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بررسی تغییرات اجتماعات گیاهی بعد از چرای شدید دام در دشت گلبهار در شمال شرق ایران

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چکیده. چرای بیش از حد دام اجتماع‌های گیاهی را تحت تأثیر قرار داده و به عنوان یکی از مهم‌ترین عوامل تخریب پوشش گیاهی در مناطق خشک و نیمه خشک در نظر گرفته می‌شود. تغییراتِ آنی اجتماع‌های گیاهی پس از چرای بیش از حد، در اکوسیستم‌های خشک تخریب‌شده در ایران، به‌ندرت مطالعه شده است. داده‌های این مطالعه از ۱۰۰ قاب تصادفی که قبل و بعد از چرای بیش از حد در دشت گلبهار واقع در شمال شرقی ایران مستقر شده بودند، جمع‌آوری شد تا تغییرات ویژگی‌های فیزیونومیکی، ترکیب و تنوع گونه‌ای اجتماع‌های گیاهی پس از چرای بیش از حد ثبت و بررسی شود. در این مطالعه، طیف فرم‌های زیستی، تغییرات RIVI گونه‌ها، ترکیب گونه‌ای و تنوع گونه‌ای قبل و بعد از چرای بیش از حد مقایسه شد. نتایج این تحقیق نشان‌داد که تروفیت‌ها فرم زیستی غالب در منطقه بوده و پس از چرای بیش از حد کاهش می‌یابند. ترکیب اجتماع‌های گیاهی منطقه پس از چرای بیش از حد بدون تغییر باقی مانده است. تنوع گونه‌ها در سطح گونه‌های نادر و فراوان پس از چرای بیش از حد کاهش یافت. یافته‌های ما حاکی از آن است که چرای بیش از حد نمی‌تواند بلافاصله ساختار پوشش گیاهی مناطقِ خشکِ تخریب‌شده را تغییر دهد. با این حال، می‌تواند باعث تغییراتی شود که ممکن است باعث کاهش خدمات اکوسیستم شود. حذف کامل چراگرها در چنین مناطقی امکان پذیر نیست؛ فنس‌کشی یا کاهش تعداد دام‌هایی که وارد منطقه می‌شوند می‌تواند برای حفظ و احیای پوشش گیاهی در منطقه استفاده شود

واژه های کلیدی. ترکیب گونه‌ای، تنوع گونه‌ای، زمین‌های خشک، فرم زیستی

Evaluating changes in the plant communities after overgrazing in the Golbahar plain, northeast of Iran

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Abstract. Overgrazing affects plant communities, and is a significant disturbance factor in arid and semi-arid regions. The immediate changes of plant communities after overgrazing in the disturbed arid ecosystems of Iran have been poorly studied. We recorded data from 100 random samples before and after overgrazing in the Golbahar plain located in the northeastern Iran to determine the changes in the plant physiognomic, species composition, and diversity after overgrazing. We compared life-forms spectra, change in the RIVI of the recorded plant species, species composition, and species diversity before and after the grazing. Our results showed that therophytes were the dominant life-form in the area, and decreased after overgrazing. The community composition of the area remained unchanged after overgrazing. Species diversity at the level of rare and frequent species reduced after overgrazing. Our findings implied that overgrazing could not immediately affect the community structure of degraded arid areas. However, it causes changes that might reduce ecosystem services in them. It is not possible to completely exclude grazers in such areas, fencing or reducing the number of the livestock entries should be applied to restore the vegetation in the area.

Keywords. arid lands, life-form, species composition, species diversity

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INTRODUCTION

Approximately one-third of earth's habitats are located in the arid and semi-arid lands (Muenchow et al., 2013). These habitats contain a significant part of world biodiversity and also a significant part of world livestock grazers. Anthropogenic disturbances, including overgrazing, are the major threats to the natural ecosystems of these areas. Desertification is the consequence of these disturbances. It is a major ecological problem that affects vegetation and soil in these areas (Jeddi & Chaieb, 2010; Muenchow et al., 2013).

Livestock overgrazing is the primary cause of disturbance in arid regions (Fallah et al., 2017; Jeddi & Chaieb, 2010; Tadey & Souto, 2016). Plant biomass reduction, a decline in the offspring production, plant community composition alteration, soil erosion, and reduced soil infiltration are the frequently reported effects of overgrazing in arid and semi-arid ecosystems (Eccard et al., 2000; Fallah et al., 2017; Jeddi & Chaieb, 2010; Tadey & Souto, 2016).

