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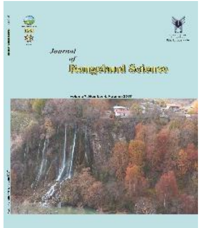

Research and Full Length Article:

The Structure of Plant Population of Forested Rangeland in Different Legal Definitions (Case Study: Sabzkouh Region, Chaharmahal & Bakhtiari Province, Iran)

Masoomeh Sadat Hosseininasab[A*], Hossein Barani[B], Mousa Akbarlou[B] and Mohamad Hadi Moayeri[C]
[A]Ph.D. Candidate of Rangeland Sciences, Gorgan University of Agricultural Sciences and Natural Resources, Iran, *(Corresponding Author), Email:hosseininasab_ma@yahoo.com
[B]Associate Professor, Department of Rangeland and Watershed Management, Gorgan University of Agricultural Sciences and Natural Resources, Iran
[C]Associate Professor Department of Forestry, Gorgan University of Agricultural Sciences and Natural Resources, Iran

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Abstract. There is less published research on ecosystems of forested rangeland in Iran. This research was conducted to investigate the forested rangeland area based on legal definition via comparison of indices species richness, diversity, and morphology of the trees and shrubs in Sabzkouh watershed, Chaharmahal Bakhtiari province, Iran. Quantitative characteristics of trees and shrubs were measured by 56 transects using the 'sample line with the fixed tree' method in 2016. In each transect five plots were thrown to measure understory factors. The data was divided into two categories, less and more than 1% and 5%, according to legal definitions of tree canopy cover percentage. In addition, timber volume was divided into two categories, less and more than 20 (m^3/ha). Two independent sample analyses (U test and T test) were used to compare between communities and Kappa index method were used check the maps accuracy. In this study, no significant differences were observed in structural changes in two community of 5% crown canopy. The results showed that in habitats, crown canopy more than 1%, and the timber volume less than 20 (m^3/ha) based on legal definition were estimated as a common area of forested rangeland. In this range the best crown canopy 0.5 to 4 percent, shrub height up to 2.7 m, the tree density 21 to 156 per ha, the (DBH) 10 cm, timber volume up to 20 m^3/ha has been extracted. This area was introduced with an increase in understory species richness. The main associated species of forested rangeland in this area were dominants shrubs. The comparisons of the maps the Kappa index confirmed the introduced area as a wooded rangeland in a good agreement. Hence, to decline a little interfered and to achieve more accurate results, it is suggested to research on native people and expert definition.

Keywords: Dry forest, Timber volume, Canopy cover, Biometry, Zagros

Introduction

Rangeland ecosystems cover 50% of the world's dry lands (Belay *et al*., 2013) of which approximately one-third consisted of rangelands with woody-herbaceous plants (Cyrus, 1998), ecosystems with a layer of bottom herbaceous plants and woody plants on the top layer (Wessels *et al*., 2011) Which, based on different vegetation thickening, is defined as savanna, Chaparral, wooded rangeland, Dehesas (Milan *et al*., 2006; Dean *et al*., 2012). In some world definition, the terms 'woodland' and 'forest' refer to any area with more than 20% tree cover (Thomas *et al*., 2015). Vegetation thickening is an expression referring to increasing from small trees and shrub in wooded rangelands or the dominance of bushes in grasslands (Papachristou *et al*., 2005; Ellis, 2011).

These areas are called as the forested rangeland in Iran. According to various definitions of forested rangeland and sparse forests, two factors, tree canopy cover and tree stand volume on the basis of legal definitions are considered as the defining unit of forested rangeland. As defined in 1986 by the constitution, if a rangeland has wild trees is named as wooded rangeland provided that the volume of trees per hectare in the north of Iran, from Astara area to Golidaghi be more than 50 m^3/ha and in other regions of Iran be over 20 m^3/ha (Moghadam, 2001). Tree canopy cover is also considered in forest classification to identify various forest classes.

In recent years, the term wooded rangeland was omitted from vocabulary of Forest, Rangeland and Watershed Organization (FRWO) and they were divided into rangelands and forests. Ranges are lands with self-growing grass, bush, shrub and dispersed tree vegetation classified into rural (with the grazing license of village council) and nomadic (with nomadic grazing license) ranges. The lands with higher than 5% woody crest vegetation are called "forest" and those with 1-5% crest vegetation are referred as "forest lands". In this bill, lands with less than 1% woody crest vegetation, if have the potential for converting to a forest are defined as "forest site". According to this classification, up to 1% woody crown vegetation in forest and grass vegetation is classified as rangeland (FRWO, 2012). Forests and rangelands are managed differently in Iran, according to the law, forests are managed by government and its assignment in the form of forestry plans is more common in northern forests, while protection plans are more carried out in non-northern forests due to their specific soil conditions such as soil sensitivity to erosion, high slope, land potential to slip and the risk of forest ecosystem destruction (Shamekhi, 2009). Range management includes range management plans, grazing license and in some cases, multi-purpose applications and range revival (Eskandari *et al*., 2008). The conflict between the government and stakeholders is the boundary of wooded rangeland and forest. According to mentioned definitions, lands with more than 1% woody vegetation are classified as forests and grazing is illegal in them. But due to a low area of grassy ranges, beneficiaries violate to forest lands and flocks illegally are grazed on them. Other forms of exploitation are fuel provision (firewood), construction, and fencing, planting fruit, herbs (Wessels *et al*., 2011) industrial resins and fiber (Heubach *et al*., 2011).

