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Species Richness, Evenness and Plant Community Stability 22 Years after Ploughing a Semiarid Rangeland

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Abstract. Rangeland ploughing and cultivation using dry land farming crops may be a major reason for the destruction of natural resources in the semiarid and sub-humid regions which may significantly change the composition and reduce the stability of the affected communities. In present research, an abandoned ploughed site was compared with a nearby reference site in the semiarid rangelands of Baharkish, Quchan, Iran in spring and summer of 2010. Frequency and canopy cover of all plant species were recorded within 40 quadrates of $1m^2$ area. Simpson, Shannon-Weiner, Hill and Macintosh indices for biodiversity, Margalof and Menhening for richness and Camargo, Simpson, Modified Nee, Smith and Wilson for evenness were used. Floristic composition, plant life forms, and important value of major plant species were compared with respect to the sites. Land ploughing and subsequent abandonment had increased total number of plant species (richness) but decreased the species heterogeneity (evenness). It resulted to non-significant differences in species diversity between the ploughed and reference sites. Ploughing had increased (8%) the important values of respruting plant species. Therefore, patchy distribution of clonal plants had reduced species evenness within the abandoned site. Furthermore, there were some increases in number of therophytes (100%) but hemicryptophytes (24%), chamaephyte (33%) and phanerophyte (100%) species were reduced in the abandoned site. In conclusion, lower evenness and high proportion of annual plants should make the abandoned site more fragile and sensitive against the future environmental fluctuations.

Key words: Abandoned field, Biodiversity, Disturbance, Vegetation dynamics, Important value

Introduction

In the rangeland ecosystems, disturbance factors such as fire, tilling and livestock grazing can significantly affect plant community composition, diversity and stability. Around 30 million hectares of the arid and semiarid steppe rangelands of Iran have been disk-ploughed for the cultivation of dry land farming crops (Moghaddam, 1998). However, most of the ploughed lands are left abandoned after the first cultivation for few years mainly due to the loss of productivity, high erosion and frequent droughts (Jankju, 2009). The abandoned lands which were the most productive rangelands before are now dominated by some noxious weeds (Moghaddam, 1998; Mesdaghi, 2002).

Studies on plant diversity provide information on the species distribution and dynamics of plant communities (Hayek *et al*., 2007; Van der Maarel, 1988). Biodiversity is considered as an appropriate index for evaluating the current management status and hence, it can be used for the future planning of the desired ecosystems. Some researchers (Fulbright, 1996; Yuguang *et al*., 2001) believe that ecosystem managers should consider the maintaining or increasing of natural ecosystems' biodiversity (e.g. forests and rangelands) as their management priorities. Thus, comparing plant diversity indices between the abandoned fields and the original rangeland sites will provide useful information on their sustainability against the environmental fluctuations. This information can be used for the management and/or rehabilitation of degraded rangelands.

Disturbance is usually considered as one of the most influential factors on the diversity of plant communities (e.g. Mackey & Currie, 2001). It reduces competition between plant groups and provides the context for the establishment of some invasive plant species by removing competitive plants temporally and providing nutrient and open space for new species (Grime, 1973). Disturbing the vegetation increases the invasion of herbaceous plant species that are adapted to the ecosystem instability (Hobbs & Huenneke, 1992). In some cases, wildlife managers plow the land to increase the vegetation diversity and enhance the growth and establishment of herbaceous plants (Fulbright, 1999). Fulbright (2004) found that rangeland ploughing led to drastic reductions in plant diversity during the first and second years after disturbance whereas plant diversity of the ploughed sites was significantly higher for 5 years after disturbance. In other studies (Bazzaz, 1968; El-Sheikh, 2005), plant diversity and species richness were significantly increased in the early years after disturbance but it was gradually reduced in the following year along with the greater number of herbaceous and woody plants in the early and later stages of the succession.

Despite numerous studies on the effects of disturbance on natural plant communities, they mainly focus on species diversity and richness indices while providing little information on species evenness, floristic composition and plant community stability. Few changes in species evenness attract the increased attention because they usually respond to human activities more rapidly rather than imposing some changes in species richness since they have important consequences for the ecosystem before a species is threatened by the extinction (Chapin *et al*., 2000). When a change in plant diversity is combined by some shifts in plant community composition, it may significantly affect plant community stability because various plant life forms respond to the environmental fluctuations differently (Ehleringer *et al*., 1999).

