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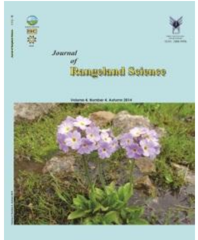

Research and Full Length Article:

Effects of Topographical Factors on Distribution of Plant Communities in Semi-Steppe Grasslands (Case Study: Ghorkhud Region, Northern Khorasan Province, Iran)

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Abstract. The purpose of this study was to investigate the effects of topographical factors on the classification of grassland plant communities in the rangelands of Ghorkhud, Northern Khorasan Province, Iran. For sampling, land units were specified. A floristic list was prepared using minimal area method based on the nested plot (Braun-Blanquet method). 116 10m^2 furrows were selected. Within each furrow, the presence and cover percent were estimated. On the basis of Braun-Blanquet classification method, cover percent of each species was ranked and the representative matrix was established. Vegetation was characterized by the means of Braun-Blanquet classification method using TWINSPAN level 2. To determine the relationships between vegetation and effective topographic factors, a Canonical Correspondence Analysis (CCA) method was used. Results showed that the region's vegetation was divided into four plant communities including *Stipa barbata-Festuca ovina*, *Festuca ovina-Agropyron trichophorum*, *Stipa hohenackeriana-Festuca ovina* and *Agropyron cristatum-Stipa barbata*, respectively. Based on results of CCA, the first and second axes (Eigenvalue=0.39, 0.29) were accounted for 50.2 and 37.7% variations, respectively and totally, the first two axes were accounted as 82% of total variation concerning the environmental factors such as aspect with the first axis and elevation and slope with the second axis.

Key words: Plant communities, Furrow, Grassland, Topography factors, Ghorkhud protected area

Introduction

The study of vegetation will enable us to solve the management problems and evaluate the plant information and trend prediction. The plant species composition should be considered for the study of vegetation. Preservation of valuable natural ecosystems requires the protection of vegetation and plant communities (Moslemi, 1997). Considering the important roles of plants in ecosystems' balance leads us to understand the relationships between plants and their environment (Gauch, 1982).

The purpose of classification is to collect a set of similar vegetation samples in order to determine different types of species based on floristic characteristics (Moghaddam, 2001). Ordination method means to sort out the subjects (Goodall, 1954), species or typical vegetation units in a multi-dimensional series (Jongman *et al.*, 1987). Mirmohammadi *et al.* (2002) classified the effective factors regarding the establishment of halophyte species in northern Gavkhoony using PCA and CCA. They found that general characteristics of the desired species habitats in terms of the soil and topographic factors distinguished and delineated their relations. So, there was a significant correlation by changing the species type and percent, slope and soil.

El-Ghani (1998) stated that the impacts of slope on soil factors were effective in the presence or absence of species and plant cover. Soil should be considered due to the accumulation of sediments and salts in the areas with low slope and high depth and more fertile regions. Similarly, Shokri *et al.* (2003) separated plant communities by the help of climatic factors using DCA and CCA in Behshahr areas, Iran.

Layon and Sagers (2002) in their study in the prairie region of Missouri Canada could distinguish the plant communities of grasses and bushes based on different climatic factors. Sharifi Niyaragh (1997) investigated the relationships between soil and climatic factors by the ordination in the natural prairie region of Ardabil, Iran. He showed that vegetation heterogeneity and resiliency had direct effects on plant communities. Moghaddam (2006) confirmed that environmental factors, altitude, rainfall and temperature played important roles in the distribution of vegetation. Another factor that could contribute to the establishment of plant communities may be the geographical factors. In addition, the amount of available water in soil, soil temperature and the light received by the plant could affect the plant communities. On the other hand, the difference in the light intensity in different directions will cause the changes in the hillside. Naqinezhad *et al.* (2009) in a survey on the effects of altitude on plant communities in southern Alborz wet meadows in Iran using CCA ordination showed that altitude had a direct effect on flora, life form, plant composition and spatial distribution of wet meadows. Species composition had a high correlation with altitudinal gradient and hemi cryptophytes were significantly increased with the increase of altitude.

