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Effect of some environmental factors on plant distribution using LFA method (Case study: Valuyeh summer rangeland of Mazandaran province)

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Abstract

The main objective of this study is to survey the effective environmental factors on distribution plant species using LFA method in north and south of Valuyeh summer rangeland, Iran. The both aspects in height of 1600 to 2200 m used the 14 transects 50 meters and 70 plots 1×1 along transect and in the direction of the predominant slope downstream towards the area. It carried out a systematic – Random sampling and recognized plant species in the plots. Also, it elevated 11 surface soil parameters, such as soil cover, basal canopy cover, litter cover, Cryptogam cover, Crust broken-ness, Erosion type & severity, Deposited materials, Soil surface roughness, Surface resist. Then the DCA and CCA analysis is used to determine the effects of environmental factors on distribution of vegetation. The result showed that the important affective factors on distribution of vegetation in two north and south aspect are elevation, slope and stability respectively.

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Introduction

Understanding the relationship between biotic and abiotic components of an ecosystem generally has been considered as a main part of ecological studies (Downing and Selkirk, 1993).The proper management of rangeland ecosystems require to recognize factors such as topography, climate, soil, vegetation and biotic (Zare Chahoki and Safizade, 2008). Also, distribution and abundance of plant has been correlated with a verity of complex environmental gradients. Environmental factors affect plants growth and need to be understood and considered by ecosystem managers. Plant growth and development are controlled by internal regulators, which are modified according to environmental conditions (Manske, 1997).The most ecologically important environmental factors affecting rangeland plants growth and distribution are topography (slope, aspect, and elevation) and soil properties (Jafari *et al.*, 2004).Thus, according to the role of plant on equilibrium of ecosystem and human interest, the relation between vegetation and environmental factors for stability and sustainability is vital. Eldridge and Tozer (1997) used CCA to investigate the effective environmental factors on distribution of some lichens and mosses in eastern Australia. Abdi and Aref (2005) showed that there are special relationships among different species distribution, soil characteristic and topography which are often affected by altitude, slope and soil depth. De Blois *et al.* (2002) investigated the effected factors on plant species distribution in hedgerows of southern Quebec. Neerkova and Hejcman (2006) investigated the effect of environmental variables on the structure of woody vegetation within one geomorphologic unit (500 ha) in Niokolo Koba National Park, Senegal. They understood that soil type and topography were the main factors affecting woody vegetation of the locality. Yebing (2008) showed that the physical and chemical characteristics of soil such as food, humidity, salinity and acidity were the effective factors on the habitat homogeny which control the pattern of plant community's distribution. Taghipour *et al.*(2008) understood that the most effective of soil and topography factors on the distribution and establishment of dominant species was moisture and altitude respectively. Layon and Sagers (2002) studied the Misiveri of United States and understood that there is minor relation in vegetation layers by CCA and DCA ordination analysis. Also they showed that the characteristic of adaptation vegetation depends on the environmental changes. Jin Tun (2002) showed that the vegetation distribution depended on the soil and climate variable. Moradi (2008) studied the Bagh shad area and showed that the distribution and establishment of plant communities related to the altitude, slope, soil texture and depth. Fahimipoor *et al* (2010) studied the relationship between environmental factors and distribution of plant type using PCA and understood that slope, altitude, texture, depth of soil and nitrogen had high effect on the distribution of species. As regards the plants existence in different region is due to environmental factors and some of these factors had higher effect on the plants existence in an area, so, the aim of this research work is to study the relationship between vegetation and environmental factors which is one of the main and effective factors on plant distribution.

Materials and methods

Valuye Area

The case study of this research work was the Valuyeh summer rangeland of Mazandaran, Iran (between 53°40´to 53°44´ N and 36°11´ to 36°13´E). The area is approximately 2365.44 hectares with a cold semi-arid climate and with elevation between 1400 to 2500 meters. Also the annual precipitation and temperature were 256.5 mm and 11.6°Crespectively (maximum and minimum temperature was 3.7°C and 19.5°C respectively). Texture of soil was loam and the soil depth in the flat and smooth slope area was 40 to 50 cm and the stone and gravel depths were 10 to 15 cm. Also, the mean of area slope was 25%. This area had different species of plants such as *Trifoliumrepens, Trifoliumpratens, Medicagosativa, Medicago Arabica, Secalmontanium, Festucaovina,*

*Carexstenophylla, Poaannua, Phlomispungen*as dominant species.

