Changes of Soil Properties and Flora in Natural Forest and Afforestation Areas (Çankırı-Eldivan Region)

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ABSTRACT

In this study, existing flora and its soil characteristics besides the silvicultural features of natural and cultured forest areas having ecological and topographic qualities alike were compared. Due to the fact that Turkey has so many different growing conditions, it is one of the most important geographical regions in terms of richness of plant species. The fact that diversity of these plant species are known, conserved and conducted in accordance with the complex relations among climate-soil and plant must be necessary. In the field of our research, the richest families are *Fabaceae*, *Asteraceae*, *Lamiaceae*, *Brassicaceae*, *Poaceae, Scrophulariaceae, Boraginaceae Caryophyllaceae*, *Apiaceae* and *Rosaceae. The ratio of the richest ten families in total species 73.83%, and also the ratio of the rest 22 families is 26.17%. At the end of the afforestation efforts of 46 years, In spite of all negative characteristics, it's shown that afforestation makes the soil approach to the natural forest soil.*

Key Words: Afforestation, Soil, Flora, Watershed restoration, Çankırı-Eldivan

INTRODUCTION

As being considered of topographic, climate and soil characteristics of Turkey, erosion has been as a basic result of decaying land covering. In addition to this, many natural and socio-economic problems such as flood, overflow, avalanche, calamity, decrease of biological diversity, rural indigence, and emigration have been met. Decline on forest in the region of The Central Anatolia having arid and semiarid climate and decaying of its land covering have been more extremely acute. As the district of Çankırı Eldivan where the research has been done and considered in terms of ecological conditions, it's a region similar problem experienced. The problems such as illegal cutting, overuse pasturage, layout, fire and beetle cause it to decrease of agricultural areas and also to decline yield.

The basic purpose on the afforestation efforts during the last periods has been wood production. Newly, in addition to this aim, some different purposes such as recreation, land save, watershed restoration, and tourism have been considered. Furthermore, biological diversity one of the current subjects of the last years has a vital effect on the afforestation efforts. This topic has appeared as two different forms. The first one is that domestic breed of its region in the selection of species which will be used in the afforestation must be employed. So these existent species having been accorded for years will be saved and make the chance of success of afforestation increase. The other topic is a change appeared with the combination of bush, weed and other species by reason of afforestation. In

forests composing the major portion of biological diversity, above all to save this richness is critically important. Afforestation is defined as problematic works on the regions having arid and semiarid climate in Turkey. Human effect and soil shallow together with climate make the trouble increase much more. On this head, the studying of watershed restoration and afforestation in Eldivan constitutes a good example. The main purpose of our study is to display how the studies of watershed restoration which were done 46 years ago effects to the flora and basic soil characteristics under the natural forest and afforestation.

MATERIAL and METHODS

Description of Study Area

Study area is in 2078.7 hectares of land and within the limitseonfines of the town Eldivan of the province Çankırı in the Central Anatolia. Its location is between the north latitude 40° 34' 41" - 40° 20' 38" and east longitude 33° 36' 00" - 33° 25' 10" (Figure 1).