Shrub lands and brush lands outside of Northern Iran is 266567 hectares cover 1.6% of total forests' area (Taheri Abkenar, 2010). Forested rangeland and sparse forests are located adjacent to most of the western areas of Iran, which in some cases the similarity became more prominent because of high density of trees in rangelands, therefore, wooded rangeland are considered as forests in the management program. Furthermore, in forests, more constraints are created by the natural barriers include climatic factors (precipitation, temperature), topography (elevation, slope, direction, etc.) and consequential soil factors, shrub, grass and Geraminae cover are more advent, and the lands become more similar to rangelands. Therefore, it is not practically possible to determine the exact boundary of these two types of land cover (Esmaeili Vardanjani, 2013). One of the comparison methods of wooded rangeland and sparse forest, as well as the evolution process of the populations and restoration operation planning is to study the stand structure. The term "stand structure" represents the form, composition, stands layering, dispersion pattern of trees in biometric indicator's categories and accuracy of the quantitative and qualitative stand indices (Pourhashemi *et al*., 2014).

Today, the satellite processing based on canopy cover is the best way for ecotone boundary classification and separate shrubland of forest (Tomppo & Czaplewski, 2002). In reality, especially with the recent large scale understory farming, the boundary between woodland and not woodland is often blurred (Szabo, 2010). The study, on the other parameter except canopy cover for define wooded rangeland of forest is rare. Generally, ecosystem boundaries are defined based on either physical or functional criteria ecologists (Post *et al.,* 2007) or in origin based on structure (Sitzia *et al*., 2012). There is some research on relation between biodiversity and forest boundary. Sass *et al.* (2012), defining protected area boundaries based on the vescular plant species richness using satellite and hydrological data in Alberta protected area. The data showed that relatively strong relationship between species richness and wet area.

In recently years many studies have being done on stands in forest and rangeland (Belay *et al.,* 2013; Esmaeili Vardanjani, 2013; Sohrabi *et al.*, 2013), compare to, prior research has documented the definition of wooded rangeland (Wessles *et al.,* 2011; Tashakori zadeh and Matinkhah, 2009; Villanueva Patrida *et al*., 2016).

Zagros's site covered 40% of total Iran's forests and is one of the most important biological reserves of Iran and has established a habitat for about 2,000 plant species and endangered species. These forests with an area of about five million hectares (Marvi Mohajer, 2005) play a vital role in groundwater storage, soil conservation and other socio-economic services (Pir Bavaghar, 2011). In the West of Iran, the interference in forested rangeland and sparse forests lead to incorporation of the forested rangelands into the sparse forest group. Grazing, excessive exploitation of wood resources, understory cultivation and so on is done on both the ecosystems and operators, and planning managers didn't distinguish them. It seems essential to know the status of these ranges and forests and to identify their ability for doing functions (soil and water conservation, forage supply, habitat, forest reservoir, etc.) in order to plan for correct and sustainable exploitation, maintaining the diversity of existing plant species and finally, preservation of other sources dependent on these ecosystems. Given the importance mentioned, this study attempted to answer the question about whether there are differences in stand structure and species richness between forested rangeland and sparse forest of Sabzkouh region. For this reason, in this study, the structural differences of wooded rangeland and sparse forests' stands in regard to altitude of the studied area, morphological differences of trees, species richness of the tree layer and the understory and diversity will be discussed. This study, based on legal definition, three tree canopy cover classes, less and more than 1%, less and more than 5% and stand volume less and more than 20 (m^3 per ha) were considered as units of forested rangeland and sparse forests. So that less units less implies forested rangeland and more units indicate sparse forests.

Materials and Methods

Study area

The study was carried out in the central Zagros, located in Chaharmahal and Bakhtiari Province, Mountain Sabzkouh. The mean annual temperature is 9.8℃ and the mean annual precipitation is 700–900 mm (FRWO, 2007). Precipitation is mainly concentrated on December–May. The region soils are sarvak formed of marl and limestone related to the geologic formation II era, especially the Cretaceous (Raeisi *et al*., 2005). Sabzkouh watershed was selected for the study because of neighboring the woody rangelands and sparse forests in this area (Fig. 1).

Sabzkouh Watershed with an area of over 59,900 ha is located in three cities Borougen Lordegan and Kiar in Chaharmahal and Bakhtiari province, Iran between 50°37'23" and 51°15'02" E and 31°29'23" and 31°59'55" N, 135 km from the provincial capital.

The maximum and minimum elevation from sea level is 3870 m and 1120 m, respectively. The area is located between two large valleys and numerous cuts, and cliffs. Cause a complex landscape with relatively steeps slopes, so that the average slope are equivalent to 58.16%. Before 1986, the area was protected as free zone, which became a hunting prohibited region due to the good conditions such as rich and unique flora and fauna species. It so was protected until 1990 since part of which equals to 63500 ha was approved as protected area according to studies conducted by the Environmental Protection Council, and after the declaration in 1991, it was practically protected as a Chartagh biosphere reserved forest (IDE, 2011). Fig. 2 shows the canopy cover map of area based on FRWO data.

