbascum speciosum in determined releves.

Group II includes southern slope with dominant species: Lactuca seriola,potentila Sp., Cleome ibrica, Bromus danthonie, Plantago lanceolata, Chonderila juncea, Ziziphora cilinopoides, Alyssum dasycarpum, Bromus tectorum, picris strigosa, Hordeum bulbosum, Bupleurum falcatum,Festuca ovina, Rosa elymatica in determined releves.

Group III includes eastern slope with dominant species: Noaea mucronata, Cirsium lappaceum, Agropyron tricophorm, Scariola orientalis, Stipa barbata, Ononis spinosa, Galium verum, Cirsium hygrophilum, Mentha longifolia, Astragalus Sp in determined releves.

Group IV includes western slope with dominant species: Agropyron tricophorm, Euphorbia descipiens, Centaurea virgata, Helichrysum psychorophila, Salvia multicaulis, Hypericum scabrum, Chonderila juncea, Astragalus parowianus in determined releves.

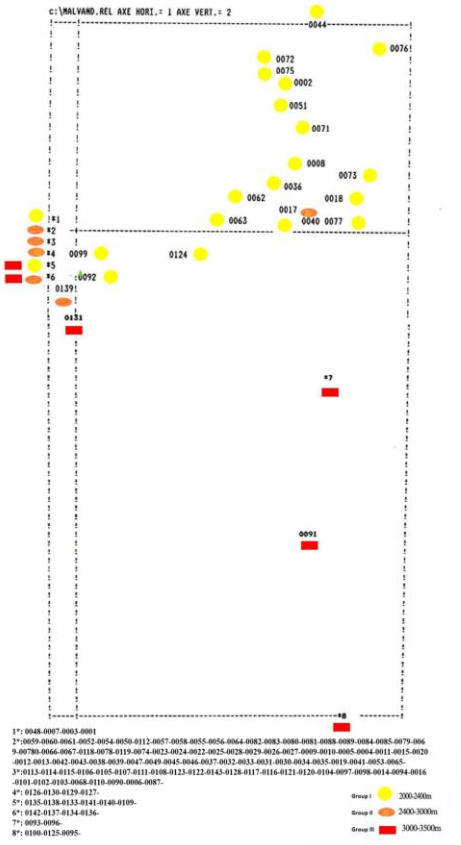

Figure 2. Releves classification regarding of elevation factor through F.C.A

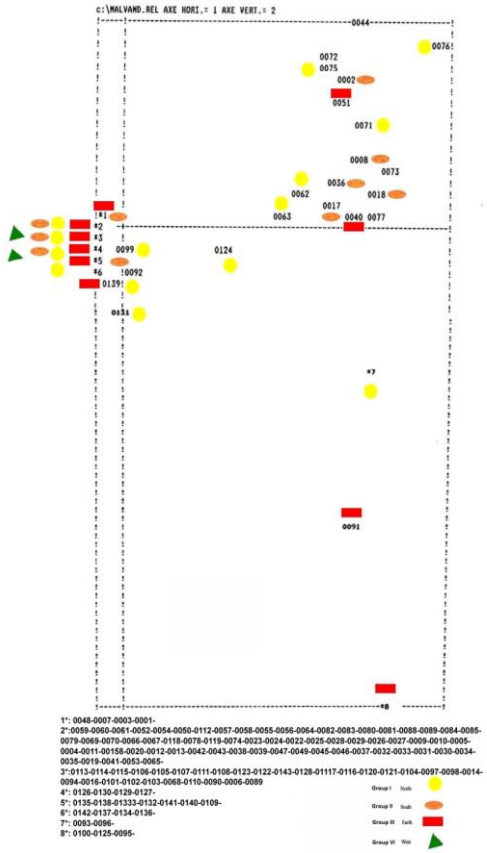

Figure 3. Releves classification regarding of aspect factor through F.C.A

Slope

This factor has been effective as a determinant ecological factor in the region. The factor of slope divides the special stations into four groups. (Fig.4)

Group I includes releves with 5-30% slope with dominant species: Bromus tectorum, Noaea mucronata, Eryngium pyramidal, Hypericum scabrum, Teucrium orientae in determined releves.

