The Use of Indicator Species and Ecological Degradation Model for Rangeland Condition Assessment in Turkey

*Sabahaddin ÜNAL[1], Bilal ŞAHIN[3], Öztekin URLA[2], Berna EFE[2]

[1]Abant İzzet Baysal University, Faculty of Agricultural and Natural Sciences,
Field Crops Department Gölköy, Bolu
[2]Central Field Crop Research Institute, Şehit Cem Ersever Cad. No: 9-11, Yenimahalle, Ankara
[3]Yapraklı Vocational High School, Çankırı Karatekin University, Çankırı, Turkey

Sorumlu yazar e-posta (Corresponding author; e-mail): sabahaddin04@yahoo.com

Abstract

Monitoring of vegetation change is essential to detect good management practices for the sustainable use of natural rangeland resources. An understanding of how the existing species in vegetation react to management methods is important for decision makers. For this reason, the vegetation changes should be determined by suitable techniques. The multivariate analysis as Detrended Correspondence Analysis and Principal Components Analysis was highly examined and its results were easily interpreted to draw conclusions. A relatively homogenous data set first, a matrix of 221 species and 44 sample sites in the province of Yozgat in the Central Anatolia Region in year 2010, was used by detrended correspondence analysis (DCA). The effects of environmental variation was minimized by this method (DCA) so that the major pattern of vegetation composition change was explained by grazing impact. Principal components analysis was performed to detect the distribution of sites along the first axis, and the distance off the x-axis. Fifteen species out of the promising 89 plant species were found to be indicators. These indicator species should be benefited for the vegetation change status and sustainable rangeland management under semiarid rangeland conditions. The fifteen plant species and bare ground showed clear responses along the first axis (grazing impact gradient), and became abundant over certain ranges of this axis.

Keywords: Monitoring, grazing impact, ecological model, sustainable rangeland management.

Türkiye'de Mera Durum Değerlendirmesi için İndikatör Tür ve Ekolojik Bozulma Modeli Kullanımı

Öz

Doğal mera kaynaklarının sürdürülebilir kullanımında iyi mera yönetim uygulamalarının belirlenmesi için vejetasyon değişiminin izlenmesi hayati bir önemdedir. Vejetasyondaki her bir türün, en azından yaygın bulunan türlerin, amenajman uygulamalarına nasıl tepki verdiğini anlama, karar vericiler için mükemmel bir araçtır. Bunun için vejetasyon değişiminin değerlendirilmesinde Doğrusal Olmayan Ana Bileşenler Analizi ve Ana Bileşenler Analizi gibi çoklu değişken analizleri oldukça faydalıdır. 2010 yılında ilk olarak Orta Anadolu Bölgesinde Yozgat iline ait 44 örnek durakta saptanan ve 221 tür içeren veri matriksinde Doğrusal Olmayan Ana Bileşenler Analizi kullanılmıştır. Bu metod ile çevresel değişim etkileri minimize edilmiş ve böylece vejetasyon değişim kompozisyonunun ana yapısı otlatma etkisiyle açıklanmıştır. Birinci eksen boyunca durakların dağılımının ve bu eksene uzak durakların belirlenmesi için PCA kullanılmıştır. Birinci eksen (otlatma etki ekseni) boyunca 15 bitki türü ve boş alan açık bir tepki gösterdi ve bu eksenin belirli bölgelerinde yoğunlaşma meydana geldi. Bitki türlerinden ümitvar 89 bitki türünden yalnız 15 bitki türü indikatör olarak bulunmuştur. Bu indikatör türler yarı kurak mera şartlarında mera değişim durumu ve sürdürülebilir mera yönetimi için kullanılabilir.

Anahtar Kelimeler: İzleme, otlatma etkisi, ekolojik model, sürdürülebilir mera yönetimi.

