Tarla Bitkileri Merkez Araştırma Enstitüsü Dergisi, 2016, 25 (1):48-57
Araştırma Makalesi (Research Article)

Rangeland Condition, Health and Biodiversity Assessments for Two Rangeland Vegetations in the Central Anatolia Region

*Sabahaddin ÜNAL Ali MERMER Hakan YILDIZ Ziya MUTLU

*Central Research Institute for Field Crops, Ankara, Türkiye
*Corresponding author e-mail (Sorumlu yazar e-posta): sabahaddin2015@gmail.com

Geliş Tarihi (Received): 11.03.2016 Kabul Tarihi (Accepted): 01.04.2016

Abstract

Improvement and management of rangelands are highly important to sustain and maintain for nowadays and next generations. The first step in vegetation studies is to determine its current vegetation status. For this reason vegetation surveys were performed on the rangelands of Kırıkkale-Akçaağaç village and Sivas-Çelebiler village in 2008. A modified wheel point method was used for vegetation survey. The results of research indicated that vegetation cover and bare ground were found as 47.10% and 52.90%; 69.43% and 30.57% in Akçakavak (21 survey sites) and Çelebiler (22 survey sites), respectively. The rangeland health class was found unhealthy and risky for rangeland in Akçakavak and Çelebiler, respectively. The 73 species in Akçakavak and 179 species in Çelebiler were counted on rangeland vegetation community. Desired plant species were also found in a satisfactory level for rehabilitation of rangelands. Simpsons' index of diversity was calculated to evaluate biological diversity of rangelands vegetation. Vegetation biodiversity was higher in rangelands of Çelebiler than that of Akçakavak. As a results it is suggested that proper management and improvement techniques should be conducted for both village rangelands.

Keywords: Rangeland health, Simpsons' index, biodiversity

Orta Anadolu Bölgesine Ait İki Merada Mera Durumu, Sağlığı ve Biyoçeşitlilikle İlgili Değerlendirmeler

Öz

Meraların yönetimi ve iyileştirilmesi, günümüz ve gelecek nesiller için sürdürülmesi ve korunması oldukça önemlidir. Mera çalışmalarının birinci basamağı mevcut mera durumunun belirlenmesidir. Bu nedenle 2008 yılında Kırıkkale - Akçaağaç ve Sivas - Çelebiler köylerinde mera vejetasyon etüdleri yapılmıştır. Modifiye edilmiş tekerlekli nokta metodu vejetasyon etüdlerinde kullanılmıştır. Araştırma sonuçları Akçakavak'ta (21 etüd noktası) ve Çelebiler'de (22 etüd noktası) bitki ile kaplı alan ve çıplak alan oranının sırayla %47.10 ve %52.9 ; %69.43 ve %30.57 olduğu görülmüştür. Mera sağlık durumu Akçakavak'ta sorunlu Çelebiler'de riskli olarak bulunmuştur. Akçakavak mera vejetasyonunda 73 tür, Çelebiler'de 179 tür sayılmıştır. Mera ıslahı için istenen bitki türleri yeterli düzeyde bulunmuştur. Mera vejetasyonlarının biyolojik çeşitliliğini değerlendirmek üzere Simpson ideksi hesap edilmiştir. Çelebiler meralarının vejetasyon biyoçeşitlilik değeri Akçakavak'tan daha yüksek olmuştur. Sonuç olarak iki köy merasında uygun yönetim ve ıslah teknikleri uygulanması önerilmektedir.

Anahtar Kelimeler: Mera sağlığı, Simpson indeksi, biyoçeşitlilik

Giriş

Rangeland is a multi-dimensional and deep content issue. Human can employ it for multiple purposes as animal feeding, watershed, wildlife and recreation area. It has got high diversity of flora, fauna and wild animals. Its use should be assessed in meaning of past, present and future applications due to its environmental importance for next generations.

Since the act of rangeland law, 25 February 1998, rangeland studies have been increased throughout Turkey. These activities were supported by different organizations (eg. TUBITAK, Universities) and government (Ministry of Food and Agriculture).

Rangeland description is based on determination of present plant species and

DOI: 10.21566/tbmaed.57008

relevant environmental features. Required information is collected as botanical composition, climatic and environmental variables on rangelands (Bakır 1969). Plant species were observed on rangelands in this study. Species were categorized as decreasers, increasers and invaders in terms of animal preference or palatability, later rangeland condition and health were calculated.

First of all, rangeland condition (excellent, good, fair, poor) and health (healthy, risky and unhealthy) should be determined (Bakır 1969; Koç et al. 2003) in rangeland studies. After that, the carrying capacity should be also figured out by yield for management system. In frame work of National Rangeland Management Project (TUBİTAK, 106G017) , vegetation surveys on 469 sites, were completed in the 9 provinces of the Central Anatolia Region from 2007 to 2011 year. The rangeland condition and health class of Ankara, Çankırı, Kayseri and Sivas provinces were in a fair and at risky, respectively (Ünal et al. 2012a; Ünal et al. 2012b; Ünal et al. 2013; Ünal et al. 2014). Vegetation cover and bare ground rates in Ankara, Çankırı, Kayseri and Sivas were also found as 60.55% and 39.45%; 65.19% and 34.81%, 57.85% and 42.15%; 60.68% and 39.32%, respectively. The cover rates of decreasers and increasers at the same vegetation surveys were calculated from 10.24% to 25.71% and from 14.72% to 24.80%, 12.62% and 19.98%; 15.53% and 22.23% in the provinces of Ankara, Çankırı, Kayseri and Sivas, respectively. The floristic composition included in 287, 327, 263 and 422 plant species in rangelands of Ankara, Çankırı, Kayseri and Sivas, respectively.