Group II includes releves with 30-50% slope with dominant species: Cerasus microcarpa, Sibbaldia parviflora, Mentha longifolia,Astragalus caprinus, Chonderila juncea, Dendrostellera lessertii, Chenopodium botrys, Silene chlorofolia in determined releves.

Group III includes releves with 50-75% slope with dominant species: Hordeum bulbosum, Cirsium lappaceum, Taeniatherum crinitum, Gypsophilla bicolor, Astragalus satiga, Bupleurum falcatum, Thymus daenensis, Euphorbia chierandenia in determined releves.

Group IV includes releves with 75-90% slope with dominant species: Pimpinella tragidum, Arenaria insignis, Valeriana sisymbriifolia, Thymus Sp., Scutelaria nepetifolia, Campanula latifolia, Scropholaria Sp., Urtica dioica, Mentha longifolia, Galium aparin, Alchemila persica, Calamagrostis psedophragmites, Rubus saxatilis, Rosa canina, Rosa canina, Ononis spinosa, Juncus infelaxus, Phragmites australis, Datisca cannabina in determined releves.

Soil PH

This factor has been effective as differential ecological factor in the region. Five groups could be distinguished in range of flora of information (fig. 6). Group I included releves where the pH is 4.5-5.5 with dominant species: Cirsium lappaceum, Arenaria insignis, Arenaria serpyllifolia, Thymus Sp.

Group II included releves where the pH is 5.5-6.5 with dominant species: Astragalus glaucops, Scariola orientalis, Stipa barbata, Bupleurum falcatum, Noaea mucronata, Salsola boissieri, Arenaria serpyllifolia, Stachys multiflora, Thymus Sp., Phlomis persica, Potentilla Sp., Lotus corniculatus, Geum Sp., Bromus tectorum, Centaurea virgata, Alyssum lanigerum, picris strigosa, Scrophularia variegata, Nepeta fissa, Ononis spinosa, Sanguisorba minor, Cirsium hygrophilum, Trifolium repens, Poa trivialis, Arenaria serpyllifolia, group III included releves where the pH is 6.5-7.5 with dominant species:

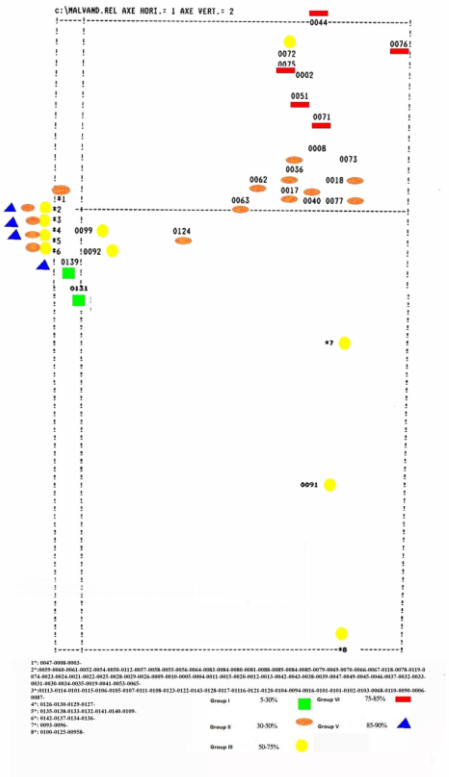

Figure 4. Releves classification regarding of slope factor through F.C.A.

