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Distribution of Plant Species and Their Relation to Soil Properties in Protected and Degraded Stands of Quercus macranthera in Northern Iran

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Abstract. *Quercus macranthera* is extended in forest areas of the upper elevations in the north of Iran and plays an effective role in conserving soil and water infiltration. The biggest problem in the region is livestock grazing and forest dwellers. The aim of this study was to study the distribution of plant species and their relation to soil properties in protected and degraded stands of *Quercus macranthera*. This study included both protected and degraded areas. Within each of the study areas, we used a random systematic 100 m × 100 m sampling grid to locate 20 circular plots (1000 m^2 plot for tree and shrub species and 8m^2 for herbaceous species) in each area. Also, in each plot, soil samples were collected from 0 to 30 cm depth. The result showed that the distribution pattern of species in both areas was different. Shrub species and invasive herbaceous species were more abundant in the degraded area. Diversity, richness and evenness in the protected area were significantly higher than the degraded area. The soil nutrient factors were significantly more in the protected area. Soil texture was no different between the two areas. It seems that conservation programs such as prevention of livestock need to be carried out in order to protect *Quercus macranthera.*

Keywords: livestock grazing, conservation, soil physical and chemical properties *Quercus macranthera* stand, Roudbar forest.

Introduction

Soil types with different structure and nutrients are important for plant growth and community development. Soil conditions are different in different forest areas and are also related to the restoration process (ZHANG & DONG, 2010). The interactions of environmental factors are important in the restoration process and must be considered in the management of the areas (GATTIE *et al.*, 2003). Well-defined species–environment relationships are important to understand vegetation patterns on forest landscapes (HIX & PEARCY, 1997). The effects of environmental variables on plant species have been the subject of many ecological studies in recent years (RAMIREZ *et al.*, 2007). Research focusing on the relationship between plant communities and environmental variables such as soils has become increasingly important in understanding the ecology of forest communities and especially their ground-layer vegetation (OLANO *et al.*, 1998).

Grazing domestic herbivores are a major ecological factor that shape structure and function of the remaining natural rangelands in the world. Biodiversity of uplands has received particular attention because it relates to productivity and

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stability. While heavy grazing generally leads to a reduction in diversity, the effects of intermediate grazing pressures differ. For example, sagebrush steppes in Montana reach maximum diversity at intermediate stocking rates; while others show maximum values in exclosures and grazing even at moderate (OLIVA *et al.,* 2016). Grazing is the common land-use throughout the world. It has substantial effects on many ecosystem processes and functions, such as nutrient pool and cycling, soil moisture and structure, vegetation composition and productivity. It has generally been concluded that grazers could affect the floristic composition and diversity in different ways, depending on the type of grazing animals, intensity of grazing and host plant species (BARDGETT & WARDLE, 2010). Livestock overgrazing is considered as the main cause of degradation through lowering both the productivity and resilience of host species, reduction of vegetation cover, increase of unpalatable species, decrease of species diversity, and alteration of soil structure and compactness. Effects of grazing on the plant community and soils are viewed as destructive agents because of the reduction of ground cover, productivity and soil erosion (AL-ROWAILY *et al.,* 2015).

Many abiotic factors, such as soil moisture, light, and nutrition affect composition of vegetation. Human-caused factors include livestock grazing, mining, and timber harvest. These factors affect the plant species composition and the establishment and stability of seedlings. There are significant correlations between human disturbances (such as livestock grazing, anthropogenic wildfire, and logging) and composition, richness and abundance (GILLESPIE *et al.,* 1999). Grazing of macro-herbivores has a great effect on forest plant community structure. Understory perennial plants in protected areas are typically more abundant than in unprotected forest stands (SABO *et al.,* 2009; JAVANMIRIPOUR *et al.,* 2012).

Understanding the relationship between plant diversity and land use history can have important implications in management decisions, especially when these ecosystems were widely used by humans (TALAMO *et al.,* 2012). Nearly 87 % of the Iranian forest and rangeland degradation was caused by human activities such as irregular grazing and wood consumption (HEYDARPOUR *et al.,* 2008). The composition and diversity of plant communities in many of these natural ecosystems were considerably affected, and the extent to which these changes were significant depended on the intensity and frequency of degradation sources and on the ability of plant species to adapt to these new conditions (HERATH *et al.,* 2009). Grazing can change competitive balance between species, composition and abundance of plants, species dominance establishment of plant species, ecosystem processes and biodiversity. These changes can progressively lead to unbalanced ecosystems, which can hardly revert to their initial state (POLASKY *et al.,* 2011; CLARK & COVEY, 2012).

