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INTERPRETATIONS OF VEGETATION CHANGES OF SOME VILLAGES RANGELANDS IN ÇANKIRI PROVINCE OF TURKEY

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ABSTRACT

Long term mismanagement of the rangelands resulted in serious rangeland deterioration throughout Turkey. Monitoring of rangelands provides information on the status and dynamics and measures how to deal with different problems encountered. In many studies ecological interpretations are based on the observation of plant species existing on the rangeland vegetation type. The objective of this study was to determine the status and make ecological interpretations on three step rangelands of Bakırlı, Gündoğmuş, and Karaören villages of Çankırı province in the highlands of Central Anatolia. The rangeland conditions and health classes of rangelands were found the same as good and unhealthy in Bakırlı, and Gündoğmuş sites, but they were fair and unhealthy in Karaören site, respectively. Correspondence Analysis with four axis explained 55.9 % of the variance of species data and Canonical Correspondence Analysis explained 38.5 % of the variance of species data and 90.8 % of species-environment relationship. Sound management techniques could be immediately implemented for the improvement and the manipulation of the study rangeland sites.

Key words: rangeland conditions, rangeland health, correspondence analysis, canonical correspondence analysis.

INTRODUCTION

Monitoring and assessing are the first step to interpret of ecological situation of rangeland vegetation. For this purpose, various models have been developed for the ecological assessment of rangeland vegetation changes. Ecological approaches and interpretations are mainly based on the characteristics of plant species existing on rangeland vegetation. Plant species disparately responses to different management techniques. The understanding of vegetation changes on rangelands is possible to realize and explain with the changes within a historical and present framework of rangeland use. Many papers have contributed significantly to an appreciation and understanding of the broad patterns of vegetation change as well as species reactions to environmental and management factors (Bosch and Gauch, 1991; Bosch, and Kellner, 1991; Robin et al. 1993; Öztaş et al. 2003; Holechek et al. 2010).

Models have been commonly used for assessments and interpretations of rangeland studies. Models contain a system of concepts or assumptions, and data collection that all assembled information is used to arrive at sound management decisions (Westoby et al. 1989). The range succession model, its concept backed to the climax and succession theory of Clements (1916), was first proposed by Dyksterhuis (1949) and was, at that time, relevant tie between the current ecological ideas and the concepts of range condition (Laycock, 1991).

Rangelands of Turkey have been misused such as early, late and heavy grazing for long time (Bakır 1987, Koc et al. 2000). Hence, monitoring and evaluating of chances in vegetation are principally and commonly accepted as significant functions and actions. There is also serious lack of information on the vegetation change processes of rangeland habitat and rangeland degradation. Rangeland condition and health are significant tools to describe the rangeland status. In addition to the studies of models constructed based vegetation changes on rangelands in Turkey should be used and improved for sound management techniques and understanding of ecological aspects.

Many techniques are based on a subjective method involving species response to grazing, and vegetation dynamic processes (Bosch and Kellner, 1991). For instances, Correspondence analysis (CA), and Canonical correspondence analysis (CCA) have been used with data sets for existing sites, species, and environmental variables (Manly, 1995). Ordination based plant species and sites models were utilized for assessing and interpreting changes on rangeland vegetation of the selected three villages.

The aims of this study are (1) to determine the rangeland condition by range succession model and health, (2) to observe species, sites and environmental features in a graph or an ordination gradient, (3) and to make interpretations on the changes on vegetation of rangelands ordination techniques.

MATERIALS AND METHODS

Study Area

The study area is included three different sites (villages) named as Bakırlı (40 ^{0} 28 ^{l} 04 ^{ll} N and 33 ^{0} 22 ^{l} 41^{ll} E), Gündoğmuş (40 ^{0} 26 ^{l} 03 ^{ll} N and 33 ^{0} 10 ^{l} 27^{ll} E), and Karaören (40 ^{0} 32 ^{l} 31 ^{ll} N and 33 ^{0} 13 ^{l} 12^{ll} E) of Şabanözü town in the province of Çankırı. The altitudes of the study sites range between 1080 m and 1168 m. Long term precipitation average is 436.9 mm which was 346.2 mm in the survey year (2004) (figure 1) (Anonymous, 2005). Long term average temperature is 11.11 ^{o} C and that was 11.03 ^{o} C in the survey year (figure 2). The long term average relative humidity is 67.7 % and 63.6 % in the survey year. According to Thornthwaite method, Central Anatolian plateau is described as extremes of hot summers and cold winters with limited rainfall (Sensoy et al. 2008).