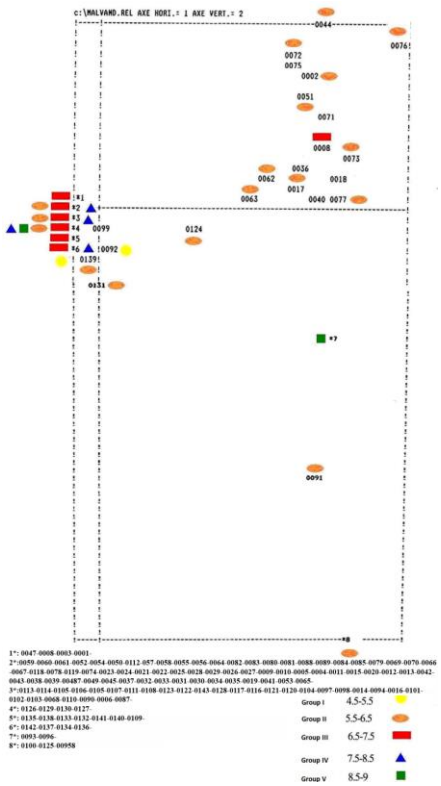

Figure 5. Releves classification regarding of soil PH factor through F.C.A

Euphorbia chierandenia, Cirsium lappaceum, Festuca ovina, Centaurea virgata, Astragalus parowianus, Echinops orientalis, Bromus tomentelus, Stachys lavandulifolia, Ononis spinosa, Cynodon dactylon, Cirsium hygrophilum, Chonderila juncea, group VI included releves where the pH is 7.5-8.5 with dominant species: Stachys multiflora, Phlomis olivieri, Helichrysum Sp., Astragalus gossypinus, Poa bulbusa and group V included releves where the pH is 8.5-9.5 with dominant species: Thymus Sp., Eryngium billardieri, Stipa barbata, Marrubium astracanicum.

In this manner, the soil pH has been able to be a cause for differentiation of these groups.

Soil EC

This factor has been effective, as differential ecological factor in the region. Four groups could be distinguished in range of flora of formation (Fig.6). Group I has dominant species Bromus tectorum, Astragalus parowianus, Cirsium lappaceum, Centaurea virgata, Phlomis olivieri, Astragalus Sp., Dendrostellera lessertii, Festuca ovina, Agropyron tricophorm, Astragalus glaucops, Euphorbia macroclada, Stachys lavandulifolia. with an EC of 1-100 µs/m, group II has the dominant species Arenaria insignis, Arenaria persica, Agropyron tauri, Thymus Sp., Asyneuma persicum, Stachys multiflora, Scutellaria nepetifolia, Bupleurum falcatum, Noaea mucronata, Scorzonera Sp., Tanacetum polycephalum, Euphorbia chierandenia with an EC of 100-200 µs/m, group III has species Astragalus parowianus, Cerasus microcarpa, Eremopoa persica, Acantholimon bromifolium, Gypsophilla bicolor, Conderila juncea, with an EC of 200-300 µs/m and group IV has species Agropyron tauri, Phlomis olivieri, Ziziphora cilinopoides, Eremopoa persica, Astragalus glaucops Acantholimon bromifolium, Cirsium lappaceum, Asyneuma persicum, Silene bupleuroides, Eryngium pyramidal with an EC of 300-400 µs/m in determined releves.

Soil texture

The ecological factor of soil texture in range flora has been able to be effective as a differential factor; in such a manner, that it has been able to divide the range flora into three groups (Fig.7).

Group I has dominant species: Astragalus parowianus, Cirsium hygrophilum, Cynodon dactylon, Cirsium lappaceum, Centaurea virgata, Alyssum minus, Picris strigosa, Chonderila juncea, Rosa elymatica, Arenaria insignis, Arenaria serpyllifolia, Ononis spinosa, Salsola boissieri with a sandy soil texture, group II has dominant species Polygonum lusuloides, Astragalus glaucops, Euphorbia chierandenia, Thymus sp., Eryngium billardieri,

Agropyron tauri, Cirsium lappaceum, Bromus tectorum, Phlomis olivieri, Astragalus sp., Stipa barbata, Festuca ovina, Bromus tomentelus, species with a sandy-loam soil texture and group III has Polygonum lusuloides, Astragalus glaucops, Euphorbia chierandenia, Thymus sp., Eryngium billardieri, Agropyron tauri, Cirsium lappaceum, Bromus tectorum, Phlomis olivieri, Astragalus sp., Stipa barbata, Festuca ovina, Bromus tomentelus, Astragalus verus, Astragalus caprinus, Hordeum bulbosum, Bupleurum Exaltatum, Cousinia ecbatanensis, Nepeta fissa, Stachys multiflora, Chonderila juncea, Noaea mucronata, Dactylis glomerata, Gypsophila bicolor, Rosa sp., Hordeum violaceum ,Scrophularia variegata, Asyneuma Exaltatum, Seratula sp., Acantholimon bromifolium, Silene bupleuroides, Centaurea virgata dominant species with sandy-clay-loam soil texture in determined releves.