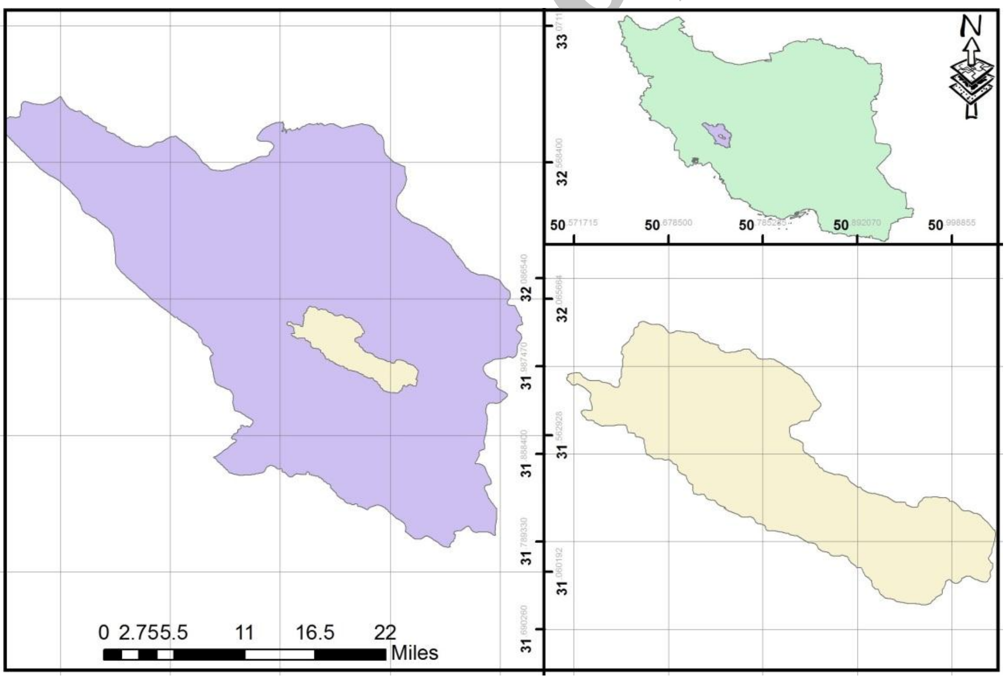

Fig. 1. Location of the study area on the map of Iran and Chaharmahal and Bakhtiari province

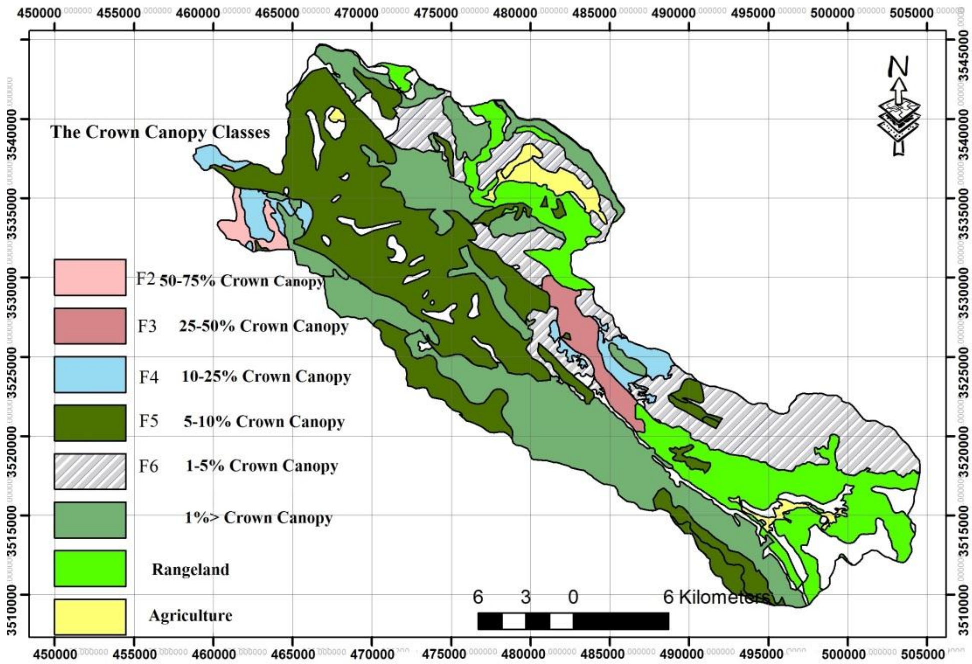

Fig. 2. Sabzkouh watershed, tree crown canopy classes (reference: FRWO, 2016)

Data collection

After preparation of base maps of vegetation from (FRWO), tree cover less than 1% and 5% were separated as woody rangeland and dry forests, respectively, according to the wooded rangeland definition (Shamekhi, 2009). In addition, another zoning was conducted based on the stand volume less and more than 20 (M^3 per ha). A total of 56 transects was thrown in a homogeneous mass of trees in a random-systematic manner in May and June 2016. Sampling was done by "sample line with a fixed number of trees" method of each transect. This sampling method, transects or sample line, is implemented and measured as systematic random including five trees in the forest. The length of the sample line depends on the mass density; and the key point is the measurement of five trees in each transect. In each field, 21 sampling units were selected for approximately the uniform stands. Then, a systematic-random sampling from transects, including five trees was implemented and measured in the forest (Zobeiri, 2007). The procedure is so that after the implementation of the starting point of the sample line and selects the tree number one and identify the species, trees' origin (seed or shoot), series of identification were recorded. The number of shoots in each coppice group (Pourhashemi *et al.*, 2014), Diameter Breast Height (DBH) (over 7.5 cm) for seed trees and all coppice stumps (Sitzia *et al.*, 2012), Tree Total Height (TDD) and small and large diameters of the crown were measured. Then a survey was conducted along specified for line transect until it cuts part of the second tree (crown or stump). The survey was continued to the fifth tree in the same manner along the line transect (Zobeiri, 2007).