Accordingly, the main goals for doing this research were (1) to compare plant diversity indices (i.e. species richness, evenness and diversity) in a ploughed rangeland that had been disk-ploughed for dry land farming crop production in the 1970-1980th but left abandoned since 1988 with a reference unplugged sites and (2) to investigate possible effects of rangeland disturbance on its floristic composition and possible relationships between plant community composition, evenness and stability.

Materials and Methods

Study area

Study was conducted in Baharkish rangelands of Quchan, Iran. Baharkish is located in the northern slopes of Binalud mountain ranges, 200 km far from the Turkmenistan border (Fig. 1). Two sites were selected which encompassed around 10 ha. General slope was north-facing and slope degree varied from 15-45% (Table 1). The average annual rainfall in the area was about 360 mm which mainly occurred as snow in winter. Geological formation was conglomerate mixed with limestone. Soil texture was clay loamy with the maximum depth in the most places being less than 45 cm (Jankju *et al*., 2008).

The "ploughed site" was in Goore-Khar paddock and located at 58° 41′ 17″ Eastern longitude and 36° 43′ 43″ Northern latitude with the average elevation of 1834 m above sea level (m.a.s.l). This site had been under dry land farming for wheat production during 1975-1988 and disk-ploughed by tractors or domestic cows. Since 1988, the ploughed site has been under the cultivation of scattered almond trees with no disk plow or irrigation so far; but it is lightly grazed by livestock in some years. The "reference site" was in Aagh-cheshmeh paddock 3 km far from the ploughed site at 58° 40′ 17″ Eastern longitude and 36° 41′ 48″ Northern latitude with the elevation of 1851 m.a.s.l. This site had never been ploughed but lightly grazed by livestock in some years. Its dominant vegetation resembled the climax of the semiarid steppe rangelands being a mixture of perennial grasses and shrubs.

Vegetation survey

Sampling was accorded with the vegetation physiognomy and site topography. Along an arbitrary base line, four line-transects were randomly established with 100 m length at least 15 m apart from each other. Five plots of 1 m^2 were randomly located along each transect. Scientific name of all plant species was recorded within each plot. In addition, their frequency and percent canopy cover were measured and recorded. For unknown species, few samples were taken from the field and then, they were given specific codes. Samples were identified by the use of some key flora books such as Flora Iranica (Rechinger, 1963-2010) and Flora of Iran (Asadi *et al*., 1998-2002; Mobayen, 1985).

Important Value (IV) was calculated for all the plant species within each site separately using the following formula (Hammouda *et al*., 2003) (Equation 1).

IV = relative cover + relative density + relative frequency (Equation 1)

Statistical analysis

A database was created for the collected data using Microsoft Excel. Plant biodiversity was assessed as both numerical and parametrical indices. For estimating plant diversity, Simpson, Shannon-Weiner, Hill and Macintosh indices were calculated by the means of Biodiversity Professional Beta (McAleece, 1997). This program was also used for measuring the plant richness via Margalof and Menhing indices. For measuring the evenness, Carmago, Simpson, Modified Nee, Smith and Wilson indices were calculated using Ecological Methodology Software (Kenny and Krebs, 2001). Furthermore, plant diversity was parametrically assessed via the rank-abundance plots using Ecological Methodology software. If needed, mean values of ploughed and reference sites were compared by the unpaired t-test using SPSS16 statistical software.