In northeastern Iran, overgrazing has been ongoing for many centuries due to the local population and pilgrims' demands (Erfanian et al. 2019a). A long history of overgrazing has induced land degradation that resulted in plant community alteration as well as soil erosion. Consequently, plant species diversity in this area might have been decreased, or species are being endangered (Memariani et al., 2016a; Maleki Sadabadi et al., 2017; Behroozian et al., 2019; Rahmanian et al., 2020). Memariani et al. (2016b) published the checklist and conservation status of the endemic species of the Khorassan-Kopet Dagh floristic province in northeastern Iran. Despite the recurrent disturbance, grazing exclusion is not applied in the area. As a result, plant communities are affected by this disturbance every year.

Theoretical and empirical studies suggest that arid ecosystems would be relatively immune to the effects of grazing, especially if these ecosystems have a long history of grazing (Cingolani et al., 2005; Milchunas et al., 1988; Salgado-Luarte et al., 2019; Sullivan & Rohde, 2002). For example, Sullivan and Rohde (2002) argued that overgrazing in the disturbed areas could not lead to progressive degradation because of the presence of unpalatable species. However, Illius & O'Connor (1999) reported that in the arid areas, overgrazing would lead to increased degradation. Plant communities do not significantly change in the rangelands with a long history of grazing because the resilience mechanisms allow for reversible changes associated with grazing intensity (Cingolani et al., 2005).

To evaluate the effects of overgrazing on plant communities of a disturbed area, we analyzed plant life-forms, species composition, and the diversity before and after overgrazing in the Golbahar plain (northeastern Iran). The area represents highly degraded rangeland that are consecutively overgrazed. Thus, we could evaluate the immediate response of plant communities to overgrazing in degraded arid rangeland and answer the following questions: (1) what were the effects of overgrazing on the physiognomy of plant communities? (2) Was there any structural and composition difference in plant communities after overgrazing? (3) What were the effects of overgrazing on species diversity at the level of rare, frequent, and dominant species?

MATERIALS AND METHODS

Study area

The Golbahar plain, located in the west of Mashhad, is a part of the northeastern slopes of the Binalood Mountains and covers ca. 11000 ha surface area (Eftekhari et al., 2014). The area has an elevation range of 1165-1300 m above sea level (Fig. 1). The Golbahar plain has an arid climate. The mean annual precipitation and mean annual temperature of the area are 204 mm and 14.7 °C, respectively (Iran Meteorological Organization-Razavi Khorassan portal, 2018). The area has been subjected to overgrazing as pasture by the sheep and goats for many years. The soil of the area is mainly formed by alluvial fans (Geological Survey of Iran, 1986). It has a loam/clay-loam texture. This area has a deep soil profile (Eftekhari et al., 2014).

Data collection

Plant species data were collected in a two-phase survey to compare the vegetation status of the area after and before overgrazing. The first phase (before overgrazing) conducted in May 2017, and the second phase (after overgrazing) performed in June 2017. Data was collected by using 100 randomly-placed quadrats in each phase. Because of the degraded nature of the vegetation in the area, the 100 was considered satisfactory. Furthermore, we used the coverage-based approaches to evaluate the species diversity of the area to ensure that the number of samples was not affecting our inferences (Chao et al., 2014; Chao & Jost, 2012; Erfanian et al., 2019a). We recorded the floristic list and canopy cover (%) for each plant species in 1 x 1 m quadrats.

Data analysis

The Raunkiaer's life-form spectrum was drawn for the plant species before and after grazing using the ggplot2 package (Wickham, 2009) in R ver. 3.5 (R Core Team, 2018). The Relative Importance Value Index (RIVI) of the recorded species was calculated for each phase. Transformation-based principal component analysis (tb-PCA) was used to visualize the changes in the species composition of the area (Legendre & Legendre, 2012). To do this, we used the approach described by Erfanian et al. (2019b).

