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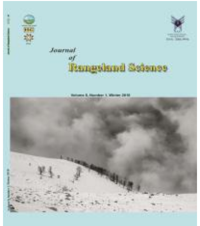

Research and Full Length Article:

Vegetation Cover Dynamics in Semi-Steppe Rangelands of Ardabil Province, Iran

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Abstract. Rangeland vegetation dynamics can be affected by various natural and unnatural factors over time. The purpose of this study was to investigate the dynamics of vegetation under the climatic conditions and soil properties. Accordingly, data collection for evaluating vegetation dynamics in rangeland ecosystems of Ardabil province was conducted at three research sites including Moqan winter rangeland, and Nour and Aqdagh Khalkhal summer rangelands in 2009 followed for four years. Vegetation variables were measured using transects and sampling plots. Meanwhile, at the location of each plot, soil moisture was measured at two or three depths of 0-15, 15-30 and 30-45 cm using a Time-Domain Reflectometer (TDR). According to the results, in the Nour site, the changes recorded for shrubs such as *Onobrychis cornuta* L. and forbs were significant ($P<0.01$). However, the changes recorded for the perennial grasses including *Alopecurus aucheri* L., *Bromus tomentellus* Boiss. *Festuca ovina* and *Koeleria caucasica* Trin. Ex Domin were not significant. In the Aqdagh site, the changes of perennial grasses including *Agropyron cristatum*, *Bromus tomentellus*, *Festuca ovina* L. and *Koeleria caucasica* as well as forbs were significant ($P<0.05$). The changes of annuals were found significant ($P<0.01$). No significant differences were recorded for the shrubs such as *Onobrychis cornuta* and *Thymus kotschyanus*. In the Moqan site, the changes of dominant shrub (*Artemisia fragrans*) and annuals were significant ($P<0.01$). Soil moistures during the growing season and over the years were varied; however, the trend of changes in soil organic carbon was slow. Accordingly, the results of this monitoring process from year to year changes in the main species of vegetation, soil, and soil erosion can be useful as a guide to correct the current methods used for the management of rangelands.

Keywords: Vegetation cover, Vegetation dynamics, Organic carbon, Soil moisture, Iran

Introduction

Monitoring of rangeland ecosystems is the most basic measure needed in rangeland management. Rangeland ecosystems in arid and semi-arid regions are mainly affected by climatic factors and the type of grazing management. Therefore, understanding the relationship between vegetation and climatic factors is a prerequisite for applying correct management methods in such ecosystems.

In this regard, study on vegetation dynamics provides an opportunity to determine the effects of climatic and management conditions on quantitative and qualitative changes in vegetation of an ecological region (Britta *et al.*, 2010). Vegetation dynamics in arid and semi-arid regions are formed as a result of complex relationships between soil and climatic elements as well as changes in soil moisture (Quevedo & Frances, 2008). Principally, range management must be based on changes in range condition and grazing capacity. For this reason, studying the rangeland vegetation changes and identifying the factors affecting it are considered as essential items for range management. Abtahi *et al.* (2014) in investigation of vegetation dynamics and range conditions in central desert of Iran reported that due to the desert conditions, the amount of vegetation and its variation were affected by the precipitation changes. Also, Fadzayi *et al.* (2008) studied short and long-term vegetation changes related to the grazing systems, precipitation and vegetation cover. They reported that the absence of a detectable grazing effect on vegetation changes may be due to overriding the influences of grazing intensity, rangeland size, precipitation variability and few replicates. Sharifi and Akbarzadeh (2013) in investigation of vegetation changes under precipitation in semi-steppic rangelands of Ardebil province showed that changes in canopy cover of woody shrub species were slow and mild while perennial grasses were affected by annual rainfall. They stated that shrub species were less affected by year-to-year changes of climatic variables.