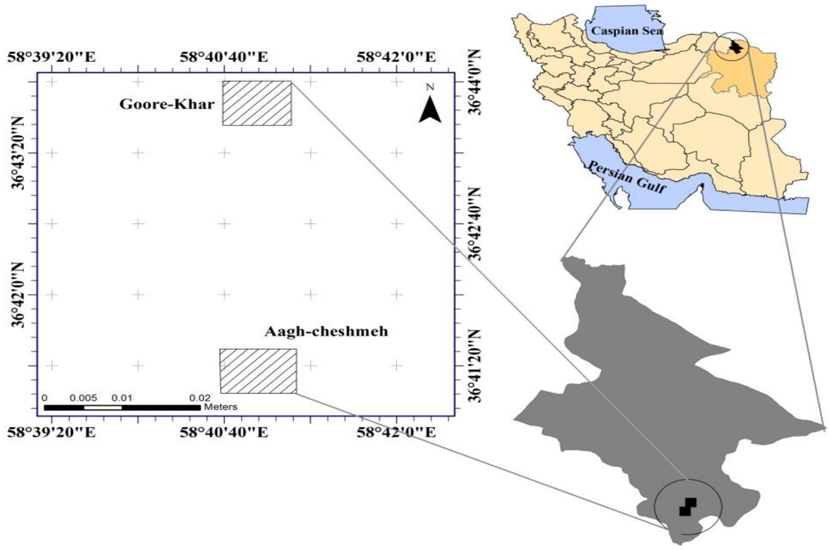

Fig. 1. Location of study sites

Table 1. Site characteristics of Goore-khar (ploughed) and Aagh–cheshmeh (reference) rangeland paddocks (adopted from Jankju *et al.*, 2008)

Site Name	Elevation (m.a.s.l)	Slope Range (%)	Slope Aspect	Soil Texture	Dominant Species
Goore-Khar	1800-1878	15-45	Northern	Clay-loam	*Seratula latifolia* and *Boissiera squarrosa*
Aagh-cheshmeh	1830-1882	15-45	Northern	Clay-loam	*Veronica* sp and *Bromus kopetdaghensis*

Results

Plant diversity indices

Plant diversity of two sites was also compared using the rank-abundance plot in which lower graph indicates higher diversity (Fig. 2). Accordingly, plant diversity was relatively higher for the ploughed site at the start of graphs. However, the graphs crossed each other at the end indicating no significant differences between the sites.

Results on comparing the biodiversity indices between the ploughed and reference sites showed similar values in terms of Simpson, Shannon Weiner, Hill and Macintosh indices (Fig. 3a). Nevertheless, for a more detailed investigation on the effects of land plowing on the components of plant diversity, species richness and evenness were also compared between the sites (Fig. 3b). The indices indicated the contrasting differences between the ploughed and reference sites. For the evenness, Simpson, Camargo, Modified Nee, Smith and Wilson indices indicated lower heterogeneity in the ploughed site than reference one. They indicate a more even distribution of plant species in the reference site but a more localized distribution in the ploughed one.

Species richness was compared using numerical indices (Fig. 3c); accordingly, Margalof and Menhinick indices indicated higher species richness in the ploughed site than the reference one.

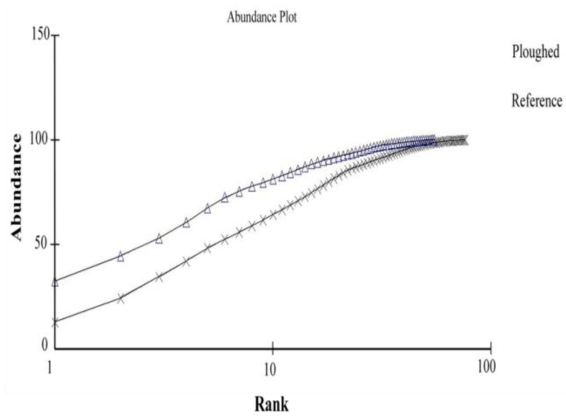

Fig. 2. Rank abundance plots for comparing species diversity between the ploughed and reference sites