For assets the crown area, the following equation was used (Equation 1).

$$\overline{CA_j} = 0.157 \times \sum_{i=1}^{5}(CD_{1ij} \times CD_{2ij})$$

(Equation 1)

Where:

$\overline{CA_j}$:Average Crown Area in j transect

CD1ij :Big diameter of (i) crown tree in j transect

CD2ij :Small diameter of (i) crown tree in j transect

For asset the crown area in hectare, the following equation was used (Equation 2).

$$CC_{ha_j} = \overline{CAJ} \times N_j \qquad \text{(Equation 2)}$$

Where:

$CA = \pi r^2$:Average Crown Area

CC_{haj} :Crown area in hectare (m^2)
N_j :Number of tree in hectare
The Canopy crown in percent asset from below relation (Zobeiri, 2007) (Equation 3).

$$CC_j\% = \frac{CA_j \times 100}{10000} \quad \text{(Equation 3)}$$

For asset the timber volume, the below relation has been used (Equation 4):

$$V = 0.4 \times (DBH)^2 \times TH \times C \quad \text{(Equation 4)}$$

Where:
V=timber volume (m^3/ha)
TH=Tree Height (m)
C=Coppice number (Zobeiri, 1994).
According to above methods, the measurement was carried on once for trees and once for shrubs in each transect in mixed communities. In the unmixed communities only tree or shrub layer was measured. Since the trees are coppice species the ellipsoid formula for the highest accuracy in estimating canopy was used in order to calculate canopy (Erfanifard and Moselo, 2013). To assess the understory herbaceous cover, five plots one square meter per transect were thrown randomly (280 plots) and then, canopy and abundance information were examined (Mesdaghi, 2005). The plot size of relatively dense ranges understory the forest can be considered one square meter (Mesdaghi, 1997). Margalef index and Simpson index were used in PAST software version 2.17 to measure species richness and species diversity, respectively (Mesdaghi, 2005). The timber volume interpolated map based on Geostatistical wizard (Inverse Distance Weighting) has been drowned in the Arc Map 10.3. Then the map projection (expected map) with the observed map (crown canopy) was assessed using the Kappa statistics. Kappa gives us a numerical rating of the degree to which this occurs (Monserud and Leemans, 1992).

Data analysis

Following data normalization using Kolmogorov–Smirnov test, the unnormal data were analyzed using Mann-Whitney U nonparametric test. Tree crown canopy between less and more than 1% and between less and more than 5% and timber volume between less and more than 20 m^3/ha were made using U test and F test.

Results

Result showed significant difference between two communities of less and more than 1% tree crown canopy for timber volume, crown canopy, tree density and tree height (Table 1).

Also, as can be seen in Table 1 the differences were significant for the all morphological traits in less and more than 20 (m^3/ha) model. The result didn't show any significant difference between two community of less and more than 5% except in canopy cover.

Tables 2 and 3 address the parameters of tree and shrub in these communities. For this purpose, three trees and three shrubs that were most abundant in the study area were studied. Among the trees in this community, *Crataegus monogyna*, *Quercus brantii* and *Fraxinus rotundifolia*, and among the shrubs, *Cerasus microcarpa*, *Daphne mucronata* and *Amygdalus orientalis* were the most frequent. The number of trees or shrubs per hectare, stand volume, canopy cross section and the tree height were measured on each transect. Examining the criterion, there was significant difference between the two communities in three models. In comparison between two community of less and more than 1%, the timber volume of the *Fraxinus rotundifolia* and the crown canopies of *Fraxinus rotundifolia*, *Crataegus monogyna* (Table 2) and crown canopy of *Daphne mucronata* (Table 3) were significantly different.

In comparison between two community of less and more than 5%, the *Crataegus monogyna* was absent. However, there were significant differences of crown canopy and the tree density for *Fraxinus rotundifolia* and *Quercus brantii* (Table 2), and similarly, significant differences of crown canopy, the timber volume and tree density for *Daphne mucronata* (Table 3).

Comparing the criteria showed that there were significant differences between two communities for all of trees species for timber volume (Table 2). Similarly, there were significant differences between two communities for canopy cover and the tree height in *Quercus brantii*. In this model, there were no significant differences between two communities for shrubs (Table 3).

