BIODIVERSITAS
Volume 15, Number 2, October 2014
Pages: 147-161

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d150206

Short-term abandonment of human disturbances in Zagros Oak forest ecosystems: Effects on secondary succession of soil seed bank and aboveground vegetation

MEHDI HEYDARI[1,♥], DAVID POTHIER[2], MARZBAN FARAMARZI[1], JAVAD MERZAEI[1]
[1]Department of Forestry and Rangeland Faculty of Agriculture and Natural Resources, Ilam University, Iran. Tel.: +988412227015, Fax.: +988412227015, ♥email: m_heydari23@yahoo.com.
[2]Centre d'étude de la forêt (CEF), and Département des sciences du bois et de la forêt, Pavillon Abitibi-Price, 2405 rue de la Terrasse, Université Laval, Québec, QC G1V 0A6, Canada.

Manuscript received: 13 April 2014. Revision accepted: 13 May 2014.

ABSTRACT

Heydari M, Pothier D, Faramarzi M, Merzaei J. 2014. Short-term abandonment of human disturbances in Zagros Oak forest ecosystems: Effects on secondary succession of soil seed bank and aboveground vegetation. Biodiversitas 15: 147-161. Zagros Oak forests in the west of Iran have been degraded by anthropogenic activities during many years and to fight against this degradation, several management strategies have been implemented. The principal objectives this study were to identify the characteristics of the soil seed bank and the aboveground vegetation that were affected by degradation and short-term abandonment of human disturbances and evaluate the potential of the soil seed bank to restore the degraded types after short-term conservation management. For that, we compared three types of Zagros forest ecosystem with different management regimes: (i) Long term disturbed type as LDT (also used and disturbed at the present), (ii) Short-term abandonment of human disturbances as SAD (5 years without human disturbances) and an undisturbed control or C (iii). We selected three replicates or stands per type. In the aboveground vegetation (ABV), 115, 72 and 51 species were recorded in C, SAD and LDT types, respectively, whereas in the soil seed bank (SSB) flora, 33, 19 and 12 plant taxa were observed in C, SAD and LDT types, respectively. The percentage of annuals increased in ABV and decreased in SSB with increasing site degradation with human activities such as animal husbandry in the forest edges. The percentage of perennial and biennial herbs decreased in ABV and increased in SSB with increasing site degradation. The Shannon index of the SSB decreased with increasing site degradation. The average seed density in the SAD type was significantly larger than that of the LDT type. DCA analysis showed that the seed bank flora of SAD and LDT types were relatively similar and differed from that of the C type. This indicates that a full recovery of degraded type in the oak forest ecosystem in the Zagros region cannot be based only on the soil seed bank present at the beginning of the protection period while a more complete recovery may require a longer period of protection.

Key words: Disturbance, oak forests, secondary succession, soil seed bank, Zagros.

INTRODUCTION

A vast area of the Zagros Mountain ranges, in the west of Iran, is covered by typical vegetation. These semi-arid forests have a major influence on the water supply, soil conservation, climate alteration and socio-economical balance of the entire country. These forests are currently considered as degraded because of firewood production, land-use change (e.g. conversion of forest into agricultural land) and livestock feeding (Sagheb Talebi et al. 2004). The vegetation of Zagros forests includes several rare plant species and many of them (186 species of tree, shrub and herbaceous) are endangered by anthropogenic activities. In addition, human activities can influence a variety of other ecological characteristics including plant richness, diversity and communities (Angermeier and Karr 1994; Ito et al. 2004).

To prevent this degradation, several management strategies, such as traditional management and long-and short-term enclosure, have been implemented in this region (Ghazanfari et al. 2004; Adeli et al. 2008; Bassiri and Iravani 2009; Zandebasiri et al. 2010). In this regard, the identification of characteristics that are directly influenced by degradation and management can provide a useful tool for detecting human activities, adjusting forest management, and improving ecosystem understanding. Floristic studies can form the basis for environmental measures through the determination of regional vegetation potential as well as protection of native vegetation and endangered species (Stace 1989; Ferrari et al. 1993).

Despite the important role of soil seed banks in the composition of different plant communities, and thus in their conservation (Wisheu and Keddy 1991; Wagner et al. 2003), the floristic studies in Zagros forests have only focused on aboveground vegetation (Basiri and Karami 2006; Akbarzadeh et al. 2007; Abasi et al. 2009; Heydari et al. 2009; Arekhi et al. 2010). Indeed, no studies dealing with soil seed banks were conducted in Zagros and, as a consequence, the potential of the lasting seed reserve in the soil for reducing the risk of local extinction of vulnerable species is still unknown (Aparicio and Guisande 1997), especially after site degradation and management. Yet, the composition of the soil seed bank is particularly important for the vegetation communities appearing under different management regimes (Fourie 2008; Hu et al. 2013). While plant community characteristics were observed to change under different management and disturbance histories (Dupouey et al. 2002; Takafumi and Hiura 2009; Tárrega et al. 2009; Beguin et al. 2011), it is likely that soil seed banks changed as well. The dynamics of soil seed banks can thus potentially play an important role in improving ecosystem management (Luzuriaga et al. 2005).

Soil seed banks can be particularly important to evaluate the degree of degradation and the recovery potential of degraded ecosystems (Snyman 2004; Scott et al. 2010) such as that of the sensitive ecosystem of Zagros. Indeed, the characteristics of aboveground vegetation and soil seed bank, as well as traits such as composition, life form, seed density, similarity, and biodiversity, can be affected by site degradation and management (Bekker et al. 1997; Tessema et al. 2012). The floristic characteristics of both the established vegetation and the soil seed bank, and their relationship under different management regimes and degree of degradation has been compared in different regions of the world (López-Mariño et al. 2000; Lindner 2009; Tessema et al. 2012; Martinez et al. 2009). The results of these studies generally indicate that the soil seed bank is a good predictor of future emerging vegetation following disturbances and can thus be used to assess the degree of degradation of affected sites.

The duration of conservation management is another important characteristic to consider in promoting ecosystem recovery after degradation. Because the socio-economic conditions of people living in some regions such as Zagros, who are very dependent on the state of the ecosystem, it is important to pay attention to the link between the duration of conservation management and people activities. The aim of the present study was thus to examine the influence of degradation and short-term conservation management on the floristic composition of both the established vegetation and the soil seed bank. With these results, we will be able to determine which species groups are most represented in each case and thus evaluate the potential of the seed bank in the restoration of the degraded region in Zagros forests after short-term conservation management.

MATERIALS AND METHODS

Site description

This study was carried out in the Zagros forests, west of Iran (Figure 1). Three types of Zagros forest ecosystems with different management regimes were compared: (1) Long term disturbed type as LDT (also used at the present), (2) Short-term abandonment of human disturbances as SAD (5 years without human disturbances) and an undisturbed control or C (3). We selected three replicates or stands per Zagros type (three replicates, stands or sites of each type, nine independent stands in total, the three sites of each management type were not clustered together). The dominant tree species of these forests was oak (*Quercus persica* Jaub. & Spach) which covered more than 90% of the study area. In addition, all types were characterized by the same conditions in terms of physiography (slope, aspect and altitude). These areas are characterized by a flat topography and their elevations range from 1000 to 1250 m (maximum height difference between these types was about 150 meters). Average annual precipitations in the study area are 590 mm while mean annual temperature is 17 °C. According to personal communication with experts and natives as well as to aerial photographs taken in 1965, The land cover of all stands were similar 50 years ago and were covered by similar dense forests. However, since that time, the rapid increase in human population promoted the intensification and the concentration of agriculture in many areas as well as animal husbandry in residual forests of SAD and LDT types. For example, several nomad populations become sedentary and settled on the edges and in the forest of SAD

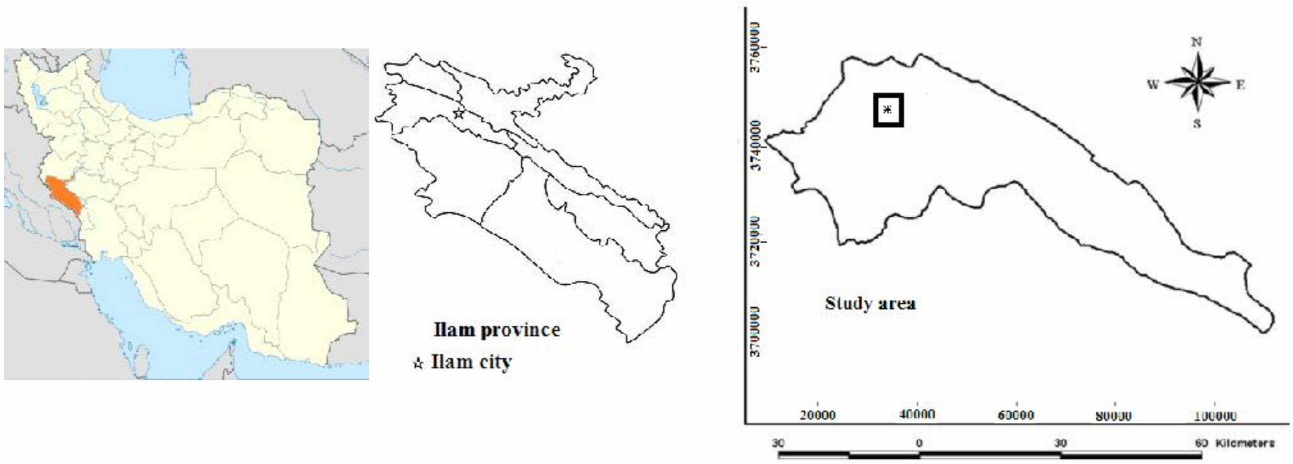

Figure 1. Location of the study site in Ilam city, Ilam province of Iran

and LDT types. Five years ago, the SAD type was protected by the Office of Natural Resources of Ilam city to prevent the entry of livestock, to exclude agriculture and animal husbandry in the forest edges, and to block road access to forests. The LDT type is still not protected and is considered as a damaged area with application of agriculture and animal husbandry. On the other hand, the C type is one of the least disturbed areas in Zagros forests and any disorder has never been recorded. Accordingly, we did not observe signs of degradation in this type during our vegetation sampling.

Above-ground vegetation (ABV) sampling

The releve method of Braun-Blanquet (1932) was used for vegetation sampling (Muller-Dombois and Ellenberg, 1974). Since the objective was not to characterize the Zagros ecosystems exhaustively but to compare them, a similar surface was studied, located in the centre of each stand, using a systematic sampling method. Two perpendicular transects of about 40 m were established in each stand and a quadrate of 1 m^2 was used as sampling unit. Fifteen quadrates were studied in each stand (seven in each transect and one in the centre), the first one randomly placed during the peak period of vegetation cover, i.e. during June 2012. All the species present in each quadrate were recorded, quantifying their abundance as a cover percentage (visually estimated always by the same researchers, so that the bias, if it exists, is similar in all the stands). Cover values higher than 100% were due to species superposition (Tárrega et al. 2009).