Introduction

The range monitoring studies are mainly focus on describing and detecting the best management techniques which include range improvement and maintenance methods. Monitoring and assessing of present status are therefore integral parts of the best or the sustainable range management. Numerous trials have been accomplished for achieving these objectives so that the useful approaches were adopted such as models, assumptions, and hypothesizes.

The recent development of the research on range ecosystem are based on using the two important tools of monitoring and assessing practices (Hurt and Bosch 1991; Gibson and Bosch 1996; Herrick et al. 2006).

Monitoring gives us opportunities as decision making and range wide new knowledge (Gibson et al. 1995). De Soyza et al. (2000) expressed that vegetation change of rangelands is an even earlier indicator of the potential for ecosystem change and deterioration which are ascribed to combinations of environmental (e.g. recurrent drought) and anthropogenic factors such as over-grazing and mismanagement of rangelands.

The vegetation change is closely linked to the management practices and its history. Hence the rangeland resource status should be repeatedly monitored over time. The main significant subjects in monitoring programs are mentioned following as being fast and sensitive to vegetation change, the trend identification, and the evaluation of sustainable management implementations, respectively. Jacobo et al. (2006) emphasized that the impact of grazing on community structure and ecosystem functioning is a key issue for range management in order to maximize livestock production and sustainability of the operations.

Many studies were completed on plant response to grazing and determination of indicators (Wilson et al. 1988; Tamzen et al. 2003; Bashari 2006; Unal et al. 2013). Many vegetation scientists (Smith, 1988; Bosch, 1989; Wikeem and Pitt 1991; Tamzen et al. 2003) have recently improved the understanding of vegetation change in the world grassland, and interpreted some of the changes within a historical framework of rangeland use (Smith, 1988; Jameson, 1988; Friedel, 1991; Laycock, 1991; David et al. 2002; Bestelmeyer and Herrick 2004; Herrick et al. 2006). Early works included the observations of Cockayne (1920), Connor (1964), and Connor and Macrae (1969) on the response of species to grazing intensities in grasslands (Gibson and Bosch 1996; Oztas et al. 2003).

The modern condition assessment techniques need quantitative relationships of how species react to environmental and management factors, especially to grazing impact (Gibson and Bosch 1996). These relationships can be used for vegetation change, and serve as a basis for the objective condition assessment and interpretation of vegetation monitoring data (Bosch and Gauch 1991). Smith (1988), and Del Giorgio et al. (1991) pointed out that multivariate analysis has been used to assess impacts on site and habitat scales directly by analyzing temporal and spatial patterns (Cao et al. 2001).

The ordination techniques are highly beneficial to describe (ter Braak 1987; Jameson 1988; Fuhlendorf and Smeins 1997; Bashari 2006; Zemmrich 2007; Pietzsch 2008) and realize (Smith 1988; Jameson 1988; Fernandez-Gimenez and Allen-Diaz 2001; Bashari 2006) the grazing impact gradient through data representing differences in composition of plant species especially induced by grazing.

Plant species and indicator species were variously assessed and interpreted by vegetation scientists for their ideas and reviews. For examples, Inam-ur-Rahim and Maselli (2004) pointed out that indicators play a fundamental role in sustainable development as pointers to reveal conditions and trends in development, and to guide users and planners in making decisions about rangeland use. In additionally, van der Westhuizen et al. (2005) said that indicator species are used for rangeland condition assessment. Moreover, Inam-ur-Rahim and Maselli (2004) defined indicators that are likely to be sufficiently widespread or common to have potential in spatially or environmentally disparate locations.

The main objective of this study was to understand the vegetation dynamics of a particular study area and determine how individual species respond to grazing impact with using multivariate approaches to identify vegetation changes and indicators. Another objective of that was to develop an ecological degradation model (EDM) for the vegetation of a particular study area by (1) reviewing the literature to draft an EDM (2) using multivariate techniques to validate the model (3) incorporating the knowledge of scientists and land managers into the model to refine and obtain a broad opinion about the model.