Table 1. Mean±SD of structure attributes of the forested rangeland and the sparse forests

Variables	Percentage tree crown canopy			Percentage tree crown canopy			Timber volume		
	Less than 1%	More than 1%	U test	Less than 5%	More than 5%	U test	Less than 20(m^3/ha)	More than 20(m^3/ha)	U test
Topography	2207±138.6	2018±83.86		2075.2±84.34	2060±138.43		2266.4±95.38	1830.9±90.42	**
Tree Height (m)	2.77±0.48	4.45±0.68	*	4.22±0.64	3.06±0.55		2.38±0.24	5.93±1.00	**
Tree density (no/ha)	21.56±3.9	146.38±48.7	**	85.8±23.14	202.08±144.13		156.58±60.04	53.84±25.31	**
Coppice number	1.36±0.18	1.67±.19		1.71±0.18	1.12±0.07		1.21±0.11	2.04±0.28	**
Crown canopy (%)	0.45±0.05	5.04±0.84	**	1.69±0.18	11.18±1.84	**	4.22±0.92	9.22±1.53	**
DBH(cm)	13.4±2.44	16.57±2.09		14.86±1.07	18.64±6.81		9.50±0.93	23.31±2.88	**
Timber Volume (m^3/ha)	4.46±1.86	24.66±5.3	**	17.66±3.79	23.43±12.98		7.88±3.53	32.54±7.05	**

*, **= The differences are significant at 5 and 1% probability levels, based on Mann-Whitney U test, respectively

Table 2. Mean±SD of tree structure parameters of the forested rangeland and the sparse forests

Variables	Species Name	Percentage tree crown canopy			Percentage tree crown canopy			Timber volume		
		Less than 1%	More than 1%	U test	Less than 5%	More than 5%	U test	Less than 20(m^3/ha)	More than 20(m^3/ha)	U test
Tree density (no/ha)	*Crataegus monogyna*	27.7±9.5	25.5±3.6		26.25±3.72	0		26.9±4.18	23.00±11	
	Quercus brantii	7.00±1.1	71.00±25.4		18.5±7.33	144±9.83	*	20.33±6.03	100.33±4.66	
	Fraxinus rotundifolia	10.66±0.66	87.6±39.7		14.37±2.6	158.6±11.7	**	18±6.77	102.25±74.87	
Timber Volume (m^3/ha)	*Crataegus monogyna*	8.7±2.08	11.04±2. 3		10.27±2.39	0		7.3±1.57	25.21±1.02	*
	Quercus brantii	1.7±0.27	70.3±28.4		37.01±3.27	102.6±19.52		10.1±4.66	107.67±30.7	*
	Fraxinus rotundifolia	9.87±4.07	38.02±8.06	*****	24.171±6.11	43.02±16.8		12.45±2.77	43.44±10.12	*
Crown canopy (m^2)	*Crataegus monogyna*	0.52±0.11	2.5±0.41	******	1.86±0.39	0		1.93±0.46	1.56±0.9	
	Quercus brantii	0.34±0.04	6.05±2.9		1.5±0.57	12.27±6.5	*	0.93±0.32	9.25±4.82	*
	Fraxinus rotundifolia	0.62±0.4	7.5±2.3	******	2.01±0.46	12.11±3.6	**	2.13±1.11	8.26±2.82	
Tree Height (m)	*Crataegus monogyna*	2. 5±0.83	4.24±0.31		3.68±0.4	0		3.52±0.45	4.47±0.93	
	Quercus brantii	4.32±1.11	5.2±0.52		4.88±0.04	5.6±1.04		4.18±0.11	6.07±0.52	*
	Fraxinus rotundifolia	5.13±1.56	7.8±2.31		8.5±2.9	5±0.56		5.64±0.99	8.17±2.97	

*, **= The differences are significant at 5 and 1% probability levels, based on Mann-Whitney U test, respectively

Table 3. Mean±SD of shrub structure parameters of the forested rangeland and the sparse forests

Variables	Tree species	Percentage tree crown canopy			Percentage tree crown canopy			Timber volume		
		Less than 1%	More than 1%	U test	Less than 5%	More than 5%	U test	Less than 20(m^3/ha)	More than 20(m^3/ha)	U test
Tree density (no/ha)	*Cerasus microcarpa*	33.5±2.5	329±20.5		73.25±11.29	761±132.4		256±172	29±2.3	
	Daphne mucronata	32.5±2.5	466±22.13		38.7±11.3	747.6±317	*	104.17±22.3	177±11	
	Amygdalus orientalis	130±2.5	100.5±20.52		83.75±23.61	0		83±23.65	0	
Timber Volume (m^3/ha)	*Cerasus microcarpa*	0.46±0.0	11.8±2.7		7.02±2.6	8.5±2.3		2.9±1.9	24.97±1.8	
	Daphne mucronata	0.56±0.32	6.7±0.2		0.78±0.23	10.6±4.4	*	2.26±0.97	21.4±3.9	
	Amygdalus orientalis	0.16±0.02	2.49±0.81		2.02±0.71	0		2.03±0.78	0	
Crown canopy (m^2)	*Cerasus microcarpa*	0.54±0.11	2.5±1.31		0.88±0.2	5.17±1.92		1.89±0.75	1.1±0.02	
	Daphne mucronata	0.39±0.08	7.82±0.88	*	1.23±0.57	11.61±3.17	*	4.07±0.11	15.45±3.6	
	Amygdalus orientalis	0.13±0	2.45±0.18		1.98±0.49	0		1.99±0.48	0	
Tree Height (m)	*Cerasus microcarpa*	1.35±0.11	1.7±0.06		1.67±0.42	1.14±3.6		1.23±0.08	2.92±0.03	
	Daphne mucronata	1. 5±0.15	2.25±0. 5		1.88±0.25	2.9±0.72		2.18±0.4	1.15±0.13	
	Amygdalus orientalis	1.32±0.06	1.91±0.16		1.8±0.17	0		1.8±0.171`	0	