Extant forests of northern Iran consist mostly of broadleaf deciduous species, but some areas are locally covered by a Mediterranean-type vegetation. Moreover, the distribution of forest types in northern Iran is heterogeneous, with forest productivity following a decreasing west-east gradient. Caspian forests appear to be very similar to broadleaf forests typical of central Europe, northern Turkey and the Caucasus (MARVIE MOHADJER, 2006). Forests of the Guilan Province are located in the western part of the Hyrcanian forest region. The dominant species in the northern forests of Iran is beech (*Fagus orientalis* Lipsky), which covers about 565,000 ha and represents the total area of indigenous forests in Guilan Province. Beech forests are the richest, most productive forest communities in Iran because of their economical and environmental value. These forests represent a major carbon pool in the region and are important for their economic value, ability to protect soil, and provide recreation resources. The greatest forest volume occurs in Iran's beech forests (ADEL *et al.,* 2013).

Quercus macranthera covers forest areas of the upper elevations in the north of Iran and plays an effective role in conserving soil and water infiltration. Also, it affects wildlife conservation in the upland. This species grows at altitudes above 1,700 m. In recent years, livestock grazing and human use have reduced and degraded these forests. Studying the effects of livestock grazing and human use on the composition and diversity of vegetation in *Quercus macranthera* forests would yield important information necessary for forest managers.

The aim of this study was to study the distribution of plant species and their relationship with soil properties in protected and degraded areas of *Quercus macranthera* in Roudbar forests in the north of Iran.

Material and Methods

Study area

The study area (Fig. 1) is located in the District 6 (Dasht Daman), at Roudbar City in the south of Guilan Province in northern Iran (36° 45′ 8″ to 36° 55′ 12″ N latitude and 49° 30′ 15″ to 49° 40′ 10″ longitude E). Elevation within the study area ranges from 1800 to 2520 m a.s.l., mean of slope is 50%, and the general aspect is south. Parent materials include lime silt, sandstone, silt stone and shill. Soils texture is loamy clay, with weak acidic pH (6.2-6.8). The maximum temperature is 21.8° C in August and minimum temperature is -3°C in February. The climate, based on the Emberger classification, is humid with mean annual precipitation of 694 mm at the nearest meteorological station (Rasht City). The biggest problem in the region is livestock grazing and forest dwellers.

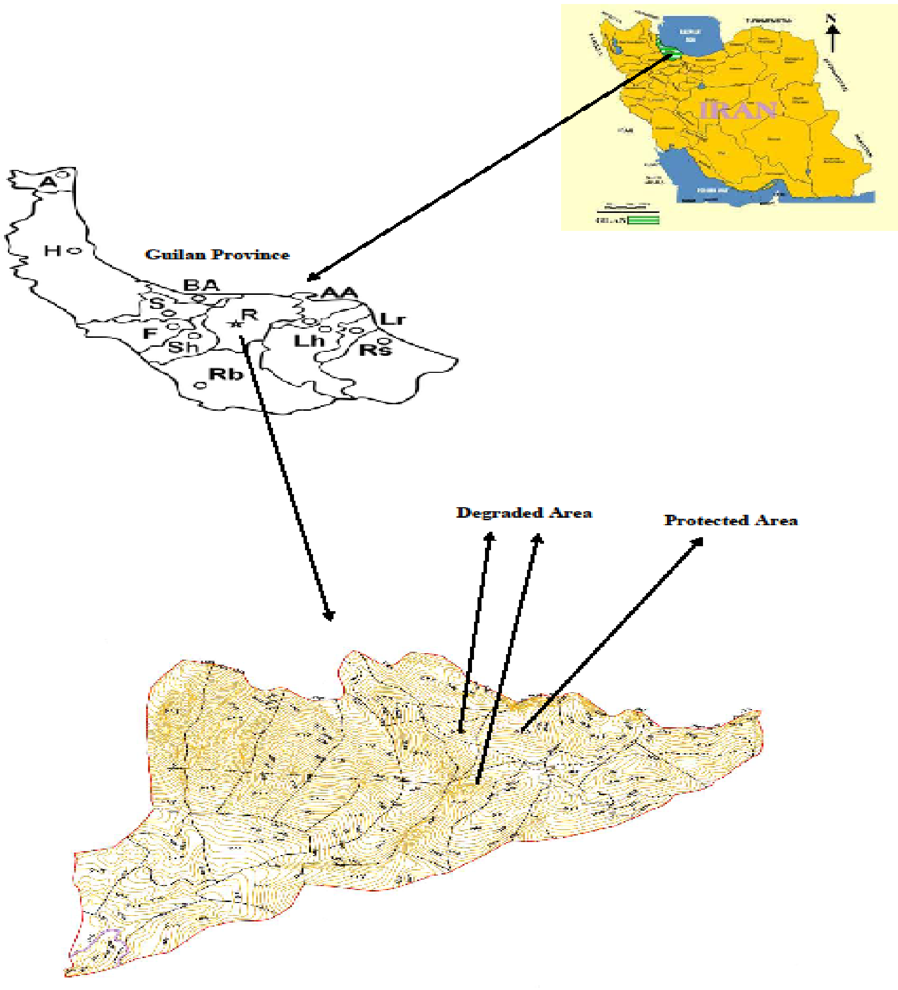

Fig. 1. Map of the study area - District 6 (Dasht Daman), at Roudbar City in the south of Guilan Province in northern Iran.