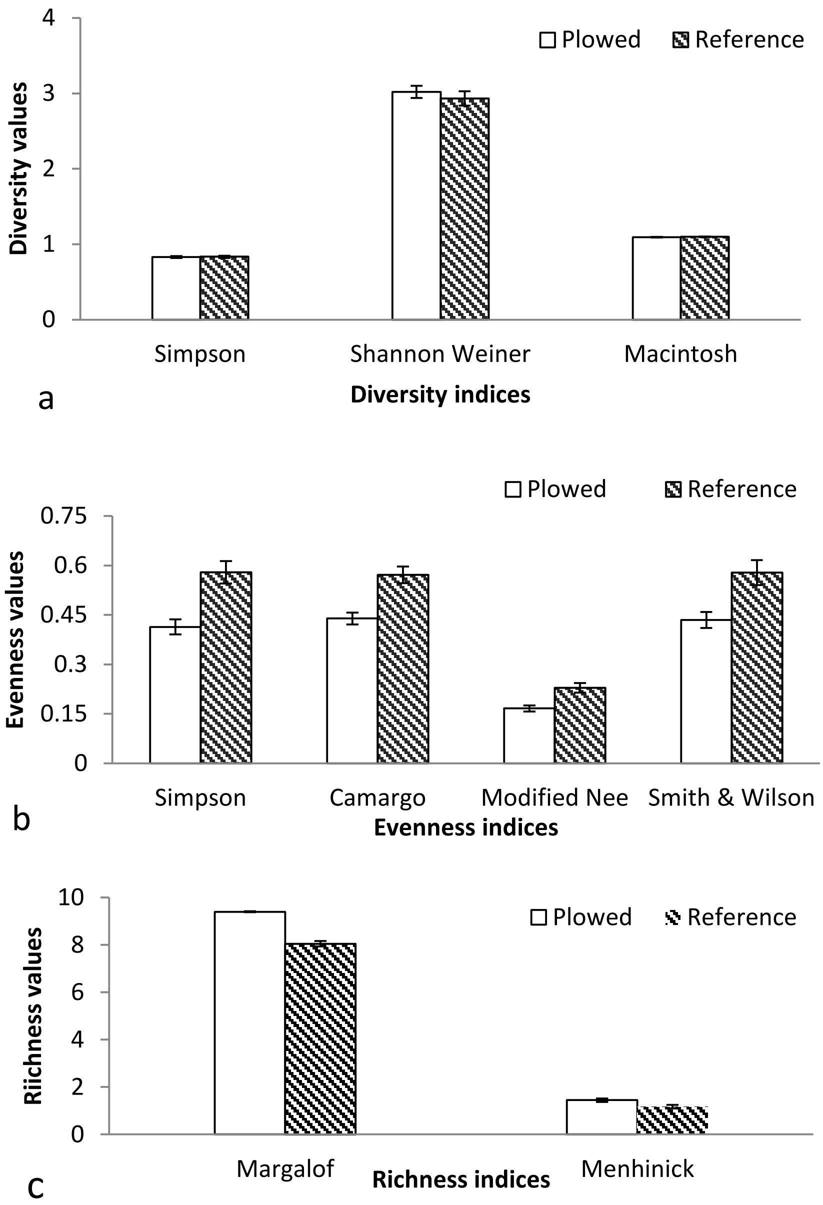

Fig. 3. Comparison of species diversity (a), evenness (b) and richness (c) values between the reference and ploughed sites

Floristic composition

Field survey and laboratory examinations led to the identification of 110 plant species from which 22 species were common between the sites (Table 2). A total of 76 plant species was found within the ploughed site which belonged to 66 plant genera and 27 plant families. For the reference site, a total of 56 plant species was identified from 46 genera and 19 families. In the ploughed sites, 17 species belonged to monocotyledonous and 59 were dicotyledonous whereas for reference site, they were 15 and 41 plant species, respectively. Asteraceae, Poaceae and Brassicaceae were the most abundant plant families in the ploughed site which included 13, 9 and 8 plant species, respectively. 12 families had only contained one species. Poaceae and Asteraceae were the most frequent plant families for the reference site and they contained nine and eight plant species respectively with seven families owning only one species.

phanerophytes which were almost extinct in the ploughed site.

Comparison of important values for 10 most abundant plant species between the abandoned and reference sites revealed significant relationships between disturbance and regeneration mode. Accordingly, three out of 10 most abundant plant species in the ploughed site might be perennial species which usually propagate via rhizomes. On the other hand, all plant species in the reference site may only reproduce by seeds (Table 4).

Plant life forms were compared as the total number and percentage of plant species allocating to each category (Table 3). The highest proportion of plant species was belonged to hemicryptophytes with their number being similar (i.e. 28) in both sites. Generally, land ploughing had increased herbaceous species in the cost of reducing woody plant species. The most positive effect of land ploughing was on therophytes namely a threefold increase in their number by the disturbance. In contrast, the most negative effect was on