Plant samples were collected in June 2012 and were identified using the available literature (Parsa 1943-1950; Ghahreman 1975-2000; Masoumiramak 1986-2000), and deposited in the herbarium of the Faculty of Forestry of the University of Ilam, Iran. The life forms were recognized based on Raunkiaer's classification (Raunkiaer 1934). The phytocorya distribution of plants was made according to Zohary (1973) and Takhtajan (1986).

Soil seed bank (SSB) sampling

Three soil samples for seed bank (randomly collected within each sample plot each with the dimensions of 400 cm^2 (20×20) and a depth of 5 cm) analysis were collected from the same sampling areas as those of the plots used for above-ground vegetation. Sampling was carried out in early spring 2012, i.e. after the end of the germination period but before the dispersion of new seeds for most species. The litter layer was included in the soil samples because this layer may contain a high number of seeds (Leckie et al. 2000). Each sample was separated into two collection bags, the organic LFH (litter-fibric-humic) material and the mineral soil, and was then stored fresh in a refrigerator, in the dark at 3-4°C for three months to cold stratify the seeds.

The soil samples were passed through a 4-mm sieve to exclude coarse stones and plant fragments, and excluded material was inspected visually for large seeds and fruits. A known volume of sieved sample soil was spread as a 5-cm deep layer overlying sterilized coarse sand in 40 × 20 cm germination trays. Leaf litter was shaken and the seeds present were added to the soil samples (Leckie et al. 2000). Forty five seed trays (for each type and totally 140) containing only sterilized sand were placed among the sample trays to test for contamination by local seeds. In the course of the germination test, no seedlings were found in these control trays. The germination trays were placed in a greenhouse at 20-25 °C where they were submitted to natural light conditions and were regularly watered with tap water from above with a fine spray. Emerging seedlings were identified, counted and removed or replanted (and grown) for later identification. Soil samples were maintained and checked weekly for emerging seedlings for approximately 1 year, since a shorter period of study could result in an underestimation of the persistent seed bank (Baskin and Baskin 1998). For each plot, the species composition and mean density (number of seeds/m^2) were determined.

Biodiversity computation

For each plot, species richness, diversity and evenness in the above ground vegetation and in the soil seed bank were determined using Magurran (Equation 1), Shannon (Equation 2), and Pielou indices (Equation 3) (Ludwig and Reynolds 1988; Kent and Coker 1994). As proposed by Magurran (1988), the total number of species was used as a richness index since it is considered to be one of the best indices of species richness (Kent and Cooker 1994). Diversity and evenness indices of the soil seed bank were based on species abundance (density). However, in the case of aboveground vegetation, these indices were based on species cover.

Magurran species richness: $D=S$ .... [1]

Shanon diversity index: $H' = -\sum_{i=1}^{S} pi \ln pi$ .... [2]

Pielou evenness index: $E = H'/\ln S$ .... [3]

Where $pi= Ni/N$, is the number of individuals of species *i, N* is total number of individuals of all species present, and *S* is the number of species present.

Data analyses

The total number of seedlings germinating per tray was summed for each plot and used for data analyses. Seedling totals were expressed as seed density per m^2. Biodiversity indices computed from the seed bank and the above-ground vegetation samples of the three types were compared using ANOVA and Duncan's multiple comparison test (Diaz-Villa et al. 2003; Leicht-Young et al. 2009). Residuals were examined by Levene and Kolmogorov-Smirnov tests to verify that the assumption of homogeneity of variance and normality, respectively, was met for both the soil seed bank and vegetation data.

To determine the characteristic genera of each stand or type, we used a cluster analysis with the indicator method of Dufrene and Legendre (1997). This method calculates an indicator value (IV) for each genus in predefined clusters (like the clusters identified by a cluster analysis). It is especially suited for identifying indicator taxa independently of the plant community as a whole (Dufrene and Legendre 1997; McGeoch and Chown 1998). This method gives an integrated measure of the relative mean abundance and the relative frequency of the studied genera in each cluster and is calculated as follows:

$$A_{ij} = N_{\text{individuals},ij} / N_{\text{individuals},i}$$
$$B_{ij} = N_{\text{locations},ij} / N_{\text{locations},j}$$
$$\text{IV}_{ij} = A_{ij} \times B_{ij} \times 100\% \quad [4]$$

Where A_{ij} (relative mean abundance) is the mean number of individuals of genus *i* in cluster *j* divided by the mean number of individuals of genus *i* in cluster *j* plus the mean number of individuals of genus *i* outside cluster *j*; B_{ij} (relative frequency) is the number of locations in cluster *j* where genus *i* is present divided by the total number of locations in cluster *j*; IV_{ij} is the relative mean abundance of genus *i* in cluster *j* multiplied by the relative frequency of genus *i* in cluster *j* multiplied by 100%. Genera that are weakly associated with a cluster because they are either not abundant or not present in all the locations within that cluster will score a low IV. Only genera that have both a high mean abundance and are present in the majority of locations of a cluster will score a high IV for that particular cluster. IV values can vary between 0 and 100%, with 0% indicating no association with a cluster, while 100% indicates that the genus was found in all locations of that particular cluster, and was absent in all other locations outside that cluster. To test whether the observed IV of a genus in a cluster was significantly higher than could be expected based on a random distribution of individuals over the locations, the observed IV was compared with 999 randomly generated IV values. These random IV values were generated with a random reallocation procedure within which the number of individuals per genus per location was randomly reshuffled over the locations (Dufrene and Legendre 1997). If the observed IV of a genus in a cluster fell within the top 5% of the random IV values (sorted in decreasing order), it was considered to deviate significantly from the expected random mean, i.e. the genus had a significantly higher IV than expected.

The similarity of the seed bank flora to the above-ground flora was determined by calculating Jaccard's similarity coefficient (IJ_S) between paired sample plots for which both seed bank and aboveground species presence/absence data were available:

$$IJ_S = [2C/(2C + A + B)] \quad [5]$$

Where, *C* refers to the number of species common to both the seed bank and the aboveground vegetation, *A* and *B* represent total number of species detected in the seed bank and the corresponding above-ground vegetation, respectively (Kent and Coker 1994). Compared with several other similar indices, Jaccard's coefficient is robust and unbiased even at small sample sizes (Ludwig and Reynolds 1988). The differences in similarity between seed bank and aboveground species among the three types were also investigated using ANOVA.

To compare the composition and abundance of species in the aboveground vegetation and in the soil seed bank, a multivariate ordination was conducted using Detrended Correspondence Analysis (DCA) (Hill and Gauch 1980). DCA was used to examine the variation in the plant species composition and was applied to the species relative abundance data. The relative abundance of species in the seed bank and the aboveground vegetation was calculated as the number of seedlings (or abundance) of one species divided by the total number of emerged seedlings (or total abundance) of all species per quadrate. Prior to analysis, seed bank density data and original cover value of vegetation data were separately adjusted by maximum value modification to prevent any bias from the species with high values (i.e. seed bank density or cover value). By this adjustment, seed bank densities and cover percentages were transformed to values in the range of 0 to 1 (McCune and Mefford 1999). To avoid artifacts arising through under-sampling of less frequent taxa in the seed bank, only taxa that were found in three or more plots were included in the DCA analysis. Rare species were down weighted to reduce distortion of the analysis. Following this procedure, sample plots were ordinated to obtain the pattern of variation in the aboveground vegetation and seed bank. For ordination of the soil seed bank and aboveground vegetation data, CANOCO 4.5 was used (ter Braak and Smilauer 1998). Yates-corrected $\chi 2$ test was performed to compare seed bank floristic composition with the standing vegetation (Arriaga and Mercado 2004).

RESULTS AND DISCUSSION

Aboveground vegetation characteristics

Flora

The aboveground vegetation was composed of a total of 115, 72 and 51 species, belonging to 80, 52 and 38 genera and 26, 21 and 16 families in C, SAD and LDT types, respectively. Compositae (12, 17 and 18 species in C, SAD and LDT types, respectively) was the most frequently observed family whereas *Centaurea* (6 species), Centaurea (6 species) and Euphorbia (5 species) were the most frequently observed genus in C, SAD and LDT types, respectively (Table 1, Figure 2).

Life forms and growth forms of ABV

Hemicryptophytes and therophytes were the dominant life form in all types. The life form spectrum of plant species was as follow: Hemichryptophyte 46% and therophyte 37% in C type, hemichryptophyte 49% and therophyte 35% in SAD type, and hemichryptophyte 41% and therophyte 41% in LDT type (Figure 3). Of the 115 species in C type, 47% were perennial forbs, 35% were annual forbs, and 5% were biennial forbs. There was 47%, 33% and 5% of perennial forbs, annual forbs and biennial forbs in SAD type. Of the 51 species in LDT type, 37% were perennial forbs, 38% were annual forbs, and 8% were biennial forbs. In other words, forbs were the largest group in all types. Annual grasses in LDT type were 2 to 3 times more numerous than in C and SAD types. The proportion of perennial forbs tended to decrease with increasing site degradation, i.e. from C to SAD to LDT types (Figure 4).

Table 1. Floristic composition, life-forms, growth forms and Phytogeography of soil seed bank and above-ground vegetation of three types

