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Biodiversity evaluation of rangelands ecosystems to achieve sustainable development (case study: Dastgerd watersed, Birjand, Iran)

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Abstract

Taken literally, the aim of biodiversity monitoring is to track changes in the biological integrity of ecosystems. Biodiversity monitoring within the rangelands may encompass many aspects and is clearly a very complex task. This study was conducted on rangelands of Dastgerd watershed with the objective of the determining the floristic composition, species diversity, richness and evenness. Systematic-randomly sampling method was used to collect the vegetation data. Accordingly, 20 plot of 10 × 10m (100m^2) quadrate were laid and vegetation parameters were recorded and all the collected plant species were identified at herbarium of Birjand university. Vegetation analyzing was performed using BIO DAP, Estimate S and PAST software. A total of 32 species belonging to 30 genera and 15 families were identified. The collected species were composed of chamaephyte (15.5 %), geophytes (19 %), hemicryptophytes (37.5 %), phanerophytes (6 %) and therophytes (22 %). Most of species belong to Asteraceae and Poaceae. Generally, the rangeland condition indicated that it is in the stage of regeneration. The high percent of species belong to class III in the area shows necessitates the need for an immediate conservation action in order to ensure the sustainable utilization and management of the rangeland.

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Introduction

Our vast country of Iran has high biodiversity due to different topography and climates and this variation range will lead to the direct and indirect benefits in local and global scale. Identification and introduction of floristic composition are particularly and locally important including the access to a particular species in a given place and time, determining the growth potential, possible increase of the density of the species, identifying resistant species, invasive species, possible access to new species and identifying destructive factors in the region (Ghollasimood *et al.*, 2006). The species diversity is not just related to the number of species in a community, and also to the number of individuals of each species, distribution, mutual relations, but also to the respective function of species, that is, related to species functional diversity (Zhang *et al.*, 2012; Song *et al.*, 2014). Through the study of plant diversity, and determining the distribution of species in the environment, plant community dynamics can be studied and appropriate management recommendations can be proposed with an emphasis on the dynamics of ecosystem (Hayek *et al.*, 2007; Vandermarl, 1993). Therefore, an understanding of patterns and processes in species diversity is critical for ecosystem management and conservation measures.

Plant diversity has been discussed in different regions (Rostampoor *et al.,* 2008; Ghollasimood *et al.*, 2006; Nikan *et al.*, 2003; Mahmoodi *et al.*, 2011). The result showed grazing exclusion is an effective way to restore the degraded grassland, and significantly influences the vegetation compositions and soil properties. High population growth, climate and land use change and extraction of natural resources are increasing the pressure on fragile watersheds. In order to stop the downward spiral of resource degradation, landscape instability, reduced biodiversity, interdisciplinary analysis and new approaches to sustainable development and integrated watershed management are needed. The runoff of this area goes directly on the runway of Birjand airport and airport facilities in the area downstream, since several reform and revival operations of vegetation have been carried out in the study area, thus the study was conducted to examine the effect of vegetation area and species richness and diversity in order to have a sustainable operation of rangeland in this area.

Materials and methods

Study area

Current study was performed in Dastgerd watershed, located at 5 km north of Birjand between 32˚54´21˝to 33˚04´41˝north latitude and 59˚12´59˝ to 59˚21´32˝ east longitude, with 13583 hectares. Minimum and maximum elevation of the area is 1514 m and 2325 m, respectively. Annual rainfall is 213.5 mm and regional climate is classified as arid. The average annual temperature is 12.9°C and relative humidity is 38.5%. From the perspective of geomorphology, Dastgerd watershed can be studied in two main areas of mountainous and plain. Mountainous regions that include more than half of the study area have been developed mainly in the northern half of the basin while the plain areas involved the major part of the southern half of the Dastgerd watershed. South Khorasan generally consists of two categories of Aridisols and Entisols and in recent studies the categories of Inceptisols and Vertisols have been observed. This study has been done in 641.30 ha of revived areas of the study basin.

Methods

In order to calculate the parameters of the research, according to the dominant vegetation of the area, 10 × 10 m quadrates were systematic-randomly placed. Sampling strategy and intensity (total of 20 quadrates) assures the complete sampling of all plant samples. Sampling was done based on the nature of society vegetation in different parts of the region. In each plot the presence of species and the density of each plant species were recorded. Species identification was carried in the herbarium of Agriculture Faculty by means of taxonomic keys and reference books (Akhani, 2005; Assadi *et al.*, 1988-2010). Biological forms of plants were classified using

Raunkiaer method (1934). In this method, plants are divided based on how to spend the inclement season of growth and the location of the bud growth in next year (Moghaddam, 2001). Biological form, growth form and the growth period were identified, to determine the numerical index of diversity, evenness and species richness ecological softwares such as Bio DAP, PAST and Estimate S were used. Margalef species richness index (1957) was calculated using PAST software, Shannon and Simpson (1949) diversity indices were calculated using Estimate S software and McIntosh evenness index was calculated using Bio DAP software. Species richness indicates the presence of all types and is obtained by counting the number of plant species in an area.