*, **= The differences are significant at 5 and 1% probability levels, based on Mann-Whitney U test, respectively

Table 4. Species richness and diversity in tree layer and understory

Indices	Species	Percentage tree crown canopy			Percentage tree crown canopy			Timber volume		
		Less than 1%	More than 1%	T test	Less than 5%	More than 5%	T test	Less than 20(m^3/ha)	More than 20(m^3/ha)	T test
Species Richness	Tree layer	2.56	4.5	**	2.59	4.4	**	3.53	3.31	
	Understory	2.7	4.79	**	5.15	1.71	**	4.58	2.02	**
Diversity in understory	*Astragalus adscendens*	0.96	0.99		0.98	0.99	*	0.98	0.98	
	Annual Grass	0.80	0.70		0.9	0.64		0.89	0.88	
	Daphne mucronata	0.89	0.73		0.93	0.72		0.96	0.96	
	Cirsium bracteosum	0.87	0.75	*	0.91	0.7		0.94	0.91	
	Agropyron brachyphyllum	0.87	0.75	*	0.66	0.76		0.81	0.00	*
	Agropyron repens	0.00	0.87	**	0	0.87	**	0.18	0.27	
	Agropyron trichophorum	0.66	0.84		0.8	0.78		0.84	0.64	
	Stipa capensis	0.58	0.72		0.84	0.63		0.85	0.6	
	Amygdalus orientalis	0.84	0.97	**	0.93	0.97	**	0.96	0.95	
	Amygdalus scoparia	0.00	0.82	*	0.5	0.8		0.66	0.75	
	Glycyrrhiza glabra	0.91	0.97	**	0.94	0.96		0.95	0.93	
	Crataegus monogyna	0.91	0.98	**	0.95	0.97	**	0.96	0.95	
	Bromus tomentellus	0.87	0.91		0.9	0.89		0.88	0.78	
	Dactylis glomerata	0.43	0.9	**	0.83	0.89	**	0.84	0.84	*
	Festuca ovina	0.72	0.88		0.8	0.85		0.72	0.82	
	Acantholimon festucaceum	0.87	0.94	*	0.83	0.93	**	0.90	0.88	
	Acanthophyllum bracteatum	0.66	0.94	**	0.83	0.93	**	0.85	0.90	

*, **= The differences are significant at 5 and 1% probability levels, based on T test, respectively

Fig. 3 shows that the results of applying interpolation methods of the timber volume sample. Fig. 4 is the outcome of the map interpolates into the crown cover 1% to 5% and timber volume. The Kappa index was 0.31 in fair level. The Kappa index between timber volume less than 20 m^3/ha and canopy cover more than 1% was 0.56 in good level.