Methods

Study Area

The survey area, Yozgat county, is placed in the Central Anatolia Region. The study sites elevations range between 825 m and 1680 m, latitude and longitude are between 39.080–40.240 (N) and 34.150–35.98 (E), respectively.

The region, which has a rough topography, is described by steppe climatic status. Long term and annual (2010 year) mean of precipitation, and temperature were as follows: 603 mm and 723 mm; 8.9°C and 11.3°C, respectively (GDSMS 2010).

The slopes of the study area are generally changeable and range from flat to steep slopes with uneven appearance.

The soil samples were analyzed for standard soil properties (CSFWRRI 2010).

Brown soils are common in the area with severe erosion. Soils are shallow in the study area with soil textures range from loam to clay-loam. It is slightly alkaline and neutral with lime values of soil samples changing from low level to high level. Although phosphorus amount of soils are low and very low level, potassium content is in high level and soils are generally low in organic matter.

Sampling

Studied sites were finely chosen for representing on vegetation changes of Yozgat province. Each sites were visited with Global Positioning Systems (GPS) device and one site was worked in there (Figure 1). Field work was conducted between May and June 2010.

The plant basal area of existing species on rangeland vegetation and bare ground were identified through Wheel Point Method with Loop (Koç ve Çakal 2004) at the fixed sites.

Two transect lines of 100 m long in each sites were sampled with an interval of 0.5 meter, so that the 200 reading points were recorded on each transect line (total 400 points).

Plant covering areas were figured out and found total covering area, then the percentages of species were calculated in the sites.

The studied 44 sites were in the indigenous vegetation of grassland in Yozgat Province.

A relatively homogeneous grazing area (RHGA), in which field work was performed, is defined as similar habitat factors. These sites were unimproved and no fertilizer or seed were applied.

The total rangeland-meadow area is 260 153 ha with 198 004 livestock units (LUs) in the Province (PAED 2011). Mean carrying capacity (MCC) in the rangelands is quantified as 34 687 LU. Present livestock units are much more 5.7 times than MCC of those rangelands.

Plant samples were properly picked up and dried up for making herbarium. They all were detected by related flora books as Davis 1965–1985, Davis 1988, Güner et al 2000. Moreover, habitat features and grazing impacts (eye estimation method as no grazing 1, slightly grazing 2, intermediate grazing 3, intensity grazing 4, high intensity grazing 5) with soil properties and erosion status, soil compactness were registered for each site.

Data analysis

Ordination Analysis

During the vegetation survey, 221 plant species were found in 44 sites of Yozgat province. All data collected were processed step by step as follows.

All vegetation data converted into cep-format, then they were controlled through pre-check software program named compose program (Bosch 2009). After that the compose program was operated, and the numbers
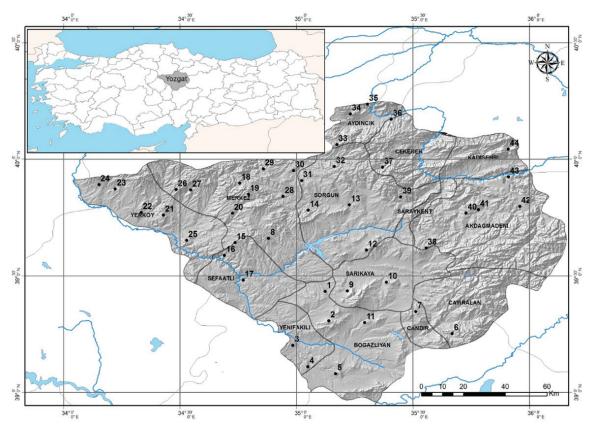
Figure 1. Study sites on the county map of Yozgat.
Şekil 1. Yozgat il haritasında çalışma durakları.

of plant species were decreased to 89 by elimination of some rare species.

Species that occurred on less than 10% of the sample sites were considered rare, and were removed from the data set to refrain introducing unnecessary data (Mentis 1983).

