The spatial distribution of rangeland vegetation depending on distance to settlement in highland rangelands of Turkey

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Abstract

The aim of this study was to assess the effects of distance from settlements on spatial pattern of rangeland vegetation in semi-arid highlands of Bayburt and Erzurum provinces, Eastern Anatolia Region, in Turkey. The vegetation was sampled using the line intercept method, and environmental variable data were collected from both locations. All data were proceeded to ordination analysis using CANOCO, in order to test relations between species composition and environmental variables. There were strong correlation between species composition and environmental variables. The results indicate that distance from permanent settlement and environmental variables are important factors affecting spatial distribution of species. As getting further from permanent settlement the environmental conditions becomes more favorable and species composition improves with respect to desirable status.

Key words: floristic composition, vegetation, distribution

Introduction

Terrain of the Eastern Anatolia (Turkey) is unsuitable for arable crop production due to geomorphologic feature and climatic conditions, hence rangelands dominate and cover about 50% of total area giving to livestock husbandry an important role for the regional agriculture. The species richness of rangeland vegetation in the region is pleasing but is threatened from both unfavourable climatic conditions and human activities (Erkovan et al. 2011). Spatial changes of the rangeland vegetation are affected by various factors such as climate, soil and grazing distribution (Holechek et al. 2004). Physical and chemical properties of the soil affect the floristic composition of rangelands vegetation (Rietkerk et al. 2000, Duckworth et al. 2000). In general, the degradation in soil triggers the changing in vegetation toward to unfavourable condition (Critchley et al. 2002).

Intensity and spatial distribution of grazing significantly affect floristic composition of the rangeland vegetation. Overgrazing reduce plant species and increase trampling which contributing in the degradation of the soil (Koc et al. 2008). Settlements cause seriously heterogeneity on spatial distribution of grazing in rural communities. Yunusbaev et al. (2003)

reported that grazing pressure increased as getting closer to the settlements or corral in Dagistan Republic of Russian Federation. Similar results have also reported for Turkey by Erkovan et al. (2003).

Factors such as soil, climate, aspect, the location of gathering places and herbivory may be the ultimate determinants of grazing and vegetation patterns. Spatial autocorrelation analysis is a commonly used method to measure spatial heterogeneity (Chang et al. 2006).

The aim of this study was to determine the effect of distance from settlements and environmental variables on spatial distribution of rangeland.

Materials and Methods

The study was conducted in Bayburt and Erzurum provinces in the eastern Anatolia region of Turkey during 2000 and 2001. Three rangeland sites in both of the locations which were close to settlement (5 km) (Site I), middle distance to settlement (20 km) (Site II), and far away to permanent settlement (30 km) (Site III) were selected to determine the effect of grazing on spatial distribution of rangeland vegetation. Seasonal suitable grazing system was applied in Erzurum province and transhumant grazing system in Bayburt province. Grazing firstly starts around the permanent settlement and then goes further areas in advanced season. In general, the rangelands around the permanent settlement suffer from early and late season grazing pressure compared to other sites.

Cold steppe climate prevail in the study areas which are characterized by long and extremely cold winter and cool, short and dry summer. As a consequence actively plant growth occurs in between a restricted period. Long term annual total precipitation in Bayburt and Erzurum province are 421.4 mm and 435.6 mm, respectively. The mean annual temperature is 6.9 ^{0}C in Bayburt, and 5.7 ^{0}C in Erzurum. Soil texture, organic matter, pH, lime, phosphorus, potassium and salt from soil samples taken from every site at the depth of 0-30 cm were analysed considering standard procedures described by A.O.A.C. (1999). The soils texture of site I, site II and site III in Bayburt province was loamy, sandy-loamy and sandy-loamy-clay, and it was loamy in site I and clay-loamy in site II and III in Erzurum province.

Floristic composition of range sites was determined by using the line intercept method developed by Canfield (1941). Eight subsamples each of 10 m in different part of sites were measured to represent an 80 m long transect and basal area was considered in the measurement.

