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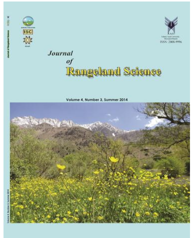

Full Length Article:

Investigation of Changes in Rangeland Vegetation Regarding Different Slopes, Elevation and Geographical Aspects (Case Study: Yazi Rangeland, Noor County, Iran)

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Abstract. In many studies, topographic factors have been considered as an important factor in establishing the vegetation in different ecosystems. So, it affects vegetation composition and diversity by influencing soil moisture, fertility and soil depth. The aim of this research was to investigate the effects of slope, elevation and geographical aspects on species growth, forage production and vegetation cover in Yazi rangeland, Noor province, Iran. Sampling was done along three transects with the length of 150 m in each unit. Along each transect, 15 plots (1 m^2) were established with 10 m distances. In each plot, species name, growth form, cover percent and soil surface percent such as percentages of stones, pebbles and amount of litter were recorded. Also, the rangeland production was measured by the clip-and-weigh method. Data were analyzed and mean comparisons were done using Duncan method. Results showed that the geographical aspects had significant impacts on forage production, vegetative form and species composition. Northern aspects had the highest forage production rate and species frequency. Also, elevation had a significant effect on forage production and vegetative form so that the elevation of 1600-1900 m and 2200-2500 m had the highest and lowest effects. Also, according to forage production and vegetative form in the range of slope classes, it is specified that it has also a significant effect on forage production seen in higher slopes.

Key words: Plant composition, Production, Topographic factors, Yazi Rangeland of Noor

Introduction

Exploring the relationships between vegetation and environmental factors is considered as the basis of appropriate management and planning in the rangeland ecosystems. Understanding the relationships between vegetation and environmental factors is inevitable because of the important role of plants in balancing the ecosystem as well as different benefits that human gain directly or indirectly from the vegetation (Ahmadi-Poor, 2004; Tamrtash *et al.*, 2012). Vegetation is significantly influenced by environmental factors such as climate, soil and topography but among all factors existing in nature, climate represents the most important factor determining the distribution of living organisms, particularly plants (Jafari *et al.*, 2010). Topographic features such as elevation, slope and aspect influence the dryness of soil, evapotranspiration and soil water availability (Vetas, 1993). Close relationship between environmental factors and vegetation leads to the restriction or expansion of a plant association in relation to prevailing environmental factors in an area (Heidari *et al.*, 2011). In other words, environmental factors cause plants with similar ecological requirements in the same area and form the plant communities (Piri-Sahragard *et al.*, 2012).

Evaluation of vegetation changes in rangeland ecosystems over time in response to environmental and managerial interactions is of high importance for the utilizers of these ecosystems (Pike *et al.*, 2002) and the results of these evaluations will lead to managerial decision making in order to improve the ecosystem both qualitatively and quantitatively (Heshmati *et al.*, 2007).

It is important to achieve the patterns of vegetation changes in rangeland ecosystems in different slopes, elevation and geographical aspects for optimal planning and management of watersheds in the country. Badano *et al.* (2005) by studying oak communities in Mediterranean regions of Chili suggested that the reduced moisture in the southern slopes along with the decreased intragroup competition led to an increased diversity in this slope aspect. Gracia *et al.* (2007) investigated the effects of aspects and altitude on species composition in Spain. They concluded that aspects and altitude had no significant effects on species diversity but changes in altitude and aspects made species composition different. Grytnes (2006) compared the species richness of vascular plants and lichens along an altitude gradient (310-1135 m above sea level) in West Norway and concluded that most species richness was at intermediate elevations as compared to the other classes. Also, Faraj Allahi *et al.* (2013) investigated the most important effects of soil factors and topographies on the species diversity of Bijar rangeland in west of Iran and expressed that the most important effective environmental factors in the changes of species diversity in their study area are soil texture (clay percent, silt and sand), gravel percent, limestone, height from sea level and slop percent.