Zare Chahuki *et al.* (2008) studied the relationships between species diversity and environmental factors using Principal Component Analysis (PCA) method in Poshtkuh rangelands of Yazd, Iran and found that such factors as texture, available water, potassium and electrical conductivity had the highest impacts on biodiversity. Yibing (2008) in a research using PCA and CCA in China showed that physical and chemical characteristics of soil such as nutrients, moisture, salinity and pH influenced the homogeneity of the habitat and distribution pattern of vegetation in these areas. Shaltout *et al.* (2002) investigated the habitat of the species in *Nitraria retusa* using DCA and concluded that the presence of this species was highly correlated with both salinity and clay soil.

Brauch (2005) in Savan Venezuela using TWINSPAN and CCA method showed that several factors such as soil fertility, the cation exchange capacity, available water, dryness period, rainfall, sand percent in soil and altitude affected the separation of Savanna.

Noy-Mayer *et al.* (1970) in a study on the vegetation of semi-arid Southern Australia found a significant correlation between the changes of vegetation and some environmental factors such as rainfall, soil texture, topography and the amount of available water.

The aim of this study was the classification of plant communities in semi-steppe grasslands of Ghorkhud region and the investigation of relationships between vegetation and the most important environmental factors affecting the distribution of plants.

Materials and Methods

Study area

Study area was located in Ghorkhud protected region in the east north of Iran. Grasslands are located between the latitude of 37°20'27'' to 37°30'30'' N and longitude of 56°08'48'' to 56°17'36'' E.

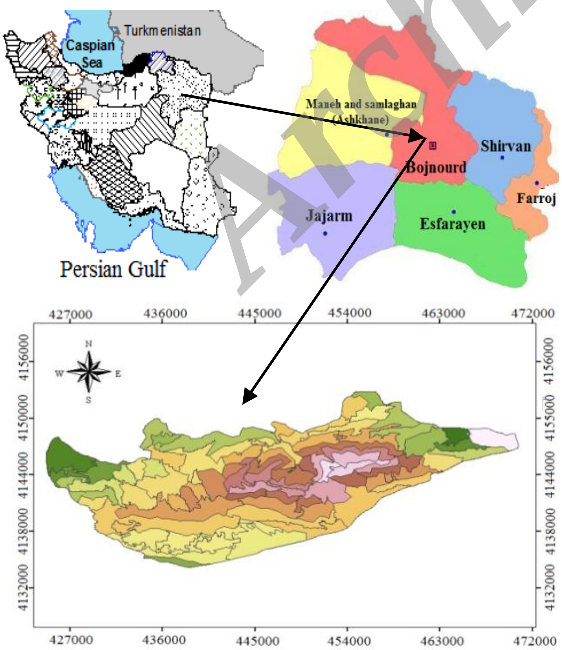

Fig. 1. Location of the study grassland sites in the north east of Iran

The elevation is between 2100-3150 m, the mean annual rainfall and temperature are 400 mm and 9°C. Regional climate based on a method introduced by De Martone (1942) is semiarid cold. General slope of the district is 0-12% and with the species such as *Juniperus*, *Berberis* sp., *Artemisia*, *Astragalus* and *Festuca* spp. (Keshtkar, 2007). Location of the study area in the country and Northern Khorasan Province is shown in Fig. 1.

Sampling method

For field sampling, digital maps of region including topographic maps, percent of slope, aspect, land use and type of vegetation were prepared; then, the aforementioned map using GIS software version 9.3 was combined in order to identify the land units. The range of land units and floristic lists were prepared by Braun-Blanquet method and minimal area was determined for the nested plot method. 116 10 m^2 furrows were selected. Within each furrow, the presence and cover percent were estimated. Based on the Braun-Blanquet classification method, cover percent of each species was ranked and the representative matrix was established. In this study, factors such as elevation, slope and aspect which affected the distribution of plant communities were considered as environmental variables.

In order to classify the vegetation of the study area and identify the groups of similar ecological plants' needs, vegetation was characterized using the Braun-Blanquet classification method and the two-way indicator species analysis.