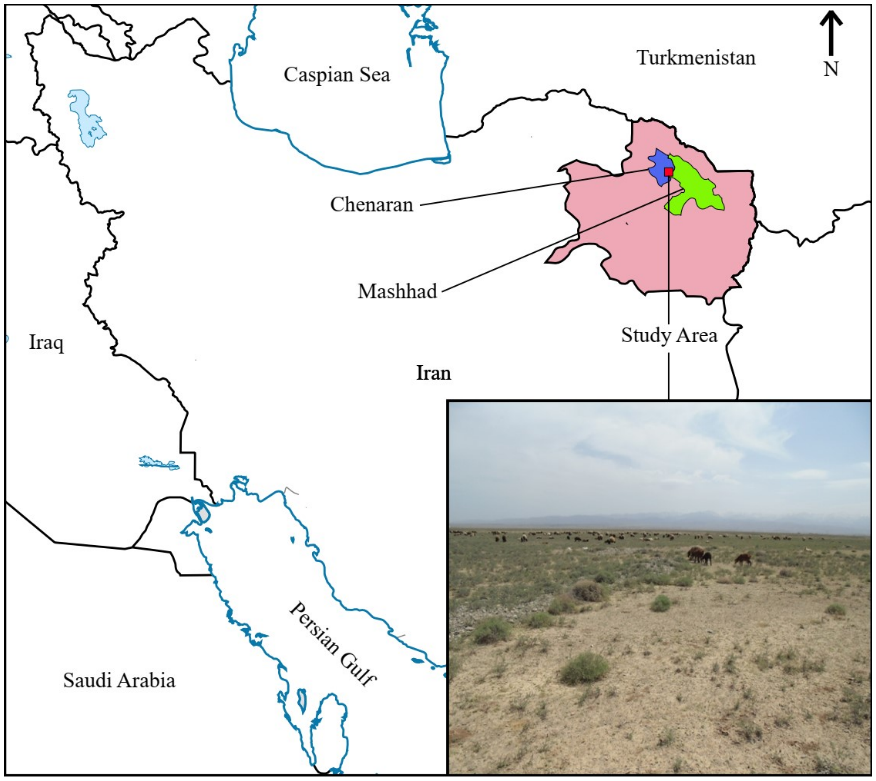

Figure 1. Geographical position and a landscape photo of the study area. The pink shaded area is Khorassan Razavi Province, Iran.

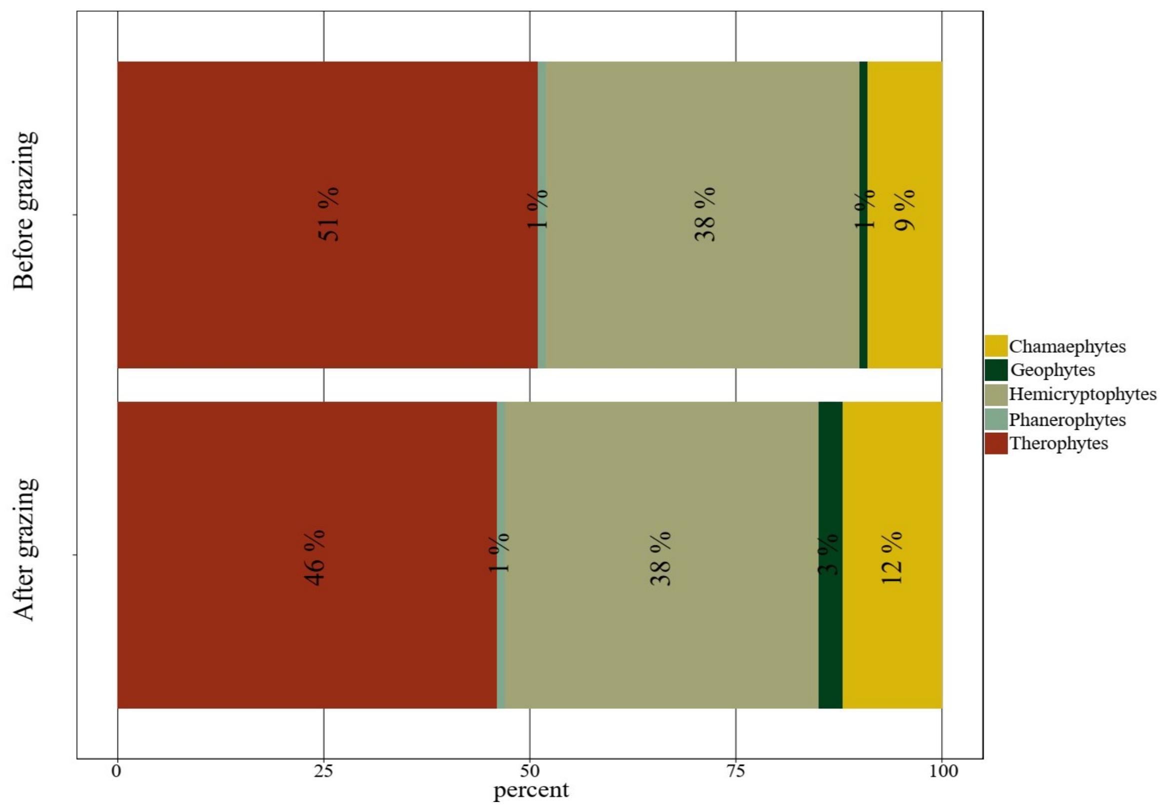

Figure 2. Raunkiær's life-form spectrum for the before and after overgrazing phases. Therophytes were the dominant life-form in the area.