Gao *et al.* (2009) have investigated the simultaneous effects of elevation and human intervention on landscape and vegetation in the mountainous village of Bejing, China and concluded that wherever the level of human intervention decreases in more remote regions, plant diversity initially decreases and but then, it increases by moving away from the critical areas. They believe that plant diversity varies with different land uses. Also, their results revealed that topographic and edaphic factors have significant effects on the level of species diversity. In another study, Haji Hashemi Jazi *et al.* (2013) evaluated the roles of topographic and soil factors on vegetation cover in the Zavareh rangeland of

Ardestan, Iran and reported that environmental factors had been measured and texture, electrical conductivity, lime, gypsum, calcium and organic matter of soil are the important effective factors in plant dispersal of various sites. Chang *et al.* (2004) investigated the topography variables (elevation, slope and slope aspect), soil type and solar radiation in relation to vegetation and suggested that slope aspect is a primary and important factor influencing the distribution of vegetation in the rangelands. In another study, Small and McCarthy (2005) considered the slope aspect as an important factor creating the vegetation changes and diversity in the ecosystem and they suggested that slope aspect affects the composition and diversity of vegetation by influencing soil moisture, fertility and depth.

Obviously, vegetation, vegetative forms and frequency of rangeland species vary in different slopes, elevation and geographical aspects due to the varying plant, soil, climatic (moisture, angle of solar radiation), topographic and managerial characteristics; hence, studying the geographic aspects provides an opportunity to manage the rangelands appropriately in the study area by identifying the changes in vegetation. Thus, this research aimed to study the effects of slope, elevation and geographical aspects on vegetation changes in Yazi spring rangelands, Noor.

Materials and Methods

Case study

With an area of 575.4 ha, Yazi rangeland is located at 110 km apart from Noor in the north of Iran (52° 3-52° 5 N and 36° 10- 36° 13 E). This is a spring (middle) rangeland with the annual rainfall of 303.2 mm and a semi-arid cool climate. Minimum (-4.9 °C) and maximum (20.7 °C) monthly temperatures in this region occur in January and July, respectively. The dominant plant species in the study area are *Agropyron intermedium*, *Bromus tomentellus*, *Artemisia sieberi*, *Onobrychis cornuta*, *Hordeum fragile*, *Astragalus siliquosus*, *Festuca ovina* and *Festuca arundinacea* (Arab Roshan and Saeedi Goraghani, 2010).

Research Methodology

The study area was assessed in 1.50000 scale with the topographic maps, geomorphologies were described and then, four elevation classes (1600-1900, 1900-2200, 2200-2500 and 2500-2800) m above sea level, four slope classes (0-10, 10-20, 20-30 and 30-50%) and four elevation classes (North, South, East and West) were presented in order to achieve the measurement used by Global Positioning System (GPS). Sampling was carried out within the pure community and for this purpose samples from the ecotone (distance between two communities) zones were avoided. For measuring the vegetation, the proper sample plot size was determined by the minimum area method and number of plots was specified after primary sampling according to the changes in vegetation as compared to the statistical method. In each unit, sampling was carried out along three transects with the length of 150 m. Along each transect, samples were taken from 15 plots (1 m^2), dimensions and 10 m distance from each other (Zare-Chahoki *et al.*, 2010). In each plot, species name and form, vegetation cover and soil coverage including stones and pebbles percent as well as litter percent were recorded. Production rate of rangeland was also measured by cutting and weighing method (Moghadam, 2008). To estimate this factor, species desirable for the livestock were selected and in all four aspects (North, South, East and West), the production rates (kg h^{-1}) of mentioned species were calculated based on the method presented by Barani (1996).

Data Analysis

After data collection, the analysis of variance was performed using SPSS18 software. For this purpose, the significant effects of slope, elevation and geographical aspects were tested and whenever the differences among treatments were significant, mean comparisons were made using Duncan multiple range test method.

Results

Effect of topographic factors on total forage production

Results indicated that different geographical aspects had significant effects on forage production (P<0.01). Results of mean comparison showed that the highest and lowest values of forage production were obtained in Northern (526 kgh^{-1}) and Southern (322 kgh^{-1}) aspects, respectively. Eastern and Western aspects with the average values of 432 and 410 kgh^{-1} respectively showed no significant differences in terms of forage production. Also, results indicated that different slopes had significant effects on forage production (P<0.01). Results of mean comparisons showed that the highest and lowest values of forage production were obtained in 20-30% (526kgh^{-1}) and 0-10% (322kgh^{-1}) slopes, respectively. Results indicated that different elevations had significant effects on forage production (P<0.05). Results of mean comparisons showed that the highest and lowest values of forage production were obtained in the elevation of 2200-2500 m (447 kgh^{-1}) and 1600-1900 m (322 kgh^{-1}), respectively (Fig. 1).