Some plant species observed in previous studies were summarized as the followings. Ankara and Çankırı have the same decreasers such as *Agropyron cristatum, Bromus tomentellus, Dactylis glomerata, Elymus repens, Koeleria cristata, Lotus aegaeus,* L. *corniculatus, Onobrychis cana, O. oxyodonta, Trifolium pratense* and *Vicia cracca. Some* increasers such as *Cynodon dactylon, Plantago lanceolata, Poa bulbosa, Stipa holosericea*, and *Teucrium polium* were found at the same provinces. The rangeland vegetation of Ankara province has got some other increasers such as *Hordeum bulbosum, Poa alpine, Dorycnium pentaphyllum, Ebenus hirsuta, Hedysarum cappadocicum.*

Some decreasers such as *Dactylis glomerata, Elymus hispidus, Lolium perenne, Poa pratensis, Koeleria cristata, Sanguisorba minor* were in Sivas province. This rangeland has increasers such as *Cynodon dactylon, Plantago lanceolata, Poa bulbosa, Stipa holosericea, Hordeum bulbosum, Bromus cappadocicus, Teucrium polium, Coronilla varia, Dorycnium pentaphyllum, Ebenus laguroides,* and *Hedysarum varium.*

Kayseri possesses some decreasers such as *Agropyron cristatum, Bromus tomentellus, Elymus hispidus, Koeleria cristata, Poa pratensis, Onobrychis cana, O. oxyodonta, O. occulta, Trifolium pratense, Medicago sativa,* and *Sanguisorba minor*. These increasers such as *Cynodon dactylon, Poa bulbosa, Festuca calieri, F. valesiaca, Stipa holosericea, Hordeum bulbosum, Ebenus laguroides, Hedysarum cappadocicum, H. varium* and *Teucrium polium* existed in Kayseri (Ünal et al. 2012a; Ünal et al. 2012b; Ünal et al. 2013; Ünal et al. 2014).

Since continuous grazing is implemented in the region, it is necessary to know biodiversity status of rangelands vegetation. West (1993) stated that livestock grazing effects appeared by two different ways, one was to increase the chances of survival of some species, the other was to enhance community and landscape-level diversity in many instances. The same author claimed that sustainable development would depend on finding balance between use and protection, from range sites to landscapes, and even on a global basis. Anonymous (1991) reported that the threat of global environmental change, accelerated species extinctions, and changing societal values has caused biodiversity to become a topic that has captured the attention of the public as well as the scientific community. Biodiversity, consisting of species diversity, ecosystem diversity, and genetic diversity, is often used as a measure of the health of biological systems (West 1993). The same author added that species occurrences and their relative abundances can be altered due to management actions, such as changes in livestock grazing systems.

Species diversity relates to the number of the different species and the number of individuals of each species within any one community (Anonymous 2015). It takes into account the abundance of each species. Species richness is the number of different species present in an area. The more species present in a sample the 'richer' the area (Anonymous 2015). Understanding the mechanism that maintain biodiversity in various

ecosystems enables the development of management practices that prevent degradation (Canals and Sebastian 2000).

The goals of this study were to detect rangeland condition and health based on plant species, and also to interpret current vegetation status of rangelands with ecological approaches and observe their biodiverisity.

Material and Method

Study area

Two pilot areas (the villages of Akçakavak and Çelebiler in the provinces of Kırıkkale and Sivas, respectively) were selected as a representative for semiarid conditions of Central Anatolia Region (Figure 1). Step vegetation has been dominated on The Central Anatolia Region. Rangeland average altitudes of Akçakavak and Çelebiler are 933.0 and 1571.9 m, respectively.

Annual feed requirements of livestock on villages of Akçakavak and Çelebiler were 866 and 1364 tons for 190 and 299 LU (Livestock Unit), respectively. Rangelands biomass yields were 24 and 78 kg/da, respectively (Anonymous 2009)

Soil features

Soil of Akçakavak is low in organic matter, clay-loam and loam texture, low P_2O_5, high K_2O and neutral-alkaline, slightly neutral of pH. Soil of Çelebiler has good organic matter, clay texture, little P_2O_5, more K_2O and neutral-alkaline, slightly neutral of pH (Anonymous 2009).

Climate : Kırıkkale – Akçakavak

It is hot, dry in summer and cold in winter. Average temperature is 12.3°C, hottest and coldest temperatures are 39,7°C (25.07.1972) and -22.3°C, respectively. Mean annual rainfall is 329.9 mm, it rains 35, 36, 13 and 16% of total rainfall, in winter, in spring, in summer and in autumn, respectively. Average relative humidity is 59%, highest and lowest of its are 79 and 39%, on December and on July, respectively (Anonymous 2009, Figure 2).