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To compare the species diversity before and after overgrazing, we used Hill diversity indices. These indices are considered as the standard framework of diversity calculations (Chao et al., 2014a, b; Ellison, 2010). The coverage-based approach was selected to eliminate the effects of unequal sampling completeness on the biodiversity results (Chao & Jost, 2012). Hill numbers of the zero (q=0, species richness), first (q=1, exponential of Shannon diversity), and second-order (q=2, Reciprocal of Simpson index) were calculated. These indices considered species diversity at the level of rare, frequent, and dominant species of plant communities, respectively (Erfanian et al., 2019a, Atashgahi et al., 2018b). We used the iNEXT package (Hsieh et al., 2016) to calculate these indices. We draw the coverage-based rarefaction and extrapolation curves for each of these indices. The 95% confidence interval (CI) of each curve was calculated by using the bootstrapping procedure of this package.

RESULTS

Therophytes were the dominant life-form in the study area. This life-form was recorded in a lower percent after overgrazing. Only one species (i.e., *Capparis spinosa* L.) with a phanerophyte life-form was recorded in the before and after overgrazing phases. The life-form spectra of the two phases are shown in Figure 2.

A list of the endemic/subendemic species of the area is presented in table 1. Two species (i.e., *Cousinia verbascifolia* Bunge and *Echinops chorassanicus* Bunge) are endemic to Iran.

RIVI reuslts are presented in Table 2. This results revealed that most of the annual species showed a decreased RIVI. Also, unpalatable plants showed a general increase in RIVI after overgrazing.

However, the diagram of tb-PCA revealed that there is no evident separation among the samples from before and after overgrazing. This diagram is shown in Figure 3. Species richness (Fig. 4, q=0 column) was significantly decreased after overgrazing. The same result was observed for the exponential of Shannon diversity (Fig. 4, q=1 column). There was no significant difference between before and after overgrazing phases, as long as the reciprocal of the Simpson index is considered (Fig. 4, q=2 column).

Table 1. Endemic and sub-endemic species of the study area. Abbreviations: Turkmenistan: Turkm., Afghanistan: Afgh.

Species	Geographical distribution
Astragalus pellitus Bunge	Iran- Turkm.- Afgh.
Cousinia verbascifolia Bunge	Iran
Echinops chorassanicus Bunge	Iran
Cousinia afghanica C.Winkl.	Iran- Afgh.
Astragalus suluklensis Freyn. & Sint.	Iran- Turkm.
Astragalus sumbari Popov	Iran- Turkm.
Cleome khorassanica Bunge & Bien. ex Boiss.	Iran- Turkm.
Cousinia eryngioides Boiss.	Iran- Turkm.
Acanthophyllum korshinskyi Schischk.	Iran- Turkm.- Afgh.
Artemisia ciniformis Krasch. & Popov ex Poljakov	Iran- Turkm.- Afgh.
Astragalus macrobotrys Bunge	Iran- Turkm.- Afgh.
Cousinia congesta Bunge	Iran- Turkm.- Afgh.
Eryngium bungei Boiss.	Iran- Turkm.- Afgh.
Erysimum aitchisonii O.E.Schulz	Iran- Turkm.- Afgh.
Iris kopetdagensis (Vved.) B.Mathew & Wendelbo	Iran- Turkm.- Afgh.
Prangos latiloba Korovin	Iran- Turkm.- Afgh.

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Table 2. Changes in the relative importance value indices (RIVI) of the recorded plant species of the study area for the before and after overgrazing phases. The 0 indicates that the species was not recorded in the studied phase. Therophytes: Th, Chamaephytes: Ch, Hemicryptophytes: He, Geophytes: Geo, Phanerophytes: Ph.