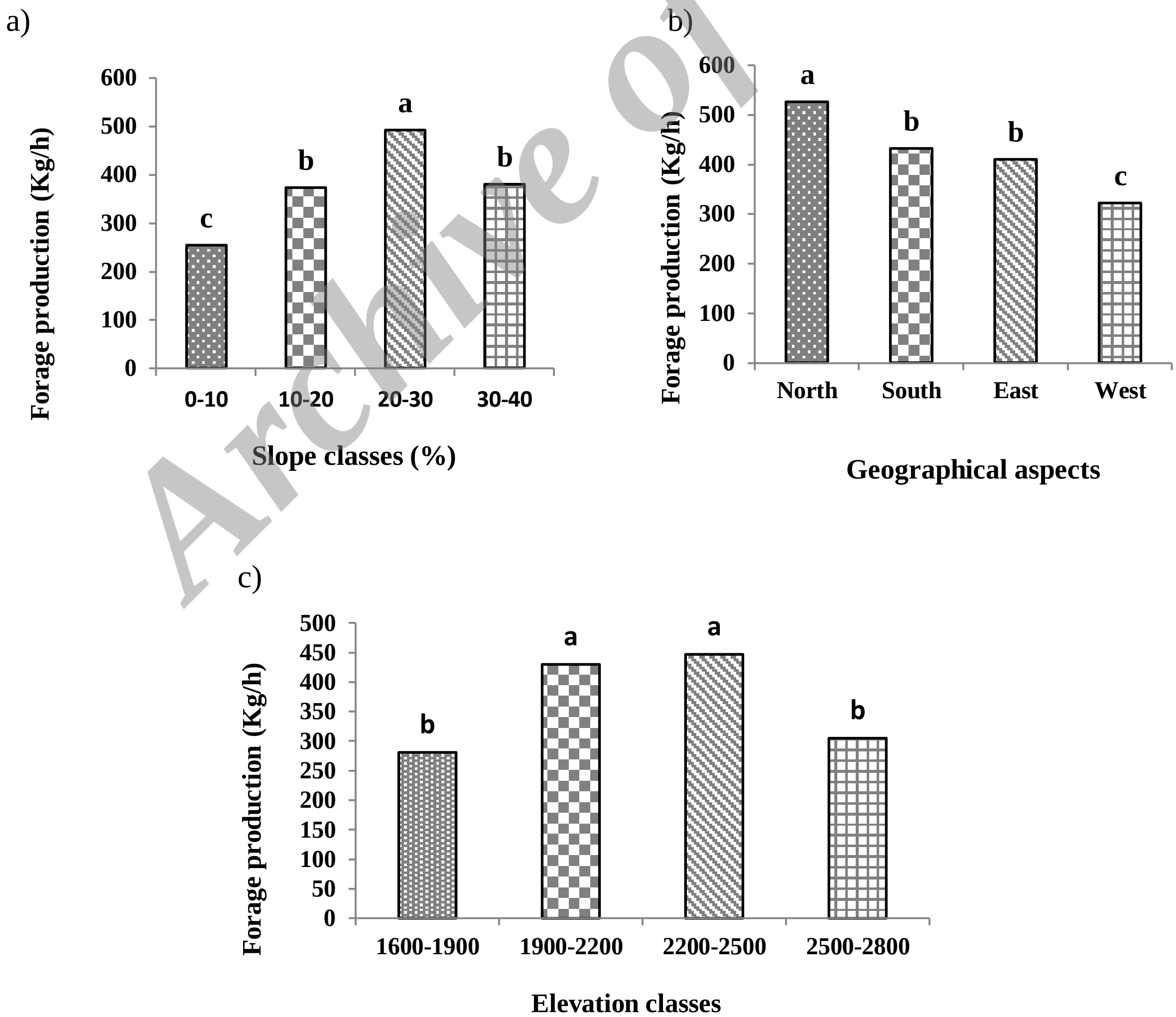

Fig. 1. Mean comparison of total forage production rates in different slopes, geographical aspects and elevations