Climate : Sivas – Çelebiler

It is hot, dry in summer and cold, snow in winter. Average temperature is 9.0°C and hottest and coldest temperatures (for last decade) are 38.2°C and -29.6°C, respectively. Mean annual rainfall is 415.0 mm, but it rains mostly out of vegetation period, especially in winter times (Anonymous 2009, Figure 2).

Sampling description

Vegetation survey was conducted during June and July 2008 in Akçavak and Çelebiler. The sample plots were representative of different condition states based on the spectral reflectance of the satellite images of the villages. Wheel point apparatus with modified loop was used to measure the percentage cover for each species in the selected sites (Koç and Çakal 2004). For each site, 400 points were observed on the two transect lines at different directions. All data were recorded in data sheets. The vegetation surveys were made in 21 sites, 22 sites and total 8400

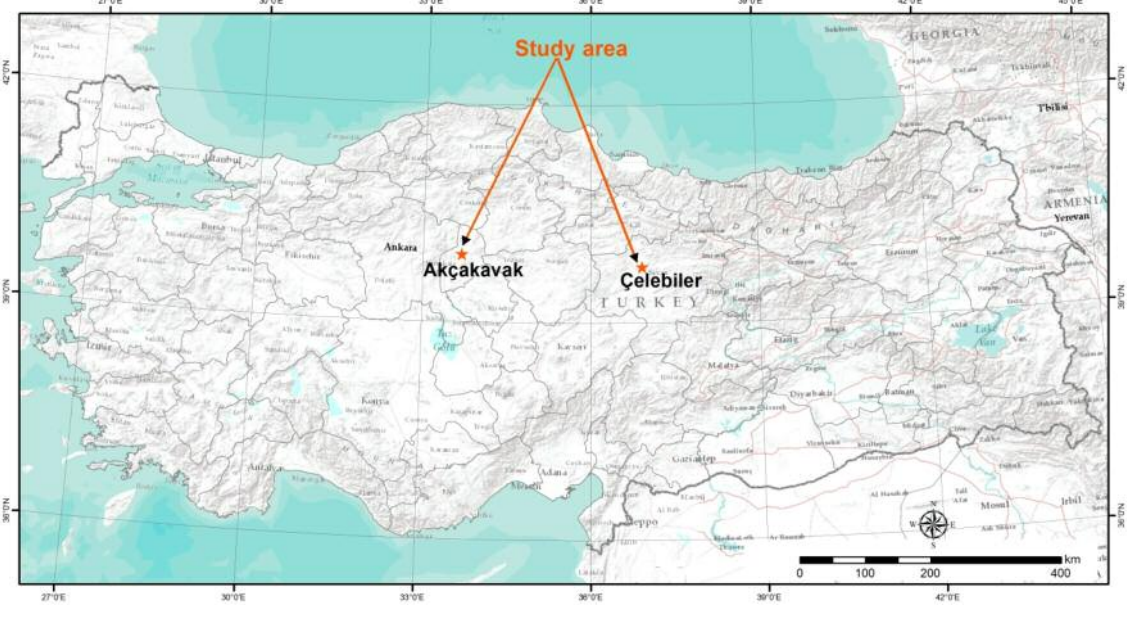
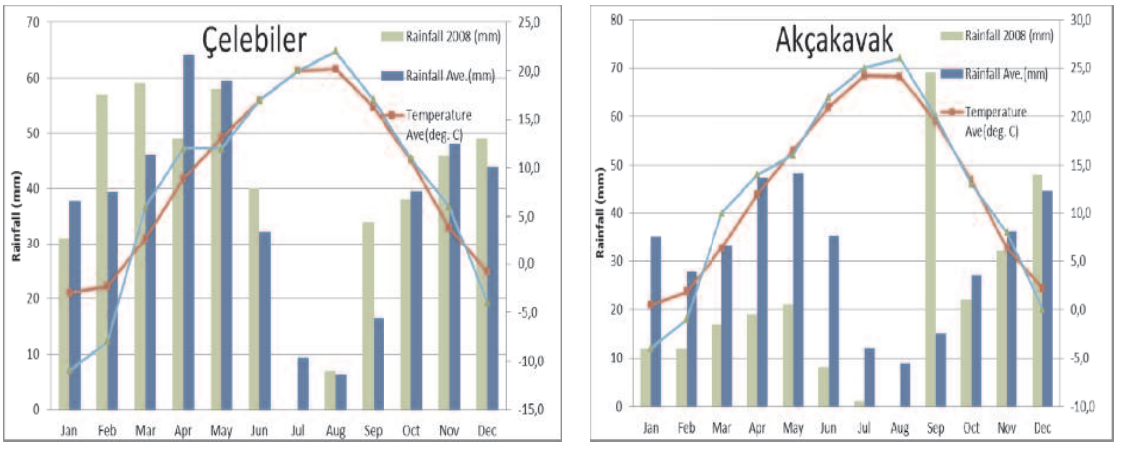


Figure 1. Study areas on the Turkey map

Şekil 1. Türkiye haritasında çalışma alanları



**Long term data 1981-2007* Uzun dönem verileri 1981-2007
Figure 2. Average rainfall and temperature for Kırıkkale and Sivas provinces
Şekil 2. Kırıkkale ve Sivas illerinde ortalama yağış ve sıcaklık

points, 8800 points were observed and recorded as plant covering area and bare ground in Akçakavak village of Kırıkkale province and in Çelebiler village of Sivas province, respectively.