Data collection

This study included both protected and degraded areas. The two areas had similar elevations, slopes and aspects. In each of the study areas, we used a random systematic 100 m × 100 m sampling grid to locate 20 circular plots (each plot is 1,000 m^2) in each area, resulting in a total of 40 plots. In each plot, type and number of woody (tree and shrub) species were recorded. Also, in a smaller sub-plot of 8m^2, we recorded the percentage of herbaceous species cover. In each plot, soil samples were collected at these 40 plots. Soil samples were collected from 0 to 30 cm depth for physical and chemical properties. In each plot, we collected a composite sample, mixing three sub-samples. Soil samples were prepared for analysis by air-drying and sieving using a 2 mm screen. Sand, silt and clay percentages were determined by the hydrometric method (Bouyoucos, 1962). Soil pH and electrical conductivity (EC) were determined using appropriate meters. Total nitrogen (N) was analyzed by the Kjeldahl method (Bremner, 1996). Available phosphor (P) was determined by colorimetry according to the Bray-II method (Bray & Kurtz, 1945). Organic carbon (OC) and organic matter (OM) were deter-mined by the Walkley & Black (1934) method. C/N ratio was calculated. Total potassium (K) was analyzed by flame atomic absorption spectrophotometer (MAPA, 1994).

Data analysis

DCA analysis was used to study plant species composition. RDA and CCA analysis were used to explore the relationship between soil factors and plant species. To determine whether to use linear or unimodal, DCA was used to evaluate the gradient length of the first axis. If gradient length was more than 3, we used CCA and if it was less than 3, we used RDA. A Monte Carlo permutation test based on 499 random permutations was conducted to test the significance of the eigenvalues of the first canonical axis (Liu *et al.*, 2012). DCA, RDA and CCA were performed by CANOCO 4.5. To evaluate herbaceous diversity, we used three indices. Species diversity was assessed with the Shannon–Wiener index, species richness was estimated according to the Margalef index. In addition, the Smith–Wilson index was utilized to calculate species evenness. All three indices were computed using Ecological Methodology and PAST software. The Kolmogorov–Smirnov test was used to evaluate the normality of parameters. Leven test was used to assess the equality of variances. Independent t test were used to compare data that were normally distributed. For parameters that were not normally distributed, the nonparametric Mann-Whitney U-test was used.

Results

DCA ordination of tree species

The distributions of tree and shrub species in the study area are shown in Fig. 1. *Quercus macranthera* is located at the centre of the graph, but was not located during the first and second axes. *Fagus orientalis* and *Sorbus torminalis* species are located at the bottom and right parts of the graph. They exist only in the degraded area. *Carpinus orientalis* and *Quercus castaneifolia* species are located in the bottom and left parts of the graph. These species had a low presence in both areas. They existed near the forest parts with *Fagus orientalis* and *Sorbus torminalis* more than ecotone areas. *Acer campester, Mespilus germanica* and *Pyrus communis* are located in the upper and left parts of the figure, and exist in ecotone and higher elevations. Shrub species of *Juniperus communis, Crataegus microphylla, Cotoneaster nummularia, Prunus spinosa* and *Berberis integgerima* were on the right side of graph. These species are the species that are present in both areas, but mostly distributed in the degraded area.

DCA ordination of Hebaceous species

The distributions of herbaceous species are shown in Fig. 2. Species that are present in the upper part of the graph include *Cruciata laevipes, Stachys byzantiana, Ornithogalum sintenisii* and *Thalspi hastulatum*. These species are found only in the degraded area and have low abundance.

Trifolium repens, located in the upper part of the graph, has a high abundance in both areas. Species that are located on the right side of graph included *Brachypodium silvaticum, Dactylis glomerata, Festuca rechingeri, Poa trivialis, Viola somchetica, Astragalus ureus, Erodium cicutarium* and *Marrubium vulgar*. These species have the highest cover percentage in the degraded area or are only present in the degraded area. Species that are located on the left side of graph included *Asplenium trichomanes, Dryopteris pallida, Viola odorata, Carex divolsa, Geranium molle, Arenaria leptophylla* and *Moehringia trinervia*. These species are only present at lower altitudes and near the forest or were more abundant in this area. Other species that are located in the lower part of the graph, such as *Alium erubescens, Urtica dioica, Polygonum aviculare, Phlomis anisodonta, Veronica persica, Hypericum perforatum, Clinopodium umbrosum, Asyneuma amplexicaule, Medicago lupulina, Crocus gilanicus* and *Milium vernale*, have lower abundance in one of the two protected or degraded areas.

RDA ordination of woody species

The RDA ordination was used because the length of the gradient was calculated (1.19) to be smaller than 3. The first (0.764) and second (0.034) axes had the largest Eigenvalues, which accounted for 97.5% of variation. The results of RDA indicated that *Quercus macranthera* had no correlation with nutrient such as N, P and K. Also, this species had a negative correlation with pH, C.N, clay and sand. *Pyrus communis* and *Quercus castaneifolia* had positive correlation with N, P, K, CEC and Sand. *Carpinus orientalis* and *Acer campester* had positive correlation with pH, clay and C/N. Shrub species of *Prunus spinosa, Berberis integgerima,* Juniperus *communis, Crataeogus microphylla, Mespilus germanica* and *Cotoneaster nummularia* and also *Sorbus torminalis* tree species had a low correlation with clay and silt, but had no correlation with other soil factors. *Fagus orientalis* only correlated with sand.