Moreover, all vegetation survey data was entered into software package program named the Integrated System for Plant Dynamics (ISPD) for the analyzing of ordination (Bosch et al. 1992). After that two ordination techniques such as detrended correspondence analysis (DCA) and principal component analysis (PCA) were performed in that software program.

The first step in the analysis was to identify possible relative homogeneous vegetation groups. For this reason, Detrended Correspondence Analysis (DCA) (Hill and Gauch 1980) was used for ordinating the data matrix. This technique was recommended by Gauch (1982) for the analysis of data sets with high sample heterogeneity, and reported by Hill and Gauch (1980) as superior to a number of

other ordination techniques for the analysis of a variety of complex field and simulated data sets.

At the second step, the distribution of various habitat factors on the ordination was found and handled as a basis to identify relatively homogeneous vegetation. Sites (if any) identified as being significantly different from any of these data groups (i. e. outliers) were removed because their relationship to other samples in the data set wasn't expressed by information in the data. This might also cause problems for the ordination (Gauch 1982).

A modification to the sample centered PCA analysis was used to combine the second and higher axes into a single residual value, which provided a measure for each site of its distance off the first axis (Bosch and Gauch 1991). The PCA ordination was inspected to ensure that no sample sites had residuals larger than 50% of the Euclidean distance of the first ordination axis. Any sample sites exceeding this were not considered to fit the ordination

model adequately. These sample sites were then discarded and the ordination was done again (Bosch and Kellner 1991; Bosch and Gauch 1991). In addition, the positions of samples along the first axis were correlated on Pearson's product-moment correlation coefficient (Sokal and Rolf 1981) for the indices of inferred accumulated grazing intensity, as well as with other habitat variables.

Indicator Species Identification and Classification

The first axis represented a grazing intensity gradient for each study site, the percentage covers of species were placed along the first axis. Species, especially possible indicators, that showed a possible correlation with the grazing impact gradient were recorded. Regression analyses on these species were performed after fitting a Gaussian (Normal) distribution curve. Although real ecological response curves were often more complex, Gaussian models were useful in describing data showing mostly unimodal responses and were generally accepted (ter Braak and Prentice 1988; Palmer 1993). The usefulness of the Gaussian response was confirmed in numerous direct gradient studies, and had become the basis for testing and designing multivariate models (Gauch 1982).

The D Statistic (Willmott 1982) or "index of agreement" was used to determine how well the recorded data fitted the relationship with the first axis (Bosch and Kellner 1991; Bosch and Gauch 1991).

Indicator species were classed into response groups on the basis of the strength and nature of their relationship with the pastoral impact gradient. Three broad categories were selected to identify with which part of the pastoral impact gradient an indicator species was mostly associated. These three categories conform with those suggested by Hurt et al. (1993), i. e., decreasers, increasers and invaders, following the pioneering concepts of Dyksterhuis (1949).

Constructing of the ecological degradation model

The ecological degradation model was made by based on the cover areas of plant species and bare ground (Figure 2 and Figure 3).

The indicator values of the regression analysis were first manually noted down on graphic paper and then the values of the x-axis and the y-axis were read from the sketch graphic paper. Later, these values were utilized to make an ecological degradation model (Bosch and Gauch 1991) (Figure 3). This model consists of composition on y-axis and utilization levels on x-axis.

Degradation increases from left to right along the ordination gradient, which is related to bare ground cover and unpalatable species. Meanwhile the cover area of perennial palatable plant species reduces from left side to right side along x axis. Range condition classes such as good, fair, poor-deteriorated, and poor-degraded have the rate of decreasers and increasers on composition with 10–20% and 33–50%; 5–10% and 14–23%; 5–8% and 10–15%; 2–5% and 0–10%, respectively in the ecological graph model.