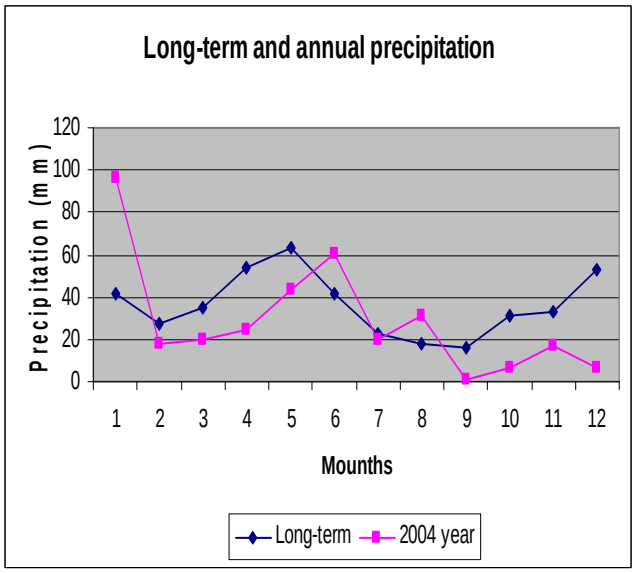


Figure 1. Precipitation average of long term and 2004 year

The procedure for physical and chemical analysis of the soils in the study areas is summarized as follows. Particle size distribution was determined by hydrometer method (Bouyoucos, 1951) , bulk density by the core method (U.S. Salinity Lab. Staff, 1954), soil moisture content at sampling by the gravimetric method (Tüzüner, 1983), organic matter by the Walkley Black method (Richards, 1954), $CaCO_3$ content using the Scheibler calcimeter (Çağlar, 1949) and plant available – P by the Olsen method (Olsen et al. 1954).

In grazed site soils of flat area had a clay texture, neutral pH (7.5), lime ratio (1.76 %), poor phosphorous (12.4 kg/ha), rich potassium contents (630 kg/ha), low organic matter content with only 0.69 percent portion. In grazed experimental area at the mountainous area, soil possessed a clay and clay loam texture, slightly alkaline p H (8.0), and neutral p H (6.88), lime ratio (4.17 %), and phosphorous contents varied from poor (15.5 kg/ha) to high (79.2 kg/ha), high potassium (1268.4 kg/ha-1305.5 kg/ha) and low organic matter (0.68-1.71 %) contents (Anonymous, 2004).

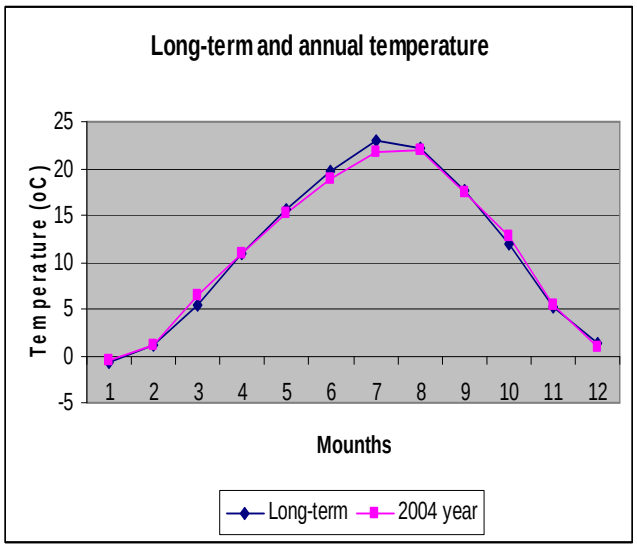


Figure 2. Temperature average of long term and 2004 year

Sampling

The sample sites were firstly selected in the area to represent different states of vegetation condition. Obvious differences in vegetation composition that were otherwise environmentally similar (e.g., with regard to slope, aspect, altitude) were regarded as different conditional states induced by management. The vegetation was sampled along randomly placed transects of varying length and spacing, depending on the available area for sampling.

A modified Wheel Point Method with Loop (Koç ve Çakal, 2004) was used to determine the plant basal area of existing species on rangeland vegetation and bare ground at the fixed sites .

A vegetation survey was carried out in these sites (villages) with the plot numbers following as 5, 8 and 10 , respectively. Two transects of each plots were undertaken of 100 m long distance, one meter distance between them and 100 points were recorded on each one (total 200 points). The percentage cover for each species was determined as the proportion of number of strikes on each species and the total strikes recorded at each site. The appropriate number of points for the surveys was determined before fieldwork and in all cases 200 points were accepted to account adequately for within-plot heterogeneity (Gibson and Bosch, 1996). Study sites had never received fertilizer or seed. Vegetation survey work was conducted during June 2004.

In addition, habitat factors (altitude, aspect, slope) and impact of rangeland use (grazing intensity [1-5, not to severely grazed]) with soil features and erosion influence (1-5, not to severely eroded), soil compactness (1-5, not to severely compacted) were recorded for each sample plots.

Data Analysis

All data were analyzed with available computer software programs. The determination of rangeland condition and health were obtained from vegetation coverage. Vegetation survey was made and plant species and environmental variables were recorded in two forms of site information and vegetation survey.