Species	LDT		SAD		C		Phytogeography	Llife form	Growth form	Family
	Aboveground	Seed bank	Aboveground	Seed bank	Aboveground	Seed bank				
Acantholimon bromoifolium Boiss.			*		*		IT	He	P-Forb	Plumbaginaceae
Achillea aleppica DC. var. *aleppica*	*				*		IT	He	P-Forb	Compositae
Alcea kurdica (Schlesht). Alef					*		IT	He	P-Forb	Malvaceae
Allium affine Ledeb.			*		*		IT	Ge	P-Forb	Liliaceae
Allium stamineum Boiss.	*				*		IT	Cr	P-Forb	Liliaceae
Amygdalus inflata Spach					*		IT	Ph	Shrub	Rosaceae
Anemone biflora DC.			*		*		IT	Ge	P-Forb	Ranunculaceae
Aristolochia olivieri Collegno in Boiss.	*		*		*		IT	He	P-Forb	Aristolochiaceae
Artemisia vulgaris L.	*				*		IT	Ph	P-Forb	Compositae
Asperula glomerata (M. B.) Griseb.					*		IT	Th	P-Forb	Rubiaceae
Astragalus (*Incani*) *abnormalis* (Rech. f.)			*		*		IT	He	P-Forb	Papilionaceae
Astragalus (Leucocercis) curviflorus Boiss.			*		*		IT	He	P-Forb	Papilionaceae
Astragalus (Hymenostegia) ferruminatus Maassoumi			*		*		IT	Ch	P-Forb	Papilionaceae
Astragalus (Alopecuroidei) kurdaicus Boiss. & Noe					*		IT	He	P-Forb	Papilionaceae
Astragalus ovinus Boiss.					*		IT	He	P-Forb	Papilionaceae
Asyneuma cichoriiforme (Boiss.) Bornm.	*		*		*		IT	He	B-Forb	Campanulaceae
Bongardia chrysogonum L.					*		M, IT	Ge	A-Forb	Podophyllaceae
Bromus danthoniae Trin.	*	*	*		*	*	Cosm	Th	P-Grass	Gramineae
Bromus sterilis L.	*		*			*	IT, ES	Th	A-Grass	Gramineae
Bromus tectorum L.	*		*		*	*	Cosm	Th	A-Grass	Gramineae
Bromus tomentellus Boiss.		*	*	*	*	*	IT	He	P-Grass	Gramineae
Callipeltis cucullaria (L.) Stev.			*		*		IT, SS	Th	A-Forb	Rosaceae
Cannabis sativa L.					*		Cosm	Th	A-Forb	Canabaceae
Capsella bursa-pastoris (L.) Medicus	*		*				Cosm	He	A-Forb	Cruciferae
Onopordum carduchorum Bornm. & Beauv	*		*				IT	Ch	B-Forb	Compositae
Cardaria draba (L.) Desv.	*		*				M	He	A-Forb	Cruciferae
Carthamus oxyacantha M. B.				*	*		IT, SS/M	Th	A-Forb	Compositae.
Carthamus glaucus L. subsp. *glaucus*	*		*		*	*	IT	Th	A-Forb	Compositae
Centaurea behen L.	*		*		*		M/IT	He	P-Forb	Compositae
Centaurea bruguierana (DC.) Hand-Mzt.	*		*		*	*	IT	He	A-Forb	Compositae
Centaurea iberica Trev. ex. Spreng.				*	*		IT,M	He	A-Forb	Compositae
Centaurea koeieana Bornm.					*		IT	He	P-Forb	Compositae
Centaurea virgata Lam. Subsp. *squarrosa* (Willd.) Gugler					*		IT	He	P-Forb	Compositae
Centaurea intricata Boiss. Subsp. *kermanshensis* Wagenitz					*		IT	He	P-Forb	Compositae
Cephalaria dichaetophora Boiss.	*	*	*	*	*	*	Es	Th	A-Forb	Dipsaceae
Cerastium inflatum Link ex Desf.					*		IT	Th	A-Forb	Caryophyllaceae
Chardinia orientalis (L.) O. Kuntze				*	*	*	IT	Th	A-Forb	Compositae
Chenopodium album L.					*		Cosm	Th	A-Forb	Chenopodiaceae
Chenopodium botrys L.					*	*	IT	Th	A-Forb	Chenopodiaceae
Cichorium pumilum Jacq.	*	*		*			IT, ES, M	He	A-Forb	Compositae
Cirsium congestum Fisch. & C. A. Mey. ex. DC.	*		*				ES	Ge	P-Forb	Compositae
Cirsium spectabile DC.	*		*		*		IT	Ge	P-Forb	Compositae
Conyza canadensis (L.) Cronq.	*		*				IT	Th	A-Forb	Compositae
Conyzanthus squamatus (Spreng.) Tamamsch.	*	*		*			IT, ES, SS	He	P-Forb	Compositae
Convolvulus betonicifolius Mill.	*		*				IT	He	P-Forb	Convolvulaceae
Coronilla scorpioides (L.) W.D.J. Koch			*		*		IT	He	A-Forb	Papilionaceae
Cousinia stenocephala Boiss.	*		*		*		IT	He	P-Forb	Compositae
Cousinia cylindracea Boiss.	*		*	*	*		IT	He	P-Forb	Compositae
Cousinia jacobsii Rech. F.					*		IT	Th	B-Forb	Compositae
Cousinia pichleriana Bornm. Ex Rech. F.	*		*				Cosm	Th	A-Forb	Compositae
Crataegus pontica C. Koch			*		*	*	Cosm	Ph	Tree	Resedaceae
Crepis kotschyana (Boiss.) Boiss.					*		IT	Th	A-Forb	Compositae
Dianthus macranthoides Hausskn. ex Bornm.			*		*		IT-ES	He	P-Forb	Caryophyllaceae
Dianthus strictus Banks & Soland. var. *strictus*					*	*	IT	He	P-Forb	Caryophyllaceae
Echinochloa crus-galli (L.) P. Beauv.	*				*	*	PL	Th	A-Grass	Gramineae
Echinops mosulensis Rech. F.					*	*	IT	He	A-Forb	Compositae
Eremostachys macrophylla Montbr. & Auch.			*		*		IT	He	P-Forb	Labiatae
Eryngium billardieri F. Delaroche					*		IT	He	P-Forb	Umbelliferae
Eryngium noeanum Boiss.			*		*		IT	He	P-Forb	Umbelliferae
Euphorbia macrostegia Boiss.	*		*		*		IT	He	P-Forb	Euphorbiaceae
Euphorbia petiolata Banks & Soland.	*		*		*	*	IT,M	Th	A-Forb	Euphorbiaceae
Euphorbia aleppica L.	*		*		*		IT	Th	A-Forb	Euphorbiaceae

Euphorbia denticulata Lam. .	*		*		*		IT	He	P-Forb	Euphorbiaceae
Euphorbia macroclada Bioss.	*		*		*		IT	He	P-Forb	Euphorbiaceae
Ferulago angulata (Schlecht.) Subsp. *cardochorum* (Boiss. & Hausskn.)			*		*		IT	He	P-Forb	Umbelliferae
Ferulago macrocarpa (Fenzl) Boiss.			*		*		IT	He	P-Forb	Umbelliferae
Galium aparine L.					*		PL	Th	A-Forb	Rosaceae
Gladiolus segetum Ker-Gawl.					*		IT	Ge	P-Forb	Irideaceae
Glycyrrhiza glabra L.	*						IT	Ch	P-Forb	Papilionaceae
Gundelia tournefortii L.	*		*			*	IT	He	A-Forb	Compositae
Gypsophila pallida Stapf var. *pallida*			*		*		IT	He	P-Forb	Caryophyllaceae
Hedysarum wrightianum Aitch. & Baker					*		IT	Th	A-Forb	Papilionaceae
Helianthemum salicifolium (L.) Miller		*			*	*	IT-ES	Ch	P-Forb	Cistaceae
Heliotropium denticulatum Boiss. & Hausskn				*	*		IT	Ch	A-Forb	Boraginaceae
Heliotropium europaeum L.					*		IT,ES	Th	A-Forb	Boraginaceae
Heliotropium noeanum Boiss	*				*		IT	Th	A-Forb	Boraginaceae
Heteranthelium piliferum (Banks & Soland.) Hochst			*	*	*	*	IT,ES	Th	P-Grass	Gramineae
Hordeum bulbosum L.	*				*		IT,M,ES	Cr	P-Grass	Gramineae
Hordeum spontaneum C. Koch	*		*		*		IT,M	Th	A-Grass	Gramineae
Hypericum helianthemoides (Spach) Boiss.			*		*		IT	He	P-Forb	Hypericaceae
Lactuca serriola L.					*		IT,ES	He	B-Forb	Compositae
Malabaila porphyrodiscus Stapf & Wwttst.					*			He	P-Forb	Umbelliferae
Marrubium vulgare L.			*		*		IT, M	He	P-Forb	Labiatae
Marrubium cuneatum Russel					*		IT	He	P-Forb	Labiatae
Medicago rigidula (L.) All	*				*	*	IT	PL	A-Forb	Papilionaceae
Medicago polymorpha L.		*	*		*	*	IT,M	Th	A-Forb	Papilionaceae
Medicago radiata L.		*	*	*	*	*	M,IT	Th	A-Forb	Papilionaceae
Mindium laevigatum (Vent.) Rech. f. & Schiman-Czeika				*	*	*	IT	He	P-Forb	Campanulaceae
Muscari tenuiflorum Tausch				*	*		IT	Ge	P-Forb	Liliaceae
Nigella oxypetala Boiss.					*	*	IT	He	A-Forb	Ranunculaceae
Noaea mucronata (Forssk.) Aschers. et Schweinf.			*	*	*		IT	Ch	P-Forb	Chenopodiaceae
Onosma hebebulbum DC.			*		*		IT	He	P-Forb	Boraginaceae
Onosma microspermum Stev	*		*		*		IT	He	P-Forb	Boraginaceae
Onosma sericeum Willd.			*		*		IT	He	P-Forb	Boraginaceae
Ornithogalum brachystachys C. Koch			*		*		IT,M	Cr	P-Forb	Liliaceae
Onobrychis haussknechtii Boiss.					*		IT	He	P-Forb	Papilionaceae
Papaver dubium L.	*	*			*		IT	Th	A-Forb	Papaveraceae
Phlomis bruguieri Desf.			*		*		IT	He	P-Forb	Labiatae
Phlomis olivieri Benth			*		*		IT	He	P-Forb	Labiatae
Picnomon acarna (L.) Cass.	*		*		*	*	IT,ES	Th	A-Forb	Compositae
Poa bulbosa L.	*		*		*		IT,ES,M,SS	Cr	P-Grass	Gramineae
Prangos uloptera DC.		*	*		*		IT	He	P-Forb	Umbelliferae
Quercus brantii Linddl	*				*	*	IT	Ph	Tree	Fagaceae
Ranunculus arvensis L.			*		*		IT,M	Th	A-Forb	Ranunculaceae
Reseda lutea L.					*		IT,M,ES	He	B-Forb	Resedaceae
Salvia bracteata Banks & Soland				*	*		IT	He	P-Forb	Labiatae
Salvia palaestina Benth.					*		IT	He	P-Forb	Labiatae
Scandix pecten-veneris L.	*		*				IT,SS	Th	A-Forb	Umbelliferae
Senecio vernalis Waldst.& Kit.					*	*	IT,ES,M	Th	A-Forb	Compositae
Silene chlorifolia Sm.	*		*		*		IT-ES	He	P-Forb	Caryophyllaceae
Silene longipetala Vent.	*		*		*	*	IT	He	B-Forb	Caryophyllaceae
Smyrniopsis aucheri Boiss.			*		*		IT	He	P-Forb	Umbelliferae
Stachys inflata Benth.			*		*		IT	Ch	P-Forb	Labiatae
Stachys kurdica Boiss. & Hohen.	*		*		*		IT	He	P-Forb	Labiatae
Taeniatherum crinitum (Schreb.) Nevski	*	*			*		M,IT	Th	A-Grass	Gramineae
Taraxacum montanum (C.A. Mey) DC.			*	*	*		IT	He	P-Forb	Compositae
Teucrium polium L.			*		*	*	IT,M	He	P-Forb	Labiatae
Torilis tenella (Delile) Reichenb.	*				*		IT,M	Th	A-Forb	Umbelliferae
Torilis leptophylla (L.) Reichenb.	*		*	*			IT,M	Th	A-Forb	Umbelliferae
Trifolium echinatum M. B.			*		*	*	IT	Th	A-Forb	Papilionaceae
Trifolium scabrum L.			*		*	*	IT	Th	A-Forb	Papilionaceae
Trifolium purpureum Loisel. var. *purpureum*		*			*		IT	Th	A-Forb	Papilionaceae
Trigonella elliptica Boiss.			*		*	*	IT	Th	A-Forb	Papilionaceae
Tulipa montana Lindl.					*		IT,M	Cr	P-Forb	Liliaceae
Turgenia latifolia (L.) Hoffm.					*	*	IT,ES,M	Th	A-Forb	Umbelliferae
Tragopogon longirostris Bisch.	*			*			IT	He	B-Forb	Compositae
Urospermum picroides (L.) Desf.	*		*		*		M,IT	Th	A-Forb	Compositae
Vaccaria grandiflora (Fisch. & DC.) Jaub. & Spach	*						IT	Th	A-Forb	Caryophyllaceae
Velezia rigida L.			*		*	*	IT	Th	A-Forb	Caryophyllaceae
Vicia peregrine L						*	IT-M	Th	A-Forb	Papilionaceae
Zoegea leptaurea L.			*		*		IT	Tr	A-Forb	Compositae