After the classification of vegetation in order to determine the relationships between vegetation and effective topographic factors, Canonical Correspondence Analysis (CCA) method was performed using PC-ORD version 5.

Results

According to TWINSPAN classification, herbs cover was divided into four groups and the association species for each group was determined as follows (Fig. 2).

The first group consisted of *Stipa barbata-Festuca ovina* (*St.br-Fe.ov*): 38 plots were established in the group covering about 32.7 of the grassland area. The group had altitudinal range of 1900-2000 m and the slope was 12-15% towards the north (Table 1).

For the second cover group involving *Festuca ovina-Agropyron trichophorum* (*Fe.ov-Ag.tr*): 22 plots were established in the group covering 18.9% of the grassland area. The group had altitudinal range of 1800-1900 m and the slope was 8-15% towards the south (Table 1).

The third group cover consisted of *Festuca ovina-Stipa hohenackeriana* (*Fe.ov–St.ho)* had 38 plots in the group and about 32.7% of the grassland area. The group had altitudinal range of 1700-1800 m and the slope was 5-8% towards the south west (Table 1).

The fourth group involving *Agropyron cristatum- Stipa barbata* (*Ag.cr-St.ba*): 18 plots were established in the group covering about 15.5% of the grassland area. The group had altitudinal range of 1400-1500 m and the slope was 5-8% towards the northwest (Table 1).

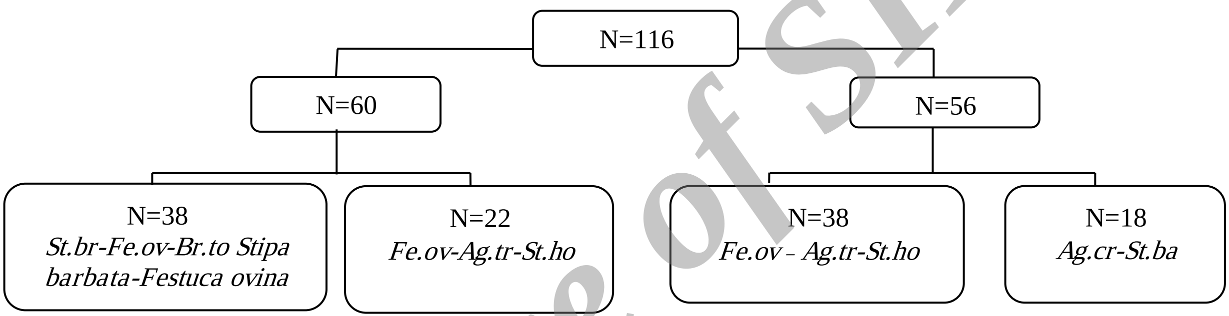

Fig. 2. Areas of vegetation classification using method TWINSPAN

Table 1. Dominant species percent in the group covering the grasslands of Ghorkhud region

Group Cover	Dominant Species			
	Ag.cr-St.ba	*Ag.tr-Fe.ov*	*Fe.ov-Ag.tr*	*St.ba-Fe.ov**
Stipa barbata	8.83	3.85	5.77	9.34
Festuca ovina	10.38	9.42	14.63	8.13
Bromus tomentellus	0.38	0.23	6	5.52
Agropyron trichophorum	1.50	40.31	7.04	1.31
Stipa hohenackeriana	7.66	5.15	6.13	2.02
Agropyron cristatum	9.11	0.02	0.00	1.71

**St.ba-Fe.ov-Br.to = Stipa barbata-Festuca ovina-Bromus tomentellus, Fe.ov-Ag.tr = Festuca ovina-Agropyron trichophorum, Ag.tr-Fe.ov = Agropyron trichophorum-Festuca ovina, Ag.cr-St.ba = Agropyron cristatum- Stipa barbata*