Plant samples, which were unknown while making survey, were picked up and dried up for making identification at office. They were detected with using Davis 1965-1985, Davis et al. 1988, Güner et al. 2000. Moreover, environmental factors (altitude, aspect, slope) and current state of rangeland use (grazing intensity, hay yield) with soil properties (pH, organic matter, N, P_20_5, K_2O etc) and erosion impact were recorded for each study site. Plant species, bare ground and stoniness rates on rangelands were detected.

The rangeland condition (based on decreasers and increasers in vegetation) were classified as excellent, good, fair, poor and the rangeland health were also graded as healthy, at risky, and unhealthy with the basal covering of vegetation (Koç et al. 2003).

Data Analysis: Data analysis were performed with available computer software programs. The identification of rangeland health and condition were calculated from vegetation cover and plant species cover. Vegetation survey was conducted in addition plant species and environmental variables were filled in two forms of site information and vegetation survey.

The rangeland condition (only cover of decreasers and increasers limited used) and health (vegetation cover) of villages were computed with the basal cover of vegetation community.

Plant species observed were categorized into three groups as decreasers, increasers and invaders (Anonymous 2005). Rangeland condition was arranged as poor (1-25%), fair (26-50%), good (51-75%) and excellent (76-100%). Rangeland health was placed in one of three categories: healthy (>71%), at risky (56-70%), and unhealthy (55% >) (Koç et al. 2003; Anonymous 2012).

Biodiversity index: Simpson's index (D) (Simpson 1949) is used to investigate vegetation diversity of Akçakavak and Çelebiler grasslands. This index takes into account both species richness, and an evenness of abundance among the species present. The formula for calculating Simpson's index is:

$$D = \frac{\sum n_i(n_i - 1)}{N(N-1)}$$

where ni = the number of individuals of each individual species

N = the total number of organisms of all species

The value of D ranges between 0 and 1. With this index, the value 0 represents infinite diversity and, the value 1, no diversity. That is, the bigger the value, the lower the diversity in other words. To calculate index, frequence of all species record on each sampling point was adjusted so that the total frequence would be made up to 100.

Results and Discussions

General assessment for rangelands condition and health

Rangeland health and condition in Akçakavak and Çelebiler were calculated as unhealthy and fair; risky and fair, respectively (Table 1).

Table.1 Bare ground, decreasers, increasers, and invader species percentages on sites of the two villages
Çizelge 1. İki köye ait duraklarda çıplak alan, azalıcılar, çoğalıcılar ve istilacı türlerin oranları

Akçakavak*

Descriptive statistics	VC	BG	D	IC	IV	Dec.URC	IncURC	SURC
Minimum	31.66	28.65	0.53	11.06	7.71	1.23	20.48	21.23
Maximum	71.35	68,34	23.08	36.56	42.78	32.34	72.49	52.34
Average	**47.10**	**52.90**	7.67	19.86	19.57	15.78	43.11	**36.26**
SE	10.24	10.24	5.12	5.83	7.82	8.22	12.18	8.28
CV (%)	21.74	19.35	66.83	29.34	39.97	52.08	28.25	22.83

Çelebiler

Descriptive statistics	VC	BG	D	IC	IV	Dec.URC	IncURC	SURC
Minimum	4.01	19.59	1.20	9.73	25.29	2.18	16.60	15.57
Maximum	69.36	44.82	28.75	32.43	49.69	36.79	45.08	48.75
Average	**58.04**	**30.57**	10.54	23.08	35.80	14.62	33.17	**29.63**
SE	20.31	7.22	7.79	5.06	6.96	9.88	6.32	8.74
CV (%)	34.99	23.62	73.87	21.93	19.43	67.60	19.06	29.49

*Explanation: VC: Vegetation cover, Dec.URC: Decreasers Used for Range Condition, BG: Bare Ground, IncURC: Increasers Used for Range Condition, D: Decreasers, SURC: Species Used for Range Condition, IC: Increasers, SE: Standart error,IV: Invaders, CV (%):Coefficient variation

**Açıklama: VC: Bitkiyle kaplı alan, Dec.URC: Mera Durumunun Tespitinde Kullanılan Azalıcı Türler, BG: Çıplak Alan, IncURC: Mera Durumunun Tespitinde Kullanılan Çoğalıcı Türler, D: Azalıcılar, SURC: Mera Durumunun Tespitinde Kullanılan Bitki Türleri, IC: Çoğalıcılar, SE: Standart hata, IV: İstilacılar, CV (%):Değişim katsayısı (%)*