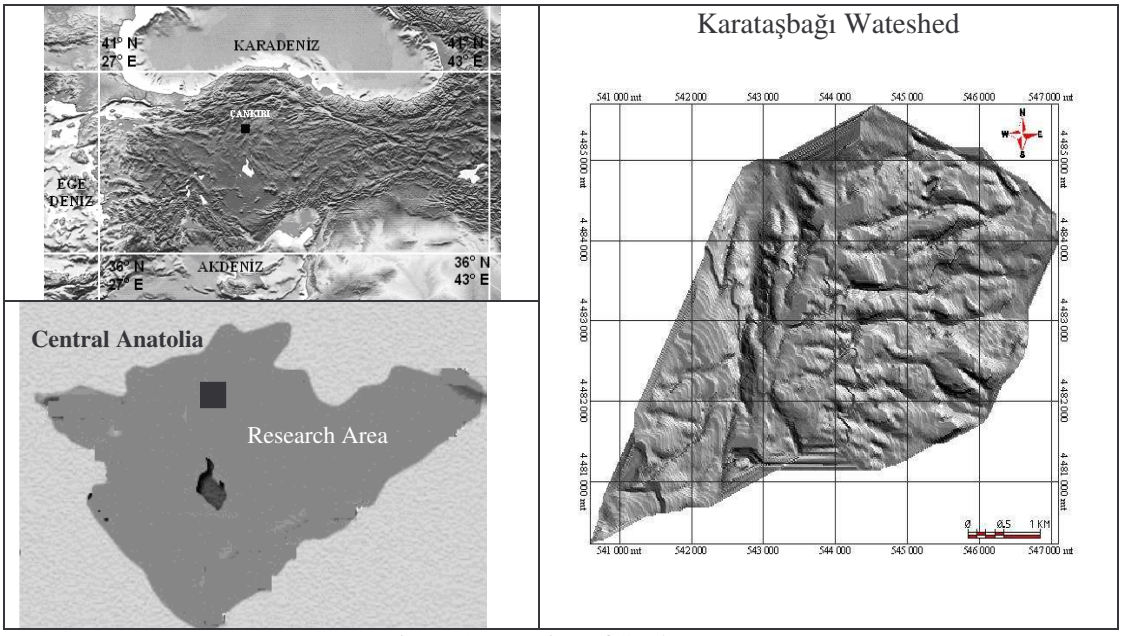

Figure 1. Location of Study Area

Study area is on the twilight area between the step climate of Central Anatolia and the climate of West Black Sea, which are macro climate regions of Turkey. By using the measurement reading (Anonymous, 2001) of Meteorological Station in Eldivan, the method of Thornthwaite was used to determine the climate type of research area (Özyuvacı 1999). According to this, Eldivan has a type of climate which is arid-semi humid, mesothermic, having surplus water in winter and pretty nearly the same effect of maritime climate (Göl, 2002). Geological formations of research area consist of metamorphic and volcanic fasiers belonging to Neogene and Cretaceous. Eldivan Ophiolitic Complex detected by Akyürek (1979) is a material of oceanic-crust which initial arrangement has been saved in spread of ophiolitic melange observed in Central Anatolia (Anonymous, 1988). In respect of Soil

Taxonomy (1999), the soils of Çankırı-Eldivan Karataşbağı watershed have been included to the classifications of Lithic Xerorthent, Typic Xerorthent, Typic Calcicxerept, Typic Haploxerept, Lithic Calcicxerept ve Lithic Haploxerept (Göl and Dengiz 2007).

Methods

By using the Digital Elevation Model (DEM) belonging to Göl and Dengiz (2007), which was made previously on research area and observing topographical maps drawn to a scale 1:25.000, sampling dots and places of land cavities has been determined. Two-number sample regions which are similar alike in terms of the characteristics of slope, aspect, height in natural forest and afforestation areas. Sample areas were limited as 20x20=400 m². Heights and diameters of all the trees and age of three ones of supreme trees were measured (Kantarcı 1979). In the study, it was used clizimeter, altimeter, calipers, heightmeter, increment borer and compass.

Soil profile was digged in each sample area. In the soil profile, condition of outer-soil, absolute and physiological depth, drainage state, skeleton, root distribution, humidity, structure, stoniness and carbonates were assessed according to Çepel (1998) and Kantarcı (2000). From soil profiles, natural distorted soil samples in respect of the genetic horizon base were taken. On these samples, grain distribution was determined by using hydro-meter method (Bouyoucos, 1951), saturation % (Richards, 1954) besides, organic matter were designated by the newly version of the method Walkley-Black, which was modified by Jackson (Nelson and Sommers 1996). The total nitrogene were determined according to the method Micro Kjeldahl (Bremner, 1996) pH, EC and salt in the soil samples were analyzed in respect of (Rhoades, 1996; U.S. Salinity Lab. Staff, 1954) and lime ($CaCO_3$) was analyzed by Richard and Donald (1996). Plant materials in the region were collected as a result of land-studies during the periods of vegetation development (bloom, bearing, seed etc.) in 2008. These plants collected have been put into herbarium material in accordance with its modern systematic rules. Minimum 2 samples of each plant species were prepared and after identifying these species, they were preserved in the Herbarium of Forestry Faculty of Çankırı Karatekin University.