The rangeland condition (only cover of decreasers and increasers used) and health (vegetation cover **)** of villages were calculated with the basal cover of rangeland vegetation. All plant species were classified into three groups as decreasers, increasers and invaders (Anonymous, 2008). Rangeland condition was rated as poor (1-25 %), fair (26-50 %), good (51-75 %) and excellent (76-100 %). Rangeland health was ranges in one of three categories: healthy (>76 %), at risky (56-75 %), and unhealthy (55 % >) (Koç et al. 2003).

Ordination (correspondence analysis) procedure of multivariate statistical methods was used for the development of ecological condition assessment methodologies (Manly, 1995).

Canonical correspondence analysis (CCA) which is a simple method for arranging species along environmental variables for analyzing and visualizing the relationships between many species and many environmental variables. CCA considerably extends the analytical power of ecological ordination (Ter Braak, 1987). Outcomes from ordination analysis can utilize the states framework to present a description of surveyed vegetation (Bosch and Kellner, 1991; Filet, 1994).

Table 1. Rangeland conditions and rangeland health values of sites

	Bakırlı site	**Gündoğmuş site**	**Karaören site**
Decreasers (%)	38.22	19.94	14.79
Increasers (%)	**44.14**	**62.40**	**64.06**
Invaders (%)	20.44	2.45	13.40
Range condition score *	60.30	51.14	46.82
Range condition	Good	Good	Fair
Canopy cover (%)	48.37	24.97	37.53
Rangeland health	Unhealthy	Unhealthy	Unhealthy

(*) Range condition score = **Decreasers (%) + Increasers (%)**

RESULTS

Rangeland condition and health

Rangeland condition and health in Bakırlı site found as good and unhealthy, respectively (Table 1). The decreaser and increaser plant species played an important role for the determination of rangeland condition (Table 2). The percentages of decresears and increasers were 38.22 % and 44.14 %, respectively. A few samples as the decreasers of legumes and grasses were *Medicago varia, Lotus corniculatus*, and *Agropyron cristatum, Dactylis glomerata, Hyparhaenia hirta*, respectively.

Table 2. Decreaser, increaser and invader plant species of three units

Decreaser	Increaser	Invader
Bakırlı site		
Plots 1-6 (transect lines 1-12)		
Medicago varia Trifolium spp.	*Cynodon dactylon*	*Medicago minima*
Lotus corniculatus	*Festuca ovina*	*Trigonella* spp.
		Alyssum linifolium
Agropyron cristatum	*Poa bulbosa*	*Teucrium chamaedrys*
Dactylis glomerata	*Stipa holosericia Artemisia fragrans*	*Astragalus barbajovis*
Hyparhaenia hirta	*Convolvulus* spp. *Plantago* spp.	*Bromus tectorum*
Hordeum bulbosum Koeleria cristata Lolium		*Juncus heldreichianum*
perenne		*Bromus japonicus*
Phleum pratense		*Eryngium campestre*
		Euphorbia macroclada
		Anthemis wiedemanniana
		Circium vulgare
Gündoğmuş site		
Plots 7- 14 (transect lines 13-28)		
Decreaser	Increaser	Invader
Onobrychis arenaria	*Cynodon dactylon*	*Peganum harmala*
Agropyron cristatum Poa pratensis	*Poa bulbosa*	*Juncus heldreichianum*
	Stipa holosericia Artemisia fragrans Thymus squarrosus	
Karaören site		
Plots 15-22 (transect lines 29 - 44)		
Decreaser	Increaser	Invader
Agropyron cristatum	*Festuca ovina*	*Aegilops umbellulata*
Hyparhaenia hirta Koelaria cristata	*Stipa holosericia*	*Alyssum pateri*
Medicago varia Trifolium spp.	*Thymus squarrosus*	*Astragalus strictispinus*
Lotus corniculatus		*Elymus caput-medusae*
		Eryngium campestre
		Medicago minima
		Phlomis armenica
		Teucrium polium
		Trigonella monspeliaca

Rangeland condition and health of Gündoğmuş site appeared as good and unhealthy, respectively (Table 1). In the site of Gündoğmuş, it was recorded the occurrence of decreaser plant species such as *Agropyron cristatum, Poa pratensis, Onobrychis arenaria,* and increaser as *Cynodon dactylon, Artemisia fragrans* and *Thymus squarrosus* and invader plant species of *Juncus heldreichianum* (Table 2).

Rangeland condition and healthy obtained as fair and unhealthy in Karaören site, respectively (Table 1). In this village, it was recorded the existence of decreaser plant species such as *Agropyron cristatum, Hyparhaenia hirta, Medicago varia* and *Lotus cornicultus, Trifolium* spp. and increaser as *Festuca ovina, Koeleria cristata , Stipa holosericea* and *Thymus squarrosus* (Table 2).

The percentages of canopy cover of Bakırlı, Gündoğmuş, and Karaören sites were 48.37 %, 24.97 %, and 37.53 %, respectively. According to the description of Koç et al. (2003), rangeland health values of all three sites were an unhealthy.