Canonical Correspondence Analysis (CCA) was used to determine the relationships between vegetation and environmental variables using

CANOCO, version 4.5 for windows (Leps and Smilauer 2003). Due to many zeros species data were transformed using the transformation ln (10 x X + 1), where X= species number in species score (ter Braak and Smilauer 2002). Automatically selection was used to determine the variance explained by individual variables. Monte Carlo permutation tests used to test the significance of each variable.

Results and Discussion

Ordination analysis showed that spatial distribution of samples were significantly affected by distance from settlements in both location, but site I of Bayburt and site II of Erzurum became more similar compared to the other sites (Fig. 1). The relationships between species and environmental variables were presented in CCA ordination diagrams (Figure 2). The sites are clearly separated along axes but site I of Bayburt and Site II of Erzurum overlapped on same axes. The CCA revealed some gradients such as the relationship between floristic composition and environmental variables which are shown in the CCA for Bayburt and Erzurum (Fig. 2). The cumulative percentage variance of the species and species-environmental relationship were high for Bayburt and Erzurum sites. There was considerably cumulative percent variance of species-environment relations, which were 16.6, 29.6, 39.5 and 47.0 for Bayburt and 25.1, 36.7, 45.6 and 53.8 for Erzurum.

Slope, distance from the settlement, altitude and phosphorus, potassium, organic matter, clay and sand content of soil were significantly correlated to species distribution in Bayburt ($p<0.05$) (Fig. 2) whereas all environmental variables (slope, distance, altitude and phosphorus, potassium, organic matter, clay, sand, silt, lime and salt content of soil) were significantly correlated to species distribution in Erzurum ($p<0.01$) (Fig. 2).

The results of this study revealed that the distance from the permanent settlements plays an important role to the determination of floristic composition, which mainly originated from differences of spatial distribution of grazing intensity and season. The most affected areas from grazing are those around the permanent settlements because the domestic animals are grazing freely around them during early and late season (Koc et al. 2008). Kellner and Bosc (1992) have found that vegetation pattern of semi-arid rangelands were formed through grazing of herbivores. Overgrazing has caused decrease of the palatable perennial plants and destruction of the native rangelands (Belsky 1992, Metzger et al. 2005).

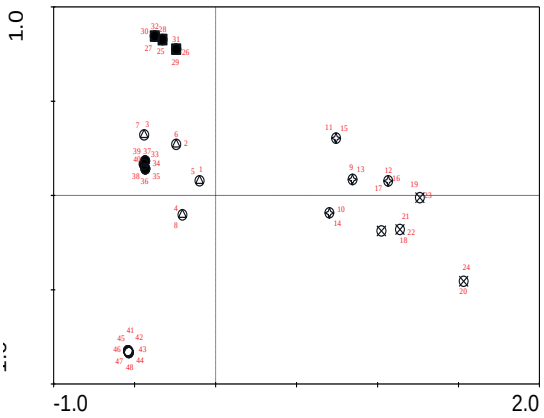

Figure 1 Ordination showing that samples varied according to distance to settlement and locations. Non-filled triangles within non-filled circle represent close to settlement at Bayburt (site I); star within non-filled circle represent middle distance to settlement at Bayburt (site II); x-mark non-filled circle represent long distance to settlement at Bayburt (site III); filled square represent close to settlement at Erzurum (site I); filled circle represent middle distance to settlement at Erzurum (site II); and non-filled circle represent long distance to settlement at Erzurum (site III)

The ordination analysis showed that soil properties had significant effect on species pattern. Vegetation and soils are dynamic systems and the condition of one affects the other. The spatial heterogeneity of overgrazing pressure, determined by the distance from the permanent settlements, causes heterogeneity in spatial distribution of soil and vegetation properties because heavy grazing and unsuitable season affect more severe around the permanent settlement or corral (Yunusbaev et al. 2003, Koc et al. 2008, Arevalo et al. 2011). Duckworth et al. (2000) have found that, apart from settlements, environmental factors such as altitude, topography also significantly affect species composition and soil properties. In the experimental areas, permanent settlement or corral used in summer are located in high elevation areas in both sites hence the differences in species composition and soil properties between sites can not be solely attributed to grazing distribution.