Sampling Method

Initially, in order to general reorganization of this area and investigation of plant vegetation, field surveys were conducted. Then the slope, aspect and elevation in both north and east aspect were obtained using GPS. In addition, both landscapes in height of 1600 to 2200 m used the 14 transects 50 meters and 70 plots 1×1 along transect and in the direction of the predominant slope downstream towards the area. It carried out a systematic – Random sampling and recognized plant species in the plots. So that each point of height used one 50 m transect and 10 plots within 5 m from each other. Also it is estimated the length and weight of ecological forms such as shrub, grass, forbs on each transect using LFA. Each ecological forms is repeated in 5 steps and 11 surface soil parameters such as soil cover, basal canopy cover, litter cover, Cryptogam cover, Crust broken-ness, Erosion type & severity, Deposited materials, Soil surface roughness, Surface resist is determined in each step. At the end, the stability, Nutrient cycling status and infiltration features were determined.

Analysis Methods

The field sampling data was evaluated by LFA (designed by Tongway and Hindly, 2004) as input data. Also the DCA method was used for plant species group and The CCA method was used to determine the effective factors on the species distribution and vegetation type. All the analysis was conducted by Canoco5 and PC-ORD software.

Results and discussions

Ecological Groups determination using DCA analysis in north aspect

In order to find the kind of ordination, the DCA analysis was used to determine gradient length firstly. As the gradient length was more than 3 so, the CCA method was used. So, the DCA analysis in north aspect of area showed that the first axe had the highest Eigen value (0.5) and is significant axe. This axe justified 50% of changes. Also, Eigen value for axe 2 was obtained 0.3 (Table 1).

Table 1. The result of DCA analysis in north aspect of Valuyeh, Mazandaran.

	Axe1	Axe2	Axe3	Axe4
Eigen values	0.545	0.382	0.289	0.236
Cumulative percentage variance	11.8	20.0	26.3	31.4
Lengths of gradient	4.962	3.612	3.581	3.015

Also plant species in north aspect of the area is divided to 4 ecological groups based on DCA analysis (Fig 2).

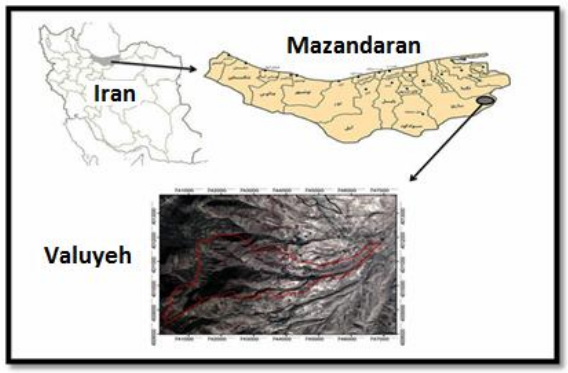

Fig. 1. The Valuyeh area of Mazandaran.

Group 1:

Galum verum, Salvia atropatana, Onobrychis cornuta, Phleum iraicum, Taraxacum vulgar, Sanguisorba minor, Hypericum scabrum, Poa annua

Group 2:

Descurainia Sophia, Eryngium caucasicum, Festuca ovina, Trifolium repens, Secal montanum, Myosotis alpestris, Medicago sativa,Trifolium pretense

Group 3:

Dactylis glomerata, Marrubium vulgar, Festuca arunium, Medicago arabica

Group4:

Astragalus sp, Thymus kotshya, Phlomis pungen

Relation between vegetation and environmental factors using CCA in north aspect

After that the CCA method is used to determine the most effective factors. The results showed that the first axe justified 0.39 of total changes (Table 2), so Eigen value for this axe is 39%. Afterwards, the second axe justified 20% of changes. The species and environmental correlation for the first and second axes were 8.4 and 12.8 respectively. Moreover, Monte Carlo test is significant in level 1.

Table 2. The results of CCA analysis in north aspect of Valuyeh, Mazandaran.

	Axe1	Axe2	Axe3	Axe4
Eigen values	0.393	0.202	0.177	0.144
Cumulative percentage variance	11.8	20.0	26.3	31.4
Species-environment correlation	8.4	12.8	16.6	19.7

Also, the most effective environmental factor on the plant species is height that has high correlation with Axes 1 and 2 (Table 3 and Fig. 2).Afterwards the species factors have high correlation with Nutrient cycling soil.

Table 3. The values of correlation plant species and environmental factors with axes of ordination.

Row	Parameters	Axe1	Axe2	Axe3	Axe4
1	Elevation	0.6354	0.3824	0.3242	-0.0543
2	Slope	-0.2438	-0.7612	-0.0295	-0.1394
3	Texture soil	-0.0064	0.1943	-0.5748	-0.2361
4	Stability	-0.2384	-0.4246	-0.3313	0.2890
5	Infiltration	0.2299	-0.2925	0.4068	0.3998
6	Nutrient cycle	0.4227	-0.3462	0.0283	0.5082

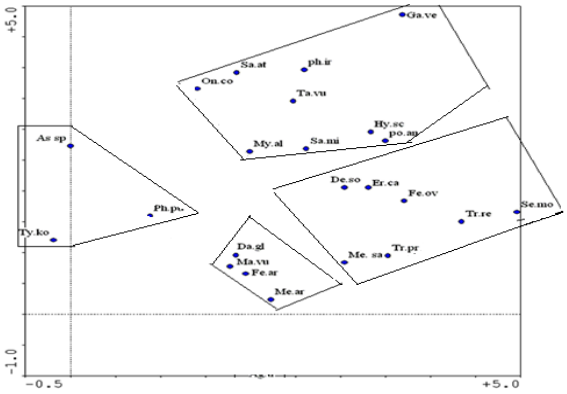

Fig. 2. DCA diagram for plant species in north aspect.