Results and Discussions
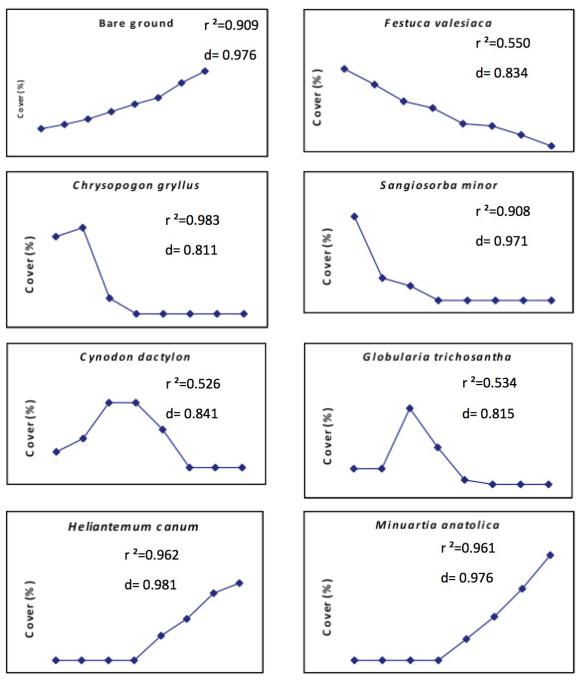
Ordination techniques

According to the results of the DCA ordination technique, a relatively homogeneous area was detected throughout 44 sites which had similar ecological aspects. Then the centered PCA ordination was performed with the sample sites by species matrix of new dataset. All sites were placed along degradation gradient by means of deterioration levels.

Indicator species identification

Of the 221 species were found during the surveys, 89 species remained after applied compose program, and finally 45 species were detected as possible indicators.

The analyses of regression resulted fifteen plant species and bare ground. A_d-statistic value as over 0.3 referred the continuing grazing severity (Table 1). Each plant species was individually analyzed for abundance and regression in order. After regression analysis, results were carefully checked and some plant species were selected as indicators which have the values of r^2 and D higher than 0.300 (Table 1 and Figure 2).

The ecological classifications of species, based upon response to grazing, were classified

Figure 2. The values of r² and d statistics of indicator species.
Şekil 2. İndikator türlerinin r² ve d istatistik değerleri.

as decreasers, increasers, and invaders in plant species coverage (Dyksterhuis 1949).

The fifteeen species (six decreasers, three increasers, and six invaders) out of all plant species (221 species) on botanical composition were identified as indicators for rangeland vegetations in Yozgat Province.

Indicators for good and fair range conditions

Decreaser plant species result in a good range condition. But they are extremely influenced negatively under the over grazing pressure. These highly palatable plants decline in increasing of grazing pressure (Dyksterhuis 1949; Hurt et al. 1993; Koç et al. 2003; Holechek
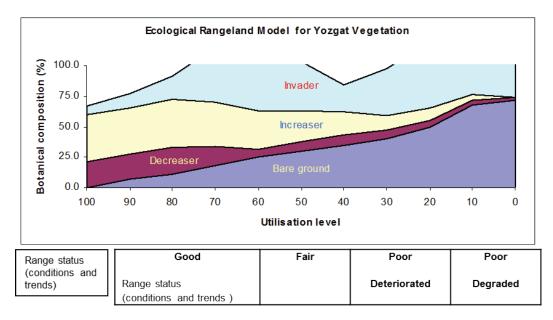
Figure 3. The graph of ecological degradation model without bare ground, and explanations of range condition and trend.
Şekil 3. Boş alan olmadan ekolojik bozulma modeli grafiği ve mera durum ve eğiliminin açıklanmaları.

et al. 2004; David 2011). The six decreaser plant species of the rangeland in the Yozgat Province were determined as indicators, three grass species such as downy brome (*Bromus tomentellus*), scented grass (*Chrysopogon gryllus*), orchardgrass (*Dactylis glomerata*), two decreaser legumes such as variegated alfalfa (*Medicago varia*), and sainfoin (*Onobrychis oxydonta*) and one from other family, Rosaceae, small burnet (*Sangiosorba minor*). In this study, three increaser species, two grasses and one species from Globulariaceae family, were identified. Two grasses were as following; Volga fescue (*Festuca valesiaca*) and bermuda grass (*Cynodon dactylon*). The one species from other family was blue globe daisy (*Globularia trichosantha*).