According to Table 2, the first and second principal components were accounted for 87.9% of total vegetation change while the first component is of more importance so that 50.2% of the changes might be related to it and 37.7% was related to the second component. According to the results of canonical analysis in the first axis, the aspect had a higher correlation (r =0.43) with the first axis. Similarly, the height (r =0.72) and slope (r =0.98) showed high correlations with the second axis of CCA diagram (Table 2). Cover group of *S. hohenackeriana-Fe. ovina* had a strong and positive relationship with the first axis regarding CCA diagram indicating that species were positively associated with the direction (Fig. 3). It belongs to the species: *Echinaria capitata, Agropyron trichophorum, Borago officinalis, Phlomis concellata, Asperula glomerata, Hordeum glaucum, Teucrium polium, Muscari neglectum.* Cover group of *Ag. cristatum- St.barbata* had a negative relationship with the first axis with respect to CCA diagram showing that species were inversely related to the direction. It belongs to the species including *Myosotis arvensis, Stipa hohenackeriana, Salvia viridis, Serratula latifolia, Astragalus siliqusus, Phleum pratense, Agropyron cristatum, Tulipa montana, Hypericum perforatum, Turgenia latifolia* and *Artemisia sieberi*. Cover group of *S. barbata-Fe. ovina* had a positive and strong correlation with the second axis with regard to CCA diagram. These species were positively associated with the height and slope. It belongs to the species involving *Dactylis glomerata, Echinops robustus, Festuca rubra, Festuca ovina Thymus kotschyanus, Marrubium vulgare, Onobrychis cornuta, Verbascum thapsus* and *Rosa beggeriana*. Finally, the forth cover group of *Fe. ovina-Ag. trichophorum* had a negative and strong correlation with the second axis regarding CCA diagram (Fig. 3). This species was inversely related to the slope and altitude involving such species as *Myosotis arvensis, Stipa hohenackeriana, Salvia viridis, Andropogon schemun, Serratula latifolia, Agropyron cristatum, Artemisia sieberi, Ajuga chameecistus, Hypericum perforatum, Turgenia latifolia* and *Phleum pratense.*