Family	Species	Life-form	RIVI before	RIVI after	status
Amaranthaceae	*Amaranthus blitoides* S.Watson	Th	0.329	0.931	Increased
	Amaranthus retroflexus L.	Th	0.149	0.000	decreased
	Atriplex tatarica L.	Th	0.000	0.465	Increased
	Ceratocarpus arenarius L.	Th	4.972	5.311	Increased
	Chenopodium botrys L.	Th	0.334	0.228	decreased
	Noaea acrocarp (Forssk.) Asch. & Schweinf.	Ch	0.644	1.036	Increased
	Salsola kali L.	Th	0.577	1.781	Increased
Apiaceae	*Eryngium billardieri* F.Delaroche	He	0.273	0.000	decreased
	Eryngium bungei Boiss.	He	0.329	0.562	Increased
	Foeniculum vulgare Miller	He	0.149	0.000	decreased
Asteraceae	*Acantholepis orientalis* Less.	Th	0.254	0.811	Increased
	Achillea wilhelmsii K. Koch	He	0.670	0.000	decreased
	Acroptilon repens (L.) DC.	He	0.509	1.320	Increased
	Artemisia ciniformis Krasch. & M.Pop. ex pojark	Ch	0.180	1.179	Increased
	Artemisia scoparia Waldst. & Kit.	Ch	2.063	4.215	Increased
	Carthamus oxyacantha M.Bieb.	Th	0.745	2.142	Increased
	Centaurea depressa M.Bieb.	Th	0.365	0.000	decreased
	Centaurea virgata Lam.	Ch	1.741	2.039	Increased
	Chondrilla juncea L.	He	0.000	0.793	Increased
	Cichorium intybus L.	He	0.000	0.299	Increased
	Cousinia afghanica C.Winkl.	He	1.334	0.263	decreased
	Cousinia congesta Bunge	He	0.665	0.000	decreased
	Cousinia eryngioides Boiss.	He	0.415	0.249	decreased
	Cousinia microcarpa Boiss.	He	0.391	0.000	decreased
	Crepis sancta (L.) Babcock	Th	0.712	0.000	decreased
	Cymbolaena griffithii (A.Grey) Wagenitz	Th	0.111	0.000	decreased
	Echinops chorassanicus Bunge	He	1.087	2.055	Increased
	Echinops leiopolyceras Bornm.	He	0.428	0.719	Increased
	Gundelia tournefortii L.	He	0.547	0.000	decreased
	Koelpinia linearis Pall	Th	0.260	0.000	decreased
	Lactuca glauciifolia Boiss.	Th	0.000	0.385	Increased

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Table 2. continued.

	Lactuca orientalis Boiss.	Ch	3.064	2.916	Decreased
	Lactuca serriola L.	He	0.000	0.613	Increased
	Launaea acanthodes (Boiss.) Kuntze	He	0.609	3.481	Increased
	Onopordon heteracanthum C. A. Mey.	He	2.797	1.914	decreased
	Picnomon acarna (L.) Cass.	Th	0.000	1.338	Increased
	Pulicaria gnaphalodes (Vent.) Boiss.	Ch	1.056	2.688	Increased
	Thevenotia persica DC.	Th	0.149	0.000	decreased
	Tragopogon graminifolius DC.	He	0.180	0.000	decreased
	Xanthium brasilicum Vell.	Th	0.180	0.755	Increased
Boraginaceae	*Anchusa italica* Retz	He	0.273	0.000	decreased
	Echium italicum L.	He	0.578	0.000	decreased
	Heliotropium europaeum L.	Th	6.895	7.048	Increased
	Nonea caspica (Willd.) G.Don.	Th	0.775	0.000	decreased
	Trichodesma incanum (Bunge.) A.DC.	He	0.305	0.000	decreased
Brassicaceae	*Alyssum linifolium* Steph. ex Willd.	Th	2.498	0.657	decreased
	Erysimum badghisi (Korsh.) Lipsky	He	0.105	0.546	Increased
	Goldbachia laevigata (M.Bieb.) DC.	Th	0.118	0.000	decreased
	Malcolmia africana (L.) W.T.Aiton	Th	1.784	0.315	decreased
	Sisymbrium altissimum L.	Th	0.242	0.000	decreased
Capparaceae	*Capparis spinosa* L.	Ph	0.305	3.225	Increased
	Cleome coluteoides Boiss.	He	0.516	0.000	decreased
Caprifoliaceae	*Scabiosa olivieri* Coult.	Th	0.328	1.014	Increased
	Scabiosa rotata M.Bieb.	Th	0.111	0.776	Increased
Caryophyllaceae	*Acanthophyllum korshinskyi* Schischk.	Ch	2.905	0.334	decreased
	Gypsophila bicolor (Freyn & Sint.) Grossh.	He	0.305	0.000	decreased
	Holosteum glutinosum Fisch. & C.A.Mey	Th	0.217	0.000	decreased
	Minuartia meyeri (Boiss.) Bornm.	Th	0.334	0.000	decreased
	Silene chaetodonta Boiss.	Th	0.118	0.000	decreased
Convolvulaceae	*Convolvulus arvensis* L.	He	0.000	0.334	Increased
	Convolvulus pilosellifolius Desv.	He	0.242	0.000	decreased
Cyperaceae	*Carex stenophylla* Wahlenb.	He	0.000	0.475	Increased
Euphorbiaceae	*Chrozophora tinctoria* (L.) A.Juss.	Th	0.000	0.491	Increased
	Euphorbia granulata Forssk.	Th	0.831	0.228	decreased