Effect of topographic factors on vegetative form and species percent

a) Slope

The highest grass species percent belonged to the slope of 20-30 followed by the slope of 30-40 percent. The highest shrub percent was observed in the slopes of 10-20 and 0-10 percent, respectively. For the forb species, the higher values of 30-40% were obtained in the slope of 30% and lower value (9%) was belonged to the slope of 0-10% (Fig. 2a).

b) Aspects

Results showed that the highest grass species percent was observed in the northern aspect followed by the eastern, western and southern aspects, respectively. The highest shrub percent was observed in the southern and western aspects with the average values of 30.2 and 22.12%, respectively, but the northern site with the slope of 15.96% had the lowest shrub percent. For the forbs species, the northern and southern aspects with the average values of 29.24 and 16% had the highest and lowest vegetative form percent, respectively (Fig. 2b).

c) Elevations

Results showed that the highest grass species percent belonged to the 220-2500 elevation. The highest shrub percent was observed in 2200-2500 and 2500-2800 elevations with the slopes of 31.3 and 28.03%, respectively. In contrast, the lowest percentage of shrub plants with average values of 23% obtained in 1600-1900 m elevation. For the forb species, the highest values were obtained in 1900-2200 m elevation (Fig. 2c).

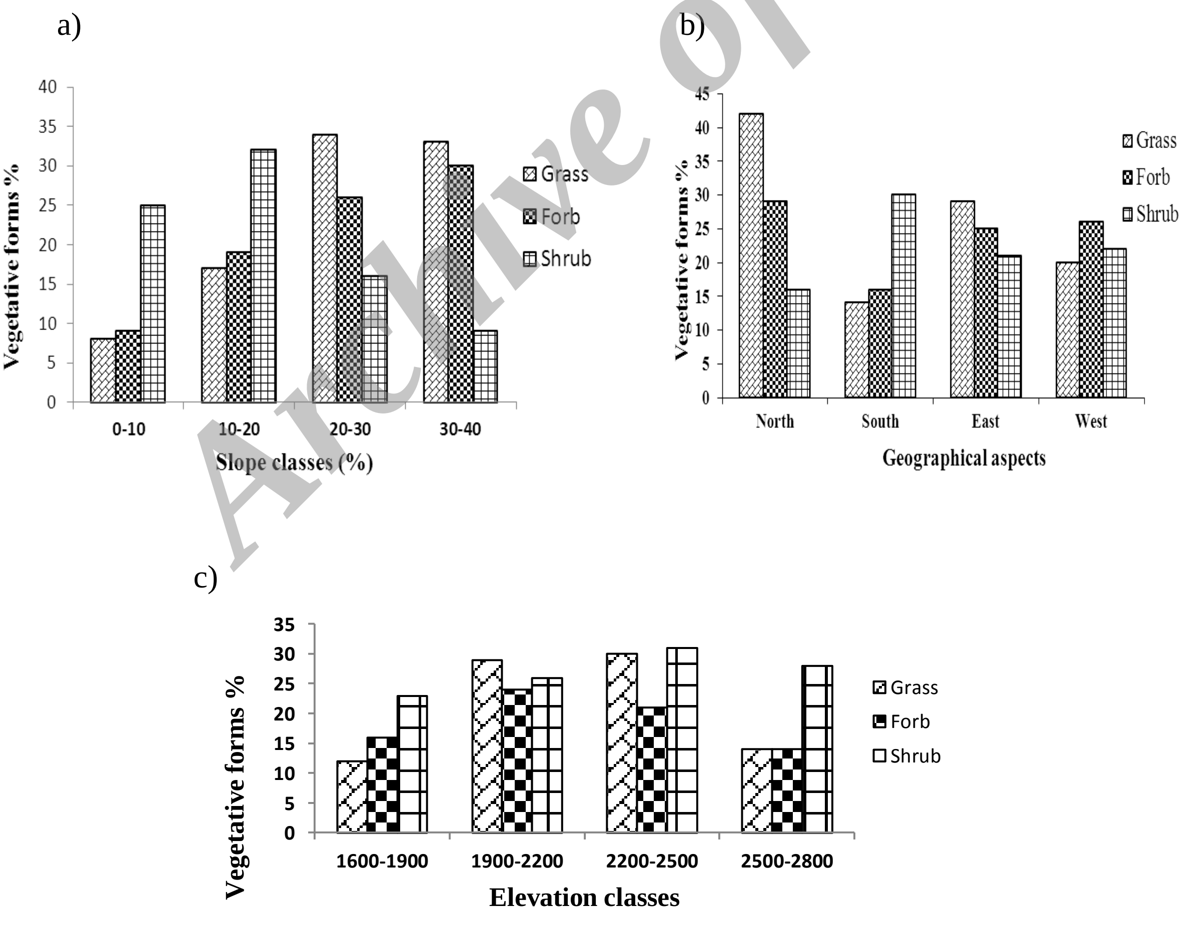

Fig. 2. Comparison of vegetative forms in a) different slopes, b) different geographical aspects and c) different elevations

Effects of geographical aspects on canopy cover of individual species

Result of mean comparisons concerning the geographical aspects for canopy cover percent of each species are shown in Table 1. Results showed that among the forb species, *Artemisia sieberi* represented the highest frequency percent in the southern, eastern and western sites but in the northern site, *Trifolium* sp. had the highest percent among forb species.