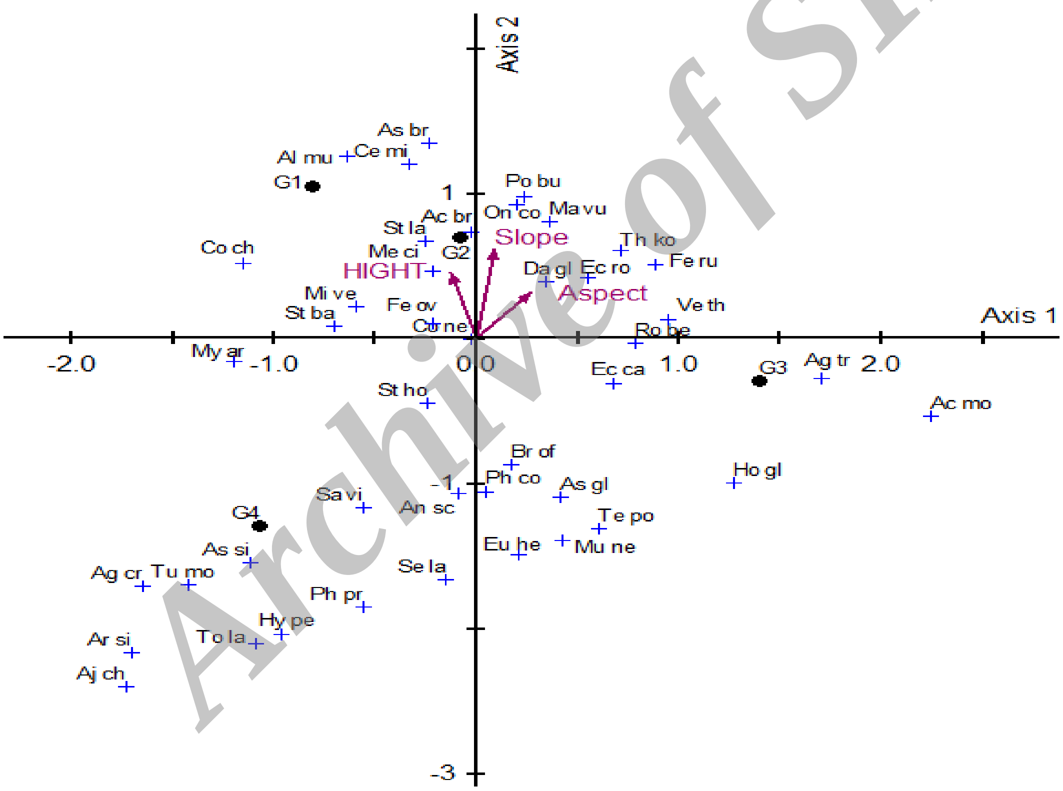

Fig . 3. Distribution of cover groups based on the topographic factors and. CCA method, (●) is the representative of the vegetation sampling site, (+) is the representative of the vegetation types

Poa bulbosa (Po bu), Onobrychis cornuta (On co), Marrubium vulgare (Ma vu), Thymus kotschyanus (Th ko), Dactylis glomerata (Da gl), Echinops robustus (Ec ro), Festuca rubra (Fe ru), Verbascum thapsus (Ve th), Rosa beggeriana (Ro be), Astragalus brevidens (As br), Cerasus microcarpa (Ce mi), Alyssum murale (Al mu), Acanthophyllum brevibracteatum (Ac br), Stachys lavandulifolia (St la), Melica ciliata (Me ci), Festuca ovina (Fe ov), Stipa barbata (St ba), Cousinia nekarmanica (Co ne), Minuartia verna (Mi ve), Myosotis arvensis (My ar), Stipa hohenackeriana (St ho), Salvia viridis (Sa vi), Andropogon schemun (An sc), Astragalus siliqusus (As si), Serratula latifolia (Se la), Agropyron cristatum (Ag cr), Tulipa montana (Tu mo), Phleum pratense (Ph pr), Hypericum perforatum (Hy pe), Turgenia latifolia (To la), Artemisia sieberi (Ar si), Ajuga chameecistus (Aj ch), Agropyron trichophorum (Ag tr), Echinaria capitata (Ec ca), Acer monspessulanum (Ac mo), Borago officinalis (Br of), Phlomis concellata (Ph co), Asperula glomerata (As gl), Hordeum glaucum (Ho gl), Teucrium polium (Te po), Euphorbia helioscopia (Eu he), Muscari neglectum (Mu ne). G_1: *Stipa barbata-Festuca ovina*, G_2: *Festuca ovina-Agropyron trichophorum*, G_3: *Festuca ovina-Stipa hohenackeriana*, G_4: *Agropyron cristatum- Stipa barbata*

Table 2. Eigen vectors, Eigen values and percent of accounted variance for the first two axes in CCA method

Components	Axis1	Axis2
Altitude	-0.211	0.722**
Slope	0.150	0.988**
Aspect	0.434*	0.511*
Eigen values	0.39	0.29
Percent of variance	50.2	37.7
Percent of cumulative variance	50.2	87.9

* and**= Significant at 0.05 and 0.01probability levels, respectively

Discussion and Conclusion

Semi-steppe grasslands are mostly dispersed in the highlands of Irano-Turanian with a variety of vegetation types. Natural factors have great impacts on the distribution and composition of plants. Topography is involved in the spatial distribution of grassland communities. In current study, several plant communities were derived from the classification of vegetation indicating that four major vegetative groups were identified in terms of environmental and ecological factors.

The effectiveness of environmental factors on the distribution of each of these groups was different. Different environmental factors such as slope, altitude and aspect were involved in forming the vegetation region. Similar results were found in Damavand Mountains, Iran which estimated the effects of altitude on the plant composition (Naqinezhad *et al.*, 2009). It appears that slope is an important factor affecting the soil conditions that can affect the presence or absence of species and their distribution.