CCA ordination of herbaceous species

The CCA ordination was used because the length of the gradient was calculated (4.56) to be greater than 3. The first (0.737) and second (0.137) axes had the largest Eigenvalues, which accounted for 79.8% of variation. The results of CCA indicated that the species that are located on negative side of first axis, such as *Brachypodium silvaticum, Dactylis glomerata, Festuca rechingeri, Poa trivialis, Viola somchetica, Astragalus ureus, Erodium cicutarium* and *Marrubium vulgar*, have a low correlation with clay and silt. Species of the positive side of first axis included *Asplenium trichomanes, Dryopteris pallida, Viola odorata, Carex divolsa, Geranium molle, Arenaria leptophylla, Moehringia trinervia, Hypericum perforatum, Asyneuma amplexicaule, Clinopodium umbrosum* and *Trifolium repens*. These species have the most positive correlation with N, P, K, OC, OM, EC and CEC. Also, they have a low correlation with pH and sand. Species on the upper part of graph, *Phlomis anisodonta, Stachys byzantiana, Ornithogalum sintenisii, Thalspi hastulatum, Alium erubescens* and *Urtica dioica*, have the most negative correlation with C.N. Other species on upper part of graph, for example, *Medicago lupulina, Milium vernale, Cruciata laevipes* and *Crocus gilanicus* have no correlation with the soil variables.

Comparison of soil factors between protected and degraded areas

The result of comparisons of soil physical and chemical properties showed that N, P, K, OC, OM, EC and CEC were significantly higher in protected areas than degraded areas. Also, there were no significant differences in pH, clay, silt, sand and C.N between the two areas (Table 1).

Biodiversity indices

Result showed that biodiversity indices (diversity, richness and evenness) in the protected area were significantly higher than degraded area (Table 2).

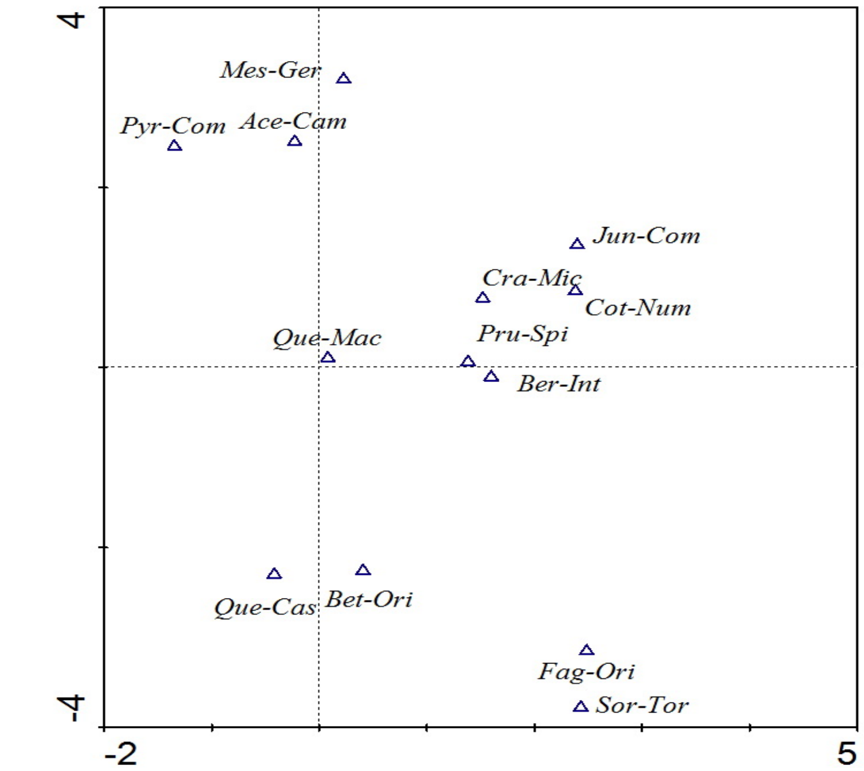

Fig. 2. DCA ordination of woody species in protected and degraded areas.