According to the graph derived from the analysis of the CCA, the *Marrubium vulgar, Festuca arunium, Astragalus sp, Thymus kotshya and Phlomispungen* species have positive correlation with elevation, infiltration and nutrient cycle and negative correlation with texture, stability and slope. Moreover, the nutrient cycle has most influence on *Medicago Arabica, Onobrychis Cornuta* and *Myosotis alpestris* species. Also, the *Salvia atropatana* species has most positive correlation with slope and negative correlation with elevation. It means that this species decrease by increasing the elevation. Also the *Galum verum, Secal montanum, Hypericum scabrum, Phleum iraicum, Taraxacum vulgar, Sanguisorba minor* species have the most positive correlation with slope and stability factors and negative correlation with elevation, nutrient cycle and infiltration factors. The *Descurainia Sophia, Medicago sativa, Trifolium pretense, Eryngium caucasicum, Festuca ovina* species has positive correlation with texture soil and negative correlation with slope, stability soil, infiltration and nutrient cycle (Fig. 3).

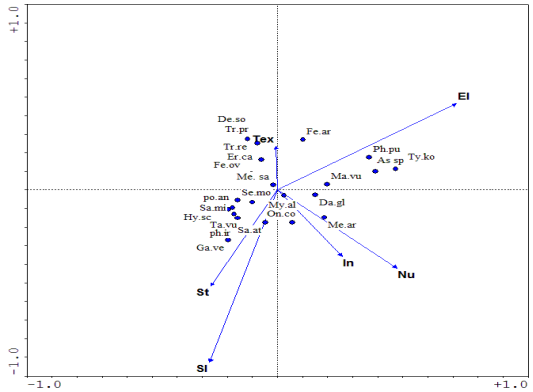

Fig. 3. CCA diagram for plant species in north aspect area.

Ecological Groups determination using DCA analysis in south aspect

Also, the DCA analysis in south aspect of area showed that the first axe had the highest Eigen value (0.54 and is significant axe. This axe justified 54% of changes. Also, Eigen value for axe 2 is 0.33 (Table 4).

Also plant species in north aspect of the area is divided to 5 ecological groups based on DCA analysis (Fig 4).

Table 4. The result of DCA analysis in south aspect of Valuyeh, Mazandaran.

	Axe1	Axe2	Axe3	Axe4
Eigen values	0.541	0.336	0.234	0.189
Cumulative percentage variance	12.2	19.8	25.1	29.4
Lengths of gradient	5.11	3.32	2.78	2.45

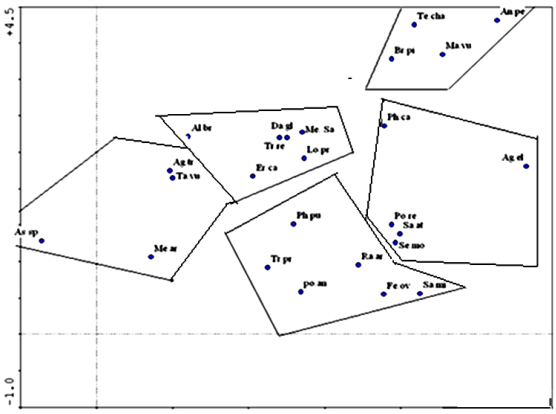

Fig. 4. DCA diagram for plant of species in south aspect.

Group 1:

Teucrium chamaedrys, Brachypodium pinnatum, Anthemis persica, Marrubium vulgar

Group 2:

Medicago sativa, Lolium prenne, Dactylis glomerata, Trifolium repens, Eryngium caucasicum, Alyssum bracteatum

Group 3:

Agilops triuncialis, Taraxacum vulgar, Medicago Arabica, Astragalus sp

Group 4:

Agropyron elongatum, Potentila reptans, Salvia atropatana, Secal montanum, Phlomis cancelata

Group 5:

Ranunculus arvensis, Festuca ovina, Sanguisorb minor, Phlomis pungen, Trifolium pretense, Poa annua

Relation between vegetation and environmental factors using CCA in south aspect

After that the CCA method is used to determine the most effective factors. The results showed that the first axe justified 0.4 of total changes (Table 5), so Eigen value for this axe is 40%. Afterwards, the second axe justified 20% of changes. The species and environmental correlation for the first and second axes were 0.89 and 0.77 respectively. Moreover, Monte Carlo test is significant in level 1.