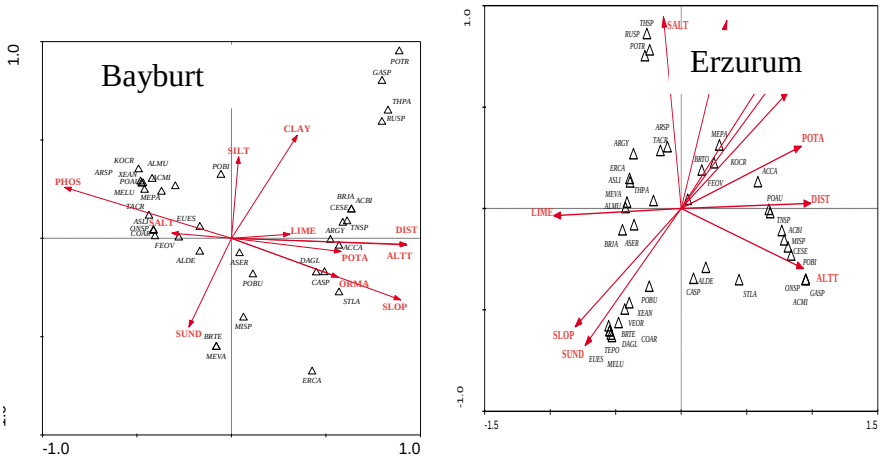

Figure 2 CCA ordination diagram of rangeland vegetation species with environmental variables. Key to abbreviations: (AGIN *Agropyron intermedium,* BRJA *Bromus japonicus,* BRTE *Bromus tectorum,* BRTO *Bromus tomentellus,* DAGL *Dactylis glomerata,* FEOV *Festuca ovina,* KOCR *Koeleria cristata,* POBU *Poa bulbosa,* POTR *Poa trivialis,* STLA *Stipa lagascae,* ASLI *Astragalus lineatus,* ASER *Astragalus eriocephalus,* MELU *Medicago lupiluna,* MEPA *Medicago papillosa,* MEVA *Medicago varia,* ONSP *Onobrychis* sp., ACCA *Acantholimon caryophyllaceum,* ACBI *Achillea biebersteinii,* ACMI *Achillea millefolium,* ALDE *Alyssum desertorum,* ALMU *Alyssum murale,* ARGY *Arenaria gypsophiloides,* ARSP *Artemisia spisigera,* CASP *Campanula* sp., CESE *Centaurea sessilis,* COAR *Convolvulus arvensis,* ERCA *Eryngium campestre,* EUES *Euphorbia esula,* GASP *Galium* sp., MISP *Minuartia* sp., POAU *Polygonum aviculare,* POBI *Potentilla bifurca,* RUSP *Rumex* sp., TNSP *Tanacetum* sp., TACR *Taraxacum crepidiforme,* TEPO *Teucrium polium,* THSP *Thesium* sp., THPA *Thymus parviflorus,* VEOR *Veronica orientalis,* XEAN *Xeranthemum annuum,* pH, ORMA organic matter, LIME, SALT, PHOS phosphorus, POTA potassium, SUND, SILT, CLAY, ALTT altitude, DIST distance, SLOP slope)

In conclusion, the rangelands around the permanent settlements suffer from heavy grazing pressure and this affects adversely rangeland vegetation. Severity of overgrazing pressure and, as a consequence, the degradation of vegetation in the vicinity of permanent settlement and middle points is higher than that of the rangelands away from the permanent settlement. However seriously soil and vegetation degradation are also seen on the areas away from the permanent settlements because neither early season nor late season grazing pressure prevail. Therefore, it is essential to develop sustainable range management strategies for areas

experiencing transhumance or seasonal suitable grazing management schemes.

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