The highest grass species percent in the northern aspects belonged to *Agropyron intermedium*, *Festuca ovina* and *Bromus tomentellus* but the two former species were absent in the southern site. Results also showed that species of *Stipa barbata* and *Hordeum fragile* and species of *Stipa barbata* and *Festuca arundinacea* in the eastern and western aspects had the highest percent. Among the shrub species, *Acantholimon* sp. in the northern aspect, *Acanthophyllum* sp. and *Astragalus siliquosus* in the southern aspect, *Onobrychis cornuta* and *Thymus vulgaris* in the eastern aspect showed the highest coverage percent as compared to the other aspects. Also, the highest and lowest shrub species percent in different aspects belonged to *Acantholimon* sp. and *Thymus vulgaris* species.

Table 1. Mean comparison of different geographical aspects for canopy cover of each species

Species	Vegetative Forms	North	South	East	West	Value F
Artemisia sieberi	Forb	7.53	5.34	5.59	6.62	0.95
Centaurea cyanus	Forb	0^{b}	0^{b}	1.30^{a}	0.97^{a}	7.54*
Cousinia sp.	Forb	0^{b}	0.58^{a}	0^{b}	0^{b}	579.6**
Euphorbia amygdaloides	Forb	0^{b}	2.23^{a}	3.75^{a}	3.98^{a}	4.22*
Ferula sp.	Forb	0^{b}	0^{b}	1.45^{a}	0^{b}	602.3**
Galium verum	Forb	1.23^{a}	0^{b}	0^{b}	0^{b}	590.3**
Malva neglecta	Forb	0^{b}	0^{b}	0^{b}	4.53^{a}	787.7**
Marrubium vulgare	Forb	1.1^{b}	3.87^{a}	0^{c}	0^{c}	41.1 **
Nepeta persica	Forb	3.32^{b}	3.07^{b}	6.88^{a}	0^{c}	6.87*
Plantago major	Forb	0^{b}	0^{b}	0^{b}	3.12^{a}	756.9**
Sanguisorba minor	Forb	0.46^{a}	0^{b}	0.34^{ab}	1.50^{a}	4.98*
Salvia sclarea	Forb	2.19^{a}	0^{b}	0^{b}	0^{b}	712.7**
Stachys lavandulifolia	Forb	0^{b}	0^{b}	0^{b}	1.55^{a}	612.4**
vulgare Traxacum	Forb	4.31^{a}	0^{c}	2.48^{b}	0^{c}	8.42
Trifolium sp.	Forb	8.62^{a}	0^{c}	3.39^{b}	3.97^{b}	56.2
Agropyron intermedium	Grass	15.19^{a}	0^{c}	5.33^{b}	0.58^{c}	213.7**
Bromus tomentellus	Grass	6.14^{a}	1.08^{b}	0^{c}	0.49^{b}	62.1 **
Dactylis glomerata	Grass	3.07^{a}	0^{c}	3.28^{a}	1.44^{b}	6.38 *
Festuca arundinacea	Grass	5.40	4.87	2.76	3.93	1.04
Festuca ovina	Grass	7.04^{a}	0^{c}	2.67^{b}	2.50^{b}	7.32 *
Hordeum fragile	Grass	1.03^{b}	0^{c}	5.54^{a}	0^{c}	48.4 **
Melica persica	Grass	0^{c}	6.07^{a}	0^{c}	3.55^{b}	61.8 **
Poa bulbosa	Grass	4.13^{a}	0^{c}	3.66^{ab}	2.76^{b}	5.02 *
Stipa barbata	Grass	0^{c}	2.22^{b}	5.89^{a}	4.89^{a}	4.95 *
Acantholimon sp.	Shrub	9.12	9.02	7.30	8.98	1.09
Acanthophyllum sp.	Shrub	0^{d}	11.22^{a}	3.36^{c}	7.69^{b}	97.1 **
siliquosus Astragalus	Shrub	4.34^{a}	5.42^{a}	0.43^{c}	2.32^{b}	3.34 *
Onobrychis cornuta	Shrub	2.50^{c}	4.18^{b}	6.08^{a}	2.59^{c}	4.71 *
Thymus vulgaris	Shrub	0^{b}	0^{b}	4.12^{a}	0.52^{b}	60.2 **