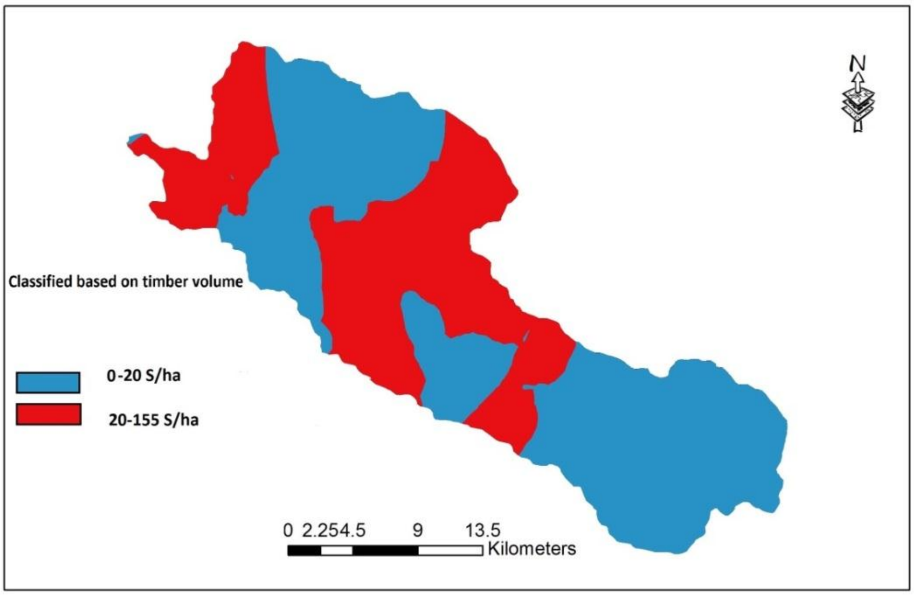

Fig. 3. The interpolation method (IDW[4]) of timber volume

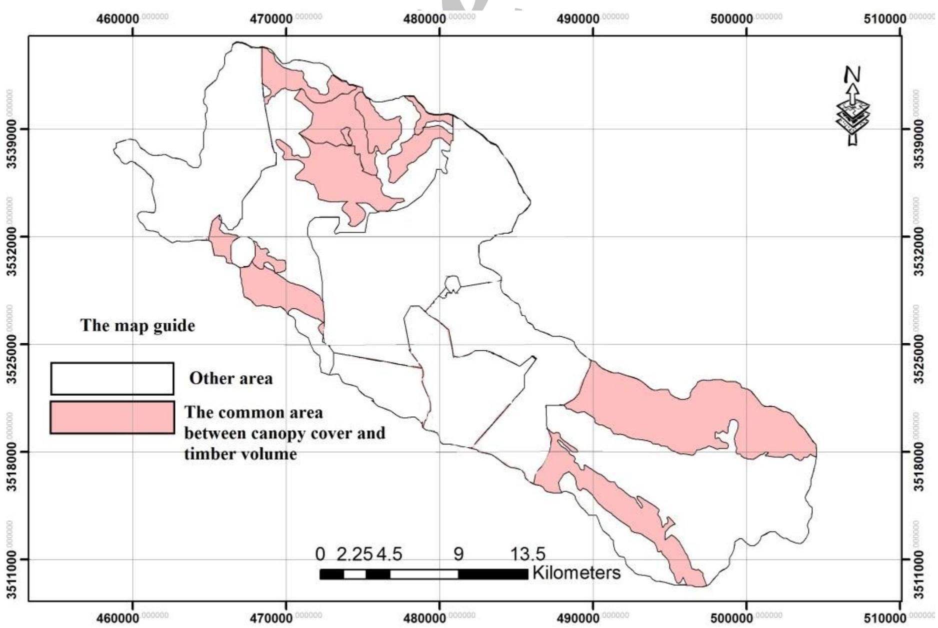

Fig. 4. The interpolation method (IDW) of the crown canopy (1-5) percent and timber volume

[4] - Inverse Distance Weighting

Discussion

Based on the results that have been checked in this study the morphological factors as a tree height, tree density, crown canopy and timber volume were significantly different from the 1% canopy cover. This means that this area was suitable for being introduced as the limit of the boundary of forested rangeland and rangeland. As in 5% crest vegetation, the difference between the two areas was not significant except in canopy cover; it seems that this scale cannot be a proper point in separating boundaries of forested rangeland and forest. So, the canopy cover 5% is located in forest area. The canopy covers of 7% in a forest reported by Sohrabi *et al*. (2013), that the present research showed the same results. The timber volume less, more than 20 m^3/ha is significantly different too, in all morphological and topography indices which, can be introduced as an upper limit of the boundary.

The schematic feature of crown canopy means in three models (Fig. 5) compare the means of canopy cover in each model. At least canopy cover recorded number was 0.45 percent that was introduced as a start point of wooded rangeland. This is confirmed, some definition of legal that say wooded rangeland is introduced into less than 1%, as Shamekhi (2009) noted. Three models in 4 percent canopy cover had common point. This point can be introduced as an upper part of wooded rangeland. However, there is no research on this subject.

Thus, the timber volume less than 20 m^3/ha is the suitable boundary of forest and forested rangeland. Shamekhi (2009) has explained that, in the legal guideline the volume timber index in more than 20 m^3/ha was one of the important separate wooded rangeland units. But, because of some ambiguity, this definition is not usable.

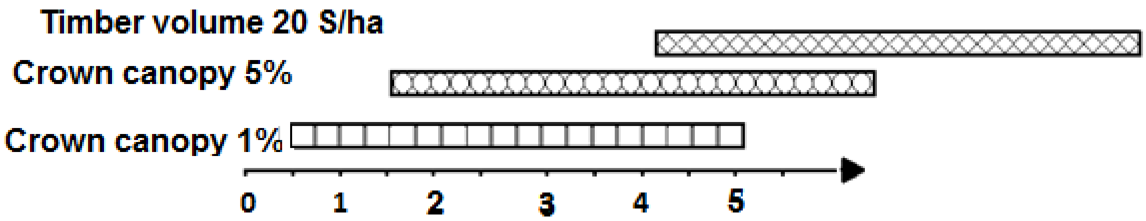

Fig. 5. The schematic feature of crown canopy means in three models

In 1 to 4 percent canopy cover range the best density 21 to 156 trees per hectare, the tree height 2.38 to 2.7 m, and the crown canopy 0.5 to 4 percent were introduced. The density of trees had a little contradiction with the results of Sohrabi *et al*. (2013) in Ardal forests, and Sadeghi kaji *et al*. (2014) in Helen protected area in central Zagros forest, Iran, who obtained tree density 152 and 154.25 trees per ha. Salehi *et al*. (2011) in destroying forest at Poldokhtar, Lurestan province, Iran had extracted the higher values of these morphological tree indices except in tree density. It means that, our result except in tree density was not interfered with forest. The higher shrub density in this area is the reason for the density. This finding was in agreement with the results of Askari (2012) in Chartagh, Iran, that had extracted the DBH, density, crown canopy of shrubs and trees in different methods of sampling. Similarly, Jazirehi and Ebrahimi Rastaghi (2013) showed that the cover layering in southern Zagros is a compound of tree and shrubs.

It should be note; there is no significant difference for height of trees in all habitats except oak tree. It is because of even-aged trees in the region and a uniform forest in the past, Sohrabi *et al*. (2013) had the same result.

It seemed that the forested rangeland area is covered by associated specie as *Cerasus microcarpa*, *Daphne mucronata* and *Amygdalus orientalis*. However, *Amygdalus orientalis* has the highest frequency in the timber volume less than 20 m^3/ha. In studies of Heidari (2005), also reported that the presence of associated species (*Crataegus monogyna* and *Amygdalus orientalis*) were rare in the forest stands.