Results and discussion

A total of 32 species (non-tree), 30 genus belong to 15 families were encountered within 641 ha (Table 1).

The families of Asteraceae, Poaceae and Chenopodiaceae, respectively, accounted the highest frequency as 36.98, 15.48 and 7.63 percent (Fig 1). According to some literature studies, when the destruction rate of vegetation is high, some of plant families such as Asteraceae will become more present in the flora of the region. Yavari *et al.,* (2001) and Tavakoli, (2006) examined the Sisab region in Khorasan and stated that species of Asteraceae have the highest frequency due to degradation in the region.

Table 1. The floristic list of plant species in the study area.

Family	species	Growth Form	Growth Period	Life Form	Palatibility
Apiaceae	*Ferula assa-foetida*	forb	P	Ch	II
Apiaceae	*Eryngium bungei*	grass	P	He	II
Asteraceae	*Artemisia aucheri*	bush	P	Ch	II
Asteraceae	*Launaea acanthodes*	forb	A	He	III
Asteraceae	*Achillea wilhelmsii*	forb	A	Th	II
Asteraceae	*Gundelia tournefortii*	forb	A	He	III
Asteraceae	Cousinia sp.	forb	P	He	III
Asteraceae	Scorzonera sp.	forb	A	He	III
Asteraceae	*Artemisia sieberi*	bush	P	Ch	II
Asteraceae	*Lactuca orientalis*	forb	A	Th	III
Asteraceae	*Echinops polygamus*	forb	A	Ch	III
Asteraceae	*Centaurea aucheri*	forb	P	He	III
Boraginaceae	*Hellotropium ellipticum*	forb	A	Th	III
Brassicaceae	Alyssum sp.	forb	A	Th	III
Caryophyllaceae	Acanthophyllum sp.	bush	P	Ch	III
Chenopodiaceae	Salsola sp.	forb	A	Th	II
Chenopodiaceae	*Atriplex canescens*	shrub	P	Ch	II
Euphorbiaceae	*Euphorbia aucheri*	forb	A	He	III
Fabaceae	*Astragalus heratensis*	bush	P	He	II
Fabaceae	*Sophora pachycarpa*	forb	A	He	III
Iridaceae	*Iris songarica*	forb	A	Ge	III
Labiateae	*Thymus vulgaris*	forb	A	Th	II
Labiateae	*Ziziphora tenuior*	forb	A	Th	III
Poaceae	*Stipa barbata*	grass	P	He	II
Poaceae	*Agropyron trichophorum*	grass	P	Ge	I
Poaceae	Hordeum sp.	forb	A	Ge	II
Poaceae	*Bromus tectorum*	grass	A	Th	II
Polygonaceae	*Polygonum hyrcanicum*	forb	A	Th	II
Polygonaceae	*Rheum ribes*	forb	A	Ge	II
Rosaceae	*Amygdalus scoparia*	shrub	P	Ph	II
Tamaricaceae	*Tamarix stricta*	shrub	P	Ph	II
Zygophyllaceae	*Peganum harmala*	forb	P	He	III

Life forms: (Th, Therophyte; He,Hemicryptophyte; Ch,Chamaephyte; Ge,Geophyte; Cr,Cryptophyte; Ph, Phanerophyte); Growth period: (P: Perennial, A: Annual).

Life form of plants shows the taxonomic characteristics of them and represents their adaptation to the environmental conditions. Ghollasimood *et al.,* (2014) introduced 108 plant species in semi- steppe rangelands of West Zagros. Based on results, Poaceae was the largest families with 16 species and therophytes were the dominant plant growth form with 33.3%.in the study area.

Table 2. The frequency of life form, growth form &growth period of species.

Growth period	Frequency (%)	Growth form	Frequency (%)	Life-form	Frequency (%)
P	43.75	forb	65.62	Ch	18.75
A	56.25	grass	12.5	Ge	15.62
		bush	12.5	Ph	6.25
		shrub	9.37	He	37.5
				Th	21.88

Life forms: Ch = Chamaephyte, Ge = Geophyte, He = Hemicryptophyte, Ph = Phanerophyte, Th = Therophyte, Growth period: P: Perennial, A: Annual.