*, **: Significant at 5%, 1%, respectively
Means followed by the same letters in each rows are not significantly different (P<0.05)

Discussion and Conclusion

It is necessary to recognize and understand the relationships between a phenomenon and other influencing and influenced phenomena for studying that phenomenon. Given the importance of rangeland vegetation as the first food ring in rangeland ecosystems, understanding the topographic and environmental factors affecting plant establishment seems to be inevitable. Based on the results of this study, there is a specific relationship between qualitative and quantitative characteristics of vegetation such as forage production, vegetative forms, palatability and distribution of vegetation types in relation to aspect. This result is in accordance with the results reported by Ahmadi-Poor (2004), Heshmati *et al.* (2007) and Pike *et al.* (2002) who suggested that the rangeland conditions and forage production in the rangelands are largely influenced by topographical factors such as slope aspect in addition to management factors. Also, results suggested that vegetation composition varies with the aspects so that shrub species such as *Acantholimon* sp., *Acanthophyllum* sp. and *Astragalus siliquosus* constitute 30% of vegetation in the southern aspect while grass species constitutes only 14% of vegetation cover. Vegetation in the northern aspect was mostly composed of palatable grasses and forb species such as *Trifolium* sp., *Agropyron intermedium* and *Festuca ovina*; however, in this geographical aspect, shrub species constitute only 16% of vegetation. This could be explained by lower reception of solar energy and lower evapotranspiration as well as suitability of growing conditions for forb species in these aspects (northern aspects). This result confirms the results obtained by Piri-Sahragard *et al.* (2012), Faraj Allahi *et al.* (2013) and Chang *et al.* (2004) who suggested that aspect is a key and important factor influencing the distribution of vegetation in rangelands. Vegetation in different geographical aspects of the study area has changed that can be attributed to environmental factors and different utilization and management methods. Based on the obtained results, it was observed that the highest and lowest vegetation percent occurs in the northern and southern aspects, respectively; this can be explained by suitable conditions for plant growth in the northern aspect as compared to the other aspects due to the angle of solar radiation and a higher soil moisture and depth. This result to some extent confirms the results of Heydari *et al.* (2011), Geo *et al.* (2009), Haji Hashemi Jazi *et al.* (2013) and Badano *et al.* (2005). It seems that the differences in radiation intensity in different aspects create mesoclimatic changes (Manguran, 1998). Hence, the southern slopes are always warmer and less moist than the other slope aspects and this causes the species establishment in different slope aspects which have different ecological characteristics. However, the southern slopes cannot be considered unfavorable. Also, due to the coldness, northern slopes are grazed later by livestock and because of having more favorable moisture conditions, northern aspects have dense vegetation (Tamrtash *et al.*, 2012).