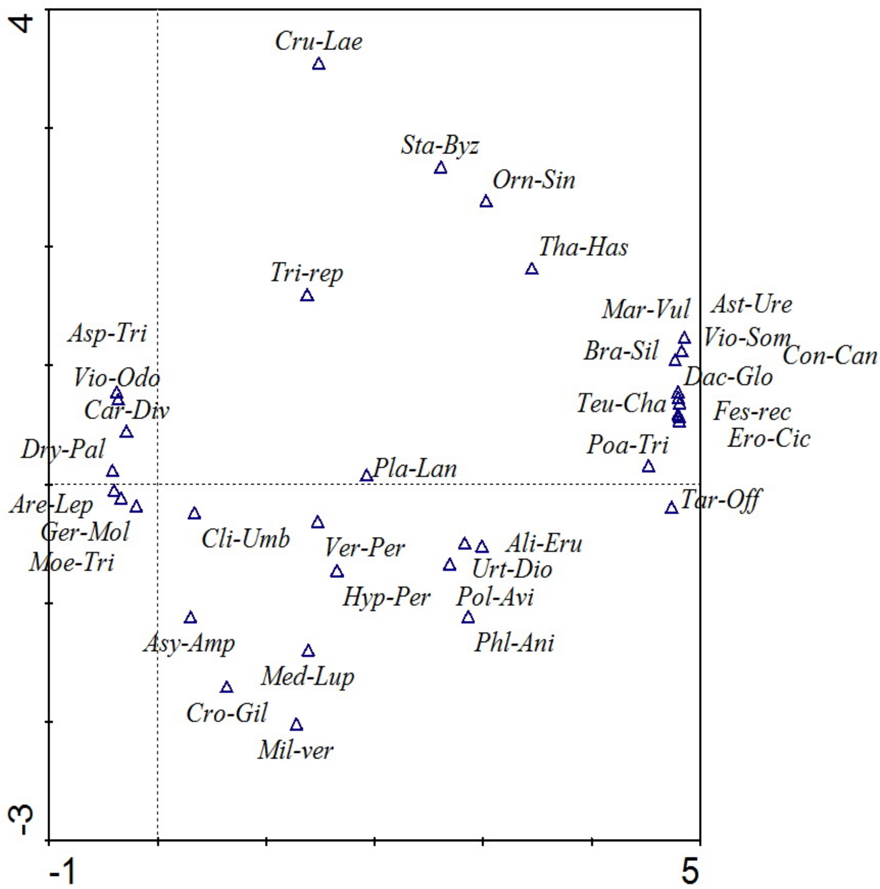

Fig. 3. DCA ordination of herbaceous species in protected and degraded areas.

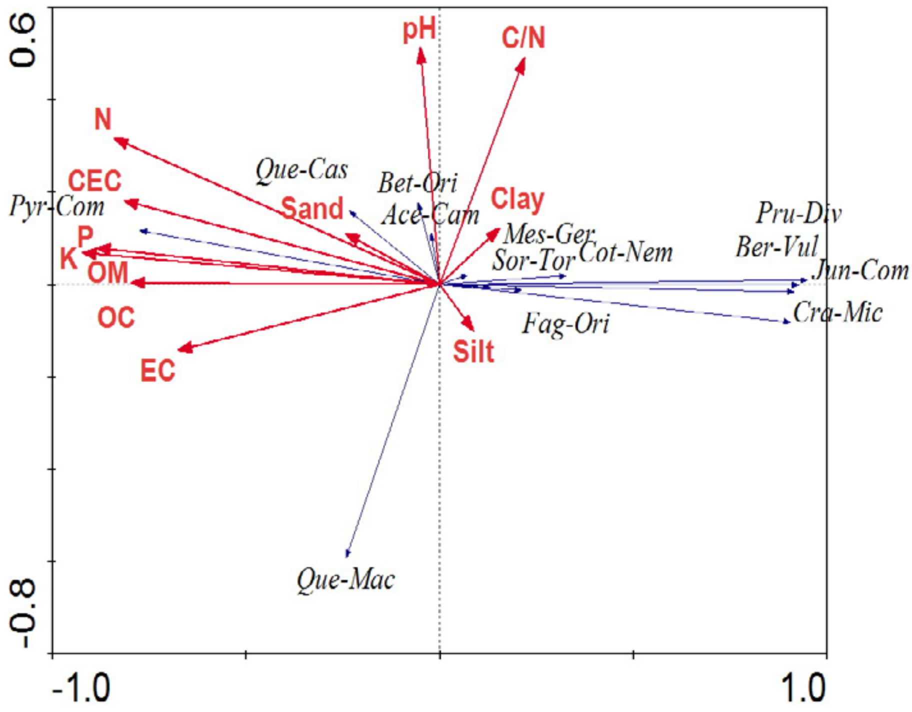

Fig 4. RDA ordination of woody species and soil factors.