Note: IT: Irano-Turanian, M=Meditrrranean, Es=Euro-Siberian, SS=Saharo-Sindian, COSM=Cosmupolite, Th=Therophyte, He= Hemi-cryptophyte, Cr=Cryptophyte, Ch=Chamaephyte, Ph=Phanerophyte, A=Annual, B=Biennial, P=Perennial, F=Forb, G=Grass. *: Presence

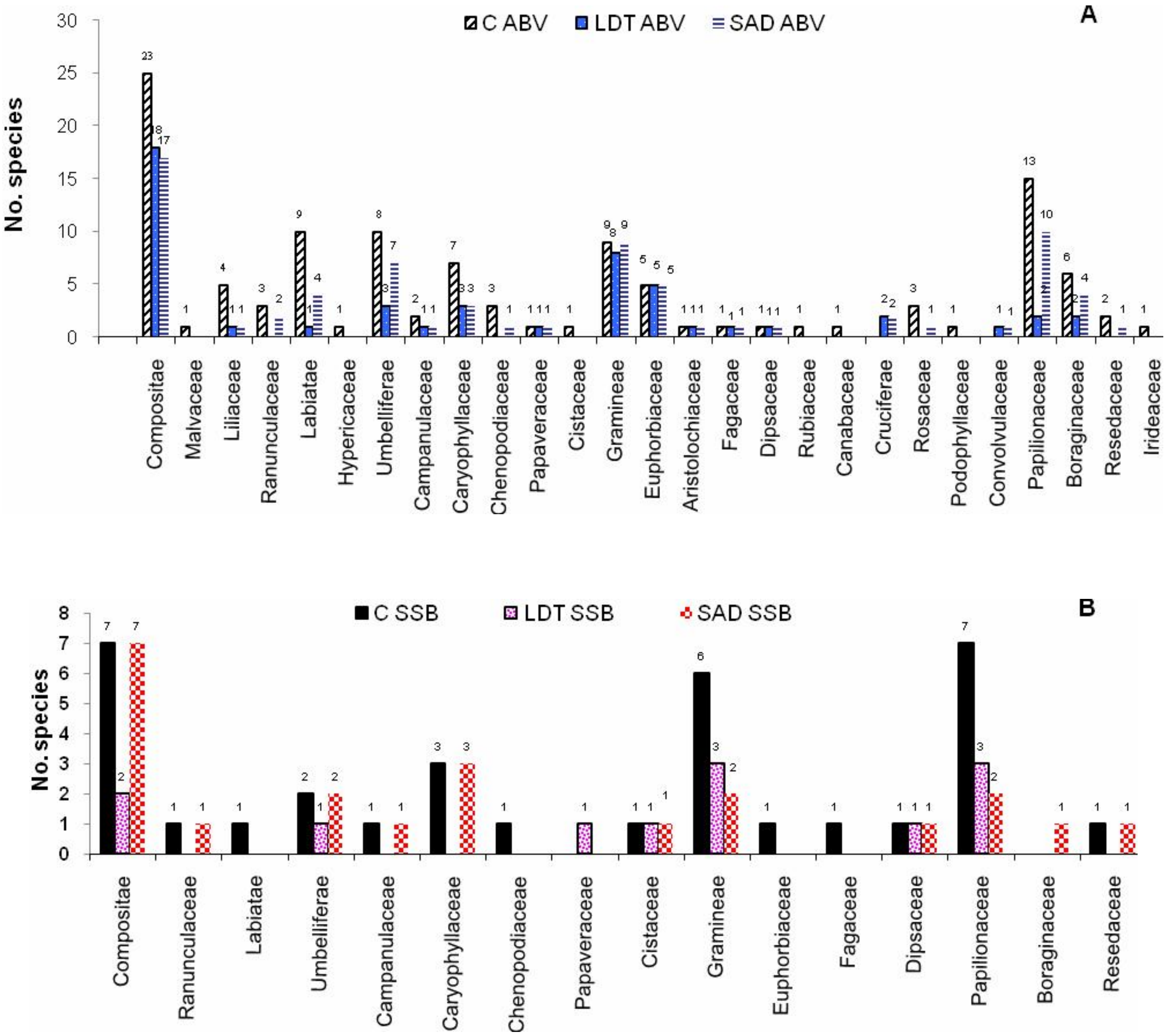

Figure 2. The percentage number of species in each plant family in ABV (A) and SSB (B) types.

Phytogeography of ABV

The Phytogeographical elements in C type included: Irano-Turanian (70%), Irano-Turanian/Mediterranean (13%), Irano-Turanian/Euro-Siberian (6.8%) and Cosmopolitan (4%) (Figure 4). Irano-Turanian (65%), Irano-Turanian/ Mediterranean (9%), Irano-Turanian/Euro-Siberian (3.9%) and Cosmopolitan (8%) were the dominant Phytogeographical elements in SAD type while the phytogeographical elements of the LDT type were dominated by Irano-Turanian (53%), Irano-Turanian/Mediterranean (9%), Irano-Turanian/Euro-Siberian (6%) and Cosmopolitan (11%). Hence, the Irano-Turanian and Irano-Turanian/Mediterranean were the dominant phytogeographical elements in all three types. However, the percentage of Irano-Turanian decreased from C to SAD and then to LDT types. Conversely, the proportion of Cosmopolitan and Pluriregional increased with increasing site degradation, i.e. from C to SAD to LDT types (Figure 5).

Soil seed bank characteristics

Flora

The soil seed bank flora comprised 33, 19 and 12 plant taxa belonging to 25, 18 and 9 genera, and 14, 11 and 11 families in C, SAD and LDT types, respectively. In C type, the most frequently observed species were in the following families: Papilionaceae (7 species, 20%), Compositae (7 species, 20%) and Gramineae (6 species, 17%). *Bromus* and *Trigonella*, with 12 and 9% of the total number of species, were the largest genus in this type. In the SAD type, Compositae (6 species, 30%) and *Medicago* (11%), were the most frequently observed family and genus, respectively. Compositae (3; 30%) and Papilionaceae (3 species; 30%) were also the dominant families in the LDT type. *Medicago* and *Bromus* (16.7% each) had the highest abundance in this type (Table 1, Figure 2).

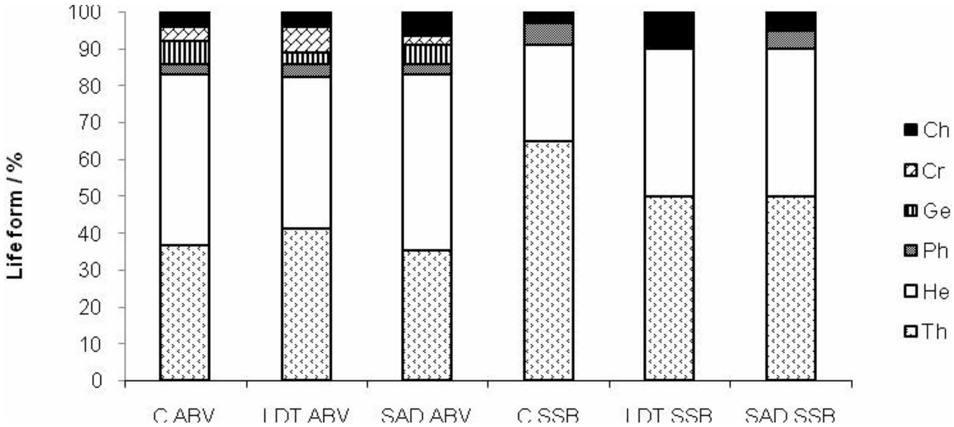

Figure 3. The life form spectrum of plant species for aboveground vegetation and soil seed bank in (C), (SAD) and (LDT) types. Th: Therophytes, He: Hemicryptophytes, Ph: phanerophytes, Ge: Geophytes, Ch: Chamephytes and Cr: Cryptophytes.

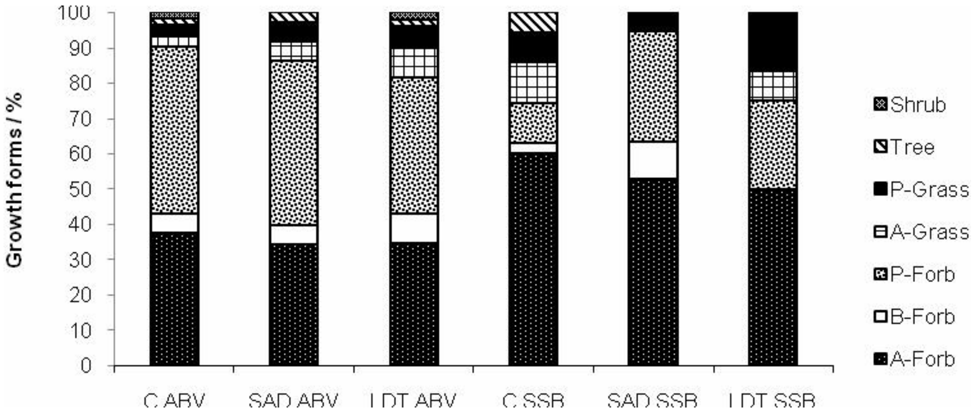

Figure 4. Percentage number of species in vegetation and soil seed bank (0-10 cm) for different types according to growth forms (P: perennial A: annual and B: biennial).