Vegetation changes in rangelands are affected by various natural and human factors. Climatic factors including drought and wet condition are inevitable natural factors. Ragnelands attain stability over time. However, human factors and especially range management play an effective role in maintaining either the stability or destruction of rangelands (Kashki *et al*., 2012). Moradi *et al*. (2012) investigated range health in semi-arid rangelands of Zagros-Semirom. The results of this study highlight the difficulty of detecting changes over extensive areas of rangeland, and of separating management induced effects from climatic effects on an environment which experiences wide spatial and temporal variations in rainfall. Evaluation of rangeland vegetation dynamics as a comprehensive flexible and proper way is applied for monitoring qualitative and quantitative changes in vegetation to make appropriate management decisions for rangeland ecosystems. Asadian *et al*. (2017) studied the relationships between environmental factors and plant communities in enclosure rangelands of Gonbad, Hamadan, Iran. Their results showed that in the long-term enclosure, plant communities tend towards a uniform and homogeneous composition consequently leading to the improvement of the rangeland vegetation conditions. O’Connor and Roux (1995) studied the effect of rainfall variability and livestock grazing on vegetation changes of kayoo shrublands in South Africa during 1949-1971. They concluded that changes in vegetation community were mainly due to the rainfall fluctuations; however, the effect of livestock grazing was more important in the long-term. The amount and trend of vegetation changes in shrublands of Southwestern Utah during

1933-1989 were investigated by Yorks *et al*. (1992). They concluded that moderate grazing was the most effective factor to improve condition and trend of these rangelands. Also, O'Connor (1995) reported that short-term drought had a little effect on changes in plant community composition; but together with more sever grazing, the plant composition was changed in favor of non-palatable perennial species. Understanding the relationship between plants and the environment and determining the factors affecting vegetation composition are important issues. Without a historical record of rangeland productivity, differences in yields cannot be precisely quantified (Haynes *et al*., 2013).

Jafarian *et al*. (2013) compared soil physical and chemical properties in grassland and shrub land communities of Iran and concluded that soil condition in the shrub land was more desirable than grassland because there was a greater percentage of vegetation in alkalin soils having high depth, low slope and the average infiltration. Kohestani and Yeganeh (2016) studied the effects of range management on vegetation of summer rangelands of Mazandaran province, Iran. The results showed that the Range Management Plans (RMPs) have increased the available forage production up to 14.7%. Nekooei *et al*. (2012) assessed the implementation impact of grassland management on their production, condition and trends in Komijan city of Markazi province, Iran. They measured production factors, status and trends in five grassland pastures with and without plans. They found that forage production and grazing capacity were increased in the rangelands with plans. Navarro *et al*. (2002) studying the rangelands of New Mexico observed that the canopy cover of *Bouteloua eriopoda* and *Hilaria mutica* was similar and did not change significantly under dry and wet conditions of a 48-year period (1952-1999). In other words, the positive effects of wet period have been offset by the occurrence of drought. Yavari *et al*. (2003) surveying the dynamic of rangeland plants in semi-arid region of North Khorasan found that vegetation type was not changed under deferred grazing while production and vegetation cover increased. In another study, Amiri and Basiri (2008) found that enclosure increased the cover and density of vegetation. In a study in North Africa, Le Houerou and Boulos (1991) showed that uncontrolled overgrazing led to the elimination or drastic reduction of most desirable plant density and palatable species and their replacement by undesirable and toxic species. Jianshuang *et al*. (2013) showed that short-term grazing exclusion changed the aboveground biomass and coverage at both community and species levels. Tietjen *et al*. (2010) investigated the effects of climatic changes on the coupled dynamics of water and vegetation in drylands; their results showed that two main factors controlled the response of plant types towards the climatic change, namely a change in water availability and a change in water allocation to a specific plant type. The aim of this study was to investigate the rangeland vegetation dynamics and to determine the effects of climatic on qualitative and quantitative changes of vegetation cover over five years.

Materials and Methods

Sites information

The research was conducted in three sites, and the characteristics of three sites are as follows:

Nour site is located at 45 km East of Ardabil city between latitudes of 37°59′ 40″ and 38°01′ 30″ N, and longitudes of 48° 35′ 38″ and 48° 36′ 30″ E with an altitude of 2760-2822 m above sea level in a mountainous land unit and semi-steppe vegetative region. It has a cold semi-arid climate with an average annual precipitation of 480 mm.