Table.2 Sites of healthy, risky and unhealthy in Akçakavak
Çizelge 2. Akçakavak'ta sağlıklı, riskli ve sorunlu duraklar

Health class	Site numbers	Descriptive statistics	Vegetation cover	Bare ground
Healthy	1	Minimum Maximum Average SE CV%	28.65	71.35
Risky	2	Minimum	34.72	59.95
		Maximum	40.05	65.28
		Average	37.39	62.61
		SE	3.77	3.77
		CV%	10.08	6.02
Unhealthy	18	Minimum	45.60	31.66
		Maximum	68.34	54.40
		Average	55.98	44.02
		SE	7.04	7.04
		CV%	12.58	15.99

The percentages of vegetation cover and bareground of Akçakavak and Çelebiler were found as 47.10%, and 52.90%; 58.04% and 30.57%, respectively. The percentages of decreasers, and increasers in botanical composition of Akçakavak and Çelebiler were 15.78%, and 43.11%; 14.62% and 33.17%, respectively. A value of the range condition is also 36.26% and 29.63% in Akçakavak and Çelebiler, respectively.

Ankara, Çankırı, Kayseri, and Sivas provinces had similar status for range condition and health, in a fair and at risky, respectively (Ünal et al. 2012a; Ünal et al. 2012b; Ünal et al. 2013; Ünal et al. 2014).

Table 3 Sites of good, fair and poor in Akçakavak
Çizelge 3. Akçakavak'ta iyi, orta ve zayıf duraklar

Condition class	Site numbers	Descriptive statistics	D	IC	IV	SURC
Good	1	Minimum Maximum Average SE CV%	32.34	33.09	34.57	52.34
Fair	18	Minimum	6.74	20.48	15.28	26.74
		Maximum	29.52	72.49	65.53	49.52
		Average	16.28	42.61	41.11	36.83
		SE	6.61	12.55	11.47	6.64
		CV%	40.59	29.46	27.89	18.04
Poor	2	Minimum	1.23	51.54	41.46	21.23
		Maximum	4.88	53.66	47.23	24.88
		Average	3.05	52.60	44.35	23.05
		SE	2.58	1.49	4.08	2.58
		CV%	84.58	2.84	9.19	11.20

Table.4 Sites of healthy, risky and unhealthy in Çelebiler
Çizelge 4. Çelebiler'de sağlıklı, riskli ve sorunlu duraklar

Health class	Site numbers	Descriptive statistics	Vegetation cover	Bare ground
Healthy	9	Minimum	73.57	19.59
		Maximum	80.41	26.43
		Average	76.55	23.45
		SE	2.54	2.54
		CV%	3.32	10.82
Risky	12	Minimum	58.64	30.64
		Maximum	69.36	41.36
		Average	65.27	34.73
		SE	4.01	4.01
		CV%	6.15	11.55
Unhealthy	1	Minimum Maximum Average SE	55.18	44.82
		CV%		

Table 5. Sites of good, fair and poor in Çelebiler
Çizelge 5. Çelebiler'de iyi, orta ve zayıf duraklar

Condition class	Site numbers	Descriptive statistics	D	IC	IV	SURC
Good	--	Minimum Maximum Average SE CV%	--	--	--	-
Fair	13	Minimum	6.80	28.98	25.29	25.47
		Maximum	36.79	45.08	49.69	48.75
		Average	20.18	35.33	32.59	34.91
		SE	9.20	4.83	6.35	7.32
		CV%	45.57	13.68	19.48	20.97
Poor	9	Minimum	2.18	16.60	34.64	15.57
		Maximum	9.96	35.83	49.01	24.91
		Average	6.59	30.04	40.45	21.99
		SE	2.61	7.16	5.05	2.97
		CV%	39.63	23.83	12.49	13.52

Rangeland status of Sivas - Çelebiler was almost the same those provinces mentioned above. But Kırıkkale - Akçakavak had the similar range condition and different range health class. As a result over-grazing and mismanagement have recently undergone on regional rangelands.

Akçakavak village

Rangelands health

Rangeland health values of the study sites were given in Table 2. The 18 sites out of 21 sites found unhealthy, which is very high. It means that the rangeland degradation continues in Akçakavak.

Rangeland condition

The condition data of survey sites were presented in Table 3. Three different classes of rangeland conditions were detected as good (1 site), fair (18 sites), and poor (2 sites) in the village of Akçakavak. Most of observed sites was at fair condition. It indicates that rangeland degradation occurs. Maintanence and rehabilitation measures should be immediately implemented in Akçakavak rangelands.

Çelebiler village

Rangelands health

Rangeland health values of the study sites in Çelebiler village were given in Table 4. The plant cover and bare ground were calculated as 76.55% and 23.45%; 65.27% and 34.73%; 55.18% and 44.82% at healthy (9 sites), risky (12 sites), and unhealthy (one site), respectively. This means that degradation is continuing on this rangeland.