Ordination without environmental variables

Indirect gradient analysis with correspondence analysis produced eigenvalues of 0.862, 0.579, 0.394, 0.343 for the first four axes respectively. Total inertia was 3.897 that meant total variance in dataset. The eigenvalue represents the variance in the sites x species data set that is attributed to a particular axis (Jongman et al. 1995). In the study, the four axes explained 55.9 % of the cumulative variance in the community matrix (Table 3). The first axes only explained 22.1 % of the cumulative variance in the species data.

Table 3. The results of Correspondence Analysis of species and sample plots

Axes	1	2	3	4	Total inertia
Eigenvalues	0.862	0.579	0.394	0.343	3.897
Cumulative percentage variance of species data	22.1	37.0	47.1	55.9	
Sum of all eigenvalues					3.897

Species and sites appeared on the ordination gradient suggested that rangeland sites with the same plant species matched each other and formed the three groups (units) (Figure 3), such as: *Poa bulbosa, Stipa holosericea, Artemisia fragrans* formed the first group of the site 7-14 (unit two)*; Agropyron cristatum, Thymus squarrosus* formed the second group of sites 7-14 (unit two); and finally *Festuca ovina, Koelaria cristata, Agropyron cristatum, Medicago varia, Astragalus spp.* sites formed the third group of the 16-23 (unit one (sites 1-6) and unit three (sites 15-22) (Figure 3).

Ordination with environmental variables

Direct gradient analysis with Canonical Correspondence Analysis produced species-environment correlations, cumulative percentage variance of species-environment relation and sum of all canonical eigenvalues (Table 4). Sum of all eigenvalues and sum of all canonical eigenvalues were 3.897 and 1.651, respectively. Species-environment correlations were obtained as 0.962, 0.883, 0.866 and 0.812

Table 4. The results of Canonical Correspondence Analysis of species, sample plots and environmental variables

	Axes				
					Total inertia
	1	2	3	4	
Eigenvalues	0.782	0.289	0.246	0.182	3.897
Species-environment correlations	0.962	0.883	0.866	0.812	
Cumulative percentage variance of species data	20.1	27.5	33.8	38.5	
Cumulative percentage variance of species-environment relation	47.4	64.8	79.8	90.8	
Sum of all eigenvalues					3.897
Sum of all canonical eigenvalues					1.651

for axis 1, 2, 3, and 4, respectively. The axis one explained 20.1 and 47.4 % of the cumulative percentages of variance of species data and species-environment relation, respectively. The four axes explained 38.5 and 90.8 % of the cumulative percentages of variance of species data and species-environment relation, respectively.

Relationships of Sites, Species and Environmental Variables

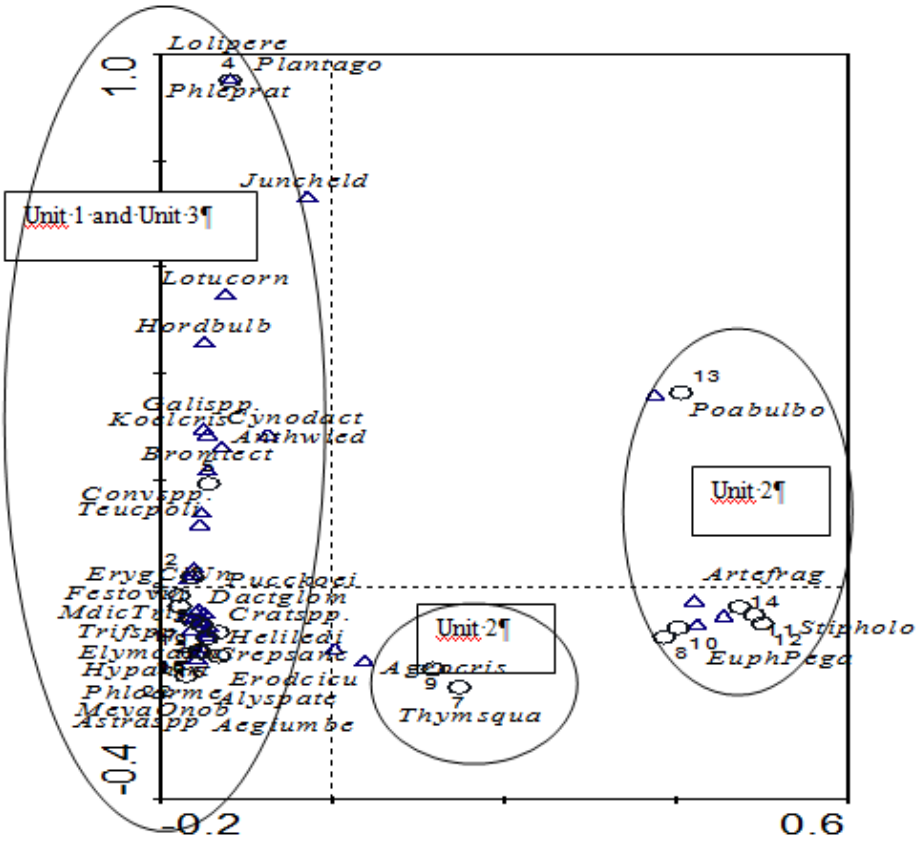
Relationships of sites, species and environmental variables are significant for the interpretation of the ecological assessment of rangelands (Figure 4).