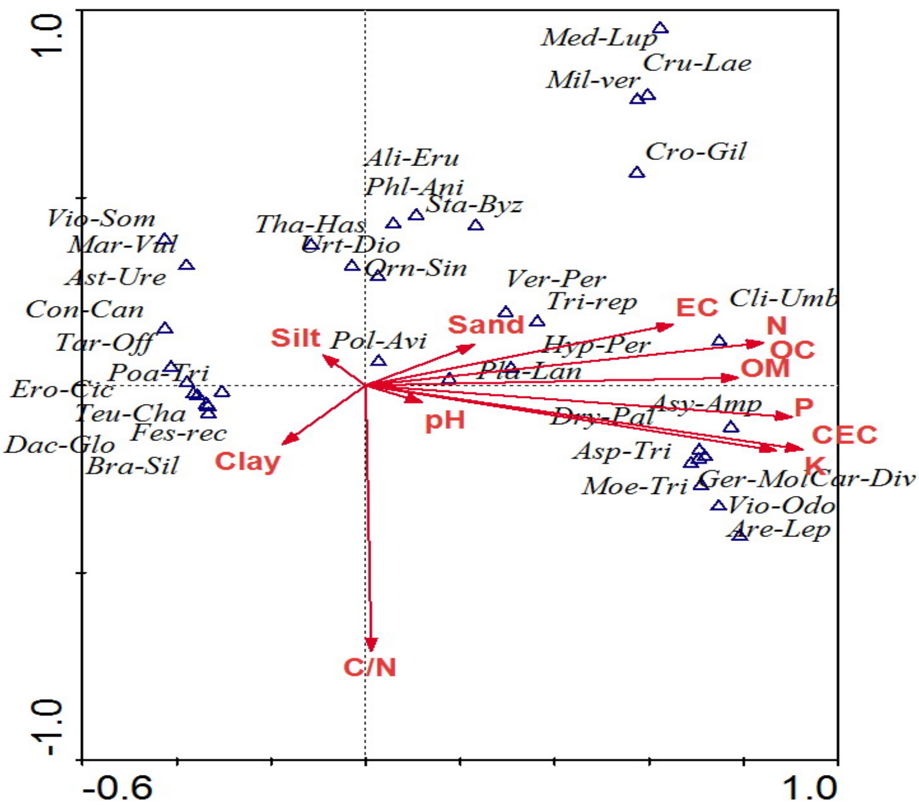

Fig. 5. CCA ordination of herbaceous species and soil factors.

Table 1. Soil properties in protected and degraded areas.

	Protected area	Degraded area
N	0.43[a]	0.3[b]
P	7.14[a]	5.18[b]
K	273.5[a]	178.95[b]
pH	6.6[a]	6.57[a]
EC	0.89[a]	0.58[b]
OC	3.18[a]	2.48[b]
OM	5.41[a]	4.22[b]
Clay	39.3[a]	40.35[a]
Silt	34.05[a]	34.4[a]
Sand	29.15[a]	24.95[a]
CEC	37.95[a]	28.75[b]
C.N	10.05[a]	10.55[a]

Table 2. Biodiversity indices in protected and degraded areas.

	Protected area	Degraded area
Richness	2.92[a]	2.13[b]
Evenness	0.73[a]	0.6[b]
Diversity	2.66[a]	2.08[b]

Discussion

The results of DCA ordination showed that species composition is different between the protected and degraded areas. Indeed, livestock grazing and human interventions have changed species composition. *Fagus orientalis* and *Sorbus torminalis* were two tree species that were only present in the degraded area, thereby marking a different distribution with that of the protected area. In the degraded area, some shrub species—such as *Juniperus communis*, *Crataeogus microphylla*, *Cotoneaster nummularia*, *Prunus spinosa*, and *Berberis integgerima*—were present with similar distributions, causing different species composition in the degraded area. In fact, livestock grazing and environmental destruction have paved the way for invasion of the area by such species. *Carpinus orientalis* and *Quercus castaneifolia,* which were present in both areas, recorded the same distribution. In the study area, these two species were mainly found at near-forest areas. *Acer campester, Mespilus germanica* and *Pyrus communis* were among the species with disposition toward higher points; their conditions, however, was almost the same in both areas. *Quercus macranthera*, as the dominant species of both areas, showed the same distribution. Shrub species had, indeed, been the main cause for changed species composition and distribution. Shrub invasion has been considered the main outcome of livestock grazing around the world (PERELMAN *et al.,* 1997). The reaction of shrubs to grazing, however, is not the same for all different species; *Mespilus germanica*, for instance, has shown different behaviour.

Changed species composition was also observed at the herbaceous layer. In the protected area, *Asplenium trichomanes, Dryopteris pallid, Viola odorata, Carex divolsa, Geranium molle, Arenaria leptophylla* and *Moehringia trinervia* were the main components, while in the degraded area, species such as *Brachypodium silvaticum, Dactylis glomerata, Festuca rechingeri, Poa trivialis, Viola somchetica, Astragalus ureus, Erodium cicutarium*, and *Marrubium vulgar* were the common species. Livestock grazing has paved the way for invasion of the aforementioned species, ergo leading to changed herbal composition of the area. These species are mostly annual invading plants, which produce large amounts of seeds and therefore change dominance pattern. MARTINS DA SILVA *et al.* (2009) in Portugal, GODEFROID *et al.* (2005) in Belgium, and MINCHINTON *et al.* (2006) in the USA declared that with their high competitive power and their large amount of seeds, invader species change species composition of grazed-up, destroyed regions.