Table 6. Plant species found rangelands vegetation in Akçakavak and Çelebiler villages
Çizelge 6. Akçakavak ve Çelebiler köyleri mera vejetasyonunda bulunan türler

Akçakavak Total plant species 73
Legumes: Annual *Trigonella* spp., *Trifolium arvense*
Legumes: Perennial *Astragalus* spp. *Medicago* spp., *Onobrychis cana*
Grasses: Annual *Aegilops* spp., *Bromus sterilis*, *Taeniatherum caput-medusae*, *Vulpi*a spp.
Grasses: Perennial *Agropyron* spp., *A. cristatum*, *Andropogon ischaemum*, *Bromus tomentellus*, *Crysopogon gryllus, Cynodon dactylon, Elymus* spp., *Festuca ovina, Koelaria cristata, Stipa* sp., *Poa bulbosa*
Others: 50 plant species *Artemesia fragrans, Thymus sipleus, Achanthus* spp., *Achilla* spp., *Anthemis* spp., *Centauria virgata*, *Teucrium chamedrys, T. polium, Xantheranum annum*
Çelebiler Total plant species 179
Legumes: Annual *Trifolium* spp., *Trigonella fisheriana., Vicia* spp.
Legumes: Perennial *Astragalus* spp., *Genista albida, Dorycynium pentaphillium, Ebenus lagaroides, Coronilla varia, C. orientalis, Hedysarum varium, Medicago falcate, Lotus* spp., *Medicago varia, Onobrychis cana, O. cornuta, Vicia cracca*
Grasses: Annual *Aegilops* spp., *A. trunciata, Bromus japonicus, B. tectorum, Taeniatherum caput-medusae, Phleum exaratum, Setaria viridis*
Grasses: Perennial *Agropyron* spp*., Bromus tomentellus, Koelaria cristata, Dactylis glomerata, , Festuca ovina, Cynodon dactylon, Elymus* spp., *Poa bulbosa, Stipa lessingiana, S. hohencokeriana*
Others: 124 plant species *Adonis aestivalis, Artemesia fragrans, Thymus urgeus, T. callieri, Acanthalimon acerosum, Achanthus hirsutus, Achillea millefolium, Globloria orientalis, G. tricosantha, Bungea trifida, Bunium micrcartum, Cardus* spp*, Carex* spp*., Centauria deprasa, Centauria iberica, Centauria solstitialis, Centauria virgate, Setaria viridis, Condorilla* spp*., Circium* spp*., Convolvulus cantabrychus, Crepis sancta, Curiciata coronata, Daphne ceracea, Dianthus zonatus, Draba burinicofolia, Echinum* spp*., Eryngium campestre, Globloria orientalis, Globloria tricosantha, Heliantemum canum, Helichrysum orentale, Holosteum umbellatum, Minuartia anatolica, Onosma* spp*., Anthemis tinctoria, Paranchia kurdica, Phlomis armenica, Phlomis pungens, Plantago lanceolata, Poligala anatolica, Poliganum* spp*., Potentilla recta, Rezeda lutea, Rosa canina, Salvia criptantha, Salvia scleria, Scabiosa rotate, Scandix aucheri, Scutellaria orientalis, Sedum acre, Sideris tinctoria, Silene italica, Stachys annua, Stachys bupescens, Tanacetum armenum, Teucrium chamaedrys, Teucrium polium, Thesium* spp*., Torilis arvensis, Tragopogon* spp*., Valerianella viciaria, Verbascum cheiranthifolium, Veronica multifida, Xarantenum annum, Ziziphora capitata, Ziziphora tenior*

Rangelands condition

The condition data of survey sites are in Table 5. Two different classes of rangeland conditions were identified as fair (13 sites), and poor (9 sites) in the village of Çelebiler. The existence of rangeland degradation should be immediately stopped by implementation of rehabilitation methods.

Plant species

There were 73 species and 179 species on vegetation in Akçakavak and Çelebiler, respectively (Table 6).

Ankara, Çankırı, Kayseri and Sivas provinces contained 287, 327, 263 and 422 plant species in their rangelands vegetation, respectively (Ünal et al. 2012a; Ünal et al. 2012b; Ünal et al. 2013; Ünal et al. 2014). High species number indicates plant species richness of regional rangelands vegetation community. The existence of desired plant species on range vegetation is a good potential for over-seeding and improving of rangelands.