Altitude placed in an opposite side of a groups of environmental variables such as grazing intensity, erosion, aspect (which were the same dimensions and the similar relations) in the graph. This means that altitude has adverse relationship of them. In addition to this increasing altitude clearly seemed the decreasing of grazing intensity and erosion impact.

Increaser plant species *Poa bulbosa* had a close relationship with grazing intensity. Slope and altitude were closely and positively related to some species such as *Medicago varia, Onobrychis arenaria,* and *Festuca ovina*

(Figure 4). Low grazing impact stimulated to increase the rate of increaser plant species.

Sites 16, and 22 were in the high slope areas. Some environment factors such as grazing intensity and soil erosion appeared at the similar sites to 8, 10 ,11,12 ,13, and 14 . Sites 7 and 9 had the same aspect.

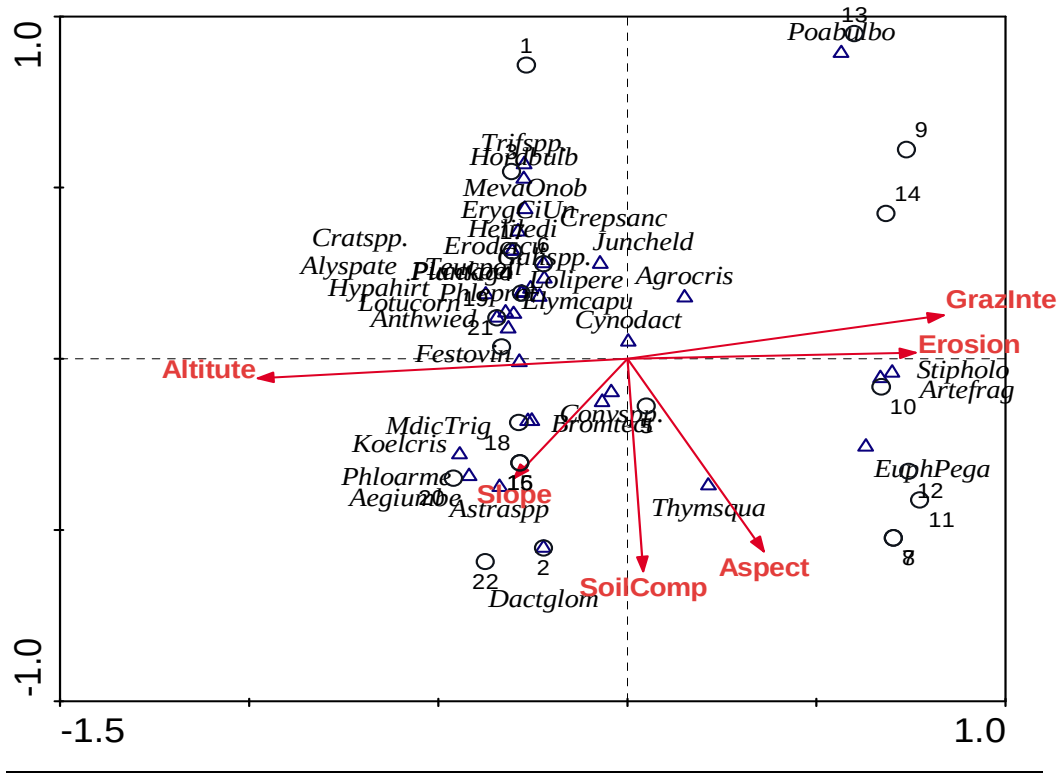


Good	Fair	Good	**Range condition***

(**) Unit 1= Bakırlı site, Unit 2= Gündoğmuş site, Unit 3= Karaören site

* **species explanations**	Festovin: *Festuca ovina*
Aegiumbe: *Aegilops umbellulata*	Galispp. : *Galium incanum, G. floribundum*
Agrocris: *Agropyron cristatum*	Heliledi : *Helianthemum ledifolium*
Alyspate. : *Alyssum pateri*	Hordbulb : *Hordeum bulbosum*
Anthwied :*Anthemis wiedemanniana*	Hypahirt :*Hyparhaenia hirta*
Artefrag : *Artemisia fragrans*	Juncheld: *Juncus heldreichianum*
Astraspp: *Astragalus strictispinus Astragalus barbajovis, Astragalus* lycius	Koelcris : *Koelaria cristata*
	Lolipere: *Lolium perenne*
Bromtect: *Bromus tectorum*	Lotucorn : *Lotus corniculatus*
ErygCiUn : *Eryngium campestre, Circium* spp., Unknown	MdicTrig :*Medicago minima, Trigonella fischeriana T. monspeliaca*
Juncheld: *Juncus heldreichianum*	
Convspp. : *Convolvulus* spp.	MevaOnob : *Medicago varia, Onobrychis arenaria*
Cratspp. :*Crataegus* spp.	Phleprat: *Phleum pratense*
Crepsanc : *Crepis* sancta	Phloarme: *Phlomis armenica*
Cynodact : *Cynodon dactylon*	Plantago : *Plantago* spp.
Dactglom : *Dactylis glomerata*	Poabulbo: *Poa bulbosa*
Elymcapu: *Elymus caput-medusae*	Pucckoei : *Puccinallia koeieana*
Erodcicu : *Erodium cicutarium*	Stipholo : *Stipa holosericea*
EuphPega : *Euphorbia macroclada, Peganum harmala*	Teucpoli : *Teucrium polium*
Festovin : *Festuca ovina*	Thymsqua *Thymus squarrosus*
Aegiumbe : *Aegilops umbelilata*	Trifspp. : *Trifolium* spp.