The results of species relations and soil factors revealed the fact that different species have reacted to soil differently. Herbaceous and woody species, which presence was greater in the degraded area, had no relationship with nutrients such as N, P, K, and C; they, rather, preferred soils with higher clay and silt percentages. Nutrients have, indeed, no effect on such species. Species present in the protected area, however, showed a direct relationship with nutrients. Furthermore, comparative results of soil factors in the two areas showed that nutrients were significantly more abundant in the protected area, which provided chances of better growth for the species. Livestock grazing has imposed a negative effect on the chemical part of the soil. No negative effect was, however, observed for the physical part, based on comparative results of soil pattern for the two areas. In their study on Pol-e-Dokhtar of Iran, SALEHI *et al.* (2011) concluded that amounts of N, P, K, and K were significantly lower in the degraded area. HEIDARIAN AGHAKHANI *et al.* (2010) carried out a study on Bojnord, Iran; they showed how livestock grazing has led to significantly decreased amounts of carbon, N, P, K, and organic materials. In addition, *Quercus macranthera* had no relationship with nutrients; it grew better in areas with lower pH, clay, and C.N ratio. It seems that factors other than soil features are influential in the species distribution. They can include climate factors such as temperature or precipitation, and also topography and latitude.

Livestock grazing had a negative effect on diversity of herbaceous species such that richness, evenness, and diversity were all significantly lower in the degraded area. Apart from trampling, livestock eat from palatable species, ergo leading to the development of non-palatable ones. This alters the dominance pattern of the area; some species cannot well grow and develop in such situations. KEELEY *et al.* (2003) in southern Sierra Nevada, BOUHIM *et al.* (2010) in western Morocco and CESA & PARUELO (2011) in southern Argentina concluded that diversity is higher in the protected areas than degraded areas. Finally, results showed that livestock grazing and human activities can have serious negative effects on the soil. These, furthermore, pave the way for entrance of invader species. That is why programmes for the management and protection of *Quercus macranthera* forests seem especially important. It is also hoped that similar programmes are being strictly planned to prevent entry of animals into similar other areas.

References

ADEL M.N., H. POURBABAEI, A. OMIDI, C.D. DEY. 2013. Forest structure and woodyplant species composition after a wildfire in beech forests in the north of Iran. - *Journal of Forestry Research*, 24 (2), 255–262. [DOI]

AL-ROWAILY S.L., M.I. EL-BANA, D.A. AL-BAKRE, A.M. ASSAEED, A.K. HEGAZY, M.B. ALI. 2015. Effects of open grazing and livestock exclusion on floristic composition and diversity in natural ecosystem of Western Saudi Arabia. - *Saudi Journal of Biological Sciences*, 22: 430–437. [DOI].

BARDGETT R.D., D.A. WARDLE. 2010. Aboveground-belowground linkages: biotic interactions, ecosystem processes and global change. Oxford University Press, Oxford.

BOUAHIM S., L. RHAZY, B. AMAMI, N. SAHIB, M. RHAZI, A. WATERKEYN, A. ZOUAHRI, M. MESLEARD, S. MULLER, P. GRILLAS. 2010. Impact of grazing on the species richness of plant communities in Mediterranean temporary pools (western Morocco). - *Comptes Rendus Biologies*, 333: 670–679. [DOI].

BOUYOUCOS C.J. 1962. Hydrometer method improved for making particle-size analysis of soil. - *Agronomy*, 54: 464–465.

BRAY B.M, L.T. KURTZ. 1945. Determination of total, organic and available forms of phosphorus in soils. - *Soil Science,* 59: 39–45.

BREMNER J.M. 1996. Nitrogen-Total. - In: SPARKS D.L., et al. (Eds.), *Methods of Soil Analysis.* Soil Science Society of America, Inc. – American Society of Agronomy, Inc., Madison, Wisconsin, USA, pp. 1085–1122.

CESA A., J.M. PARUELO. 2011. Changes in vegetation structure induced by domestic grazing in Patagonia (Southern Argentina). - *Journal of Arid Environments*, 75: 1129-1135. [DOI].

CLARK J.A., K.R. COVEY. 2012. Tree species richness and the logging of natural forests: A meta-analysis. - *Forest Ecology and Management*, 276: 146–153. [DOI].

GATTIE D.K, M.C. SMITH, E.W. TOLLNER, S.C. MCCUTCHEON. 2003. The emergence of ecological engineering as a discipline. - *Ecological Engineering*, 20 (5): 409–420. [DOI].

GILLESPIE T.W., A. GRIJALVA, C.N. FARRIS. 1999. Diversity, composition, and structure of tropical dry forests in Central America. - *Plant Ecology*, 147: 37−47. [DOI].

GODEFROID S., S. PHARTYAL, G. WEYEMBERGH, N. KOEDAM. 2005. Ecological factors controlling the abundance of non-native invasive black cherry (*Prunus serotina*) in deciduous forest understory in Belgium. - *Forest ecology and management,* 210: 91–105. [DOI].

HEIDARIAN AGHAKHANI M., A.A. NAGHIPOUR, H. TAVAKOLI. 2010. The effects of grazing intensity on vegetation and soil in Sisab rangelands, Bojnord, Iran. - *Iranian Journal of Range and Desert Reseach*, 17 (2): 243-255.