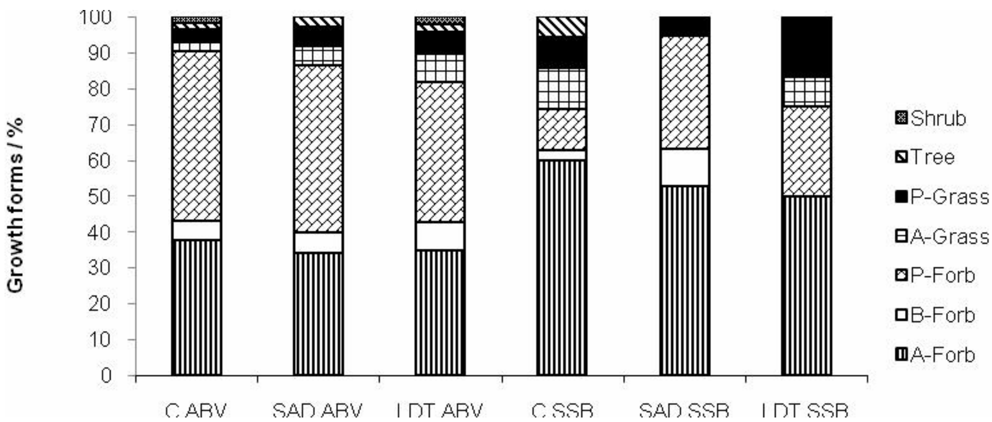

Figure 5. Phytogeographical elements in this region. IT = Irano-Turanian, M= Meditrrranean, Es= Euro-Siberian, SS = Saharo-Sindian, Cosm= Cosmupolite, PL= Pluriregional.

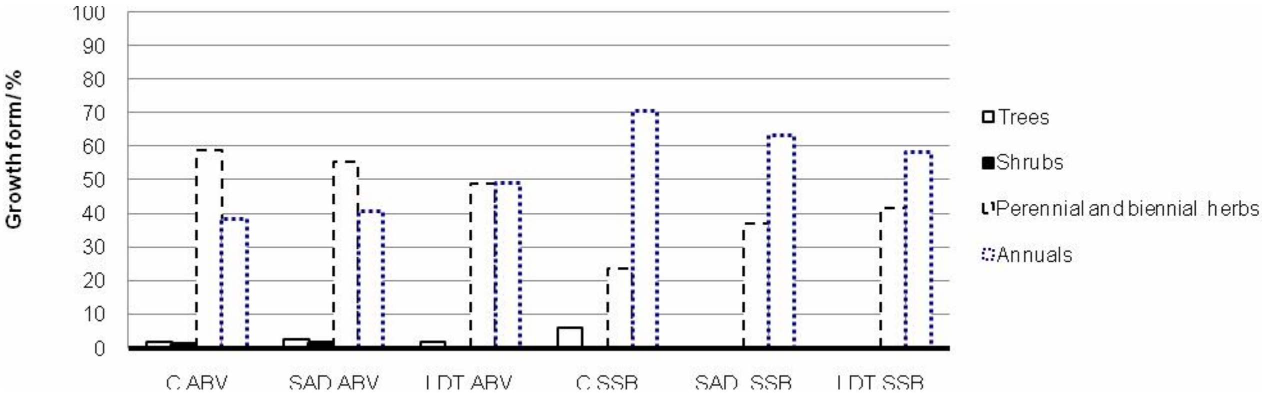

Figure 6. Percentage of species belonging to different life forms in aboveground vegetation and soil seed bank

Life forms and growth forms of SSB

Therophyte was the dominant life form of plant species in the soil seed bank of all the studied sites. The proportions of the principal life form of plant species in C, SAD and LDT types, respectively, were 65%, 50%, and 50% for therophyte and 26%, 40%, and 40% for hemichryptophyte. Contrary to therophytes, the occurrence of hemichryptophytes was higher in LDT type than in other types. Camephytes also increased from C to LDT types (Figure 3). As for the growth forms of the 34 species in C type, 60% were annual forbs, 11% were perennial forbs, and 11% were annual grasses. There were 50% and 30% of annual forbs and perennial forbs, respectively, in the SAD type. Also, of the 12 species in the LDT type, 50% were annual forbs, 25% were perennial forbs, and 16% were perennial grasses. The C type had more annual forbs than the two other types. However, the proportion of perennial forbs was higher in the soil seed bank flora of SAD and LDT types as compared to the C type. Perennial grasses increased in LDT type in compared with C and SAD types. Grasses in LDT type were less than C type (Figure 4).

Phytogeography of SSB

The phytogeographical elements in C type included Irano-Turanian (53%), Irano-Turanian/Mediterranean (15%), and cosmopolitan (9%) while Irano-Turanian (36%), Irano-Turanian/Mediterranean (30%), Irano-Turanian/ Euro-Siberian (11%) and Irano-Turanian/Euro-Siberian/Sahara-Sindian (11%) were dominant phytogeographical elements in the SAD type. In the C type, Irano-Turanian (32%), Irano-Turanian/Mediterranean (18%), Irano-Turanian/ Euro-Siberian/Sahara-Sindian (15%), Irano-Turanian/Euro-Siberian/Mediterranean (15%) and Cosmopolitan (7%) were the dominant phytogeographical elements. Overall, the Irano-Turanian and the Irano-Turanian/Mediterranean were the dominant phytogeographical elements. The Irano-Turanian elements in soil seed bank decreased from C to SAD and to LDT type. The proportion of Cosmopolitan was higher in C than in LDT site. Sahara-Sindian elements were only present in SAD and LDT types, with a highest percentage in C type (Figure 5).

Table 2. Number of species belonging to different growth forms recorded in the types. Stand diversity is the cumulative richness of the above ground vegetation and the soil seed bank.

Life form	C ABV	C SSB	SAD ABV	SAD SSB	LDT ABV	LDT SSB
Trees	2 (1.7%)	2 (5.88%)	2 (2.7%)	0	1 (1.96%)	0
Shrubs	1 (0.85%)	0	1 (1.35%)	0	0	0
Perennial and biennial herbs	69 (58.9%)	8 (23.5%)	41 (55.4%)	7 (36.84%)	25 (49.01%)	5 (41.66%)
Annuals	43 (38.46%)	23 (70.5%)	28 (40.5%)	12 (63.15%)	25 (49.01%)	7 (58.33%)
Vegetation diversity	115	33	72	19	51	12
Site diversity (ABV+SSB)	148		91		63	

Table 3. Means ± SE of plant biodiversity indexes and average seed density of the different types.

Diversity indexes and seed density	Seed bank & vegetation	Sites			F	Sig.
		LDT	SAD	C		
Magurran richness	Seed bank	2.11 ±0.11 [c]	7.14 ±0.19 [b]	16.17 ±0.23 [a]	320	<0.01
	Vegetation	16.11 ±0.42[c]	24.12 ±0.73[b]	39.43±.2.13[a]	125	<0.01
Pielou evenness	Seed bank	0.61 ±0.002 [b]	0.89 ±0.001 [a]	0.87 ±0.004 [a]	52	<0.01
	Vegetation	0.76 ±0.02[b]	0.73 ±0.003[a]	0.76 ±0.004[a]	4.2	<0.05
Shanon diversity	Seed bank	0.37 ±0.04 [c]	1.46 ±0.04 [b]	2.61 ±0.01 [a]	294	<0.01
	Vegetation	2.41 ±0.03 [b]	2.91 ±0.01 [b]	3.25 ±0.04 [a]	79	<0.01
Seed density		13±.0.95[c]	48.8 ±1.5[b]	196.32 ±4.28[a]	325	<0.01

The proportions of species belonging to different life forms indicate that Perennial and biennial herbs of ABV were more abundant than in the SSB whereas annuals dominated the SSB of all types. The abundances of perennial and biennial herbs in ABV decreased from C to SAD to LDT while the reverse was observed in SSB (Figure 6 and table 2). The survey of site diversity (ABV+SSB) showed that the C type was more diversified than the other two types (Table 2).

As for the annuals, their abundance in ABV decreased with increasing site degradation, i.e. from LDT to C, whereas it increased with increasing site degradation in SSB. In the case of perennial and biennial herbs, their proportion decreased with increasing site degradation in ABV while the reverse was observed in SSB (Figure 6).

Diversity of ABV and SSB

The Shannon diversity was significantly different among types for the soil seed bank and the aboveground vegetation. As indicated by the Magurran (S) richness and the Pielou evenness indices, differences between SSB and ABV were significant for all three types. The post hoc Duncan's test indicated that the species richness in ABV of the C type, with 39 species, was significantly higher than the other types, followed by SAD and LDT types. The C type had the highest species richness in the soil seed bank while that of the SAD type was higher than that of LDT type. The Pielou evenness index was significantly different among sites, with C and SAD types being associated with the highest value in both soil seed bank and aboveground vegetation. The Shannon index of aboveground vegetation in C type was higher than that of the two other types which were statistically similar. On the other hand, the Shannon index of the soil seed bank in the C type was significantly higher than that of the SAD type which, in turn, was significantly higher than that of the LDT type. The mean number of seeds ranged from 13 to 196 per m^2 and differed significantly among types ($F=325$, $P<0.001$). The post hoc Duncan's test showed that the average seed density of C type was significantly higher than that of the SAD type which was significantly higher than that of the LDT type (Table 3).

Important value (IV) in ABV and SSB

In the C type, the highest IV values were associated with *Bromus tectorum* L. and *Medicago radiata* L while the highest IV values in the SAD type were associated with the following species: *Echinops mosulensis* Rech. F, *Conyza canadensis* (L.) Cronq, *Cousinia stenocephala* Boiss*, Undelia tournefortii* L. In the LDT type, the following species produced the highest IV values: *Cirsium congestum* Fisch. & C. A. Mey. ex. DC, *Onopordon carduchorum* Bornm. & Beauv, *Scandix pecten-veneris* L, *Hordeum bulbosum* L. and *Cichorium pumilum* Jacq. In the soil seed bank, the highest IV values in the LDT type were for: *Papaver dubium* L, *Prangos uloptera, Trifolium purpureum* Loisel. var. *purpureum*; in the SAD type: *Gundelia tournefortii* L*, Torilis leptophylla* (L.) Reichenb, *Conyza canadensis* (L.) Cronq*, Conyza canadensis* (L.) Cronq. and *Echinops mosulensis* Rech. F.; and in the C type: *Bromus tectorum* L. and *Medicago radiata* L.

Relationship between seed bank and vegetation

The Jaccard's similarity coefficients between the aboveground vegetation and the soil seed bank were 0.25, 0.08 and 0.089 in C, SAD and LDT, respectively, based on presence/absence data. These coefficients were different among the three types with significantly higher coefficient value associated with the C type while the SAD and LDT types were statistically similar (Table 4).

For the entire ABV flora, 29 species were common to the three types. These species are recognized to be resistant to site degradation, such as: *Aristolochia olivieri* Collegno in Boiss, *Asyneuma cichoriiforme* (Boiss.) Bornm., *Bromus danthoniae* Trin., *Bromus tectorum* L, *Torilis tenella* (Delile) Reichenb, *Taeniatherum crinitum* (Schreb.) Nevski, *Silene chlorifolia* Sm., *Silene longipetala* Vent, *Onosma microspermum* Stev. In addition, 30 other species were only common to C and SAD types. These species are thought to be sensitive to site degradation so that they were absent from the LDT type. Some new species, such as *Acantholimon bromoifolium* Boiss, *Allium affine* Ledeb, seem to reappear in the SAD type while they were absent from the LDT type.