Table 2. continued.

	Euphorbia szovitsii Fisch & C.A.Mey.	Th	0.303	0.000	Decreased
Fabaceae	*Alhagi maurorum* Medik.	He	0.453	0.562	Increased
	Astragalus campylorrhynchus F. & M.	Th	0.365	0.000	decreased
	Astragalus commixtus Bunge	Th	0.478	0.000	decreased
	Astragalus oxyglottis M.Bieb.	Th	0.105	0.000	decreased
	Astragalus pellitus Bunge	He	0.118	0.000	decreased
	Medicago sativa L.	He	0.149	0.000	decreased
	Melilotus officinalis (L.) Pall.	He	0.242	0.000	decreased
	Meristotropis xanthioides Vassilcz.	Geo	0.000	0.369	Increased
	Sophora pachycarpa C.A.Mey.	He	0.857	0.369	decreased
	Trigonella monantha C.A.Mey.	Th	1.276	0.000	decreased
	Vicia villosa Roth	He	0.359	0.000	decreased
Geraniaceae	*Erodium oxyrrhynchum* M.Bieb.	Th	0.267	0.507	Increased
Iridaceae	*Iris songarica* Schrenk	Geo	0.273	0.228	decreased
Juncaceae	*Juncus inflexus* L.	He	0.242	0.193	decreased
Lamiaceae	*Marrubium vulgare* L.	He	0.453	0.562	Increased
	Perovskia abrotanoides Karel	Ch	0.710	0.000	decreased
	Ziziphora tenuior L.	Th	0.309	0.000	decreased
Malvaceae	*Malva neglecta* Wallr.	He	0.360	0.000	decreased
Nitrariaceae	*Peganum harmala* L.	He	1.293	1.811	Increased
Papaveraceae	*Fumaria vaillantii Loisel.*	Th	0.210	0.000	decreased
	Hypecoum pendulum L.	Th	0.161	0.000	decreased
	Roemeria hybrida (L.) DC.	Th	0.273	0.000	decreased
Plantaginaceae	*Linaria simplex* L.	Th	0.093	0.000	decreased
	Plantago lanceolata L.	He	0.000	0.299	Increased
	Veronica biloba Schreb. ex L.	Th	0.105	0.136	Increased
Poaceae	*Aegilops triuncialis* L.	Th	0.757	0.000	decreased
	Avena sterilis L.	Th	0.367	0.000	decreased
	Boissiera squarrosa (Banks & Soland.) Nevski	Th	2.484	2.600	Increased
	Bromus danthoniae Trin.	Th	2.120	1.393	decreased
	Bromus tectorum L.	Th	5.025	6.452	Increased
	Elymus repens (L.) Gould	He	0.111	0.000	decreased
	Eremopyrum bonaepartis (Spreng.) Nevski	Th	2.782	1.295	decreased
	Hordeum murinum L.	Th	6.908	4.333	decreased

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Table 2. continued.