Figure 3. Correpondence Analysis biplot of species and sample plots and comments of the current situation (*)(**)



***** Species explanations in Figure 2

SoilComp= Soil compaction
Grazinte= Grazing intensity
Erosion= Soil erosion

Figure 4. Canonical Correspondence Analysis triplot of species, sample plots, and environmental variables *

DISCUSSION

Rangeland condition and health

Each sites were individually evaluated for rangeland health and condition. Good, and fair sites of rangeland conditions were determined in the study sites. Rangeland conditions in Bakırlı, and Gündoğmuş sites were found as good, but that in Karaören site was fair.

All sites were found as unhealthy with respect to rangeland health. The decreaser plant species such as *Medicago varia, Lotus corniculatus, Agropyron cristatum, Koelaria cristata and Hyparhaenia hirta* were detected in Bakırlı and Gündoğmuş sites more than those in Karaören site. Thus, range condition scores in Bakırlı and Gündoğmuş sites were higher than those in Karaören site. There appeared a range of differences on the distribution of plant species among the sites. While *Agropyron cristatum* was seen in Gündoğmuş site, *Dactylis glomerata* was seen only in Bakırlı site.

The increaser grasses as *Festuca ovina*, and *Stipa holosericea* were detected in Bakırlı and Karaören. In the site of Gündoğmuş, it was observed the occurrence of decreaser plant species such as *Poa pratensis, Onobrychis arenaria*, and increasers as *Cynodon dactylon*, and *Artemisia fragrans* and invader plant species of *Juncus heldreichianum* and *Peganum harmala. Thymus squarrosus* was found in Karaören and Gündoğmuş sites. Some plant species as *Festuca ovina, Koeleria cristata, Onobrychis arenaria, Cynodon dactylon, Artemisia fragrans* and *Thymus squarrosus* were recorded in the previous studies of rangelands of Central Anatolian (Bakır,1970; Özmen, 1977).

The plant species of *Cynodon dactylon* as a grass, *Artemisia fragrans* as shrub which commonly dominate this region described by Bakır (1970); Özmen (1977) and Tokluoğlu (1979).

Grazing impact influences first decreaser plant species, latter it effects increaser plants. Continuous uncontrolled grazing causes to disappear desirable plants over time. At the same period, the percentages of bare ground and invader plants seem to increase on botanical composition, therefore, these properties can be considered early indicators of degradation on rangeland vegetation. Therefore, the determination of the current condition of rangeland vegetation is an effective tool for decision makers with respect to preserving and improving of appearing status of range site. Degraded rangelands are tended to soil erosion, losing biodiversity, damaging wildlife habitat (Holechek et al. 2010).

The assessment of plant composition of rangeland on the certain intervals is important to monitor and distinguish changes in vegetation over time on the same site. Majority of

Turkey rangelands as seen in this study sites are also in poor or fair condition because of continuing mismanagement techniques on the rangelands for long time (Koç et al. 2000; Çakal et al., 2007; Şimşek et al., 2007) and it can be concluded that this situation indicates a failure of current management and a need for good management practices.

Ordination without environmental variables

Indirect gradient analysis with correspondence analysis indicated that there were relations between species and sites (Figure 3). Species and sites appeared on the ordination gradient suggested that rangeland sites with the same plant species matched each other and formed the three groups (units), as follows: *Poa bulbosa, Stipa holosericea, Artemisia fragrans* formed the first group in Gündoğmuş site*; Agropyron cristatum, Thymus squarrosus* formed the second group in Gündoğmuş site; and finally *Festuca ovina, Koeleria cristata, Agropyron cristatum, Medicago varia, Astragalus spp.* species formed the third group in Bakırlı and Karaören sites.

As observed the placing of units in the ordination gradient, unit one and three were almost in the same vertical position, but unit two seemed completely in a different place. So Gündoğmuş site was degraded rangeland and poor condition. In Gündoğmuş site, there appeared considerably the high percentage abundance of shrub plant species in botanical composition.

All range sites seemed to have enough decreaser plant species to natural recovery thus sound management applications should be performed to maintain and improve the range condition. If the density of desired plant species in the botanical composition is 25 percent or higher, this is considered as critical density for the desired plant species to recover in the natural rangelands (Vallentine, 1989; Altın et al. 2005).