Three species were unique to the LDT type (*Cichorium pumilum* Jacq, *Scandix pecten-veneris* L, *Conyzanthus squamatus* (Spreng.) Tamamsch) while 52 were unique to the C type, such as the following: *Chenopodium album* L, *Cerastium inflatum* Link ex Desf, *Chenopodium botrys* L, *Chardinia orientalis* (L.) O. Kuntze, *Centaurea Koeieana* Bornm, *Centaurea virgata* Lam. Subsp. *squarrosa* (Willd.) Gugler, *Centaurea iberica* Trev. ex. Spreng. *Carthamus oxyacantha* M. B, *Cannabis sativa* L, *Asperula glomerata* (M. B.) Griseb.

For the entire SSB flora, five species, resistant to site degradation, were common to the three types: *Medicago Cephalaria dichaetophora* Boiss, *polymorpha* L, *Helianthemum salicifolium* (L.) Miller, *Bromus tomentellus* Boiss, and *Medicago radiata* L. Four of these species were annual forbs and throphytes. Moreover, four other species other species were only common to C and SAD were only common to C and SAD types, *Chardinia* orientalis (L.) O. Kuntze, *Mindium laevigatum* (Vent.) Rech. f. & Schiman-Czeika, *Turgenia latifolia* (L.) Hoffm, *Nigella oxypetala* Boiss. Three species were unique to the LDT type: *Papaver dubium* L, *Prangos uloptera* DC, *Trifolium purpureum* Loisel. var. *purpureum*, and 24 were unique to the C type, such as: *Crataegus pontica* C. Koch, *Chenopodium botrys* L, *Centaurea bruguierana* (DC.) Hand-Mzt, *Carthamus glaucus* L. subsp. *glaucus*, *Bromus tectorum* L, *Bromus sterilis* L, *Teucrium polium* L, *Quercus brantii* Linddl, *Picnomon acarna* (L.) Cass., *Dianthus strictus* Banks & Soland. var. *strictus*, *Echinochloa crus-galli* (L.) P. Beauv, *Echinops mosulensis* Rech. F.

Soil seed bank and aboveground vegetation species were clustered along the two ordination axes of the DCA ordination diagrams. The eigenvalues for the first two DCA axes are, 0.723 and 0.37. The ordination of ABV and SSB flora of the three types were distinct in composition and displayed clear patterns according to the particular conditions of the types (Figure 7). For aboveground vegetation and soil seed bank, the flora of C and SAD types separated along the horizontal axis while the flora of SAD and LDT types separated distinctly from C type along the vertical axis. According to the DCA ordination, the flora of SAD and LDT types seems closer to each other and distinct from the C type. Yates-corrected $\chi 2$ was not significant and accordingly, the presence/absence of plant species in the soil seed bank and in the aboveground vegetation is not related to each other (p>0.01) (Table 5).

Species composition in aboveground vegetation and soil seed bank

In all three types, most of the taxa found in the aboveground vegetation were not present in the soil seed bank. On the other hand, most of the soil seed bank taxa were found in the above-ground vegetation. These results agree with the general observations of low similarity between aboveground vegetation and persistent soil seed bank floras in forest ecosystems (Graham and Hutchings, 1988; Bakker et al. 1996), which suggest that the aboveground vegetation does not necessarily reflect the soil seed bank composition (Olano et al. 2002). This dissimilarity is reported for the first time in the Zagros forest ecosystem where similarity between aboveground and seed bank components was low in all types, and even decreased with increasing site degradation. Indeed, changes in land use may negatively affect natural ecosystems by eliminating many plant species (Steffan-Dewenter and Westphal 2008). However, results from various regions indicated that the similarity between soil seed bank and above-ground vegetation can increase (Bakker and de Vries 1992), decrease (Chaideftou et al. 2009; Tessema et al. 2012) or stay the same (Peco et al. 1998) with increasing site degradation.

Table 4. Jaccard's similarity coefficient in types, between above-ground vegetation and soil seed bank in each type

Sites	Jaccard's similarity coefficient
C ABV/ C SSB	0.25±0.03 [a]
SAD ABV/ SAD SSB	0.08 ±0.002 [b]
LDT ABV/ LDT SSB	0.0.89 ±0.005 [b]
F	96
Sig	0.002**

Note: Values are Mean, (n =45), Different upper-case letters represent difference significant (P < 0.05), * Significant (α= 5%), ** Significant (α=1%) according to Duncan test.

Table 5. Yates-corrected χ^2 test result for comparisons of seed bank composition and above-ground vegetation

Sites	Only seed bank Species richness	Both seed bank and vegetation	Only vegetation species richness	Total richness	Yates corrected χ^2	Nexp	Nobs	Occ. type	P-value
LDT	0	14	119	136	0.002	11	11	0	1
SAD	2	16	112	131	2.89	18	16	-	0.45

Nobs.= Observed frequency of the common occurrences, Nexp. = Expected frequency of the common occurrences, Occ. type=Occurrence type, It is positive (+) if Nobs. < N exp.and it is negative (-) if N obs.> N exp.

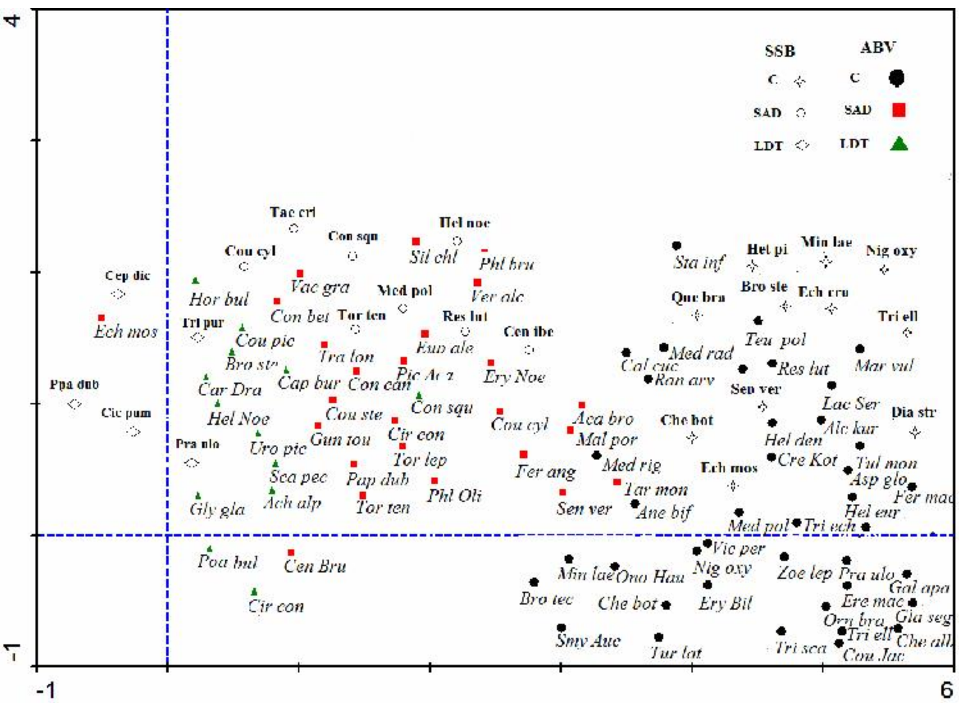

Figure 7. DCA Ordination of the relevés based on relative density of the soil seed bank (a) and relative percentage cover of above ground vegetation (b). The sigens are based on IV.

In the LDT type, many species present in the seed bank were absent from the aboveground vegetation, as in the case of *Bromus tomentellus* Boiss, *Trifolium purpureum* Loisel. var. *purpureum* and *Medicago polymorpha* L. Similarly, Leck and Simpson (1987) found some species in high numbers in the seed bank that had less or no presence in the aboveground vegetation. In the SAD type, species such as *Heliotropium denticulatum* Boiss. & Hausskn, *Salvia bracteata* Banks & Soland, and *Chardinia orientalis* (L.) O. Kuntze, that were only present in the soil seed bank, may have been eliminated from the aboveground vegetation by damaging agents such as grazing (Ghorbani et al. 2008). The negative effect of grazing was also observed in a semi-arid Savanna of Ethiopia (Tessema et al. 2012). Conversely, the elimination of some species in the aboveground vegetation via degradation and unsuitable conditions can cause the loss of soil seed stocks over the long term (Thompson and Grime 1979; Meissner and Facelli 1999). Other reasons explaining low similarity between aboveground vegetation and soil seed bank communities include delayed germination or extended dormancy under stress (Ma et al. 2012), germination requirements, life-cycle pattern, reproductive strategy, and seed dispersal (Warr et al. 1994).

The percentage of perennial species in the soil seed bank composition of the LDT type was higher than that of the aboveground vegetation community whereas this difference was much lower in the case of annuals. Accordingly, the similarity between aboveground vegetation and soil seed bank components was low in temperate grasslands dominated by perennial species (Bakker et al. 1996), but high in communities dominated by annuals, such as many early successional stages and Mediterranean grasslands (Peco et al. 1998; Ferrandis et al. 2001). In our study, the damaging agents that affected the LDT type increased the presence of annual species that are usually observed in arable land and degraded sites (Eloun et al. 2007): *Onopordum carduchorum* Bornm. & Beauv, *Capsella bursa-pastoris* (L.) Medicus, *Cirsium congestum* Fisch. & C. A. Mey. ex. DC, *Conyza canadensis* (L.) Cronq, *Cichorium pumilum* Jacq, and *Heliotropium noeanum*. Increasing annual species after site degradation and the elimination of sensitive species to grazing has also been observed in other environments (Lenzi-Grillini et al. 1996; Mengistu et al. 2005; Anderson and Holte, 1981). The establishment and reproduction capabilities of these species are likely adapted to unstable environments and are thus considered as anthropogenic species (Ghorbani et al. 2003; Eloun et al. 2007).

Hemicryptophytes and therophytes were the dominant life form in all types for both SSB and ABV. These great percentages of hemicryptophytes and therophytes agree with the dominant biological spectrum of the regional climate of Zagros (Zohary 1973). Our results showed that in soil seed banks, the number of hemicryptophytes decreased with increasing degradation whereas the number of therophytes increased. Therophytes generally produce numerous small seeds that are likely less susceptible to damage and their proportion in the soil seed bank remained high even in the degraded site (Najafi tere Shabankareh 2008). Accordingly, the percentage of Therophytes was also high in the aboveground vegetation of the LDT type. Similar increasing presences of therophytes with increasing site degradation were already observed in the flora of Vienna (Jackowiak 1998) and of northern Iran (Ghahreman 2006). However, the use of the occurrence of therophytes as an indicator of the human impact on vegetation communities is limited to sites and ecosystems which include a considerable pool of this life form (Zerbe 1993).