Some plant species encountered in the previous studies are as follows: *Agropyron cristatum, Bromus tomentellus, Koeleria cristata* (Ünal et al. 2012a; Ünal et al. 2012b; Ünal et al. 2013) *Dactylis glomerata, Elymus repens, Lotus aegaeus, L. corniculatus, O. armena, O. oxyodonta, Trifolium pretense,* and *Vicia cracca.* (Ünal et al. 2012a; Ünal et al. 2012b) *Agrostis stolonifera, Elymus hispidus, Phleum montanum* and *Poa pratensis* (Ünal et al. 2013), *Onobrychis occulta* and *O. oxyodonta, Hedysarum pestalozzae* (Ünal et al. 2013), *Andropogon gryllus,* (Bakır 1970; Tokluoğlu 1979; Ünal et al. 2013) and *Festuca ovina* (Bakır 1970; Özmen 1977; Uluocak 1977; Ünal et al. 2010; Ünal et al. 2011; Ünal et al. 2013) *Poa bulbosa, Cynodon dactylon,* (Bakır 1970; Ünal et al. 2012a; Ünal et al. 2012b; Ünal et al. 2013), *Hedysarum varium* (Bakır 1970; Tokluoğlu 1979; Ünal et al. 2013), *Medicago sativa* (Bakır 1970; Uluocak 1977; Ünal et al. 2013), *Onobrychis cana* (Bakır 1970; Ünal et al. 2010) and *Onobrychis sativa, O. alba, O. tenuifolia* (Uluocak 1977), *Stipa holosericea* (Ünal et al. 2012a; Ünal et al. 2012b; Ünal et al. 2013). *Poa alpine* , *Hordeum bulbosum* and *Hedysarum cappadocicum* (Ünal et al. 2012a; Ünal et al. 2013), *Plantago lanceolata*, and *Teucrium polium* (Ünal et al. 2012a; Ünal et al.

Table 7. Simpson's index values (D for Çelebiler-Sivas and Akçakavak-Kırıkkale
Çizelge 7. Çelebiler-Sivas ve Akçakavak-Kırıkkale'de Simpson's index değerleri (D)

Çelebiler-Sivas		Akçakavak-Kırıkkale	
Sites	D	Sites	D
1	0.092	1	0.151
2	0.150	2	0.139
3	0.194	3	0.185
4	0.076	4	0.225
5	0.087	5	0.150
6	0.154	6	0.088
7	0.083	7	0.159
8	0.121	8	0.208
9	0.071	9	0.163
10	0.049	10	0.148
11	0.120	11	0.318
12	0.101	12	0.119
13	0.106	13	0.129
14	0.087	14	0.127
15	0.030	15	0.094
16	0.104	16	0.138
17	0.114	17	0.212
18	0.128	18	0.095
19	0.072	19	0.167
20	0.043	20	0.107
21	0.087	21	0.233
22	0.095	-	-
Average	0.098		0.160
Minimum	0.030		0.088
Maximum	0.194		0.318
Standart deviation	0.038		0.056
CV (%)	38.363		34.797

2012b) *Dorycnium pentaphyllum, Ebenus hirsuta*, (Ünal et al. 2012a) *Briza media, Ebenus laguroides, Puccinellia koeieana* (Ünal et al. 2013).

Some invader species were found in Kayseri province as *Alyssum desertorum, A. pateri, Taeniatherum caput-medusae, Eryngium campestre, Euphorbia macroclada, Noaea mucronata, Phlomis armeniaca, Potentilla recta, Salvia cryptantha, Scabiosa argentea, Teucrium chamaedrys, Thymus sipyleus, Vicia ervilia, Ziziphora capitata* (Ünal et al. 2013).

At the regional native steppe vegetation, dominant plant species are as follows *Thymus squarrosus* (*Thymus sipyleus*) (Bakır 1970; Özmen 1977; Tokluoğlu 1979; Ünal et al. 2010; Ünal et al. 2011), *Artemisia fragrans* (*Artemisia santonicum*) (Özmen 1977; Tokluoğlu 1979; Ünal et al. 2010; Ünal et al. 2011; Ünal et al. 2013).

Biodiversity of Rangelands

Simpson's index values were calculated for each sampling site of two villages(Table 7). According to index values species diversity is high in vegetation of both villages. Average Simpson index for Çelebiler (0.098) is less than average index of Akçakavak(0.160). Low index values indicate better diversity in Çelebiler than other. There are higher index values up to D= 0.3 at Akçakavak village. Because of high grazing pressure on Akçakavak, we can see that only one or two species as *Festuca ovina* or several annual species are dominant in grassland vegetation. Low species diversity suggests that environment is quite stressful. Species diversity is low in dry areas Bello et al., (2005). This may be another reason for low vegetation diversity (higher D value) at Akçakavak grassland as rainfal in Kırıkkale province is less than that of Çelebiler/Sivas. Understanding the mechanism for maintaining biodiversity in various ecosystems enables the development of management practices that prevent ecological degradation (Canals and Sebastian 2000).

The results of vegetation surveys showed that rangeland health and condition classes were unhealthy and fair; risky and fair on the rangelands of Kırıkkale - Akçaağaç village and Sivas -Çelebiler village, respectively**.** Palatible plant species were also existed in a satisfactory level for rangelands restoration. The calculated biodiversity indices showed that vegetation biodiversity was higher in rangelands of Çelebiler than that of Akçakavak. The study results indicate that rangeland degradation occurs, existence of rangeland degradation should be immediately stopped and implementation of rehabilitation methods should be immediately applied.

Acknowledgement

This study was carried out under the project "Sustainable Rangeland Management in Turkey" with the finance of government of Netherland (Project no:G2G07/TR/9/3)

References

Allan B. and Lowther B., 1992. Pasture grazing management. Guide to Tussock Grassland Farming (Editor: Mike Floate). AgReseach, Invermay, New Zealand Pastoral Agriculture Research Institute Ltd. Mosgiel, New Zealand

Altın M., 1999. Fertilizer Applications on Meadow and Rangeland. Training and Application Handbook of Range Act. 1. The Turkish Ministry of Agricultural And Rural Affairs. General Director of Agricultural Production and Development

Anonymous, 1991. Threats to biodiversity in the United States. U.S. Environ. Protection Agency, Washington, D.C.