The effects of slope on the presence of species are due to the accumulation of soil sediments, high depth and also low leaching which has declined the washing of food and fertility is usually more (El-Ghani, 1998). Plants such as *Onobrychis cornuta*, *Poa bulbosa*, *Marrubium vulgare* and *Thymus kotschyanus* in steep slopes are present significantly where the minimum requirement is needed for the ecological life. Considering that the study area is mountainous, the altitude could directly and indirectly affect the other environmental factors such as rainfall and temperature and the plant. This conclusion was in agreement with results reported by Shokri *et al.* (2003), Layon and Sagers (2002) and Sharifi Niyaragh (1997). By increasing the height of elevation, some plant species such as *Astragalus gossypinus, Acantholimon arenaceum* and *Centaurea hyrcanica* are more present in contrast to the annual plants such as *Bromus tectorum, Hordeum glaucum* and *Echinops robustus* that are to be reduced. So, it can be concluded that by increasing the altitude, permanent and perennial plants had significant effects on the composition of plant communities. It appears that temperature affected the presence of grassland plant communities. Therefore, lower temperature in High Mountains may lead to more dominance of plant communities with species composition of *Festuca ovina*, *Stipa barbata* and *Bromus tomentellus* and some herbaceous plants and shrubs form a cushion. Moghaddam (2006) showed that environmental factors, altitude, rainfall and temperature play important roles in the distribution of vegetation. Other factors that could contribute to the establishment of plant communities are the geographical factor, water availability, soil temperature and the amount of light received by the plant; on the other hand, the difference in the light intensity in different directions caused the changes in the hillside.

The effects on the geographical distribution of the species are based on light and moisture absorption which are evident in the grassland area so that such species as *Poa bulbosa*, *Dactylis glomerata* and *Festuca rubra* grow in the relative humidity and the northern slopes;

in contrast, such species as *Stipa hohenackeriana*, *Andropogon schemun*, *Artemisia sieberi* and *Agropyron cristatum* grow in drier area and the southern slopes. For each plant community, the ecological needs and tolerance are different according to the characteristics of habitat and environmental factors. The results of this study showed a significant correlation between environmental factors such as aspect, elevation and slope with the ecological groups. How to maintain the relationships of watershed vegetation, soil and water resources and improve and restore the rangelands in the studied area and the areas with similar conditions can play major roles in the area.

Literature Cited

Brauch, Z., 2005. Vegetation-environmental relationships and classification of the seasonal savannas in Venezuela. *Jour. flora*, 200: 49-64.

Braun-Blanquet, J., 1972. Plant Sociology: The study of plant communities, hafner publishing, New York.

De Martone, M., 1942. Geography universelle, VI: I, 140.

El-Ghani, M. M., 1998. Environmental correlates of species distribution in arid desert ecosystems of eastern Egypt go vernal. *Arid Environments*, 38: 297-313 pp.

Gauch, H. G., 1982. Multivariate analysis in community ecology, Cambridge University Press Cambridge, UK. 360p.

Goodall, D. W., 1954. Objective methods for the comparison of vegetation III. An essay in the use of factor analysis. *Australian Jour. Botany*, 1: 39-63.

Jongman, R. H. G., Ter braak, C. J. F. and Van Tongeren, O. F. R., 1987. Data analysis in landscape ecology. Pudoc. Wageningen. 299 p.

Keshtkar, H., 2007. Investigated the ability of satellites to map land cover (case study: Ghorkhud protected area in northern province). Range management master's thesis, department of natural resources, Tehran university. 141 p.

Layon, J. and Sagers, L., 2002. Correspondence analysis of functional groups in a riparian landscape. *Jour. Plant Ecology*, 164: 171-183.

Mirmohammadi, S. A., Amini, M. and Hajiabadi, A., 2002. Factors affecting the establishment of four Halophytes in the north marshes Gavkhooni using the ordination method. *Jour. Agricultural Sciences & Natural Resources*, 6 (2): 215-229. (In Persian).

Moghaddam, M., 2001. Vegetation ecology and descriptive statistics. Tehran university press, 285 p. (In Persian).

Moghaddam, M., 2006. Terricolous plant ecology. Tehran University Press, 701 p. (In Persian).

Moslemi, M., 1997. Relationship between vegetation and soil using the ordination method, the national park of Kolahghazi, range management master's thesis, University of Tarbiat Modarres. 106 pp. (In Persian).