Impact of degradation on species richness and diversity

The effect of site degradation on soil seed bank and aboveground vegetation species richness and diversity has been mainly studied in grasslands and to a lesser extent in forests. In most studies, both soil seed bank and aboveground vegetation species richness and diversity were found to decrease with increasing site degradation (Boutin and Jobin 1998; Kirsten and Scharer 2001; Zechmeister and Moser 2001). Some other studies showed the opposite, i.e. an increase in soil seed bank diversity following the exposure of the site to a destructive agent such as grazing (Malo et al. 2000). Diversity indices can thus be a useful tool to survey the effect of different management practices on floristic diversity (Waldhardt et al. 2003). Our results showed that species richness of the aboveground vegetation and the soil seed bank declined with site degradation, thus agreeing with the general trend. Opposite results from the literature might be due to different degradation intensities, types and duration (Lugo 1997; Chaideftou et al. 2009).

There was no significant difference between LDT and SAD types in terms of aboveground vegetation diversity. Because species diversity is an indicator of sustainable forest management, we could be inclined to conclude that the short-term conservation management was not able to improve the site conditions. Accordingly, Takafumi and Hiura (2009) investigated the effects of disturbance history and environmental factors on the diversity and productivity of understorey vegetation in a cool-temperate forest in Japan and showed that species richness and the Simpson index decreased with increasing disturbance frequency. However, the soil seed bank diversity of the LDT type was lower than both the C and the SAD types, suggesting that aboveground vegetation diversity of the SAD type could exceed that of the type LDT over a longer period of time. On the other hand, the higher diversity and richness in the C type can be related to the high ecological sustainability of the region, especially in terms of soil and access to seeds, because species diversity is considered as one of the most important indices reflecting the sustainability of forest communities (Eshaghi Rad et al. 2009).

Seed density

The number of germinants emerging from a soil seed bank depends on the characteristics of the study sites (Meissner and Facelli 1999). Different factors can slow or stop regeneration establishment in degraded sites such as low soil fertility, soil compaction (Curtis et al. 1993; DeFalco et al. 2009), lack of seed sources or excessive distance from seed sources (Cubiña and Aide 2001), and depleted soil seed banks (Mukhongo et al. 2011). In our case, the soil seed bank density was highest in the C type and lowest in the LDT type. Because soil seed banks partially reflect aboveground vegetation (Ren et al. 2007), the low species richness in the soil seed bank of the LDT type may partly explain the low species richness in the vegetation. Mukhongo et al. (2011) stated that species establishment from persistent seed banks is difficult in degraded areas. Similarly, Tessema et al. (2012) showed that degradation from grazing reduces seed density. Hence, the lower seed density in the LDT type could be explained by soil compaction produced by cattle. The less compacted soil of the C type could allow more seeds to be buried. Accordingly, DeFalco et al. (2009) compared seed banks between two contrasting anthropogenic surface disturbances (compacted and trenched) and adjacent undisturbed controls, and showed that seed bank density significantly increased with decreasing soil compaction.

Soil seed bank and vegetation recovery

The restoration of degraded lands is a topic that is receiving considerable attention in many parts of the world (Montagnini 2001). The soil seed bank can contribute to plant community dynamics following disturbance (Plassmann et al. 2009), but the low species compositional similarity between soil seed bank and aboveground vegetation in type LDT suggests that restoration of degraded sites cannot rely only on soil seed banks (Bossuyt and Honnay 2008). DCA analysis showed that the seed bank flora of SAD and LDT types were relatively similar and differed from that of the C type. This result is supported by the comparison of five pastures representing different management regimes that were clearly separated by an ordination analysis between less and more intensive management (Chocarro et al. 1989). Therefore, it can be argued that the 5-year period during which the SAD type was under protection was not sufficient to approach conditions of the C type. In some areas, short term conservation management was successful in restoring degraded sites but in other cases, even 20 years of protection failed to allow site recovery, likely because of differences in degradation severity (Basiri and Iravani 2009). The rest period has introduced as an important factor to recovery by soil seed bank (Solomon et al. 2006). As for the LDT type, the high number of perennial species found in the soil seed bank might impair the possibilities of recovery as stated by Heydari et al. (2012) in west of Iran that showed after human disturbances the percentage of perennial species in soil seed increased. They emphasized that these species remain in the soil for long periods until suitable conditions be provided. In other word due to degradation the relative balance of species is lost (Based on control site).

CONCLUSION

Various characteristics of aboveground vegetation and soil seed bank such as life form, seed density, richness and diversity have been affected by site degradation. After 5 years of protection, some of these characteristics showed signs of recovery by diminishing their differences relative to the undisturbed type. In addition, the appearance of some species in the SAD type that were absent from the LDT type are promising. However, a full recovery of degraded sites in the oak forest ecosystem in the Zagros region cannot be based only on the soil seed bank present at the beginning of the protection period while a more complete recovery may require a longer period of protection.

REFERENCES

Abasi S, Hosseini SM, Pilevar B, Zare H. 2009. Effects of conservation on woody species diversity in Oshtorankooh region, Lorestan. Iranian J For 1: 1-10.

Adeli K, Jalilvand H, Yakhkeshi A, Fallah A. 2008. Evaluating of forest sustainability affected by tribal forestry (Case study: Shoul Abad-Lorestan, Iran). Iranian J For Poplar Res 1 (16): 23-37.

Akbarzadeh M, Moghadam MR, Jalili A, Jafari M, Arzani H. 2007. Vegetation dynamic study of Kuhrang enclosure. Iranian J Range Desert Res 13 (4): 324-336.

Anderson JE, Holte KE. 1981. Vegetation development over 25 years without grazing on sagebrush-dominated Rrangeland in southeastern Idaho. J Range Manag 34 (1): 25-29.

Angermeier P, Karr J. 1994. Biological integrity versus biological diversity as policy directives: protecting biotic resources. Bioscience 44: 690-697.

Aparicio A, Guisande R. 1997. Replenishment of the endangered *Echinospartum algibicum* (Genisteae, Fabaceae) from the soil seed bank. Biol Conserv 81: 267-273.

Arekhi S, Heydari M, Pourbabaei H. 2010. Vegetation-Environmental Relationships and Ecological Species Groups of the Ilam Oak Forest Landscape, Iran. Caspian J Environ Sci 8 (2): 115-125.

Arriaga L, Mercado C. 2004. Seed bank dynamics and tree-fall gaps in a northwestern Mexican Quercus-Pinus forest. J Veg Sci 15: 661-668.

Bakker JP, de Vries Y. 1992. Germination and early establishment of lower salt-marsh species in grazed and mown salt marsh. J Veg Sci 3: 247-252.

Bakker JP, Poschold P, Strykstra RJ, Bekker RM, Thompson K. 1996. Seed banks and seed dispersal: important topics in restoration ecology. Acta Bot Neerl 45: 461-490.

Basiri R, Karami P. 2006. The use of diversity indices to assess the plant diversity in Mrivan, Chenareh forests. J Agric Sci Nat Res 13 (5): 12-22.

Baskin CC, Baskin JM. 1998. Seeds. Ecology, Biogeography, and Evolution of Dormancy and Germination. Academic Press, San Diego.

Bassiri M, Iravani M. 2009. Vegetation changes in the central Zagros 19 years after experimental enclosure. J Rangeland 2 (3): 155-170.

Beguin J, Pothier D, Côté SD. 2011. Deer browsing and soil disturbance induce cascading effects on plant communities: a multilevel path analysis. Ecol Appl 21(2): 439-451.

Bekker RM, Verweij GL, Smith REN, Reine R, Bakker JP, Schneider S. 1997. Soil seed banks in European grasslands: does land use affect regeneration perspective. J Appl Ecol 34: 1293-1310.

Bossuyt B, Honnay O. 2008. Can the seed bank be used for ecological restoration? An overview of seed bank characteristics in European communities. J Veg Sci 19: 875-884.

Boutin C, Jobin B. 1998. Intensity of agricultural practices and effects on adjacent habitats. Ecol Appl 8 (2): 544-557.

Braun-Blanquet J. 1932. Plant sociology: The study of plant communities. McGraw-Hill, New York.

Chaideftou E, Thanos CA, Bergmeier E, Kallimanis A, Dimopoulos P. 2009. Seed bank composition and above-ground vegetation in response to grazing in sub-Mediterranean oak forests (NW Greece). Plant Ecol 201: 255-265

Chocarro C, Fanlo R, Fillat F, Garc´ıa A, Navascués I. 1989. Comparación entre dos métodos de muestreo en prados de siega en los montes Cantábricos y el Pirineo Central español. Principales resultados. Acta Biol Mont 9: 291-300.

Cubiña A, Aide TM. 2001. The effect of distance from forest edge on seed rain and soil seed bank in a tropical pasture. Biotropica 33 (2): 260-267.

Curtis D, Wright T. 1993. Natural regeneration and grazing management a case study. Aust J Soil Water Conserv 6 (4): 30-34.

DeFalco LA, Esque TC, Kane JM, Nicklas MB. 2009. Seed banks in a degraded desert shrubland: Influence of soil surface condition and harvester ant activity on seed abundance. J Arid Environ 73 (10): 885-893.

Diaz-Villa MD, Maranon T, Arroyo J, Garrido B. 2003. Soil seed bank and floristic diversity in a forest-grassland mosaic in southern Spain. J Veg Sci 14: 701-709.

Dufrene M, Legendre P. 1997. Species assemblages and indicator species: the need for a flexible asymmetrical approach. Ecol Monogr 67: 345-366.

Dupouey JL, Dambrine E, Laffite JD, Moares C. 2002. Irreversible impact of past land use on forest soils and biodiversity. Ecology 83: 2978-2984.

Eloun H, Ghorbani J, Shokri M, Jafarian Z. 2007. Vegetation composition in two Rangelands and adjacent cultivated lands in a Part of Tangab Dam sub basin in Firozabad at Fars Province. J Rangeland 4 (1): 370-385.

Eshaghi Rad J, Manthey M, Mataji A. 2009. Comparison of plant species diversity with different plant communities in deciduous forests. Int J Environ Sci Technol 6 (3): 389-394.

Ferrandis P, Herranz JM, Martı´nez-Sanchez JJ. 2001. Response to fire of a predominantly transient seed bank in a Mediterranean weedy pasture (eastern-central Spain). Ecoscience 8: 211-219.

Ferrari C, Bona Feede F, Alessandrini A. 1993. Rare plants of the Emilia-Romagna Region (Northern Italia): A data bank and computer mapped atlas for conservation purpose. Biol Conserv 64: 11-188

Fourie S. 2008. Composition of the soil seed bank in alien-invaded grassy fynbos: Potential for recovery after clearing, Sout African J Bot Botany 74: 445-453.

Ghahreman A, Naqinezhad AR, Hamzeh B, Attar F, Assadi M. 2006. The flora of Tehreatend Black Alder Forests in the Caspian Lowlands, northern Iran. Rostaniha 7 (1): 5-30.

Ghahreman A. 2000. Colored Flora of Iran 1975-2000. Vol. 1-20, Research Institute of Forests and Rangelands, Tehran, Iran.

Ghazanfari H, Namiranian M, sobhani H, Mohajer RM. 2004. Traditional forest management and its application to encourage public participation for sustainable forest management in the northern Zagros Mountains of Kurdistan province, Iran. Scandinavian J For Res 4: 65-71.