RESULTS

Watershed Rehabilitation Studies (Since 1962)

"The Directorate of the Soil Protection and Pasture Rehabilitation" was established within the forest organization in order to carry out watershed rehabilitation studies in the 1950s. While the forest organization started to afforest slope areas, The General Directorate State Hydraulic Works started the rehabilitation project of Dümeli (Eldivan) Karadere watershed and stream improvement studies. There were great changes in the use of land and the cover of the land as a result of these studies. It was reported as a result of these studies carried out between 1955 and 1961 that there were strong erosions

in the 42% of the watershed. It was stated that there were floods that caused deaths and loss of goods in the years of 1913, 1949, 1952, 1961 and 1962. Between 1964 and 1967, the State Hydraulic Works built tree little dam, six rehabilitation benches, twelve mixed-benches, 121 dry wall benches and a terrace which is 3700 m in length reinforced with bush bunch (Anonymous 1967).

The afforestation studies were started in 1962. Plantation was made with naked-rooted saplings black pine aged 2+0. In 1983, Çankırı Directorate of Forest Enterprise applied "The Project of Eldivan Gölez Erosion Control and Afforestation Inside-Forest Application". Within the project, black pine saplings aged 2+0 were planted. It was stated that the features of the flora changed depending on the slope. It was reported that juniper, the species of oak in the form of bush, the species of milk-vetch, wild sainfoin, vitch grass, mullein etc., single or multi-years herbaceous species were common (Anonymous 1983). According to the use of the land and the distribution of the cover of the land in 2006, it was provided that a decrease in the area of the degraded black pine and degraded coppice (-5.7 %) along with the farm areas produced from forests (-15.8 %), but an increase in the forests of black pine (21.3 %) (Göl and Dengiz 2007).

Silvicultural and Flora Properties of Study Area

The findings related to the stand constitutions of natural forest and afforestation areas chosen in the watershed of The Karataşbağı Stream and the four sample areas (1^{st} and 2^{nd} samples are in the natural forest, 3^{rd} and 4^{th} samples are in plantation) that were taken to determine various silvicultural features of them are given below. While evaluating the findings, the sample areas of natural and afforestation forest are consolidated together.

The sample areas chosen in natural forests take place in the altitudes of 1200 m and 1250 m. the stand canopy in the areas are valued as full (80-100 %). In the natural forests, the dominating species is the black pine *(Pinus nigra* Arn. subsp. *nigra* var. *caramanica* (Loudon) Rehder). Oak (*Quercus cerris* L., *Q. pubescens* Willd,) joins the mixture on the below tree floor. On the bush floor, *Quercus cerris* L., *Q. pubescens* Willd, *Crataegus monogyna* Jacq., *Colutea cilicica* Boiss.et Bal., and *Rosa canina* L**.** join the mixture. The canopy of the A1 floor is 90-100 %, the canopy of the A2 floor is 80% and the canopy of the A3 floor is 10 %. It was determined that the canopy of the bush floor is 10-30 % and the canopy of grass floor is 10 %. Thirty-two trees were counted in the first sample area (400 m^2). The highest is 26 m, the largest is 55 cm and the oldest is 79 years old of the trees that are all black pines. Sixty-six trees were counted in the second sample area. Although the main species of the A1 floor in this area is black pine, oak joins the mixture at a high rate (50%). The highest of the black pines is 15 m, the largest one is 32 cm ($d_{1.30}$) and the oldest is 70 years old. The highest of the oaks is 7 m, the largest one is 8 cm ($d_{1.30}$) and the oldest is 36 years old.