Results of this study indicate that the intermediate elevation classes of 1900-2200 and 2200-2500 have the highest forage production percent. It seems that the reason of this fact is the existence of plant cover in a transitional zone (Ecotone) with favorable temperature and phlegmatic conditions so that the plants of upper and lower zones have overlapping with each other. Also, the results of this research indicate that the slope had an expressive influence on forage production and the highest forage production was observed in high slope class. The main reasons can be divided into two categories: first, this rangeland has been considered as one of the great centers of animal husbandry and is used by native nomadic as livestock grazing. Usually, in traditional management system, range grazing started with low gradients and high slopes attract less attention. In these regions, it is observed that grazing in the rangeland with low slopes had more redundancy and by this reason, they are more damaged. The second is high forage production in high slopes due to the existence of stony exterior and rocky zones that can be counted as a harbor for plant species of these zones. This result confirms the results presented by Vetas (1993) and Heidari *et al.* (2011). They expressed that in high slopes, the increase of gravel stones increases the water infiltration and decreases the evaporation, and this capability contributes the plants in more affective usage form and short time and severe rainfalls.

Based on the abovementioned issues, it could be said that vegetation changes in a region will vary as a result of natural factors. Also, it would be possible to assess the applied management practices by evaluating vegetation changes in an area over time. It is also necessary to note that the increased cover percent always does not represent the improved conditions, but by evaluating the species composition, it should be determined which group of plant species have been increased as a result of changes.

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چکیده. در بیشتر مطالعات عوامل توپوگرافی به‌عنوان شاخص‌هایی مهم در ایجاد پوشش‌های مختلف گیاهی در اکوسیستم مطرح شده‌اند به‌طوری‌که عوامل توپوگرافی با تأثیر بر رطوبت، حاصلخیزی و عمق خاک تأثیر زیادی در ترکیب و تنوع پوشش گیاهی یک منطقه دارد. با توجه به نقش و اهمیت عوامل شیب، ارتفاع و جهت‌های مختلف جغرافیایی بر تغییرات کمی و کیفی پوشش گیاهی، تحقیق حاضر به مطالعه اثر این عوامل محیطی بر روی تغییرات پوشش گیاهی در مرتع یازی شهرستان نور پرداخته است. در هر واحد (سایت)، نمونه‌برداری در طول ۳ ترانسکت ۱۵۰ متری انجام گرفت. در طول هر ترانسکت، ۱۵ پلات با ابعاد یک متر مربع و در فاصله ۱۰ متری از هم قرار گرفته و در هر پلات اسامی گونه‌ها، فرم رویشی، درصد پوشش تاجی، فراوانی و درصد پوشش سطح خاک از جمله درصد سنگ و سنگریزه و درصد لاشبرگ ثبت و میزان تولید علوفه در هر واحد بر اساس روش قطع و توزین تعیین گردید. پس از جمع‌آوری داده‌ها، تجزیه و تحلیل آن‌ها با استفاده از نرم افزار $SPSS_{18}$ صورت گرفت. نتایج حاصل از این پژوهش نشان داد جهت دامنه بر روی تولید علوفه، فرم‌های رویشی و ترکیب گونه‌ای تأثیر معنی‌داری داشته و شمال جغرافیایی دارای بیشترین میزان تولید علوفه و حضور گونه‌های گیاهی بوده است. ارتفاع از سطح دریا نیز بر تولید علوفه و فرم‌های رویشی تأثیر معنی‌داری داشته به‌طوری‌که دامنه ارتفاعی ۲۵۰۰-۲۲۰۰ و ۱۹۰۰-۱۶۰۰ به ترتیب دارای بیشترین و کمترین میزان تولید علوفه بودند. همچنین بر اساس تولید علوفه و فرم‌های رویشی موجود در طبقات شیب دامنه، مشخص شد که این عامل نیز به‌طور معنا داری بر تولید علوفه و فرم‌های رویشی تأثیر گذاشته و در شیب‌های بالاتر افزایش تولید علوفه می‌باشد.

کلمات کلیدی: ترکیب گیاهی، تولید، عوامل توپوگرافی، مرتع یازی نور