Aqdagh site is located at 35 km South of Khalkhal city, between latitudes of 37°26′ 90″ and 37° 27′ 60″ N, and longitudes of 48° 33′ 33″ and 48° 34′ 03″ E with an altitude of 2512-2588 m above sea level in a mountainous land unit and semi-steppe vegetative region. It has a cold semi-arid climate with an average annual precipitation of 450 mm.

Moqan (Boran-winter range) site is located at 40 km South of Parsabad city, between latitudes of 39°20′ 09″ and 39° 21′ 44″ N and longitudes of 47° 31′ 88″ and 47° 34′ 63″ E with an altitude of 340-380 m above sea level in a plain land unit and semi-steppe vegetative region. It has a temperate climate with an average annual precipitation of 276 mm (Sharifi & Akbarzadeh, 2008).

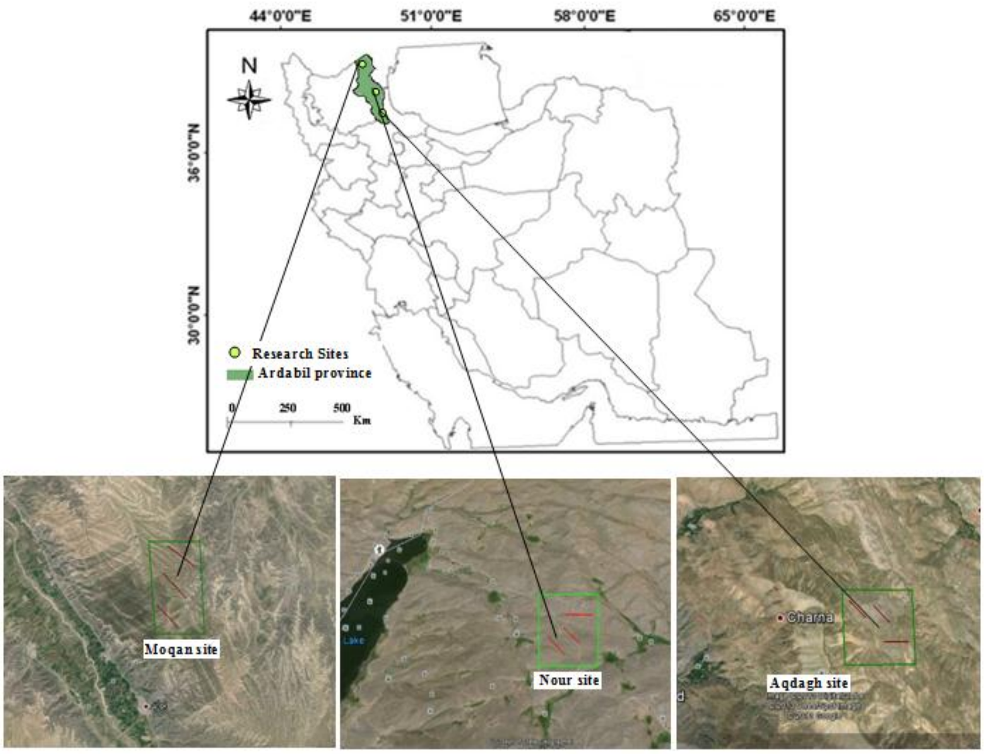

Fig. 1. Research sampling sites (Moqan, Nour and Aqdagh)

Research Method

Data collection was performed through the establishment of three transects and 30 plots (quadrates) in the study sites. According to the area of the site, the length of transects was determined to be between 300-1000 m. The size of plots considering canopy diameter and distance between individuals of the biggest canopy cover was equivalent to (1.5×1.5 m). Ten plots were established on each transect by random systematic method at 50 m intervals.

Measurement of relevant factors was conducted when dominant species were at completion of vegetative growth stage (Before the livestock enter the rangeland). Vegetation parameters including the canopy cover percent of perennial grasses, forbs, shrubs, annual plants and total canopy cover were estimated. Simultaneously, soil moisture in root zone of species was measured at two different depths (0-15, 15-30 cm) in Nour and Aqdagh sites and at three depths (0-15, 15-30, 30-45 cm) in Moqan site using a Time-Domain Reflectometer (TDR) instrument (Fig. 2).