Table 2. Floristic composition of the ploughed and reference sites

Species in Reference Site	Species in Ploughed Site	Plant Families
Ixiolirion tataricum (Pall.) Herb.	*Ixiolirion tataricum* (Pall.) Herb.	Amaryllidaceae
Bunium cylindricum (Boiss. & Hohen.) Drude	*Bunium cylindricum* (Boiss. & Hohen.) Drude	Apiaceae
Eryngium bungei Boiss.	*Eryngium bungei* Boiss.	Apiaceae
Zeravschania aucheri (Boiss.) M. Pimen.	*Turgenia latifolia* (L.) Hoffm.	Apiaceae
Artemisia kopetdaghensis Krasch.	*Achillea wilhelmsii* C. Koch	Asteraceae
Cirsium turkestanicum Petr.	*Acroptilon repens* (L.) DC. subsp. *australe* (Iljin) Rech. f.	Asteraceae
Centaurea virgata Lam.	*Centaurea virgata* Lam.	Asteraceae
Cousinia elata Boiss. & Buhse	*Cousinia elata* Boiss. & Buhse	Asteraceae
Cousinia smirnowii Trautv.	*Cousinia smirnowii* Trautv.	Asteraceae
Cymbolaena griffithii (A. Grey) Wagenitz	*Echinops* sp.	Asteraceae
Jurinea monocephala Aitch. & Hemsl. subsp. *sintenisii* (Bornm.) Wagenitz	*Jurinea monocephala* Aitch. &Hemsl. subsp. *sintenisii* (Bornm.) Wagenitz	Asteraceae
	Koelpinia linearis Pall.	Asteraceae
	Leontodon asperrimus (Willd.) Boiss. ex Ball	Asteraceae
Scariola orientalis (Boiss.) Sojak subsp. *orientalis*	*Scariola orientalis* (Boiss.) Sojak subsp. *orientalis*	Asteraceae
	Scorzonera pusilla Pall.	Asteraceae
	Seratula latifolia Boiss.	Asteraceae
	Taraxacum sp.	Asteraceae
Lappula microcarpa (Ledeb.) Gurke		Boraginaceae
Alyssum niveum Dudley	*Alyssum niveum* Dudley	Brassicaceae
Erysimum ischnostylum Freyn. & Sint.	*Alyssum* sp.	Brassicaceae
	Arabis nova Vill.	Brassicaceae
	Cardaria draba (L.) Desv.	Brassicaceae
	Clausia turkestanica Lipsky	Brassicaceae
	Conringia persica Boiss.	Brassicaceae
	Sisymbrium integerrimum Rech. f. & Aell.	Brassicaceae
	Goldbachia laevigata (M. B.) DC.	Brassicaceae
Acanthophyllum glandulosum Bunge ex Boiss.	*Acanthophyllum glandulosum* Bunge ex Boiss.	Caryophyllaceae
Stellaria alsinoides Boiss. & Buhse	*Dianthus crinitus* Sm. subsp. *turcomanicus* (Schischk.) Rech. f.	Caryophyllaceae
	Holesteum sp.	Caryophyllaceae
	Noaea mucronata (Forsk.) Aschers. & Schweinf.	Chenopodiaceae
	Convolvulus arvensis L.	Convolvulaceae
	Convolvulus lineatus L.	Convolvulaceae
	Carex stenophylla Wahlenb.	Cyperaceae
	Euphorbia aucheri Boiss. A. H. Pahleran	Euphorbiaceae
Euphorbia boissieriana (Woron.) Prokh.	*Euphorbia bungei* Boiss.	Euphorbiaceae
Astragalus (Anthylloidei) raddei Basil.	*Astragalus (Anthylloidei) raddei* Basil.	Fabaceae
Astragalus (Caprini) subrosulaiformis Sirj. & Rech. f.	*Astragalus (Platonychium) meschedensis* Bunge	Fabaceae
Astragalus (Onobrychioidei) brevidens Bunge	*Astragalus (Cremoceras) ochreatus* Bunge	Fabaceae
Astragalus (Platonychium) meschedensis Bunge	*Medicago lupulina* L.	Fabaceae
Onobrychis sintenissii Bornm.	*Trigonella monantha* C. A. Mey. subsp. *noeana* (Boiss.) Huber-Mor.	Fabaceae
Hypericum perforatum L.		Hypericaceae
	Gladiolus atroviolaceus Boiss.	Iridaceae
	Iris kopetdaghensis (Vved.) Mathew & Wendelbo	Iridaceae
	Phlomis cancellata Bunge	Lamiaceae