Based on the results presented in Table 2, hemicryptophytes have the dominant biological form of the region and included 37.5 percent of all recorded species. After that therophytes are in the next place (21.87 %). These results indicate that at higher altitudes, annual grasses (therophytes) are decreased and perennial plants and shrubs (hemicryptophytes) are increased. In similar areas with mountainous regions including Rostam-abad upstream sector 800-2600m (Moradi *et al.*, 2010), Alamut with the elevation range of 660 to 4175 m (Charkhchiyan *et al.*, 2008), Khanchay Tarom Olya with the elevation range of 400-2765 m (Mousavi, 2004) the dominance of hemicryptophytes has been reported as 37%, 53.4% and 56.8%. Also Behboodi (2010) in the study of the biological spectrum of plants in Tandooreh National Park concluded that the life-forms of hemicryptophytes and therophytes are more dominant. The region is classified to semi-arid climate with snowy winters and hot and dry summers and the shortage of rainfall. Gholami *et al.*, (2006) confirmed the same issue in the study of biodiversity of plant species around the protected area of Bazangan. High proportion of therophytes in flora of Dastgerd watershed can be attributed to the desired consistency of these life forms with the seasonal rainfall. Such a high percentage of hemicryptophytes can also be related to the positive response of plants to the grazing exclusion. In a similar study by Shokri *et al.*, (2006) in the Alborz mountain ranges, they found that by the medium and light grazing intensity, the greatest life form of vegetation is related to hemicryptophytes, but therophytes are replaced by hemicryptophytes due to intensity of grazing.

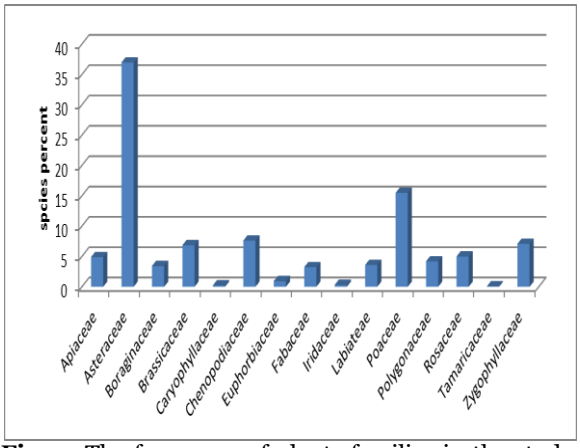

Fig. 1. The frequency of plants families in the study area.

Based on the results of Table 2, the most available species in the area consist of annual species that shows the adjustment of their species to the climatic conditions of the region. Because of low rainfall, the conditions are only favorable for the establishment of annual plants and these plants create a temporary habitat.

In Figure 2 the number of plant species belonging to each family is proposed. These species appeared in 4

forms of forbs, grasses, bushes and shrubs and a high frequency of each form is shown in Figure 3. Due to the mountainous region, perennial plants are more than any other form in the study area. In relation to the palatability class, the majority of species are grouped in class III that include 53% of species. 44% of species are grouped in class II and only 3% of species are classified in Class I. (Figure 4).

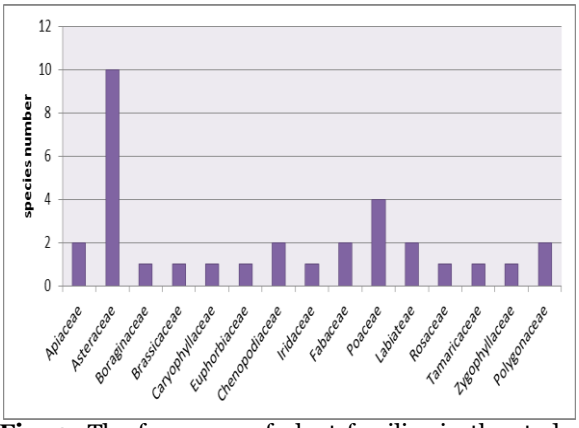

Fig. 2. The frequency of plant families in the study area

Diversity indices

Results of McIntosh evenness index was calculated as 0.8 using BIO DAP software. Evenness index shows the manner distribution and population distribution of species. The species distribution is more uniform (frequency of species is the same), the stability will be more, thus there will be greater biodiversity. Since the region has dominant and rare species and individuals with medium frequencies are more, therefore, according to the results it can be said that population has a high evenness. Mesdaghi and Sadeghnejad (2000) argue that due to the presence of rare species in the reference areas and invasive species in the critical region, the evenness in the region will be more compared to the reference and key areas. It can be inferred that the frequency of invasive species in the study area has been steadily increasing.