Climatic data including precipitation and temperature were collected from the nearest synoptic station (Ardabil, Khalkhal and Pars-Abad), and the

Embrothermic curves were drawn. The collected data of vegetation cover, soil moisture, and organic carbon were entered into the Excel software. After classifying the data, statistical analysis was performed using a general linear model and one-way ANOVA using SAS software. Means comparison of canopy cover for indicator species and different plant groups such as shrubs, grasses, forbs, and total canopy cover, ground cover, soil moisture, and soil organic carbon was performed using Duncan's method at 5% probability level. Interpreting the results of data analysis was done with regard to the distribution of rainfall, accumulated effective precipitation (from early October until the date of field data collection), annual precipitation and temperature plotted using Ombrothermic diagrams.

Fig. 2. Soil moisture monitoring by using a Delta-T Devices Ltd version 4.0 type HH2 Cambridge-England

Results

Embrothermic curves of the nearest synoptic station (Ardabil, Khalkhal and Pars-Abad) to the study area during 2008-2009 and 2011- 2012 are presented in Figs. 3-8.

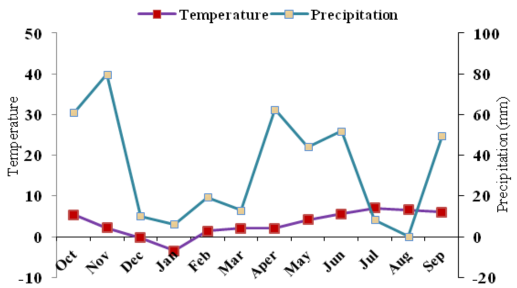

Fig. 3. Temperature and precipitation of Nour site, Ardabil synoptic station, Iran (2008-2009)

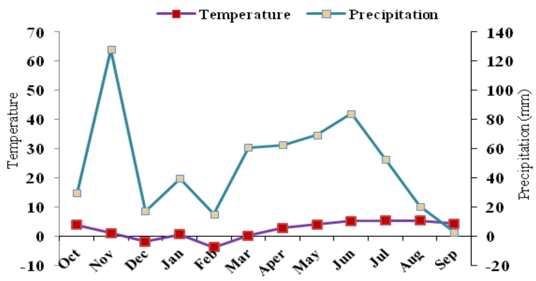

Fig. 4. Temperature and precipitation of Nour site, Ardabil synoptic station, Iran (2011-2012)

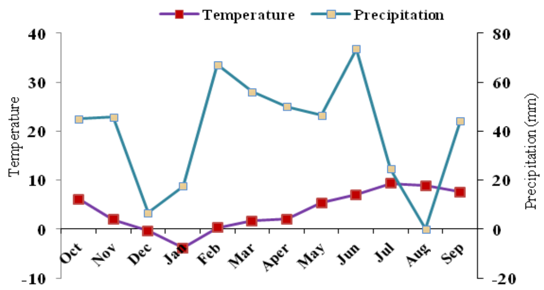

Fig. 5. Temperature and precipitation of Aqdagh site, Khalkhal synoptic station, Iran (2008-2009)

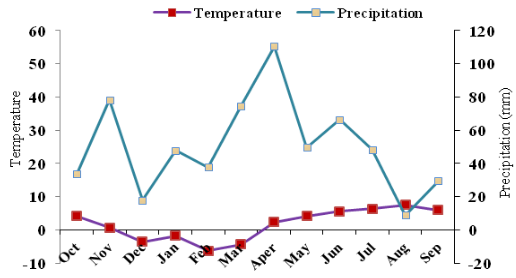

Fig. 6. Temperature and precipitation Aqdagh site, Khalkhal synoptic station, Iran (2011-2012)

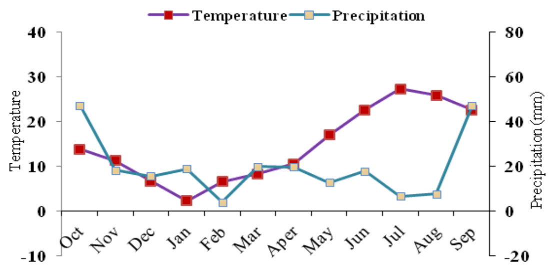

Fig. 7. Temperature and precipitation of Moqan site, Parsabad synoptic station, Iran (2008-2009)