Species in Reference Site	Species in Ploughed Site	Plant Families
	Salvia chloroleuca Rech. f. & Aell.	Lamiaceae
Stachys lavandulifolia Vahl.	*Stachys lavandulifolia* Vahl.	Lamiaceae
Ziziphora clinopodioides Lam.	*Ziziphora tenuior* L.	Lamiaceae
Allium cristophii Trautv.	*Allium scabriscapum* Boiss.	Liliaceae
Eremurus stenophyllus (Boiss. & Buhse) Baker	*Gagea stipitata* Merkl. ex Bunge	Liliaceae
Gagea gageoides (Zucc.) Vved.	*Bellevalia* sp.	Liliaceae
Gagea stipitata Merkl. ex Bunge	*Tulipa micheliana* Hoog	Liliaceae
Tulipa micheliana Hoog		Liliaceae
	Orobanche sp.	Orobanchaceae
	Hypecoum pendulum L.	Papaveraceae
	Papaver dubium L.	Papaveraceae
	Roemeria hybrida (L.) DC.	Papaveraceae
	Roemeria refracta DC.	Papaveraceae
Acantholimon evinaceum (Jaub. et Spach.) Lincz.	*Acantholimon evinaceum*	Plumbaginaceae
Acantholimon raddeanam Czernjak		Plumbaginaceae
Bromus kopetdaghensis Drobov	*Boissiera squarrosa* (Banks & Sol.) Nevski	Poaceae
Bromus tectorum L.	*Bromus danthoniae* Trin.	Poaceae
Elymus elongatus (Host) Runemark	*Bromus tectorum* L.	Poaceae
Festuca alaica Drobov	*Elymus elongatus* (Host.) Runemark	Poaceae
Melica persica Kunth	*Eremopyrum* sp.	Poaceae
Poa timoleontis Heldr. ex Boiss.	*Poa timoleontis* Heldr. ex Boiss.	Poaceae
Poa trivialis L.	*Heteranthelium piliferum* (Banks & Sol.) Hochst.	Poaceae
Poa versicolor Besser	*Stipa arabica* Trin. & Rupr.	Poaceae
Stipa hohenackeriana Trin. & Rupr.	*Trisetum* sp.	Poaceae
	Bongardia chrysogonum (L.) Spach	Podophyllaceae
Polygonum patulum M. Bieb.	*Polygonum aviculare* L.	Polygonaceae
	Primula sp.	Primulaceae
Thalictrum sultanabadense Stapf.	*Ceratocephala testiculata* (Crantz) Roth	Ranunculaceae
	Reseda lutea L.	Resedaceae
Cerasus pseudoprostrata Pojark.	*Rosa persica* Michx. ex Juss.	Rosaceae
Cotoneaster nummularius Fisch. & C. A. Mey.		Rosaceae
Rosa canina L.		Rosaceae
Asperula glomerata (M. Bieb.) Griseb. subsp. *turcomanica* (Pobed.) Ehrend. &Schonb. -Tem.	*Callipeltis cucullaria* (L.) Rothm.	Rubiaceae
Asperula setosa Jaub. & Spach	*Galium tricornutum* Dandy	Rubiaceae
Callipeltis cucullaria (L.) Rothm.	*Haplophyllum acutifolium* (DC.) G. Don	Rutaceae
Crucianella gilanica Trin.		Rubiaceae
Galium tricornutum Dandy		Rutaceae
Verbascum sp.	*Veronica* sp.	Scrophulariaceae
Veronica ferganica M.Pop.		Scrophulariaceae
	Viola occulta Lehm.	Violaceae
	Peganum harmala L.	Zygophyllaceae

Table 3. Summary of plant life form spectra for the ploughed and reference sites

Reference Site			Ploughed Site		
Proportions	Frequency	Life form	Proportions	Frequency	Life form
3.51	2	Phanerophytes	0.00	0	Phanerophytes
15.79	9	Chamaephytes	10.67	8	Chamaephytes
49.12	28	Hemicryptophytes	37.33	28	Hemicryptophytes
15.79	9	Geophytes	17.33	13	Geophytes
15.79	9	Therophytes	34.67	26	Therophytes

Table 4. Important Values (IV) and reproduction mode of 10 most abundant plant species in the ploughed and reference sites

Reference Site			Ploughed Site		
Species Name	Propagation Method	IV	Species Name	Propagation Method	IV
Veronica sp.	Seed	45.13	*Seratula latifolia*	Resprute	23.73
Bromus kopetdaghensis	Seed	21.35	*Boissiera squarrosa*	Seed	22.02
Acantholimon raddeanam	Seed	17.81	*Poa timoleontis*	Seed	17.31
Stellaria alsinoides	Seed	16.56	*Alyssum* sp.	Seed	15.48
Polygonum argyrocoleon	Seed	15.81	*Elymus elongatus*	Seed	14.56
Callipeltis cucullaria	Seed	13.36	*Rosa persica*	Resprute	1.3.05
Gagea gageoides	Bulb	11.63	*Scariola orientalis*	Seed	11.78
Acantholimon glandulosum	Seed	10.10	*Bromus danthoniae*	Seed	11.84
Scariola orientalis	Seed	9.53	*Alyssum niveum*	Seed	9.84
Astragalus meschedensis	Seed	9.38	*Achillea wilhelmsii*	Resprute	7.07