The study of numerical index enables our communities to determine the effect of environmental stresses in a single community in order to select the best habitat in the same group for the purpose of protecting. A population that has high diversity and richness is important in terms of protection.

Measuring the Margalef richness index showed the amount of 3.7 for this region. Since livestock grazing causes impairs in vegetation and soil so it can be one of the reasons of decline in the diversity and richness in grazing exclusion areas. But since the conditions are better, the rehabilitation of rangelands must be increased and this causes an increase in the number of species in the pasture and species richness will be increased (Danin 1977; Jouri 2008; Dehghan, 2011). Therefore, in this watershed, due to the revived activities and grazing exclusion during the past years and the high number of non-palatable species, the frequency of species has been increased resulting in the enhanced species richness. The results of this survey is consistent to the results of Ejtehadi *et al.,* (2002) stating that grazing exclusion increases the richness of species.

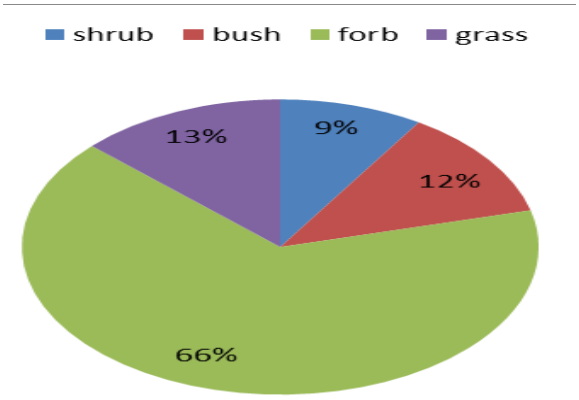

Fig. 3. The frequency of growth forms in the study area

Measuring the species diversity is considered as a measure to show the influence of ecological factors on the ecosystem of the area. The values obtained from species diversity are considered as a reflection of the influence of environmental factors. The result showed, Shannon index in this range is 3.2. Krebs (2001) stated that the numerical value of this index will be from zero to 4.5. If there is only one species in sampling unit or a community is under stress and degradation, this index would be zero and when all individuals are the same, the value will be maximum.

In fact when Shannon index is less, it shows the harder conditions of community. When both groups of evenness and richness indicators in a community have relatively high numerical values this issue will indicate the high species diversity in the area. Mesdaghi and Sadegh-Nejad (2000) believe Shannon index has more sensitivity to rare species and shows assess protective effects. Magurran (1988) describes the average frequency in the population with a large number of species abundance are too high or too low, the average variation that studies in this area are also confirmed.

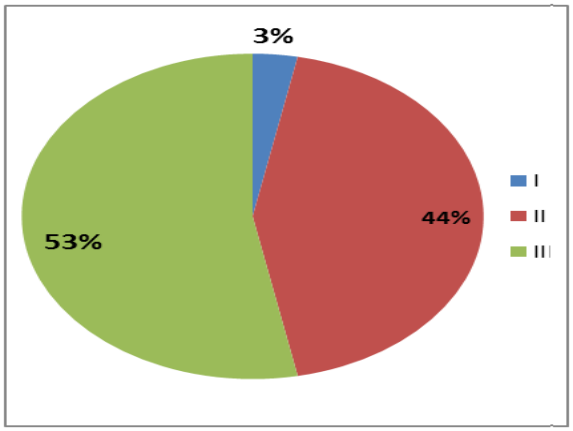

Fig. 4. The frequency of palatability classes in the study area**.**

Also, according to results by Estimate S software Simpson diversity index is 0.59. When Simpson index is more close to 1 it reveals evenness is high.

Results indicated that the average pastures in the early stages of succession are highly diverse with high species richness. Due to variety of invasion species or class III, this area consider as weak pasture.

Conclusion

According to the results it seemed seeding and enclosure the region in recent years led to create good conditions with relatively high diversity. But, considering the small amount of biological operations foreseen in the watershed plan prepared for the area, has been implemented, This increase can be attributed to the return of native plants in the area during the enclosure and because the area is still in transition sequences and the vegetation reached from the intermediate stage to a higher stage, have a high diversity. However, the majority of plant species in this area belong to Class III that shows greater attention to the region through seeding and planting piles by local adaptation of plants and other operations reveal biologically. High diversity in this area revealed a proper management and purposeful strategy to preserve biodiversity, has been carried out since last 7 year.

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