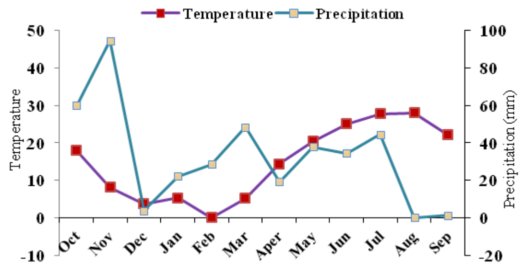

Fig. 8. Temperature and precipitation Moqan site, Parsabad synoptic station, Iran (2011-2012)

Fluctuations in rainfall and erratic distribution of rainfall during the growing season are major factors affecting vegetation. Results showed that based on the severity of droughts and wet years occurred during the period of the project, the amount and distribution of rainfall as well as temperature changes had significant impacts on vegetation variable including total canopy cover, canopy cover of plant groups, canopy cover of major species, and so forth. Annual precipitation and accumulated effective precipitation during study years in Ardabil province rangeland area as well as dates of data collection are shown in Table 1.

Table 1. Precipitation (mm) changes at three sites during the study years

Sites	Precipitation	2009	2010	2011	2012
Nour	Date of data collection	June 2	June. 8	June 7	June 12
	Effective cumulative precipitation (mm)	158.23	214.57	205.81	216.06
	Annual Precipitation (mm)	405	553.78	437.50	581.80
Aqdagh	Date of data collection	June 8	June. 24	June 14	June 25
	Effective cumulative precipitation (mm)	170.1	256.12	224.44	226.54
	Annual Precipitation (mm)	477.2	624.51	415.89	603.45
Moqan	Date of data collection	October 22	October 28	October 23	October 22
	Effective cumulative precipitation (mm)	124.50	60.51	69.90	4.80
	Annual Precipitation (mm)	234.53	486.93	226.43	394.80

Accumulated effective precipitation is total precipitation from early October until the date of field data collection

According to the results of one-way analysis of variance between years in Nour site, the results showed that changes in shrub (*Onobrychis cornuta* L.) and forbs species were significant ($P<0.01$). Also, year-to-year soil moisture in the depths root was also significant ($P<0.01$) in this site while changes in the amounts of soil organic carbon, soil cover, total canopy cover and perennial grasses (*Alopecurus aucheri* L., *Bromus tomentellus* Boiss. *Festuca ovina* and

Koeleria caucasica Trin. Ex Domin) were not significant (Table 2).

Table 2. Analysis of variance and mean comparisons of the variables monitored at Nour site

	Variables	Years of data collection				Pr>F
		2009	2010	2011	2012	
Canopy cover (%)	*Alopecurus aucheri* L.	2.95 a	2.48 a	3.05 a	3.22 a	0.923 ns
	Astragalus aureus willd.	3.96 a	3.60 a	4.81 a	6.03 a	0.851 ns
	Bromus tomentellus Boiss.	3.04 a	2.83 a	2.47 a	2.85 a	0.923 ns
	Festuca ovina L.	13.66 a	14.76 a	14.63 a	15.97 a	0.797 ns
	Koeleria caucasica	0.17 a	0.53 a	0.43 a	0.32 a	0.695 ns
	Onobrychis cornuta L.	1.57 b	6.11 a	5.63 a	1.97 b	0.006 **
	Thymus kotschyanus Boiss.	2.81a	3.39 a	3.97 a	3.78 a	0.658 ns
	shrubs	8.87 b	16.08 a	16.76 a	13.78 ab	0.016 *
	Perennial forbs	13.20a	9.43 ab	12.98 a	8.60 b	0.042 *
	Perennial grasses	27.27a	28.86 a	27.02 a	25.72 a	0.842 ns
	Annual plants	3.25 a	2.20 a	1.48 a	3.18 a	0.076 ns
	all species	52.49a	56.62 a	58.23 a	51.86 a	0.325 ns
Soil moisture (%)	Soil Depth 1 (0-15 cm)	5.78b	9.67 a	5.59 b	4.32 b	0.000 **
	Soil Depth 2 (15-30 cm)	10.45b	16.15 a	8.09 b	6.75 b	0.000 **
	Mean (0-30 cm)	8.11 b	12.91 a	6.84 b	5.54 b	0.000 **
Soil cover (%)		78.27 a	64.35 a	81.66 a	81.67 a	0.000 **
Soil organic carbon (%)		2.57 a	2.88 a	2.69 a	3.04 a	0.058 ns