Discussion

Species diversity

Components of species diversity include the number of species (species richness), their relative abundance (species evenness), the particular species percent (species composition), the interactions among species (non-additive effects) and the temporal and spatial variations in these properties (Van der Maarel, 1988; Ejtehadi *et al*., 2009). Disturbances can contribute to the maintenance of diversity in two ways: firstly, they contribute to the maintenance of species richness (Connell, 1978; Pickett, 1980); secondly, they can increase spatial heterogeneity (Whittaker & Levin, 1977). Here, we found that rangeland plowing and subsequent land abandonment significantly increased species richness but decreased spatial heterogeneity (evenness). Contrasting effects of disturbance on species richness and evenness led to a non-significant difference in species diversity between the ploughed and reference sites.

Richness

Species richness was higher in the ploughed site than the reference one in the semiarid steppe rangeland of Baharkish. Joshi *et al.* (1992) and Fulbright (2004) also found a sharp decrease in species richness in the early years after land plowing but diversity was increased to the higher level than the pre-disturbed areas few years later. Similar results were observed in the ploughed and reference sites of Baharkish area, in other words, number of annual species was 3 times higher in the disturbed site but number of perennial plants (chamaephytes, hemicryptophytes and geophytes) was almost similar in the sites (Table 3). Guo (1996), Wilson and Tilman (2002) and El-Sheikh (2005) also found high species richness at the intermediate disturbance levels which referred to the simultaneous presence of annual and perennial plant species. In theory (Connell, 1978), greater species richness may occur during an intermediate time period following disturbance because number of annual species occupying the disturbed patches increases relative to undisturbed patches; perennial species established after the disturbance increase species richness. Accordingly, in our research, a 22 year period of land abandonment should represent an intermediate step in the secondary succession which also includes higher species richness as compared with the undisturbed site. Succession trend in this research was similar to that found in Korea (Lee, 2002) and Egypt (El-sheikh, 2005) but it is faster than plant changes in Arizona (Bazzaz, 1968).

Evenness

Plant community evenness was decreased as a result of rangeland ploughing. Lower evenness indicates a less spatial heterogeneity (Whittaker & Levin, 1977) or a patchy distribution of plant species. For both plants (Lavorel *et al*., 1999) and soil microorganisms (McGrady-Steed *et al.*, 1997), spatial plant distribution is governed more strongly by the traits of resident and invading species rather than species richness *per se*. In our research, lower evenness can be due to high proportion of resprouting plants in the ploughed site. Rhizomatous spreading plants such as *Seratula latifolia*, *Rosa persica* and *Achillea wilhelmsii* are amongst the 10 most common plant species in the ploughed site (Table 4).

Furthermore, *Acroptilon repens*, *Centaurea virgata*, *Carex stenophylla*, *Phlomis cancellata*, and *Galium tricornutum* that are well-known noxious and respruting plant species had invaded many places within the ploughed site. *Acroptilon repens* and *Phlomis cancellata* were allelopathic species, too. Hence, the ploughed site was less heterogeneous (patchier) with the rhizomatous plants dominating some places creating pure stands of their own clone and out-competing the other plant species.

Stability

Since the study area had been grazed by livestock for centuries before conducting this study (2009), they were intermediately or even severely disturbed before the rain-fed crop cultivation (1975-1988). Thus, a theoretical model to predict the effects of plowing based on disturbance effects on a climax community may not be applicable in this semiarid steppe rangeland (Fulbright, 2004). Further, vegetation changes in the arid and semiarid rangelands may correspond to state-and-transition model of succession rather than the transition model of sequential community replacement leading to a climax community (Laycock, 1991). In Baharkish rangelands, clonal plants had invaded some places in the ploughed site and created a relatively stable community that was different from the reference community even 22 years after the land abandonment. Nevertheless, a comparison between the floristic compositions of the ploughed and reference sites indicates the differences in their stability against the possible environmental fluctuations.