Ghorbani J, Das PM, Das AB, Hughes JM, McAllister HA, Pallai SK, Pakeman RJ, Marrs RH, MG. 2003. Effect of Restoration Treatments on the Diaspore Bank Under Dense pteridiumStands in the UK. Appl Veg Sci 6: 189-198.

Ghorbani J, Eloun H, Shokri M, Jafaryan Z. 2008. Species composition of standing vegetationand soil seed bank in a scrubland and shrubland. Rangeland 2 (3): 264-276.

Graham DJ, Hutchings MJ. 1988. Estimation of the seed bank of a chalk grassland ley established on former arable land. J Appl Ecol 25: 241-252.

Heydari M, Mahdavi M, Atar Roushan S. 2009. Identification of relationship between some physiographic attributes and physico-chemical soil properties and ecological groups in Melehgavan protected area, Ilam. Iranian J For Poplar Res 17 (1): 149-160.

Heydari M. 2012. Effect of human disturbances and management on above ground vegetation composition and soil seed bank in Zagros forest ecosystem, Ilam city. [PhD-Dissertation]. Guilan university, Sowme'eh Sara, Iran.

Hill MO, Gauch HG. 1980. Detrended correspondence analysis, an improved ordination technique. Vegetatio 72: 47-58.

Hu ZH, Yang Y, Leng PS, Dou DQ, Zhang B, Hou BF. 2013. Characteristics of soil seed bank in plantation forest in the rocky mountain region of Beijing, China. J For Res 24 (1): 91-97.

Ito S, Nakayama R, Buckley GP. 2004. Effects of previous land-use on plant species diversity in semi natural plantation forests in a warm-temperate region in south-eastern Kyushu, Japan. For Ecol Manag 196: 213-235.

Jackowiak B. 1998. The hemeroby concept in the evaluation of human influence on the urban flora of Vienna. Phytocoenosis 10: 79-96.

Kent M, Coker P. 1994. Vegetation description and analysis, A practical approch. Edinburgh University Press. Edinburgh.

Kirsten AL, Scharer HM. 2001. Population dynamics of the annual plant *Senecio vulgaris* in ruderal and agriculture babitats. Basic Appl Ecol 2: 53-64.

Leckie S, Vellend M, Bell G, Waterway MJ, Lechowicz MJ. 2000. The seed bank in old-growth, temperate deciduous forest. Canadian J Bot 78: 181-192.

Leicht-Young SA, Pavlovic NB, Grundel R, Frohnapple KJ. 2009. A comparison of seed banks across a sand dune successional gradient at Lake Michigan dunes (Indiana, USA). Pl Ecol 202 (2): 299-308.

Lenzi-Grillini CR, Viskanic P, Mapesa M. 1996. Effects of 20 years of grazing exclusion in an area of the Queen Elizabeth National Park, Uganda. African J Ecol 34 (4): 333-341.

Lindner A. 2009. A rapid assessment approach on soil seed banks of Atlantic forest sites with different disturbance history in Rio de Janeiro, Brazil. Ecol Engineer 35: 829-835

López-Mariño A, Calabuig E, Fillat F, Bermúdez FF. 2000. Floristic composition of established vegetation and the soil seed bank in pasture communities under different traditional management regimes. Agric Ecosyst Environ 78: 273-282.

Ludwig JA, Reynolds JF. 1988. Statistical Ecology: a primer on methods and computing. John Wiley and Sons, New York.

Lugo, A.E, 1997. The apparent paradox of reestablishing species richness on degraded lands with tree monocultures. For Ecol Manag 99: 9-19

Luzuriaga AL, Escudero A, Olano JM, Loidi J. 2005. Regenerative role of seed banks following an intense soil disturbance. Acta Oecologica 27: 57-66.

Ma M, Zhou X, Ma Z, Du G. 2012. Composition of the soil seed bank and vegetation changes after wetland drying and soil salinization on the Tibetan Plateau. Ecol Engineer 44: 18-24.

Magurran A. 1988. Ecological diversity and its measurement. Croom Helm, London.

Malo JE, Jime´nez B, Suarez F. 2000. Herbivore dunging and endozoochorous seed deposition in a Mediterranean dehesa. J Range Manag 53 (3): 322-328.

Martinez ML, Pérez-Maqueo O, Vázquez, G, Castillo-Campos G, García-Franco J, Mehltreter K, Equihua M, Landgrave R. 2009. Effects of land use change on biodiversity and ecosystem services in tropical montane cloud forests of Mexico. For Ecol Manag 258: 1856-1863.

Martinez-Duro E, Luzuriaga AL, Ferrandis P, Escudero A, Herranz JM. 2011. Does aboveground vegetation composition resemble soil seed bank during succession in specialized vegetation on gypsum soil? Ecol Res 27 (1): 43-51.

Masoumiramak A. 1986-2000. Astragalus communities of Iran. Vol. 1-4, Publishing Research Institute of forests and Rangelands, Tehran.

McCune B, Mefford MJ. 1999. PC-ORD, Multivariate Analysis of Ecological Data, Version 4, MjM Software Design, Glenden Beach, Oregon, USA.

McGeoch MA, Chown SL. 1998. Scaling up the value of bioindicators. Trends Ecol Evol 13: 46-47.

Meissner RA, Facelli JM. 1999. Effect of sheep exclusion on the soil seed bank and annual vegetation in chenopod shrublands of South Astralia. J Arid Environ 42: 117-128.

Mengistu T, Teketay D, Hulten H, Yemshaw Y. 2005. The role of exclosures in the recovery of woody vegetation in degraded dryland hillsides of central and northern Ethiopia. J Arid Environ 60 (2): 259-281.

Montagnini F. 2001. Strategies for the recovery of degraded ecosystems: experiences from Latin America. Interciencia 26: 498-503

Mukhongo JN, Kinyamario JI, Chira RM, Musila W. 2011. Assessment of soil seed bank from six different vegetation types in Kakamega forest, Western Kenya. African J Biotechnol 10 (65): 14384-14391

Muller-Dombois D, Ellenberg, H.1974. Aims and methods of vegetation ecology, John Willey, New York.

Najafi tere Shabankareh K, Jalili A, Khorasani N, Ziba J, Asri U. 2008, Similarity between standing vegetation and soil seed bank in Geno. Iranian J res Dev 21: 171-182.

Olano JM, Caballero I, Laskurain NA. 2002. Seed bank spatial pattern in a temperate secondary forest. J Veg Sci 13(6): 775-784.

Parsa A. 1950. Flora of Iran 1943-1950. Vol. 1-5, Tehran University Press, Tehran, Iran.

Peco B, Ortega M, Levassor C. 1998. Similarity between seed bank and vegetation in Mediterranean grassland: a predictive model. J Veg Sci 9: 815-828.

Plassmann K, Brown N, Jones MLM, Edwards-Jones G. 2009. Can soil seed banks contribute to the restoration of dune slacks under conservation management? Appl Veg Sci 12: 199-210.

Raunkiaer C. 1934. The Life Forms of Plant and Statistical Plant Geography. Clarendon Press, Oxford.

Ren H, ShenW, Lu H, Wen X, Jian S 2007. Degraded ecosystems in China: status, causes, and restoration efforts. Landscape Ecol Engineer 3: 1-13.

Sagheb Talebi KH, Sajedi T, and Yazdian F. 2004. Forests of Iran. Research Institute of Forests & Rangelands. Tec. Pub. No 339. Tehran.

Scott K, Setterfield S, Douglas M, Andersen A. 2010. Soil seed banks confer resilience to savanna grass-layer plants during seasonal disturbance. Acta Oecologica 36 : 202-210.

Snyman HA, 2004. Soil seed bank evaluation and seedling establishment along a degradation gradient in a semi-arid rangeland. African J Range Forage Sci 21: 37-47.

Solomon TB, Snyman HA, Smit GN. 2006. Soil seed bank characteristics in relation to land use systems and distance from water in a semi-arid rangeland of southern Ethiopia. South African J Bot 72 (2): 263-271

Stace CA. 1989. Plant Taxonomy and Biosystematics. 2nd ed. Edward Arnold, London.

Steffan-Dewenter I, Westphal C. 2008. The interplay of pollinator diversity, pollination services and landscape change. J Appl Ecol 45 (3): 737-741.

Takafumi H, Hiura T. 2009. Effects of disturbance history and environmental factors on the diversity and productivity of understory vegetation in a cool-temperate forest in Japan. For Ecol Manag 257: 843-857.

Takhtajan A. 1986. Floristic Regions of the World. University of California Press, San Fransisco.

Tárrega R, Calvo L, Taboada A, Garcia-Tejero S. Marcos E. 2009. Abandonment and management in Spanish dehesa systems: Effects on soil features and plant species richness and composition. For Ecol Manag 257: 731-738.

ter Braak CJF, Šmilauer P. 1998. CANOCO Reference Manual and User´s Guide to Canoco for Windows. Software for Canonical Community Ordination version 4. Centre for Biometry, Wageningen.

Tessema ZK, Boer WFD, Baars RMT, Prins HHT. 2012. Influence of Grazing on Soil Seed Banks Determines the Restoration Potential of Aboveground Vegetation in a Semi-arid Savanna of Ethiopia. Biotropica 44 (2): 211-219.

Thompson K, Grime JP. 1979. Seasonal variation in the seed bank of herbaceous species in ten contrasting habitats. J Ecol 67: 983-921.

Wagner M, Poschlod P, Setchfield, RP. 2003. Soil seed bank in managed and abandoned semi-natural meadows in Soomaa National Park, Estonia. Annales Botanici Fennici 40: 87-100.

Waldhardt R, Simmering D, Albrecht H. 2003. Floristic diversity at the habitat scale in agricultural landscapes of central Europe-summary, conclusions and perspectives. Agric Ecosyst Environ 98(1): 79-85.

Warr SJ, Kent M, Thompson K. 1994. Seed bank composition and variability in five woodlands in South-West England. J Biogeogr 21: 322-335

Wisheu IC, Keddy PA, 1991. Seed banks of a rare wetland plant community: distribution patterns and effects of human-induced disturbance. J Veg Sci 2: 181-188.

Zandebasiri M, Ghazanfari H, Sepahvand A, Fatehi P. 2010. Presentation of decision making pattern for forest management unit under uncertainty conditions (Case study: Taf local area-Lorestan). Iranian J For 3 (2): 109-120.

Zechmeister HC, Moser D. 2001. The infiuenece of agricultural land-use intensity on Bryophyte species richness. Biodiv Conserv 10: 1609-1625

Zerbe S. 1993. Fichtenforste als Ersatzgesellschaften von Hainsimsen-Buchenwäldern : Vegetation, Struktur und Vegetationsveränderungen eines Forstökosystems. Berichte des Forschungszentrums Waldökosysteme. ser. A 100: 1-173.

Zohary M. 1973. Geobotanical Foundations of the Middle East. 2 Vols. Amsterdam, Stuttgart.