The third and the fourth sample areas were chosen in the afforestation areas were chosen in the altitudes of 1105 m and 1285 m in the west. At the afforestation studies, the slopes were chosen different from each other in order to see the effect of the depth of the soil and the slope. Slope of the third sample area is 45 % and slope of the fourth sample area is 0-5 %. The saplings of black pine aged 2+0 which were forested mono-culturally were used. Stand canopy on the above-tree floor was provided by 80-100% in both areas. Moreover, it was seen that the forest started to regeneration in the below-tree floor and in the bush floor. The stand canopy of the A1 floor was valued as 70-80%, the canopy of the A2 floor was valued as 70-80%, and the canopy of the below-tree floor was valued as 10-20% in the third sample area where the slope is high and the erosion is strong. Because the stand canopy didn't occur entirely in this sample area, the canopy in the bush and grass floor was valued as high (60-70 %). In the bush floor, lots of species of oaks, azarole, (*Colutea cilicica* Boiss.et Bal.), rose hip, juniper, plum, filix mas and (*Astragalus angustifolius* Lam. subsp. *pungens* (Willd.) Hayek) were encountered. The sample area was separated by gullies, and it was seen that the stream rehabilitation study was done with dry wall benches during the watershed rehabilitation studies. The A1 floor canopy was valued as 90-100 %, A2 was valued as 70-80%, in the fourth sample area where the slope is low. Stand canopy was valued as 60-70% due to the oaks that join the mixture at a rate of 50% in the A3 floor. The species similar to grass that were encountered in the third sample area were also seen in the bush floor. Thirty-two trees were counted in the third sample area (400 m^2). Although 2500 saplings were planted, it was seen that there were 800 trees in hectare. The highest is 19 m, the largest is 29 cm ($d_{1.30}$) and the oldest is 42. The main species of the A1 floor is the black pine in the fourth sample area. Thirty-five trees were counted totally. Although the slope was low in this sampling area, that the depth of the soil was low affected the development of the height and the width of the trees badly. In this sampling area, the highest is 12 m , the largest is 24 cm ($d_{1.30}$) and the oldest is 41 in the A1 floor.

Research area is in the A4 square according to P.H. Davis's Grid system. 118 genus and 172 taxons belonging to 32 families (including species and subspecies) were determined as a result of the evaluation of the samples of nearly 500 plants that we collected during the area studies that we carried out between April and September in order to determine the flora of the area. The richest family in our research area is *Fabaceae*, *Asteraceae*, *Lamiaceae*, *Brassicaceae*, *Poaceae, Scrophulariaceae, Boraginaceae Caryophyllaceae*, *Apiaceae* and *Rosaceae.* The rate of the ten richest families to the total species is 73.83 %, the rate of the species that separated to the remaining 22 families is 26.17 % (Table 2).

Some Soil Physical and Chemical Properties of Study Area

It was determined that there was dry-mull-type humus, litter heaping which was 4 cm wide in the first sample area and 5.5 cm wide in the second sample area which were chosen in the natural forests. It was seen that in the opened soil profile, there was a deep physiological depth in the first sample area (130+ cm) and there was a medium-deep physiological depth in the second sample area (60+ cm). Stoniness was valued as medium (0-15 cm) in above soils due to strong surface erosion, and it was valued as high amount in the below soils due to the main material. Although stoniness is high and the main material is close to the surface, a cracked main rock structure let the tree seeds go deep. It was determined that it couldn't be provided for enough litter heaping (3-4 cm) in the third and the fourth sample areas which were chosen in the afforestation area and it was seen that the mixture of the soil and the litter was not good. Stoniness was valued as medium (15-30 %) on the surface and as high (50-60 %) on the below soils in both sample areas. Absolute depth of the soil is low (25-40 cm) due to the strong erosion, and the physiological depth is high (130 cm) due to the cracked main rock structure.

The results of the analyses of the natural and the afforestation area soils are given at Table 1. These soils have a sandy, with clay, loam structure. In the afforestation areas stand canopy didn't occur entirely, there are problems in litter accumulation. The amount of coarse fragments is high in natural forest soils. Soil reactions (pH) vary among very light acid (pH 6.1), light acid (pH 6.7), and strong alkali (pH 8.1). The content of lime and organic matter of soils affected the reaction of the soil directly. pH is low in the above horizon soils where the amount of organic material is high, and the pHs of the below horizon soils whose amount of lime is high are valued as high. The amount of lime of the soils that belong to third sampling area decreases with the depth. The lowest pH was valued in the fourth sample area. Also, the amount of lime of the soils of this area is low. When the soils are evaluated in the view of saltiness, the results are like this: The soils that belong to the first, the second and the third sampling areas are saltless or very little salty. They are medium-salty or too salty in the fourth sampling area. The electrical conductivity of the soils of this area is EC=6.81dS/m. That the amount of the salt is high and the depth of the soil is insufficient affected the development of the height and with of the trees badly. Depending on the amount of the dead cover which heaped on the soil and soil dampness, the amount of organic material and total nitrogen changed. It was seen that the heap of organic material of the soils approximated the soils of the natural forests as a result of the afforestations which were made 46 years ago. The amount of organic material in the above horizon soils of the natural forests is rich and very rich. The above horizon soils of the artificial forests are rich (Table 1).