As going to right side of the ordination axis, bare ground and invader plant species as *Euphorbia macroclada, Peganum harmala, Juncus heldreichianum* increase thus the rangeland deterioration triggers to increase the soil erosion (Figure 3).

The survey results of the unit two indicated that the mismanagement or misuse of rangeland caused the high rate occurrence of shrub species in botanical composition, after that herbaceous plants dominated vegetation converted into shrub plant species. These chances can be considered as an indicator of degradation for desertification. Similar findings and thoughts were previously expressed for the change of rangeland vegetation (de Soyza et al. 2000).

Ordination with environmental variables

Direct gradient analysis with Canonical Correspondence Analysis explained the variations of the species–environment and the species. Moreover, the influences of environmental factors clearly appeared on the sites and the species. There became different species and sites on the various factors. Changes in environmental conditions can potentially change dominance patterns and species composition, effectively changing the habitat type or potential natural community (Robin et al. 1993).

Relationships of Sites, Species and Environmental Variables

The interpretation of the ecological assessment of rangelands should be based upon the relationships of sites, species and environmental variables (Figure 4). The most productive information could be produced on basis of these relationships.

The opposite relationships were found between altitude and some environmental variables such as grazing intensity, erosion, aspect on the observation in the figure 4. The grazing intensity, erosion and aspect of environmental factors have close relationships that means high or low grazing intensity reasons for high or low soil erosion (Koç et al. 2008).

Stipa holosericea, Artemisia fragrans, Peganum harmala, and *Euphorbia macroclada* had a close relationship with grazing intensity and soil erosion. Moreover, desirable plant species (decreasers and increasers) were in opposite sites of grazing intensity and soil erosion. This relation indicated that grazing management and measure for soil erosion were extremely important considerations for rangeland vegetation in the future uses. Under the semi-arid rangeland condition, controlled (protected) grazing system is more useful for rangelands instead of completely closed grazing system that doesn't support any benefits for rangelands (Holechek et al. 2010).

Slope and altitude were closely and positively related to some species such as *Koeleria cristata, Dactylis glomerata* and *Festuca ovina* (Figure 4). Decreasing grazing intensity encourages the high percentages of decreasers species in the botanical composition (Bakır,1999). Traditional grazing management practices in villages generally causes seriously rangeland degradation around the settlement (Sürmen, 2004; Koç et al. 2008). This situation caused to disappear desirable plant species. For this reason, some measures should be immediately taken to improve rangeland condition.

CONCLUSION

In this study, the rangeland conditions and health classes of rangelands were found as good and unhealthy in Bakırlı, and Gündoğmuş sites, but they were fair and unhealthy in Karaören site. Rangelands of each sites need the implementation of the suitable management and improvement techniques.

The chances on rangelands and their relations with environmental factors were determined with the use of ordination techniques, consequently it is possible to make ecological interpretations on the rangeland such as appearing close relationship between grazing intensity and soil erosion. Further studies contribute to obtain more valuable comments and conclusions on steppe vegetation of the Central Anatolia Region.

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LITERATURE CITED

Altın, M., Gokkus, A. and Koc, A. 2005. Range and Meadow Improvement and Development. The Turkish Ministry of Agriculture and Rural Affairs.

Anonymous, 2004. Soil analysis results of village rangelands. Central Soil, Fertilizer and Water Resources Research Institute, Ankara .

Anonymous, 2005. The climatic data of the Çankırı Province for long term (1975-2003) and 2004 year. The General Director of State Meteorological, Annual Climatic Observation Table.

Anonymous, 2008. Meadow and Range Plants Handbook. The General Directorate of Agricultural Production and Improvement, The Turkish Ministry of Agriculture and Rural Affairs.

Bakır, Ö. 1970. A Rangeland vegetation survey in the field of Middle-East Technical University. Ankara University, Agricultural Faculty Presses,382. Ankara.

Bakır, Ö. 1987. Rangeland Condition and Classification. Pasture – Meadow Management . Ankara University, Agricultural Faculty Presses, 992, pg. 270-306.

Bakır, Ö. 1999. Grazing Capacity. The Rangeland Act , Training and Application Hand Book 1, The General Directorate of Agricultural Production and Improvement, The Turkish Ministry of Agriculture and Rural Affairs, pg. 181- 206.

Bosch, O.J.H. and H.G. Gauch, 1991. The use of degradation gradients for the assessment and ecological interpretation of rangeland condition. Tydskrif Weidingsveren . S. Afr., 8 (4).

Bosch, O.J.H. and K Kellner, 1991. The use of a degradation gradients for ecological interpretation of condition assessments in the western grassland biome of southern Africa. Journal of arid Environments, 21: 21-29.

Bouyoucos, J.G. 1951. Recalibration of hydrometer for making mechanical analysis of soils. Argon J., 43:434-437.