CONCLUSION

This study showed that different ecological factors do not have similar importance and effective in the distribution of species. In such manner that, an ecological factor has been effective as principal factor that is elevation. Some factors could be effective as determinant factors; including: elevation, aspect and slope. These factors have been effective in the separation of the flora of a formation. Some factors are effective as differential ecological factors; including PH, EC and texture of soil. These factors have been effective in the separation of a part of flora of a formation. In regard to applied principles in eco- phytosociology method for data collecting, we can certainly declare that floristic markers led to correct and precision results because that is according to factors governing nature, also it is able to provide results which conform and agree to the rules the govern nature in the analysis and results interpretation stage. According to our results of floristical analyses, there are 143 distinctive different releves in study region.

As expected, the most important environmental factor effecting distribution of vegetation communities is elevation as reported by Kantarci (1991) and Fontaine, (2007) and Sevgi and Akkemik (2007) as well. Fontaine, (2007) stated importance of altitude and aspect gradients for vegetation patterns in Aglasun district, Mediterranean region. According to Kantarci (1991) altitude, aspect and vertical distance from Mediterranean Sea are important and fundamental factors in the ecosystem classification in the Mediterranean region. Ozkan (2004) also reported the chief factors as altitude, aspect and landform

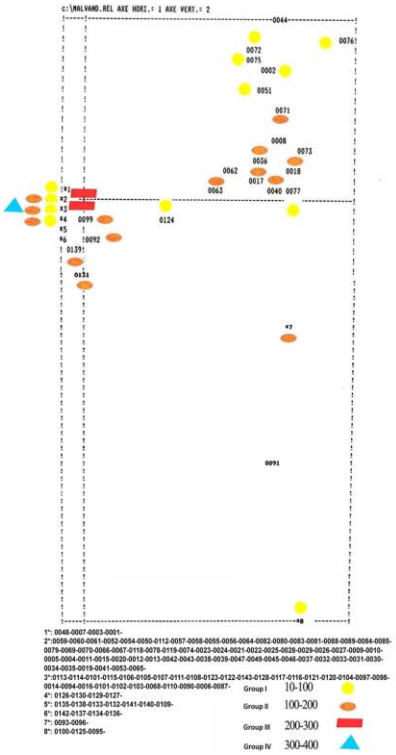

Figure 6. Releves classification regarding of soil EC factor through F.C.A

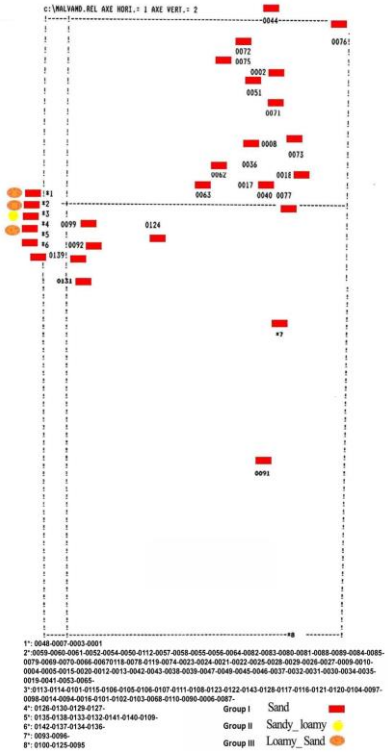

Figure 7. Releves classification regarding of soil texture factor through F.C.A

Characteristics respectively in Beysehir watershed. Similar results have been reported by Karatepe (2005) in Egidir watershed.