Means of rows followed with the same letter are not significantly different (P<5%)

In Aqdagh site, the results of the analysis of data collected in consecutive years showed that changes in Grasses (*Agropyron cristatum*, *Bromus tomentellus*, *Festuca ovina* L. and *Koeleria caucasica*) and forbs were significant (P<0.01). Also, year-to-year mean soil moisture of annual species in the depths root was significant (P<0.01). In this site, the changes in the amounts of soil organic carbon, soil cover, total canopy cover and shrub species (*Onobrychis cornuta* and *Thymus kotschyanus*) were not significant (Table 3).

Table 3. The results of mean comparisons of the monitored variables at Aqdagh site

	Variables	Years of data collection				Pr>F
		2009	2010	2011	2012	
Canopy cover (%)	*Agropyron cristatum*	2.03 b	1.50 b	4.10 a	1.82 b	0.013*
	Agropyron trichophorum	1.15 a	2.07 a	1.12 a	1.43 a	0.439 ns
	Astragalus aureus	1.19 a	1.20 a	1.45 a	2.40 a	0.622 ns
	Bromus tomentellus	1.18 ab	0.78 b	2.12 a	0.33 b	0.018 *
	Festuca ovina L.	6.30 ab	5.33 b	8.70 a	8.30 a	0.018 *
	Koeleria caucasica	1.62 b	1.52 b	2.88 a	1.00 b	0.028 *
	Onobrychis cornuta	11.85 a	16.73 a	11.02 a	15.98 a	0.405 ns
	Thymus kotschyanus	8.54 a	6.77 a	9.47 a	7.83 a	0.434 ns
	Shrubs	21.77 a	25.21 a	21.97 a	26.48 a	0.544 ns
	Perennial Forbs	15.65 a	10.18 b	14.25 ab	10.38 b	0.013 *
	Perennial Grasses	15.71b	12.85 b	20.83 a	15.48 b	0.002 **
	Annual Plants	2.09 b	2.23 ab	0.93 c	2.96 a	0.000 **
	All Species	54.95 a	51.58 a	57.43 a	55.98 a	0.452 ns
Soil moisture (%)	Soil Depth 1 (0-15 cm)	5.92a	5.05 a	4.10 a	4.00 a	0.000 **
	Soil Depth 2 (15-30 cm)	7.08 a	5.67 ab	6.88 a	4.93 b	0.557 ns
	Mean (0-30 cm)	6.50 a	5.36 ab	5.49 ab	4.46 b	0.011 *
Soil cover (%)		2.57 a	2.61 a	2.72 a	2.27 a	0.006 **
Soil organic carbon (%)		82.37 a	63.87 b	85.40 a	68.42 b	0.112 ns

Means of rows followed with the same letter are not significantly different (P<5%)

In Moqan site, the results of the analysis of data collected in consecutive years showed that changes in shrub species such as *Artemisia fragrans* and annual plants were significant (P<0.01). Also, year-to-year soil moisture in the depths root and soil cover was significant (P<0.01) while in this site, the changes in the amounts of soil organic carbon were not significant (Table 4).

Table 4. The results of means comparison of the variables monitored at Moqan site