As a result of the afforestation studies of 46 years, the soils of afforestation forest approximated the features of natural forest soil in spite of all the bad features.

DISCUSSION

When the old and the present maps of land use are evaluated together, it is seen that afforestation has been made in the agriculture and the pasture land in the study area and around it. The borders of the natural forests have expanded. In the forest areas, the unproductive coppice stands turned into coppice forest, and the open areas turned into afforestation areas. The increase in black pine forests is 21.3 %. The afforestation studies must be continued in the high-slope places where there is a risk of erosion. Afforestation must be as a mixed species forest building instead of the single one. In the places where afforestation isn't done and where there is a risk of erosion, protective herbaceous species must be encouraged. Maintenance studies must be attached importance in the natural forest and afforestation areas. With the watershed rehabilitation studies which were made after 1960-1962, 27 % of the watershed was forested and studies were successful. But wrong agricultural activities and wrong pasturing still continues. Dense forestry activities and that people support these activities increase the success in the area where the drought is the biggest problem. As a result of this success, Bülbülpınarı zone of the watershed has been opened to be used as recreation. The rehabilitation studies were successful; the risk of flood was decreased to the minimum level. The flood control structures which were built in the Karataşbağı Stream zone have stopped the erosion entirely. The stress continues in the forest areas because the people who live under rural poverty aren't aware of the protection of nature sufficiently. Consequently, when determining the targets in the watershed rehabilitation studies, economical and ecological criteria must be evaluated together.

Authorities who have the right to make decisions must take benefit from the scientific findings of earlier studies while deciding the policies of land use. So, country lands will be used more productive and sustainable.

Table 1 Some soil physical and chemical properties of Research area

Land Use	Coordinate	Horizon	Depth (cm)	Texture (%)			Soil Type	Coarse Fragments (%)	pH 1/5 water	Saturation (%)	Salt (%)	EC (dS/m)	Lime ($CaCO_3$) (%)	Organic Matter (%)	Total Nitrogene (%)
				Clay	Loam	Sand									
Natural Forest	542 941 N 4 483 338 E	Ah	0-4	31	23	46	SCL	55	7.1	80	0.12	2.69	7	7.04	0.36
		Ael	4-22	19	33	48	SL	41	6.7	64	0.12	2.61	17	5.54	0.32
		AB	22-33	30	23	47	SCL	46	7.7	56	0.11	2.38	27	3.14	0.15
		Bst	33-46	29	21	50	SCL	25	7.5	52	0.13	2.90	25	2.02	0.10
		BC	46-62	28	25	47	SCL	71	7.6	52	0.08	2.00	21	1.89	0.09
		Cv_1	62-80	27	26	47	SCL	81	7.7	44	0.09	2.08	27	0.88	0.04
		Cv_2	80+	27	27	46	SCL	75	7.7	47	0.07	1.64	24	0.77	0.03
Natural Forest	542 985 N 4 483 747 E	Ah	0-5	22	20	58	SCL	43	7.1	65	0.11	2.35	17	5.29	0.26
		Ael	5-17	14	36	50	SL	52	7.6	50	0.09	2.05	24	3.89	0.19
		AC	17-25	13	27	60	SL	52	7.5	47	0.09	2.03	22	2.02	0.10
		Cv	25+	34	31	35	SCL	55	7.7	41	0.07	1.62	26	0.88	0.04
Plantation Forest	543 539 N 4 484 863 E	Ael	0-10	33	32	35	SCL	44	7.7	47	0.09	2.22	21	2.39	0.11
		Bst	10-26	28	38	34	SCL	44	7.7	42	0.11	2.41	22	2.77	0.13
		BC	26-40	34	29	37	SCL	49	7.8	43	0.13	2.81	16	0.90	0.04
		Cv_1	40-63	20	31	49	SCL	58	7.9	39	0.07	1.70	19	0.63	0.03
		Cv_2	63-78	32	29	39	SCL	66	7.9	43	0.07	1.67	18	0.63	0.03
		Cv_3	78+	22	23	55	SCL	52	8.1	35	0.06	1.41	5	0.51	0.02
Plantation Forest	543 812 N 4 484 263 E	Ah	0-2	35	23	42	SCL	13	6.7	70	0.07	1.71	2	5.67	0.32
		Ael	2-20	34	38	28	SCL	17	6.5	51	0.19	4.08	2	3.89	0.19
		Bst	20-36	34	23	43	SCL	38	6.2	62	0.26	5.61	1	2.02	0.10
		BC	36-52	14	16	70	SL	32	7.0	50	0.14	3.11	2	1.40	0.07
		Cv	52+	28	21	51	SCL	25	6.2	58	0.33	6.81	2	1.01	0.05