Among topographic factors, slope is an important parameter which affects on physicochemical characteristics and distinguishes different vegetation types of the study area. Azarnivand (1990) implies that slope is an important factor in change of vegetation cover. Study of rangelands production in Kavir-e-Phino, located in the Hormozgan province, showed that some variables, such as slope, aspect and saturation moisture percentage and soil depth had the most effective role in the yield of plant species (Zare, 1998). On slopes, differences in species composition were explained by resource availability, especially water (Badano, 2005; Gong, 2008). By monitoring long-term vegetation change, due to the edaphic factors, south-facing slopes maintained more stress-tolerant and light-demanding flora in British chalk grasslands (Bennie, 2006; X. Gong, 2008). The difference of plant species composition and productivity, long term operating soil weathering, and erosion processes are usually accelerated on south facing slopes (Rech, 2001), resulting in different soil properties of north- and south directed slopes (Bochet and García-Fayos, 2004; X. Gong, 2008)

In arid and semi-arid regions, the relation between species distribution and salinity gradient has been reported by many investigators (Jafari, 1989; Zahran, 1989; Asri, 1993; Maryam, 1995). Soil texture controls distribution of plant species by affecting moisture availability, ventilation and distribution of plant roots. The role of soil moisture, as a key element in the distribution of the plant species, is described by Zohary and Orshan (1949) in the Dead Sea region of Israel and El-Sheikh and Yousef (1981) in Al-Kharg springs.

Abu-Ziada (1980) also showed strong relationships between vegetation pattern and soil moisture–salinity gradient in the Kharga and Dakhla Oases. Totally, each plant species has specific relations with environmental variables.

The ecological factor classifications can be also applied to the samplings in soil studies, as well as investigation of the relation of ecologic variables (Pourhashemi, 2004). Correlation results showed that *Sanicula europea, Tamus communis, Cruciata taurica*, *Epimedium pinnatum* and *Fragaria vesca* had a key correlation with pH of soil.

Results showed that among the physiographic factors (slope, orientation and elevation), the first two are the most important ones in the establishment of *Hedera pastuchowii, Solanum kieseritzkii* and *Saxifraga olymbalaria.* According to Heydari, (2009), elevation factor is highly effective in establishment of *Galium verum* and *Bromus tectorum*. Baruch (2005) identified elevation as the most important factor. Using multivariate analysis and also due to the high accuracy of the mentioned methods in analysis of the effects of environmental factors on the plant coverage, understanding of the complex relations between the species and the environment become easier. Eventually, environmental factors including slope, orientation, silt percent, acidity, organic material, soluble phosphorous were among the most effective factors in establishment of *Hedera pastuchowii, Solanum kieseritzkii, Oplismenus undulatifolius, Sedum stoloniferum, Rubus hyrcanus* and *Saxifraga cymbalaria* species (Matji, 2010).

Different responses of plant types to the investigated factors showed that the unnatural factors such as intensive grazing can change the reaction plant species relevant to the physiographical parameters by change of environmental relations especially in soil characteristics. Zarehchahooki, (2001) showed that the soil characteristics affected by aspect and slope that have important role in determination of plant ecological group. According to the indirect effects of topographic parameters on grazing rate and soil moisture, separation and grouping of the studied species, can be related to slope, aspect and elevation and also soil factors.

Due to the development of tourism industry and establishment Tele Cabin in this region, vegetation and landscape have destroyed in recent years. Ganjnameh has a long history of human occupation with ancient civilizations well reflected in the archaeological records. Existence of ruderal plant such as *Cardaria craba* in this region showed anthropogenic impacts. Based on the results of present study, the analysis of ecological factor specially soil and vegetation assessment could be useful in identifying the suitable habitat manipulation techniques such as planting, top-soiling and irrigation techniques for the rehabilitation of degraded lands of Hamedan Alvand Region. The data is also important for preservation of endemic species and establishment of agro-systems and suitable landscape in this region. However, there are certainly a variety of additional soil properties, which may be responsible for the distribution of plants and a variety of additional vegetation types occur in the region. Some of the important soil ecological parameters responsible for plant distribution in Hamedan Alvand Region seem to be moisture and landform. Further studies in soil parameters and landscape are recommended.

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