HERATH D.N., B.B. LAMONT, N.J. ENRIGHT, B.P. MILLER. 2009. Impact of fire on plant-species persistence in post mine restored and natural shrub land communities in southern Australia. - *Biological Conservation*, 142: 2175–2180. [DOI].

HEYDARPOUR Z., H. SHAABANALI, A. ASADI, I. MALEK MOHAMMADI. 2008. A study on the role of membership in forestry cooperatives in the revitalization of forestry resources in the western part of Mazandaran province. - *Iranian Journal of Agricultural Science and Natural Resources,* 15(1): 1–9.

HIX D.M., J.N. PEARCY. 1997. Forest ecosystems of the Marietta Unit, Wayne National Forest, southeastern Ohio: multifactor classification and analysis. - *Canadian Journal of Forest Research*, 27: 1117–1131. [DOI]

JAVANMIRIPOUR M., M.R. MARVI MOHADHER, V. ETEMAD, M. ZOBEIRI. 2012. Effects of grazing on natural regeneration of tree and herb species of Kheyroud forest in northern Iran. - *Journal of Forestry Research*, 23(2): 299−304. [DOI].

KEELEY J.E., D. LUBIN, C.J. FOTHERINGHAM. 2003. Fire and grazing impacts on plant diversity and alien plant invasions in the southern Sierra Nevada. - *Ecological Applications*, 13: 1355–1374. [DOI].

LIU X., W. ZHANG, F. YANG, X. ZHOU, Z.H. LIU, F. QU, S.H. LIAN, C.H. WANG, X. TANG. 2012. Changes in vegetation–environment relationships over long-term natural restoration process in Middle Taihang Mountain of North China. - *Ecological Engineering,* 49: 193–200. [DOI].

MARVIE MOHADJER M.R. 2006. *Silviculture*. University of Tehran Press, Tehran, Iran, 387 p.

MAPA. 1994. *Métodos Oficiales de Análisis*. Tomo III. Servicio de Publicaciones delMinisterio de Agricultura. Pescay Alimentación, Madrid, Spain, 662 p.

MARTINS DA SILVA P., C.A.S. AGUIAR, J. NIEMELA, J.P. SOUSA, A.R.M. SERRANO. 2009. Cork-oak woodlands as key-habitats for biodiversity conservation in Mediterranean landscapes: a case study using rove and ground beetles

(Coleoptera: Staphylinidae, Carabidae). - *Biodiversity Conservation,* 18: 605–619. [DOI].

MINCHINTON T.E., J.C. SIMPSON, M.D. BERTNESS. 2006. Mechanisms of exclusion of native coastal marsh plants by an invasive grass. - *Journal of Ecology*, 94: 342–354. [DOI].

OLANO J.M., J. LOIDI, G. ANDER, A. ESCUDERO. 1998. Relating variation in the understory of beech forests to ecological factors. - *Folia Geobotanica*, 33: 77–86. [DOI].

OLIVA G., D. FERRANTE, P. PAREDES, G. HUMANO. 2016. A conceptual model for changes in floristic diversity under grazing in semi-arid Patagonia using the State and Transition framework. - *Journal of Arid Environments*, 127: 120-127. [DOI].

PERELMAN S., R.J.C. LEON, J.P. BUSSACCA. 1997. Floristic changes related to grazing intensity in a Patagonian shrub steppe. - *Ecography*, 20: 400- 406. [DOI].

POLASKY S., E. NELSON, D. PENNINGTON, K.A. JOHNSON. 2011. The impact of land-use change on ecosystem services, biodiversity and returns to landowners: a case study in the state of Minnesota. - *Environmental and Resource Economics*, 48: 219–242. [DOI]

RAMIREZ N., N. DEZZEO, N. CHACO. 2007. Floristic composition, plant species abundance, and soil properties of montane savannas in the Gran Sabana, Venezuela. - *Flora*, 202: 316–327. [DOI].

SABO K.E., C.H. SIEG, S.C. HART, J.D. BAILEY. 2009. The role of disturbance severity and canopy cover on crop of understory plant species in northern Arizona, USA. - *Forest Ecology and Management*, 257: 1656−1662. [DOI].

SALEHI A., A. MOHAMMADI, A. SAFARI. 2011. Investigation and comparison of physical and chemical soil properties and quantitative characteristics of trees in less-damaged and damaged area of Zagross forests (Case study: Poldokhtar, Lorestan province). - *Iranian Journal of Forest*, 3 (1): 81-89 .

TALAMO A., J.L. DE CASENAVE, S.M. Caziani. 2012. Components of woody plant diversity in semi-arid Chaco forests with heterogeneous land use and disturbance histories. - *Journal of Arid Environments*, 85: 79–85. [DOI].

WALKLEY A., I.A. BLACK. 1934. An examination of the Degtjareff method for deter-mining soil organic matter, and a proposed modification of the chromic acid titration method. - *Soil Sciences*, 37: 29–38.

ZHANG J.T., Y. DONG. 2010. Factors affecting species diversity of plant communities and the restoration process in the loess area of China. - *Ecological Engineering*, 36: 345–350. [DOI].

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