Anonymous, 2005. Meadow and Range Plants Handbook. The General Directorate of Agricultural Production and Improvement, The Turkish Ministry of Agriculture and Rural Affairs, page: 317

Anonymous, 2009. The challenge of the rangelands in Turkey (Towards a sustainable rangeland economy). Government to government project G2G07/TR/9/3 Turkey – The Netherlands, Final report of the G2G project: sustainable rangeland management in Turkey, 2008 and 2009, p: 57

Anonymous, 2012. The Result Report of National Rangeland Use and Management Project, project no:106G017. The Scentific and Technological Research Council of Turkey (TÜBİTAK) Support Programme for Research and Improvement Projects of Public Institutions (1007 Programme), Public Research Grant Committee, (Unpublished Report)

Anonymous, 2015. Biodiversity. Measuring biodiversity, Student and Teachers guide www.rewardinglearning.org.uk A2AS-BIOOL-REVISED-Support-5925.doc (Access date, 20.12.2015)

Bakır Ö., 1969. Studies on the ecological factors affecting growth and improvement of major forage crops. Ankara University, Agricultural Faculty Press, 327. Ankara, page:116

Bakır Ö., 1987. Grazing Period. Management of Meadow and Rangeland. Ankara University, Agricultural Faculty Presses, 992, p: 114-132

Campbell M., 1997. Pasture weeds. Pasture Production and Management (Editors: J.V. Lovett and J.M. Scott). Reel International Books Australia Pty Ltd trading as Inkata Press, pp. 254-268

Canals R.M. and Sebastia M.T., 2000. Analyzing mechanisms regulating diversity in rangelands through comaparative studies: a case in the South-western Pyrennes. Biodiversity and Conservation, 9: 964-984

Davis P.H., 1965 - 1985. Flora of Turkey and the East Aegean Islands, Vol. 1 – 9, Edinburgh Univ. Press., Edinburgh

Davis P.H., Mill R.R. and Tan K., 1988. Flora of Turkey and the East Aegean Islands, Edinburgh Univ. Press., (supple. 1), Vol. 10, Edinburgh Univ. Press, Edinburgh

De Bello F., Leps J. and Sebastia M.T., 2005. Do species and functional diversity indices reflect change in grazing regimes ans climatic condiions in northeastern Spain? XXth Int. Grassland Congress, 26 June-1 July, 2005 Dublin, Ireland, page : 620

Filet P.G., 1994. State and transition models for rangelands. 3. The impact of the state and transition model on grazing lands research, management and extension: A review. Tropical Grasslands Vol. 28:214-222

Güner A., Özhatay N., Ekim T. and Başer K.H.C., 2000. Flora of Turkey and the East Aegean Islands, (supple. 2), Vol. 11, Edinburgh Univ. Press., Edinburgh

Koç A., Gökkuş A. and Altın M., 2003. Comparison of commonly used determination methods of rangeland condition in the world and a suggestion for Turkey. Turkey V. Field Crops Congress, 13-17 October, Diyarbakır, p: 36-42

Koç A. and Çakal Ş., 2004. Comparison of some rangeland canopy coverage methods. Int. Soil Cong. On Natural Resource Manage. For Sustainable. Development, June 7-10, 2004, Erzurum, Turkey, D7, 41-45

Simpson E. H., 1949. "Measurement of diversity". Nature 163:(4148):688 doi:10.1038/163688a0

Ünal S., Mutlu Z., Mermer A., Öztekin U., Ünal E., Aydoğdu M., Dedeoğlu F., Özaydın K. A., Avağ A., Aydoğmuş O., Şahin B. and Arslan S., 2012a. A study on assessment of rangelands in Ankara Province. Journal of Field Crops Central Research Institute 21 (2): 41-49

Ünal S., Mutlu Z., Mermer A., Öztekin U., Ünal E., Özaydın K.A., Avağ A., Yıldız H., Aydoğmuş O., Şahin B. and Arslan S., 2012b. A study on determination of condition and health of rangelands in Çankırı Province. TABAD-Research Journal of Agricultural Sciences 5(2):131-135. (Prof Dr. Selahattin İptaş Agricultural Congress)

Ünal S., Mutlu Z., Öztekin U., Hakan Y. and Şahin B., 2013. Evaluation and determination of rangeland vegetation in Kayseri Province. Journal of Field Crops Central Research Institute 22 (2): 86-95

Ünal S., Mutlu Z., Öztekin U., Hakan Y., Aydoğdu M., Şahin B., and Arslan S., 2014. improvement possiblities and effects of vegetation subjected to long-term heavy grazing in the steppe rangelands of Sivas. Journal of Field Crops Central Research Institute 23 (1): 22-30

West N.E., 1993. Biodiversity of rangelands. J. Range Manage. 46 (1): 2-13