Changes in the land use practices may lead to qualitative and quantitative modifications in the relative abundance of plant ecological groups (Mitja *et al*., 2008).

In this study like many previous researches (Joshi *et al*., 1992; Sher and khan, 2007; Asri and Mehrnia, 2002), disturbance led to the increase of annual plants. In the ploughed site, an increase in number of annual plants (therophytes) was at the cost of reducing perennial woody species (chamaephyte and phanerophyte) (Table 3). While annual plants are totally dependent on the seasonal and annual rainfall, woody species are more dependent on the stored moisture within the deep soil layers (Ehleringer *et al*., 1999; Jankju, 2006). Furthermore, annual plants are less effective for the soil and water conservation because they exist in the field only for a short period (up to 90 days) as compared with the chamaephyte and phanerophyte species that persist for the whole year. Therefore, in our research, the ploughed site with high number of therophyte species should be less stable against the environmental fluctuations as compared with the reference site with the greater proportion of perennial deep rooted plants.

Conclusions

Land plowing and subsequent abandonment caused drastic changes in plant diversity and community composition of the semiarid rangelands of Baharkish. It increased plant diversity by increasing total number of plant species; in contrast, it reduced plant diversity by increasing patchiness in the plant community. Rangeland plowing led to the replacement of chamaephayes and phanerophyte plant species with the therophytes and geophytes. Hence, despite higher number of plant species, the ploughed site may be less stable against the future environmental fluctuations.

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غنای گونه‌ای، یکنواختی و پایداری جوامع گیاهی یک مرتع نیمه خشک، ۲۲ سال پس از شخم

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چکیده. شخم مراتع و کشت محصولات زراعی دیم از عوامل اصلی تخریب منابع طبیعی در نواحی نیمه‌خشک و نیمه‌مرطوب است، که می‌تواند منجر به تغییرات عمده در ترکیب جوامع و کاهش پایداری آنها گردد. در این مطالعه اراضی مرتعی کشت و کار شده و سپس رها شده با مراتع مجاور آن که شخم نخورده اند مقایسه شدند. پژوهش در مرتع نیمه‌خشک بهارکیش واقع در شهرستان قوچان استان خراسان رضوی در دو فصل بهار و تابستان سال ۱۳۸۹ انجام شد. ۴۰ پلات ۱×۱ متری در منطقه مستقر گردید و فرکانس و تاج پوشش همه گونه‌های گیاهی ثبت شد. سپس شاخص‌های سیمپسون، شانون- واینر، هیل و مکنتاش به عنوان شاخص‌های تنوع، شاخص های مارگالوف و منهنینگ به عنوان شاخص‌های غنا و شاخص‌های کامارگو، سیمپسون، نی اصلاح شده و اسمیت و ویلسون به عنوان شاخص‌های یکنواختی محاسبه شدند. ترکیب فلورستیک، فرم‌های حیاتی گیاهان و درجه اهمیت گونه‌های گیاهی اصلی موجود در دو سایت نیز مقایسه شدند. نتایج نشان داد که شخم زمین و رهاسازی آن، منجر به افزایش تعداد کل گونه‌های گیاهی (غنا) و کاهش هتروژنیتی گونه‌ای (یکنواختی) شده است. در نتیجه تنوع سایت‌های شخم‌خورده و مرجع تفاوت معنی‌داری نشان نداد. شخم مراتع باعث افزایش ضریب اهمیت (۸٪) گونه‌های گیاهی پاجوش و ریزوم‌دار شد. بنابراین توزیع توده‌ای گونه‌های گیاهی که از طریق غیرجنسی تکثیر می-شوند باعث کاهش یکنواختی گونه‌ها در سایت رها شده گردید. همچنین در سایت شخم‌خورده و رهاشده تعداد گونه‌های تروفیت (۱۰۰٪) افزایش و تعداد گونه‌های همی‌کریپتوفیت (۲۴٪)، کامفیت (۳۳٪) و فانروفیت (۱۰۰٪) کاهش یافته است. بنابراین سایت رها شده به علت یکنواختی کمتر، و بیشتر بودن نسبت گیاهان یکساله در ترکیب جامعه، در مقابل نوسانات محیطی آینده آسیب پذیرتر است.

کلمات کلیدی: اراضی زراعی رها شده، تنوع زیستی، تخریب، پویایی پوشش گیاهی، شاخص اهمیت