Note: SCL: Sandy clay loam, SL: sandy loam,

Table 2. Floristic list of different land use of Karataşbağı Watershed

Plant Family	Genus	Natural Forest	Plantation	Grassland
Ranunculaceae	*Ceratocephalus falcatus*			x
	Clematis vitalba L.	x		
	Consolida orientalis (Gay) Schröd.		x	
	Ranunculus arvensis L.			
Berberidaceae	*Berberis crataegina* DC.	x	x	x
	B. vulgaris L.			x
Papaveraceae	*Fumaria asepala* Boiss.	x		x
	F. parviflora Lam.	x		
	Papaver dubium L.			x
Brassicaceae	*Aethionema arabicum* (L.) Andrz. ex DC.			x
	Alyssum desertorum Stapf. var. *desertorum* Stapf.		x	
	A. minutum Schlecht. ex DC.		x	
	A. minus (L.) Rothm. var. *micranthum* (Meyer) Dudley	x		
	A. murale Waldst. & Kit. var. *murale* Waldst. & Kit.		x	
	A. pateri Nyar. subsp. *pateri* Nyar.			x
	Arabis caucasica Willd. subsp. *caucasica* Willd.			x
	Camelina rumelica Velen.	x		x
	Cardaria draba (L.) Desv. subsp. *chalepensis* (L.) O. E. Schulz	x	x	
	Erysimum crassipes Fisch. & Mey.	x		
	Fibigia clypeata (L.) Medik.	x		
	Thlaspi perfoliatum L.			x
Resedaceae	*Reseda lutea* L. var. *lutea* L.	x	x	
Cistaceae	*Helianthemum nummularium* subsp. *lycaonicum* Coode & Cullen	x	x	
	H. nummularium subsp. *ovatum* (Viv.) Schinz & Thellung		x	
Polygalaceae	*Polygala anatolica* Boiss. & Heldr		x	
	P. supina Schreb.		x	
Caryophyllaceae	*Arenaria serpyllifolia* L.	x		
	Cerastium brachypetalum Pers. subsp. *roeseri* (Boiss. & Heldr.) Nyman	x		
	Saponaria prostrata Willd. subsp. *prostrata* Willd.	x		
	Silene alba (Miller) Krause subsp. *eriocalycina* (Boiss.) Walters	x	x	x
	S. chlorifolia Sm.			x
	S. italica (L.) Pers.			x
	S. vulgaris (Moench) Garcke var. *vulgaris* (Moench) Garcke		x	
	Stellaria holostea L.			x
Illecebraceae	*Herniaria incana* Lam.	x		x
Polygonaceae	*Rumex acetosella* L.			x
	R. crispus L.			
Chenopodiaceae	*Chenopodium album* L. subsp. *album* L. var. *album* L.	x		
	C. botrys L.	x		
Clusiaceae	*Hypericum linarioides* Bosse		x	x
	H. lydum Boiss.			x
	H. origanifolium Willd.			
	H. perforatum L.	x		x
Malvaceae	*Alcea pallida* Waldst. & Kit.			x
	Malva neglecta Wallr.			x
Linaceae	*Linum tenuifolium* L.			x
Geraniaceae	*Geranium asphodeloides* subsp. *asphodeloides* Burm. Fil.		x	
Fabaceae	*Astragalus angustifolius* Lam. subsp. *pungens* (Willd.) Hayek	x		
	A. anthyllioides Lam.	x	x	
	A. dipsaceus Bunge	x		
	A. karamasicus Boiss. & Bal.	x	x	
	A. lycius Boiss.	x		
	A. sigmoideus Bunge			x
	Colutea cilicica Boiss. & Bal.	x	x	
	Coronilla orientalis Miller var. *orientalis* Miller	x		
	C. varia L. subsp. *varia* L.	x		
	Onobrychis graecum (L.) Ser.			x
	Genista lydia Boiss. var. *lydia* Griseb.			x
	Lathyrus tukhtensis Czecz.			x
	Lotus corniculatus (Gris.) Boiss.		x	
	Medicago falcata L.		x	