Variables		Years of data collection				Pr>F
		2009	2010	2011	2012	
Canopy cover (%)	*Artemisia fragrans* Willd.	22.64 ^{bc}	43.97 ^{a}	18.70 ^{c}	31.25 ^{b}	0.000 **
	Salsola crassa M. B.	2.12 ^{a}	2.88 ^{a}	0.83 ^{a}	0.43 ^{a}	0.151 ^{ns}
	Shrubs	25.70 ^{c}	47.21 ^{a}	19.60 ^{c}	37.17 ^{b}	0.000 **
	Annual plants	9.28 ^{a}	1.15 ^{b}	3.07 ^{b}	2.97 ^{b}	0.000 **
	All species	35.01 ^{a}	48.70 ^{a}	22.77 ^{a}	40.44 ^{b}	0.000 **
Soil moisture (%)	Soil Depth 1 (0-15 cm)	8.53 ^{a}	8.65 ^{a}	8.06 ^{a}	5.87 ^{b}	0.000 **
	Soil Depth 2 (15-30 cm)	14.24 ^{a}	12.34 ^{a}	9.46 ^{b}	7.49 ^{b}	0.000 **
	Soil Depth 3 (30-45 cm)	12.55 ^{a}	11.64 ^{a}	9.46 ^{b}	7.49 ^{c}	0.000 **
	Mean (0-30 cm)	11.77 ^{a}	10.87 ^{a}	8.95 ^{b}	7.97 ^{c}	0.000 **
Soil cover (%)		47.06 ^{bc}	65.87 ^{a}	40.90 ^{c}	52.50 ^{b}	0.000 **
Soil organic carbon (%)		1.59 ^{a}	1.54 ^{a}	1.55 ^{a}	1.38 ^{a}	0.215 ^{ns}

Means of rows followed with the same letter are not significantly different (P<5%)

Discussion and Conclusion

Fluctuations in precipitation and erratic distribution of during the growing season are main factors affecting vegetation cover. Results showed that in Nour site, the dominant perennial grasses (*Alopecurus aucheri* L., *Bromus tomentellus* Boiss., *Festuca ovina* L. and *Koeleria caucasica*) were not significantly affected by year-to-year changes of climatic variables. The response of these species to changes in annual rainfall was slow. But the differences between years for shrub and forbs species were significant (P<0.05). Although the site Neor and Aqdagh are similar, in Aqdagh site, the differences between years for dominant shrub species and the dominant perennial grasses were significant (P<0.01). Since in Aqdagh site, the accumulated effective precipitation during the growing season during the years was changing (Table 1).

Moqan site was different from other sites; the results showed that the changes in dominant shrub specie such as *Artemisia fragrans* over four years were significant (P<0.01). Also, the soil of this site possesses adequate capacity to store moisture in deep layers. The obtained results were in accordance with the research results reported by Sharifi and Akbarzadeh (2013) stating that the changes in canopy cover of woody shrub species were slow and mild while perennial grasses were affected by annual precipitation. They also stated that shrub species were less affected by year-to-year changes of climatic variables. In terms of vegetation dynamics in a four-year period, our results clearly indicate that shrubs comprise (form) the predominant cover of these rangelands showing less sensitivity to the changes in annual precipitation and less have undergone a change under wet or drought conditions.

In all three studied sites, slow changes in soil organic carbon as a criterion of carbon sequestration in this study site indicated that the current range management condition and especially early grazing and overgrazing impact affected the quantity of plant residues and prevented from a significant increase in soil organic matter content. Because of relatively low temperature from November to April, litter decomposition in the study area had a slow process. Therefore, in such conditions, soil organic carbon changes could be applied as one of the criteria in the assessment of range condition or range trend only in long-term requiring data collection for 10 to 15 years or more. Also, Abtahi *et al.* (2014) reported that changes in soil organic carbon were very slow while soil moisture appeared as a changeable factor in accordance with soil texture and variations in rainfall.