Number of *Quercus brantii* trees in the forested rangelands was eliminated for agroforestry and as a result had a weaker base than in the thickest forests. The irregular cutting of trees for expending tilling lands and grazing were reported by Abule *et al.* (2007), Mirdavoodi (2014) and Mirakzadeh *et al*. (2011) in Zagros in western part of Iran.

It was found that the forested rangelands area were associated with an increase in understory species richness, Sitzia *et al*. (2012) had the same result in abandoned silver fir mature wooded rangeland. In contrast, the herbaceous cover was lower under high arboreal densities found by Villanueva Patrida *et al.* (2016). In the collective, the diversity number was low. However, the forested rangelands had more herbaceous species than forest; the diversity of understory confirms it. Sharafatmandrad *et al*. (2014) introduced the reasons of decline in biodiversity as extra grazing, annual plant and invasive species. It seems that reduces plant species and functional diversity and richness in this area has same reasons. The tree richness has been increased by higher canopy cover and density. The reason belongs to the Chartagh reserve forest. Trees layers species richness showed no significant difference in timber volume. It means that, maybe this boundary between wooded rangeland and forest is not powerful and other amount of timber volume should be studied.

There were more coppice trees in forest. Cutting and bolling of trees, is one of the most important damaging factors to coppice trees, Salehi *et al*. (2011) found the same result.

The Kappa index confirmed the agreement on the two models as (0.56) in good level. The range has been introduced as a forested rangeland had some interfered with forest. To achieve more accurate results, it is necessary to investigating using another definition of native people and expert of FRWO.

On the other hand, the timber volume can also be introduced as an important cognitive factor of forested rangeland. As trees are coppice species, it is partially difficult to measure the stand volume; in order to facilitate this dilemma, creating stand volume tables' specific to this area and by tree and shrub species could be useful.

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ساختار جمعیت گیاهی مراتع مشجر بر اساس تعاریف مختلف قانونی (مطالعه موردی: منطقه سبزکوه چهارمحال و بختیاری)

معصومه سادات حسینی نسب[الف*]، حسین بارانی[ب]، موسی اکبرلو[ب]، محمد هادی معیری[ج]

[الف]دانشجوی دکتری علوم مرتع، دانشگاه علوم کشاورزی و منابع طبیعی گرگان، *(نگارنده مسئول)، پست الکترونیک: hosseininasab_ma@yahoo.com

[ب]دانشیار گروه مرتعداری، دانشکده مرتع و آبخیزداری، دانشگاه علوم کشاورزی و منابع طبیعی گرگان

[ج]دانشیار گروه جنگلداری، دانشکده جنگل، دانشگاه علوم کشاورزی و منابع طبیعی گرگان

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چکیده. یکی از اکوسیستم‌های کمتر مطالعه شده در ایران مراتع مشجر است. هدف این مطالعه بررسی محدوده مراتع مشجر بر اساس تعاریف قانونی با مقایسه شاخص‌های غنای گونه‌ای، تنوع گونه‌ای، ریخت‌شناسی درختان و درختچه‌ها در حوزه آبخیز سبزکوه در استان چهارمحال و بختیاری است. خصوصیات کمی درختان و درختچه‌ها با استفاده از ۵۶ ترانسکت و به روش "خط نمونه دارای تعداد درخت ثابت" در سال ۱۳۹۵، سنجیده شد. در هر ترانسکت ۵ پلات برای اندازه‌گیری فاکتورهای زیر اشکوب انداخته شد. بر اساس تعاریف موجود در قانون، اطلاعات به دو بخش تاج‌پوشش درختی کمتر و بیشتر از یک درصد و پنج درصد تفکیک گردیدند. همچنین حجم چوب کمتر و بیشتر از ۲۰ مترمکعب در هکتار در نظر گرفته شد. آنالیز آماری مقایسه بین دو گروه مستقل و ضریب همپوشانی کاپا در نقشه‌ها برای ارزیابی ارتباط بین شاخص‌ها استفاده شد. در این مطالعه تفاوت معنی‌داری در پارامترهای پنج درصد پوشش تاجی مشاهده نشد. نتایج نشان داد در بین زیستگاه‌ها، تاج پوشش بیشتر از یک درصد و حجم چوب سرپا کمتر از ۲۰ متر مکعب در هکتار بر اساس تعریف قانونی به عنوان محدوده مراتع مشجر معنی‌دار است. در این محدوده بهترین تاج پوشش ۰/۵ تا ۴ درصد، ارتفاع درخت تا ۲/۷ متر، تراکم درخت ۲۱ تا ۱۵۶ اصله، قطر برابر سینه ۱۰ سانتی‌متر و حجم چوب تا ۲۰ مترمکعب در هکتار استخراج شد. این منطقه با افزایش غنای گونه زیر اشکوب همراه است. درختچه‌های غالب به عنوان گونه‌های همراه مرتع مشجر در این منطقه معرفی می‌شود. ضریب همپوشانی کاپا، محدوده معرفی شده به عنوان مراتع مشجر را در سطح خوب تایید می‌کند. با این‌حال برای کاهش اندک تداخل مشاهده شده و دستیابی به تعریف جامع‌تر، نیاز است که تعریف مورد استفاده بین مردم محلی و کارشناسان نیز بررسی شود.

کلمات کلیدی: جنگل خشک، حجم چوب، تاج پوشش، زیست‌سنجی، زاگرس