Plant Family	Genus	Natural Forest	Plantation	Grassland
Fabaceae	*Medicago lupulina* L.		x	
	M. minima (L.) Bart. var. *minima* (L.) Bart.	x		
	Melilotus alba Desr.			x
	M. officinalis (L.) Desr.			x
	Onobrychis armena Boiss. & Huet		x	
	Ononis spinosa L. subsp. *leiosperma* (Boiss.) Sirj.		x	
	Trifolium caudatum Boiss.			x
	T. medium L. var. *medium* L.			x
	T. pannonicum Jacq. subsp. *elongatum* (Willd.) Zoh.			x
	T. repens L. var. *repens* L.			x
	Trigonella fischeriana Ser.	x		
	Vicia cracca L. subsp. *cracca* L.		x	
	V. cracca L. subsp. *stenophylla* Vel.		x	
Rosaceae	*Alchemilla mollis* (Buser) Rothm			x
	Geum urbanum L.			x
	Potentilla recta L.			x
	Rosa canina L.	x	x	
	Sanguisorba minor Scop. subsp. *muricata* (Spach) Brip.			x
Apiaceae	*Bifora radians* Bieb.			x
	Bunium microcarpum subsp. *bourgaei* (Boiss.) Hedge & Lamond			x
	Caucalis platycarpos L.	x		
	Echinophora tenuifolia L. subsp. *sibthorpiana* (Guss.) Tutin		x	
	Laserpitium hispidum Bieb.		x	
	Turgenia latifolia (L.) Hoffmann			x
	Zosima absinthifolia (Vent.) Link			x
Rubiaceae	*Cruciata taurica* (Pallas ex Willd.) Ehrend.			x
	Galium incanum Sm. subsp. *elatus* (Boiss.) Ehrend.			x
Morinaceae	*Morina persica* L. var. *persica* L.			x
Dipsacaceae	*Scabiosa argentea* L.		x	
Asteraceae	*Achillea biebersteinii* Afan.			x
	Acroptilon repens (L.) DC.		x	
	Anthemis fruticulosa L. var. *pallida* DC.			x
	A. triumfetti (L.) All.		x	
	Carduus nutans sensu lato			x
	Centaurea depressa Bieb.			x
	C. virgata Lam.		x	
	Chondrilla juncea L. var. *juncea* L.			x
	Cichorium intybus L.			x
	Cirsium arvense subsp. *vestitum* (Wimmer & Grab.) Petrak			x
	Crepis foetida L. subsp. *rhoeadifolia* (Bieb.) Celak.	x	x	
	Crupina vulgaris Cass.		x	
	Doronicum orientale Hoffmann			x
	Inula montbretiana DC.			x
	Jurinea pontica Hausskn. & Freyn ex Hausskn.		x	x
	Pilosella piloselloides subsp. *piloselloides* (Vill.) Sojak			x
	Senecio vernalis W.&K. & Kit			x
	Tanacetum vulgare L.			x
	Taraxacum macrolepium Schischkin		x	
	T. serotinum (W.&K. & Kit.) Poiret	x	x	x
Campanulaceae	*Asyneuma amplexicaule* subsp. *amplexicaule* var. *amplexicaule* (Willd.) Hand.-Mazz.			x
	Campanula glomerata L. subsp. *hispida* (Witasek) Hayek			x
	C. rapunculoides L. subsp. *rapunculoides* L.			
Primulaceae	*Androsace maxima* L.			x
Boraginaceae	*Alkanna orientalis* (L.) Boiss. var. *orientalis* (L.) Boiss.	x	x	
	Anchusa azurea Miller var. *azurea* Miller	x		
	A. leptophylla subsp. *incana* (Ledeb.) Chamb.	x	x	x
	A. leptophylla subsp. *leptophylla* Roemer & Schultes			x
	Echium vulgare L.			
	Lappula barbata (Bieb.) Görke	x		x
	Myosotis alpestris subsp. *alpestris* F.W.Schmidt		x	