The overall conclusion is that the effect of rainfall on canopy cover was through its effect on soil moisture fluctuations. With increasing rainfall, particularly effective precipitation, a significant increase occurred in soil moisture storage. The moisture of surface soil provides the water required for annual species, perennial grasses, and most perennial forbs. For this reason, species such as *Tanacetum canescens* DC., *Polygonum alpetre* L., *Galium verum* L., and *Muscari comosum* (L.) Miller as forbs showed a positive response to the increase in annual precipitation, and their canopy cover increased. However, the response of shrubs to changes in annual precipitation was slow. In fact, moisture storage of soil with sandy loam to loamy textures and water absorption by deep roots in lower layers compensated the lack of rainfall and drought for shrub species. Hence, it can be concluded that in the drought start periods in rangeland, there was dominant vegetation such as forbs and grasses for preventing from its destruction. But for rangelands where perennial shrubs formed dominant vegetation, there is not such sensitivity. Results are in accordance with the research results reported by Kashki *et al.* (2012). Vegetation changes in rangelands are affected by various natural and human factors. Climatic factors including drought and wet conditions are inevitable natural factors. Rangelands attain stability over time. However, human factors and especially management play an effective role in maintaining either the stability or destruction of rangelands. Also, the results showed that two main factors controlled the response of plant types towards the climatic change, namely a change in water availability and a change in water allocation to a specific plant type (Tietjen *et al.*, 2010). Considerable and significant changes in total canopy cover or in its subsets (canopy cover of shrubs, perennial grasses, perennial forbs and annuals) observed in the study sites were mainly due to the changes in rainfall (amount and distribution) or because of changes in date of livestock entry into the rangeland (early grazing or late grazing). Since the capacity of soil for moisture retention depends on soil texture which is almost constant, annual assessment and monitoring of the moisture content of soil layers (regarding the accurate date for data collection) could be considered as one of the criteria for understanding vegetation dynamics in this rangeland sites. Finally, proportional to the changes of total canopy cover and its subsets resulting from annual and multi-year variations in climatic factors or due to management approaches, range management and grazing scheme should be corrected.

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مطالعه پویایی پوشش گیاهی مراتع نیمه استپی استان اردبیل ایران

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چکیده. پویایی پوشش گیاهی مراتع تحت تاثیر عوامل مختلف طبیعی و غیر طبیعی در طول زمان واقع می‌شوند. هدف از این مطالعه، بررسی پویایی پوشش گیاهی تحت شرایط آب و هوایی و خصوصیات خاک بود. بر همین اساس اندازه گیری و جمع آوری داده‌ها برای ارزیابی پویایی پوشش گیاهی در مراتع استان اردبیل در سه سایت تحقیقاتی شامل: مرتع قشلاقی مغان، مرتع ییلاقی نئور و مرتع ییلاقی آق داغ خلخال از سال ۱۳۸۷ تا ۱۳۹۱ انجام گردید. متغیرهای پوشش گیاهی با استفاده از ترانسکت و پلات اندازه گیری و نمونه برداری شد. درعین حال، در محل هر قطعه معرف، رطوبت خاک در دو یا سه عمق ۰-۱۵، ۱۵-۳۰ و ۳۰-۴۵ سانتی متر با استفاده از یک دستگاه رطوبت سنج (TDR) اندازه گیری شد. در سایت نئور در طی چهار سال نتایج نشان داد که گونه‌های بوته‌ای مانند .*Onobrychis cornuta* L و گونه-های از فورب‌ها تغییرات در سطح احتمال ۱٪ معنی‌دار بود. در حالیکه تفاوت بین سال‌ها برای گونه‌های گندمیان چندساله مانند.*Festuca ovina* L.، *Alopecurus aucheri* L.، *Bromus tomentellus* Boiss. و *Koeleria caucasica* Trin. Ex Domin معنی‌دار نبودند. در سایت آق داغ تغییرات گونه‌های گندمیان چند ساله مانند *Agropyron cristatum*، *Bromus tomentellus*، .*Festuca ovina* L و *Koeleria caucasica* و گونه‌هایی از فورب‌ها در سطح احتمال ۵٪ و گونه‌های یکساله ها در سطح احتمال ۱٪ معنی‌دار بود، اما گونه‌های بوته‌ای مانند .*Onobrychis cornuta* L و *Thymus kotschyanus* تغییرات معنی‌داری نداشتند. در سایت مغان تغییرات گونه غالب بوته‌ای (*Artemisia fragrans* Willd.) و یکساله‌ها در سطح احتمال ۱٪ معنی‌دار بود. رطوبت خاک در فصل رشد و در طی سال‌ها متغیر بوده ولی تغییرات کربن آلی خاک روندی کند داشته است. بنابراین نتایج حاصل از پایش روند تغییرات سال به سال در پوشش گیاهی گونه-های اصلی، رطوبت خاک، و نیز چگونگی وضعیت فرسایش خاک، می‌توان به عنوان راهنمای مناسبی برای تجدید نظر در تصمیم مدیریت مراتع، مورد استفاده قرار گیرد.

کلمات کلیدی: پوشش گیاهی، پویایی، کربن آلی، رطوبت خاک، ایران