Survey results obviously indicated that the following species are indicators for good rangeland condition; *Bromus tomentellus, Chrysopogon gryllus, Dactylis glomerata, Medicago varia, Onobrychis oxyodonta, Sangiosorba minor, Festuca valesiaca, Cynodon dactylon,* and *Globularia trichosantha.*

Overgrazing of rangeland always causes to reduce or remove desirable perennial plants in vegetation and as a result of this reason range condition declines (David 2011; Ünal et al.

2013). The same authors added information for opposite status that there existed an increase in the density of desirable perennial plants may be indicated a recovery in range condition.

Increaser plant species, which may increase slightly or remain stable under moderate grazing, are classified as increaser types that are moderately palatable and uncommon in the climax vegetation. As grazing pressure increases or as range condition declines fair condition, these species also decline on plant community (Dyksterhuis 1949; Hurt et al. 1993; Holechek et al. 2004).

Indicators for poor condition

The six invader species in this study were found as indicators for the range sites having poor (deteriorated and degraded) range condition score which are *Alyssium pateri* (r^2= 0.868, d= 0.948), yellow chamomile (*Anthemis tinctori*), *Phlomis armeniaca*, Sulphur cinquefoil (*Potentilla recta*), Hoary rockrose (*Heliantemum canum*), and Stitchwort (*Minuartia anatolica*).

Invaders are generally unpalatable, but they decrease or increase related to utilization level through final stages of deterioration (Dyksterhuis 1949; Hurt et al. 1993; Holechek et al. 2004). These plant species are completely accepted as being undesirable plants that are typically

Table 1. The values of r^2 and d statistics of some indicator species and bare ground.
Çizelge 1. Boş alan ve bazı indikator türlerinin r^2 ve d istatistik değerleri.

	Bare ground and plant species	r 2	d		Plant species	r 2	d
1	**Bare ground**	0.909	0.976	24	*Erodium ciconium*	0.945	0.979
2	*Achillea biebersteinii*	0.550	0.840	25	*Festuca valesiaca*	0.550	0.834
3	*Aegilops umbelliata*	0.900	0.972	26	*Fumana procumbens*	0.473	0.798
4	*Alyssum condensatum*	0.993	0.998	27	*Genista sessifolia*	0.603	0.870
5	*Alyssum pateri*	0.868	0.948	28	*Globularia trichosantha*	0.534	0.815
6	*Anthemis tinctoria*	0.922	0.975	29	*Helianthemum canum*	0.962	0.981
7	*Asphodeline taurica*	0.856	0.948	30	*Helianthemum ledifolium*	0.929	0.959
8	**Astragalus plumosus**	0.960	0.982	31	*Marrubium parviflorum*	0.976	0.989
9	*Astragalus tigridis*	0.792	0.942	32	*Medicago minima*	0.644	0.886
10	**Bromus tomentellus**	1.000	0.391	33	*Medicago sativa*	0.855	0.938
11	*Centaurea pichleri*	0.732	0.923	34	*Minuartia anatolica*	0.961	0.976
12	*Centaurea solstiitalis*	0.306	0.693	35	*Minuartia hybrida*	0.574	0.850
13	*Centaurea urvillei*	0.830	0.924	36	*Noaea mucronata*	0.333	0.713
14	*Chardinia orientalis*	0.412	0.797	37	*Onobrychis oxydanto*	0.346	0.701
15	*Chrysopogon gryllus*	0.483	0.811	38	*Phlomis armeniaca*	0.727	0.912
16	**Convolvulus holosericeus**	0.998	0.999	39	*Potentilla recta*	0.929	0.981
17	*Convolvulus lineatus*	0.812	0.917	40	*Prangos meliocarpoides*	0.908	0.976
18	*Cousinia stapfiana*	0.638	0.885	41	*Salvia crypthantha*	0.995	0.997
19	*Cynodon dactylon*	0.526	0.841	42	*Sangiosorba minor*	0.908	0.971
20	**Dactlis glomerata**	0.996	0.999	43	*Taraxacum scaturiginosum*	0.985	0.981
21	*Dianthus zonathus*	0.980	0.995	44	*Trachynia distachya*	0.998	0.999
22	*Euphorbia macroclada*	0.393	0.787	45	*Verbascum cheiranthifolium*	0.549	0.856
23	**Ebenus laguroides**	0.983	0.986				