Plant Family	Genus	Natural Forest	Plantation	Grassland
Boraginaceae	*Onosma tauricum* Boiss. & Haldr.		x	
	O. stenolobum Hausskn. ex H. Riedl		x	x
Scrophulariaceae	*Linaria corifolia* Desf.			x
	L. simplex (Willd.) DC.	x		
	Odontites vernа subsp. *serotina* (Dumort.) Corb.	x		
	Scrophularia canina L. subsp. *bicolor* (Sm.) Greuter			x
	Verbascum cheiranthifolium var. *asperulum* (Boiss.) Murb.			x
	V. cheiranthifolium Boiss. var. *cheiranthifolium* Boiss			x
	V. lasianthum Boiss. ex Bentham			x
	Veronica multifida L.	x	x	
	V. officinalis L.	x		
	V. triphyllos L.	x		
Lamiaceae	*Acinos rotundifolius* Pers.		x	x
	Ajuga chamaepitys subsp. *chia* var. *chia* (Schreber) Arcangeli			x
	A. orientalis L.			x
	Lamium purpureum L. var. *purpureum* L.			x
	Marrubium astracanicum Jacq. subsp. *astracanicum* Jacq.		x	
	Mentha longifolia (L.) Hudson subsp. *longifolia* (L.) Hudson		x	
	Phlomis armeniaca Willd.			x
	P. pungens Willd. var. *pungens* Willd.			
	Salvia candidissima Vahl subsp. *candidissima* Vahl	x	x	
	S. dichroantha Stapf		x	x
	Scutellaria orientalis L. subsp. *pinnatifida* Edmondson			x
	S. salviifolia Bentham			x
	Sideritis montana L. subsp. *montana* L.		x	
	Stachys annua subsp. *annua* var. *lycaonica* Bhattacharjee	x	x	
	Teucrium chamaedrys L. subsp. *chamaedrys* L.			x
	Thymus longicaulis subsp. *longicaulis* var. *longicaulis* C. Presl	x	x	
	T. longicaulis subsp. *longicaulis* var. *subisophyllus* (Borbas) Jalas	x	x	
	T. sipyleus subsp. *sipyleus* Boiss. var. *sipyleus* Boiss			x
Euphorbiaceae	*Euphorbia macroclada* Boiss.	x	x	x
	E. myrsinites L.			x
	E. stricta L.			x
Fagaceae	*Quercus petraea* subsp. *iberica* (Steven ex Bieb.) Krassiln	x	x	
	Quercus pubescens Willd.	x	x	
Liliaceae	*Allium. scorodoprasum* L. subsp. *rotundum* (L.) Steam			x
	Muscari armeniacum Leichtl. ex Baker	x	x	
	M. neglectum Guss.	x	x	x
	Ornithogalum oligophyllum E. D. Clarke			x
Iridaceae	*Crocus ancyrensis* (Herbert) Maw	x	x	x
Poaceae	*Aegilops umbellulata* subsp. *umbellulata* Zhukovsky	x	x	
	Agrostis stolonifera L.			x
	Alopecurus arundinaceus Poiret			x
	Bromus danthoniae Trin.			x
	B. japonicus Thunb. subsp. *japonicus* Thunb.			x
	B. squarrosus L.	x	x	x
	B. tectorum L. subsp. *tectorum* L.	x	x	x
	Dactylis glomerata L. subsp. *hispanica* (Roth) Nyman	x	x	x
	Festuca valesiaca Schleich. ex Gaudin		x	
	Poa bulbosa L.	x	x	x
	Stipa joannis Celak.		x	x

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