	Loliolum subulatum (Bank &Soland.) Eig.	Th	0.000	0.322	Increased
	Phragmites australis (Cav.) Trin. ex Steud.	He	0.149	0.829	Increased
	Poa bulbosa L.	He	0.111	0.693	Increased
	Setaria viridis (L.) P.Beauv.	Th	0.143	0.000	decreased
	Stipa lessingiana Trin. & Rupr.	He	0.273	0.334	Increased
	Taeniatherum caput-medusae (L.) Nevski	Th	0.000	0.143	Increased
	Vulpia persica (Boiss. & Buhse) V.Krecz. & Bobrov	Th	0.316	0.308	decreased
Polygonaceae	*Polygonum aviculare* L.	Th	0.365	0.157	decreased
	Polygonum patulum M.Bieb.	Th	0.489	0.414	decreased
	Polygonum polycnemoides Jaub. & Spach	Th	0.180	0.983	Increased
	Rumex chalepensis Miller	He	0.105	0.000	decreased
Primulaceae	*Androsace maxima* L.	Th	0.458	0.157	decreased
Ranunculaceae	*Ceratocephala falcata* (L.) Pers.	Th	0.210	0.000	decreased
Resedaceae	*Reseda lutea* L.	He	1.546	1.211	decreased
Rosaceae	*Rosa persica* Michx. ex Juss.	Ch	7.014	6.471	decreased
Rubiaceae	*Callipeltis cucullaris* (L.) DC.	Th	0.124	0.000	decreased
Scrophulariaceae	*Scrophuloria striata* Boiss.	Ch	0.914	0.511	decreased
Solanaceae	*Datura innoxia* Mill.	He	0.000	0.652	Increased
	Hyoscyamus pusillus L.	He	0.894	1.251	Increased
	Hyoscyamus reticulatus L.	He	1.260	1.195	decreased
Thymelaeaceae	*Diarthron vesiculosum* (Fisch. & C.A.Mey.) C.A.Mey.	Th	6.444	5.097	decreased
Zygophyllaceae	*Tribulus terrestris* L.	Th	0.453	0.719	Increased
	Zygophyllum fabago L.	He	0.485	1.179	Increased

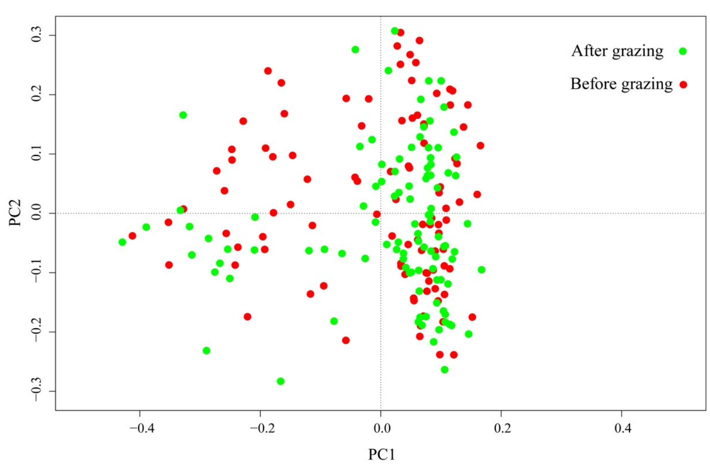

Figure 3. Transformation-based principal component analysis (tb-PCA) results showing species composition of plots for after and before overgrazing phases. Each circle denotes a plot. This graph reveals that the species composition of the study area was not differed in the before and after grazing phases.

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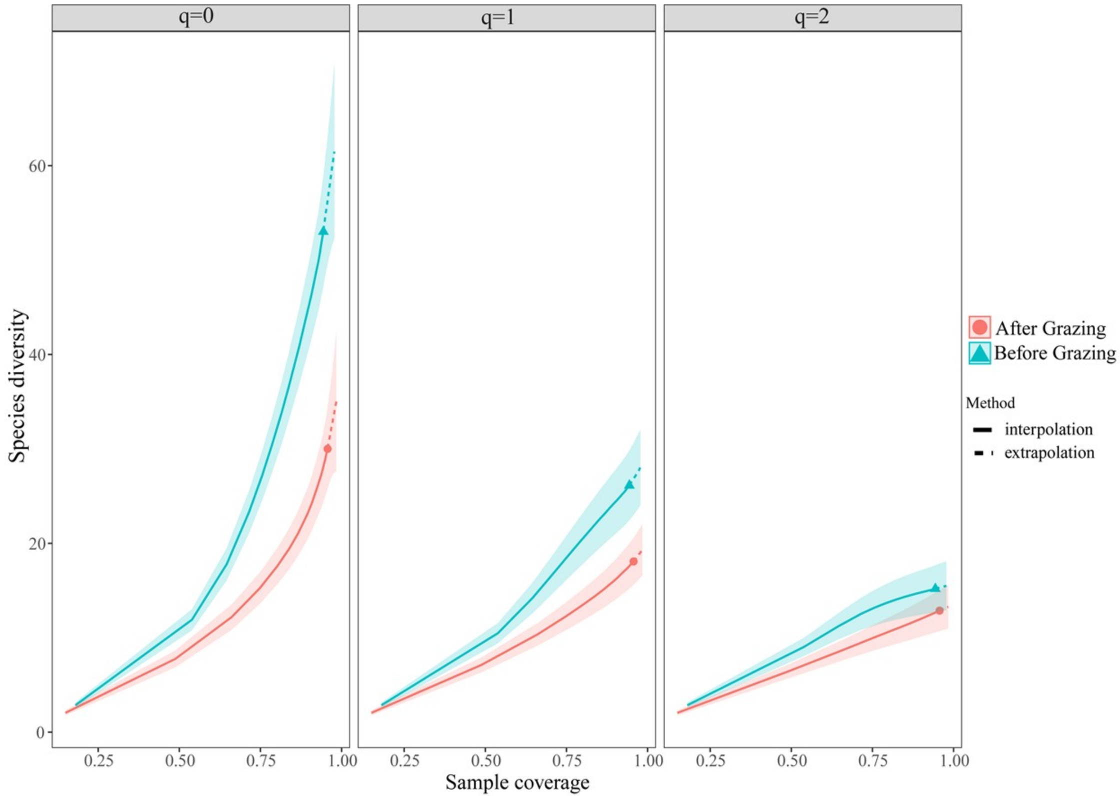