Bold written species = selected indicator species
Koyu yazılanlar = seçilmiş indikator türler

of limited value for grazing (David 2011). For this reason, grazing systems and grazing plans must be applied for controlling undesirable plant species increase on rangeland vegetation. Otherwise, their increase may cause decline in range condition (David 2011).

Invaders are generally unpalatable, and their abundance increase as overgrazing continues (Dyksterhuis 1949; Hurt et al. 1993; Holechek et al. 2004). These plant species are completely accepted as being undesirable plants that are typically of limited value to grazing (David 2011).

For the rangeland management, the occurrence of invader plant species is not required in vegetation, but they are vital significant for maintenance soil under the continuing soil erosion in the steppe rangelands (Koç et al. 2000).

Bare ground

In addition to other indicator species bare ground, an environmental variable, is also determined as an indicator having the statistical parameters of r^2= 0.909 and d= 0.976. Bare ground is also an important additional parameter for evaluating real changes in rangeland condition (Abulea et al. 2007).

Changes (especially increase in this study) in bare ground cover are highly based on grazing pressure and management techniques (continuous grazing, uncontrolled grazing etc.) (Figure 2). Moreover, bare ground cover represents rangeland health and it is one of the important criteria for interpretation and assessment of rangeland present status.

According to study results, bare ground cover increases, therefore, rangeland health

deteriorates. High grazing intensity leads to reduce palatable species in botanical composition.

Bare ground is a good indication of over-utilization or livestock pressure, and a degree of the degradation of the vegetation (Abulea et al. 2007). Fernandez et al. (2013) observed a clear relationship between livestock density and bare soil surface cover. They found that bare ground was very high in the rangelands sites in which high grazing density existed.

Conversely, while vegetation cover increases, rangeland health improves due to reducing soil erosion, high biomass yield, and improving vegetation composition with increasing palatable species area. Moreover, plant cover reduces directly negative impact of raindrops so it employs to be the best defense against soil erosion. The decrease in soil canopy coverage is a result of severity of erosion due to overgrazing (Oztas et al. 2003).

Pellant et al. (2005) cited by various authors that the amount and distribution of bare ground is one of the most important contributors to site stability relative to the site potential; therefore, it is a direct indication of site susceptibility to accelerated wind or water erosion. Bare ground, a qualitative and quantitative indicator, is positively correlated with canopy gaps, runoff and erosion (David et al. 2002). Another significant viewpoint on the use of bare ground as a quantitative indicator which would provide better precision in determining rangeland trend may be monitored and followed the trend of rangeland status over time (David et al. 2002). The assessment of rangeland health was based upon erosion, plant vigor and biodiversity (Koc et al. 2003). Moreover they focused on rangeland health having productivity and sustainability of plant community on soil cover. Erosion problems occurs 80% of the world's rangelands (Thurow 1991) and Turkey's rangeland ecosystems are most susceptible against erosion impact (Koc et al. 2000). Therefore, rangeland health is much more priority than rangeland condition. Under the prevailing conditions of soil erosion on rangelands, it is impossible to be claimed as healthy for rangeland of Yozgat.