Çağlar, K. 1949. Soil Science. Ankara University, Agricultural Faculty Presses, 985, Ankara.

Çakal, S., U. Şimşek, M.M. Özgöz, S. Dumlu, and E. Aksakal, 2007. Application projects on rangeland improvement and management on rangelands of the Eastern Anatolia Region under the framework of the number of 4342 rangeland act. Turkey VII. Field Crops Congress, , 25-27 June, Erzurum, p. 260-263.

de Soyza AG, Van Zee JW, Whitford WG, Neale A, Tallent-Hallsel N, Herrick JE, Havstad KM. 2000. Indicators of Great Basin rangeland health, *Journal of Arid Environments* 45: 289-304.

Filet, 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.

Gibson R.S. and O.J.H. Bosch 1996. Indicator species for the interpretation of vegetation condition in the St Bathans area, Central Otago, New Zealand. New Zealand journal of ecology , vol.20. No.2.

Holechek, L. J., R. D. Pieper and C. H. Herbel, 2010. Range Management, Principles and Practices (6thEdition). Pearson Education, Inc., Upper Saddle River, New Jersey, 456 p.

Jongman R., C.J.F. Ter Braak and O.F.R. Tongeren, 1995. Data Analysis in Community and Landscape Ecology. Cambridge University Press, Cambridge, UK.

Koç, A., T. Öztaş, and L. Tahtacıoğlu, 2000. Rangeland – Interaction in our Near History Problems and Recommendations. Proc. Intern. Symp. Desertification, 13-17 June, 2000, Konya, Turkey, p. 293-298.

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

Koç, A., H.İ. Erkovan, and Y. Serin, 2008. Changes in vegetation and soil properties under semi-nomadic animal raising areas in highlands, rangelands of Turkey. Current World Environ., 3: 15-20.

Laycock W. A. 1991. Stable states and thresholds of range condition on North American rangelands: A viewpoint. Journal of Rangeland Management, 44: 427-433.

Manly, B. F. J. 1995. Cluster analysis. Multivariate Statistical Methods. A primer Second edition Department of Mathematics and Statistics University of Otago, New Zealand. P. 128-145.

Olsen, S.R., C.V. Cole, F.S. Watanebe, and L.A. Dean, 1954. Estimation of available

phosphorus in soil by extraction with sodium bicarbonate. USDA Circular No.939 Washington DC.

Özmen, T. 1977. The trials on the vegetation of the rangeland in Konya Province PHD thesis (not printed),

Rangeland –Meadow and Livestock Research Institute, Ankara.

Öztaş T., A. Koç and B. Çomaklı, 2003. Changes in Vegetation and Soil Properties Along a slope on Overgrazed and Eroded Rangelands. J. Arid Environ. 55: 93-100.

Richards, L.A Ed. 1954. Diagnosis and Improvement of Saline and Alkali Soils. United States Department of Agriculture Handbook 60:94.

Robin J. T., P. E. Wigand, and J. W. Burkhardt, 1993. Viewpoint: Plant community thresholds, multiple steady states, and multiple successional pathways: legacy of the Quaternary? Journal of Rangeland Management, 46: 439-447.

Sensoy S., D. Mesut, U. Yusuf , and B. İzzet , 2008. Climate of Turkey. Turkish State Meteorological Service, P.O. Box: 401, Ankara, Turkey.

Sürmen, M., 2004. Vegetation chances related to the distances from Kümbet village center (Erzurum Province) (Master thesis). Atatürk University, The Graduate School

of Natural and Applied Sciences, Field Crops Department, Erzurum.

Şimşek, U., Ş. Çakal, M.M. Özgöz, S. Dumlu, and E. Aksakal, 2007. Determination of Rangelands of Horasan and Köprüköy Towns in Erzurum Province with use of remote sensing and geographic information system. Turkey VII. Field Crops Congress, , 25-27 June, Erzurum, p. 366-369.

Tamzen K. S., W. C. Krueger, and P.L. Shaver, 2003. State and transition modeling: An ecological process approach. Journal of Rangeland Management, 56: 106-113.

Ter Braak, C. J. F., 1987. The analysis of vegetation-environment relationships by canonical correspondence analysis . Vegetatio 69:69-77.

Tokluoğlu, M. 1979. Studies on morphological, biological and agronomical important characters of some rangeland plants . Ankara University, Agricultural Faculty Press no: 728, Ankara.

Tüzüner, A. 1983. The assessment methods of soil moisture. Central Soil, Fertilizer and Water Resources Research Institute, press no: 118, Ankara.

U.S. Salinity Laboratory Staff, 1954. Diagnosis and Improvement of Saline and Alkali soils. USDA Agricultural Handbook, 60.

Vallentine J.F., 1989. Range Development and Improvements (3 rd Ed.) Academic Press Inc., San Diego, California, 524 p.

Westoby M, B. Walker and I. Noy-Meir, 1989. Opportunistic management for rangelands not at equilibrium. Journal of Range Management, 42: 266-274.