Table 5. The result of CCA analysis in south aspect of Valuyeh, Mazandaran.

	Axe1	Axe2	Axe3	Axe4
Eigen values	0.409	0.209	0.133	0.105
Cumulative percentage variance	9.3	0.14	0.17	19.4
Species-environment correlation	0.89	0.77	0.66	0.67

Also, the most effective environmental factor on the plant species in south aspect is height that has high correlation with Axes 1 and 2 (Table 6 and Fig. 4).

Table 6. Values of correlation plant species and environmental factors with axes of ordination.

Row	Parameters	Axe1	Axe2	Axe3	Axe4
1	Elevation	0.8536	-0.0928	-0.1460	0.0522
2	Slope	-0.7942	0.0007	0.1683	0.0653
3	Texture soil	0.1963	0.0940	0.1002	-0.3630
4	Stability	0.0875	-0.4153	0.3458	-0.4031
5	Infiltration	-0.2617	0.0069	-0.1839	0.5858
6	Nutrient cycle	-0.2871	0.1442	0.4052	0.1446

According to the graph derived from the analysis of the CCA, the *Medicago sativa, Trifolium repens, Medicago Arabica, Eryngium caucasicum* and *Alyssum bracteatum* species have positive correlation with elevation, and negative correlation with infiltration, stability, slope and nutrient cycle. Also, the *Festuca ovina, Poa annua* and *Lolium prenne*species have the most positive correlation with stability soil and negative correlation with infiltration, slope and texture soil. The *Phlomis cancelata, Secalmontanum, Potentila reptans* and *Agropyron elongatum* species have positive correlation with infiltration and slope (Fig 5).

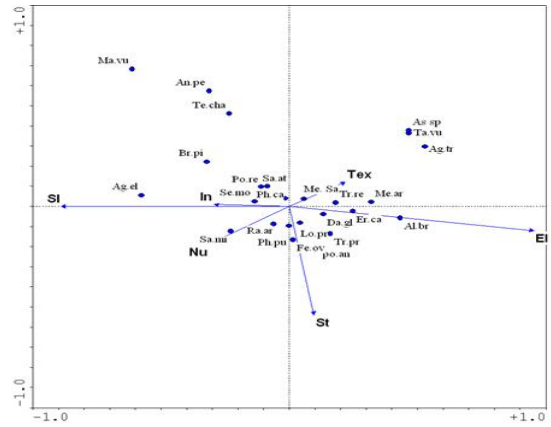

Fig. 5. CCA diagram for plant of species in south aspect area.

Conclusion

It is concluded that the most effective factors on vegetation distribution in both north and south aspects of Valuyeh area are elevation, slope and stability soil respectively. Also, the effect of environmental factors on establishment of different cushion, grass and forbs was studied. It was observed that the *Astragalus sp* and *Thymus kostachys* species in north aspect and the *Alyssum bracteatum* and *Eryngium caucasicum* species in south aspect were in higher altitude than other plant species. Ariavand(1994) expressed that cushion species have further distribution in summer rangeland elevation. Tatian (2001) confirmed the frequency of cushion species in central Alborz Mountains. In addition, the elevation is the important factors on vegetation distribution which is confirmed by others (Pinke *et al*, 2010. Cimalova and Lososova, 2009. Nohi *et al*, 1998. Khaje, 1998. Iravani, 1999. and Ghlichnia, 1996). Also, the *Festuca ovina, Medicago sativa* and *Trifolium repens* species had positive correlation with texture soil and negative correlation with elevation in both north and south aspect. It can be due to the soil moisture which is the main issue of soil formation and the important factor on vegetation distribution. Also, it might be a limiting factor of some species and establishment of above species. The canopy of non-grass is high at higher altitude by reducing the moisture. Khaje (1998) concluded the similar results in his research. Badano *et al* (2005) studied in Oakland region of Chile and expressed that the diversity is increased in south aspect due to the moisture reduction and intra-species competition reduction. Also, the results showed that the *Galum verum, Secal montanum, Hypericum scabrum, Phleum iraicum* species in north aspect and the *Phlomis cancelata, Secal montanum, Potentila reptans* and *Agropyron elongatum* species in south aspect had the most correlation with slope. However other researchers expressed that the slope and aspect are important on plant species distribution (Jafarian *et al*, 2008. Zhang *et al*, 2006. Munishi *et al*, 2011. and Tavili and Jafari, 2009). Since the vegetation has close relation with biotic and abiotic factors and it is naturally dynamics and changed by influence of environmental factors, so it should be considered that the management studies on the effective factors of vegetation is necessary. In this research work, it is concluded that the environmental factors have important roles on the separation of plant communication and the environmental factors effect on vegetation.

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