If excessive livestock regularly removes threshold amounts of biomass and litter,

a degradation spiral is started especially in heavily used areas (Teague et al. 2011). Moreover, first this progressive deterioration is explained by replacement of taller perennial grasses by shorter perennial grasses. Then annual grasses and forbs are dominant and finally bare ground widely appears (Thurow 1991; Fuls 1992; O'Connor 1992; Ash and Stafford-Smith 1996; Teague et al. 2004). Bare ground or soil may be chosen as an indicator of animal utilization.

Ecological degradation model

The ecological degradation model is also based upon survey, and multivariate statistical analysis, moreover making graph (Figure 3). Jameson (1988) explained three various models for management of rangeland ecosystems as follows (1) the statistical analyses of model-based monitoring systems, (2) model-based analyses for determining optimal management strategies, and (3) system attributes that dictate model structure. This study model fits first and second models of his three descriptions above. Furthermore, models were also categorized into research guidance models, systems behavior models and management oriented models by the same author. On this point, Rajabov (2009) also proposed a model which was based on current knowledge and available field data, and seemed to correspond to the system behavior, as suggested by Non Metric Multidimensional Scaling ordination. It hence appears to reflect the dynamics of the study area as vegetation change, land degradation, grazing intensity, current management regime etc. .

In this study, the ecological degradation model was made and presented in Figure 3, which gives an overall assessment and interpretation relevant current status of Province rangelands.

There are two main components covering composition (%) and utilization level on the graph. As observed figure 3, the four various rangeland status were that consists of range conditions such as good (from 65 to 100), fair (from 39 to 64), poor-deteriorated (from 21 to 38), and poor-degraded (from 0 to 20) in utilization levels along x axis.

Composition (%) on y axis contains the cover rates of bare ground, decreasers, increasers, and invaders in botanical composition. They all are the most important indicators for assessment and interpretation of rangelands status and trend. Bare ground rates vary from 0, 19, 38, and 45 to 18, 37, 44, and 60 at the good, fair, poor-deteriorated, and poor-degraded rangelands, respectively.

Range condition classes such as good, fair, poor-deteriorated, and poor-degraded have the rates of decreasers and increasers on composition with 10–20% and 33–50% ; 5–10% and 14–23% ; 5–8% and 10–15% ; 2–5% and 0–10%, respectively. As observed in Figure 3, the cover area of perennial palatable plant species reduces from left side to right side along x axis. Palatable species cover decrease during deteriorating and degrading of rangelands. This means that rangelands become poor, and degraded so they have the increased bare ground cover and invader species. As a results, less productivity, high erosion, and environmental harm may occur on these rangeland areas. Moreover, palatable species have given way to unpalatable species, and signs of land degradation were apparent where the most intensive grazing has taken place (Rajabov 2009). In addition, application of such ecological concepts in range assessment helps to understand the driving factors of vegetation changes and to provide a framework for solution of degradation problems and sustainable management of natural resources (Rajabov 2009).

Conclusion

Fifteen species were identified as the indicators for monitoring and following on vegetation changes in the grasslands of Yozgat Province. These fifteen species showed range condition trend because of being more sensitive to grazing intensity than to other environmental factors, which makes them useful in providing an early mark of changes in the rangeland ecological system. The indicator species are used to monitor vegetation condition which is significant process for both production and conservation of rangelands through informing and warning

rangeland managers to significant changes within range ecosystem. The assessment and interpretation of vegetation condition will give benefit information on current management practices, new measures to be taken if needed. The study area has been misused with different level of grazing intensity by now. It means that there haven't been applied any improvement and management techniques in all rangeland areas in this province. The indicator species determined for various rangeland conditions are so useful that any changes could be sensitively monitored and followed. This approach can be used to investigate current status of rangelands and also for monitoring the effects of current management techniques. When invaders for indicator of poor rangeland condition are taken precaution to be reduced, the percentages of especially decreasers and increaser also should be tried to increase in vegetation community. Consequently, the effective range management and rehabilitation techniques should be implemented for rehabilitation of these rangeland areas, perhaps it is possible that the present situation can be reversed toward climax condition.

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