Figure 4. Coverage-based rarefaction and extrapolation curve comparing Hill species diversity for the before and after overgrazing phases. The shaded area represents the 95% confidence intervals which obtained by bootstrapping method with 999 replications. These results are showing the species richness (q=0), the exponential of the Shannon diversity (q=1), and the reciprocal of the Simpson index for the two area.

DISCUSSION

Livestock overgrazing is one of the significant causes of habitat degradation in arid environments (Jeddi & Chaieb, 2010). We studied an arid area subjected to long-term livestock overgrazing. The physiognomy, vegetation structure, and species diversity were compared before and after overgrazing to investigate the response of plant communities to the overgrazing in the study area.

Impacts of overgrazing on the physiognomy of plant communities in the area

Therophytes were the dominant plants in the area. The reported percent of this life-form are higher than the other areas reported by Atashgahi et al. (2018a), Jankju et al. (2012), and Memariani et al. (2009). However, our study area had a lesser amount of therophytes when compared to that of the Erfanian et al. (2019a). They suggested the therophytes as an excellent indicator of disturbance in an area. Thus, it can be inferred that our area is more disturbed than those studies that reported a lesser amount of therophytes, and it is less disturbed than that of the Erfanian et al. (2019a) which reported a higher amount of therophytes.

The decline of therophytes after overgrazing may be due to the fact that these species are ephemeral. Haarmeyer et al. (2010) reported that the abundance of annuals was not affected by grazing in an arid area. The percent of chamaephytes and phanerophytes remained the same in both phases. Sampling error could be considered as the potential cause for the recorded variation in the other life-forms (i.e., chamaephytes and geophytes) (see Fig. 2).

Impacts of overgrazing on species composition of the area

The results of RIVI analyses revealed that most of the remained species after overgrazing are unpalatable plants. The dominance of unpalatable species in overgrazed lands was also reported by Friedel et al. (2003). The results of tb-PCA show that there is no distinction between plant communities before and after overgrazing. This finding indicates changing the species composition of an area is not one of the immediate effects of overgrazing in arid lands.

Impacts of overgrazing on the species diversity of the area

The decline of species richness (Fig. 4, q=0) might be affected by the time of the sampling — ephemeral plants might vanish from the area at the time of sampling for the after-overgrazing phase. The diversity of dominant species (Fig. 4, q=2

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column) is similar in the before and after overgrazing phases. Hosseini et al. (2020) suggested that increase in dominance of unpalatable plants could decrease the species diversity of an overgrazed area. Our results approved the equilibrium theory, which states that areas facing overgrazing for a long-history were not degraded after being overgrazed (Cingolani et al., 2005; Milchunas et al., 1988). Also, this finding suggests that heavy overgrazing could not affect the dominant species in an area. Furthermore, this finding suggests that unpalatable species are the dominant plants in the area. Although unpalatable species may seem undesirable in areas, this species could conserve species and functional diversity in overgrazed areas (Callaway et al., 2005).

CONCLUSIONS

The results of this study revealed that overgrazing caused a change in the RIVI of plant species. Overgrazing led to the dominance of unpalatable species in the area. In general, our results indicated that overgrazing in a degraded area could not affect the remaining plant communities. Exclusion cannot be applied in this area and areas with a similar condition. This finding should be considered in managing the remaining endemic vegetation of the area.

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