Naqinezhad, A. R., Jalili, A., Attar, F., Ghahreman, A., Wheeler, B. D., Hodgson, J. G., Shaw, S. C. and Maassoumi, A., 2009. Floristic characteristics of the wetland sites on dry southern slopes of the Alborz Mts., N. Iran: The role of altitude in floristic composition. *Jour. Flora*, 204: 254–269.

Noy- Mayer, I., Tadmor, N. H. and Arshan, G., 1970. Multivariate analysis of desert vegetation, Israel *Jour. Botany*, 19: 91-561.

Shaltout K. H., Sheded, M. G., Kady, H. F. E. and Al-Sudani, Y. M., 2002. Phytosociology and size structure of Nitraria retusa along the Egyptian Red Sea coast. *Jour. Arid Environment*, 53: 331-345 pp.

Sharifi Niyaragh, J., 1997. The relationship between species diversity and vegetative forms of natural grasslands in Ardabil. *Jour. Research and Development*, 33: 26-31. (In Persian).

Shokri, M. Bahmanyar, M. R. and Tatiyan, M. R., 2003. Ecological study of vegetation summer pastures Hezarjarib Behshahr. *Iranian Jour. Natural Resources*, 56 (1, 2): 131-141. (In Persian).

Yibing, Q., 2008. Impact of habitat heterogeneity on plant community pattern in Gurbantunggut Desert. *Geographical Science*, 14(4): 447-455.

Zare Chahuki, M. A., 2008. investigated the relationship between species diversity and environmental factors in pastures Poshtkuh Yazd. *Jour. Research and Development*, 21(1): 192-19. (In Persian).

بررسی عوامل توپوگرافیکی تأثیرگذار بر توزیع جوامع گیاهی علفزارهای نیمه استپی (مطالعه موردی: منطقه قرخود، خراسان شمالی)

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چکیده. این تحقیق به منظور بررسی و طبقه بندی پوشش گیاهی علفزارها و عوامل توپوگرافی موثر بر آن انجام شد. برای نمونه‌برداری ابتدا واحدهای کاری مشخص و در داخل هر یک از واحدهای کاری توده‌های معرف تعیین گردیدند. در توده‌های معرف لیست فلوریستیکی تهیه شده و سطح حداقل نمونه به روش پلات‌های تو در تو مشخص گردید. تعداد ۱۱۶ قطعه نمونه ۱۰ مترمربعی برداشت شد. در داخل هر قطعه نمونه حضور و درصد تاج پوشش گیاهان برآورد گردید. بر اساس روش طبقه‌بندی براون‌بلانکه به میزان درصد تاج پوشش هر گونه امتیاز داده شد و ماتریس توده- گونه تشکیل گردید. پوشش گیاهی منطقه با استفاده از طبقه‌بندی براون‌بلانکه (۱۹۷۲) و به کمک روش TWINSPAN تا سطح ۲ طبقه‌بندی شد. برای تعیین همبستگی بین گیاهان و عوامل توپوگرافی موثر از روش تحلیل تطبیق متعارفی (CCA) و تجزیه تحلیل آماری با استفاده از نرم‌افزار PC-ORD نسخه ۵ انجام شد. نتایج نشان می‌دهد که رستنی‌های منطقه به ترتیب به چهار گروه پوشش (***Stipa barbata-Festuca ovina***)، (***Festuca ovina- Agropyron trichophorum***)، (***Stipa hohenackeriana –Festuca ovina***)، (***Agropyron cristatum-Stipa barbata***) تقسیم شدند. بر اساس نتیجه حاصل از CCA، محور اول با (مقدار ویژه= ۰/۳۹)، ۵۰/۲٪ تغییرات مربوط به جهت شیب و محور دوم با (مقدار ویژه= ۰/۲۹) ۳۷/۷٪ از تغییرات ارتفاع و درصد شیب را توجیه نمودند.

کلمات کلیدی: جوامع گیاهی، قطعه نمونه، علفزار، عوامل توپوگرافی، منطقه حفاظت شده قرخود