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Changes in vegetation and soil properties under semi-nomadic animal raising areas in highlands, rangelands of Turkey

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ABSTRACT

Animal raising depending on rangeland is the main economic activity for settlements especially for the semi-nomadic animal raisers, in highlands of Turkey. Overgrazing and erosion are the main problems in this rangeland. The aim of this study was to determine changes in vegetation and soil properties among rangeland sites especially in the highlands of Turkey grazed during different parts of the year due to semi-nomadic animal raising system. Three rangeland sites, near permanent settlement (site I), midpoint between permanent and temporary settlement (site II), and near the temporary settlement (site III) were selected. In each site, botanical composition, canopy coverage, range condition score, and some surface soil properties such as texture, organic matter content, aggregate stability, CaCO3 content, pH, plant available P, and K content were determined. Grass frequency changed from 29 to 50 % among sites and the frequency was the lowest at the site III and the highest at the site I. The canopy coverage was the highest at the site III and the lowest at the site II. All results have indicated that overgrazing is the main problem in the rangelands under semi-nomadic animal raising areas as in throughout Turkey.

Key words: Overgrazing, soil properties, vegetation, vegetation and soil relationship

INTRODUCTION

Animal raising on rangelands is the main agricultural activity in highlands of Turkey due to short, cool summer and extreme winter conditions which restrict the growth of many crops. In semi-nomadic animal raising areas, animal owners keep their animals near winter settlements from autumn to following summer and take their animals to uplands for temporary settlement during summer months. The rangelands around permanent settlement areas suffer from early, late season and heavy grazing pressure, whereas, the rangelands around temporary settlements and between them can be excluded from early and late season grazing pressure, because there are no domestic activity in the areas in this period.

There are no rangelands that preserve their quality under mismanagement anywhere in the world (Herbel and Pieper, 1991). Heavy grazing always reduces range productivity (Holechek *et al.,* 2004), plant canopy cover (Herbel and Pieper, 1991; Koc and Gokkus, 1996) and changes botanical composition toward to poor quality (Oztas *et al.,* 2003). Soil properties and vegetation have been altered over time under different management systems. Overgrazing and its attendant effects reduce plant cover and increase trampling which the most important factor is contributing to degradation of rangeland soils (Branson *et al.,* 1981).

The rangelands in Turkey are under influence of heavy and uncontrolled grazing pressure (Koc, 2000), hence, ultimately causing land degradation all over Turkey (Koc *et al.,* 1994). The dimension of this degradation depends on both grazing intensity and extended grazing season. Generally, greatest grazing pressure was observed on rangelands around permanent settlements than in other areas within semi-nomadic animal husbandry systems, because the area confront early spring and late winter grazing pressure.

The aim of this study was to estimate changes in vegetation and soil properties among rangeland sites grazed at different seasons due to semi-nomadic animal raising system.

MATERIAL AND METHODS

This study was conducted on the rangelands of Bayburt province of Turkey in 1999 and 2000, where semi-nomadic animal raising is common. Semi-nomadic animal raising which is similar to a seasonal-suitable grazing system, has been commonly conducted in highlands of Turkey for many centuries. In this system, animals freely graze around the permanent settlement upto growth plenty of forage on the rangeland (about range ready for grazing with respect to physiological aspect), thereafter the settlement's animals were combined in a seperate herd based on type and species (cow, heifer, steer, calve and sheep) and grazing on the rangelands around the permanent settlement. When the forages on this rangeland dry due to dry summer conditions, animals are driven to temporary settlements located on the uplands. Animal owners move with the animals and remain there until autumn when they return to the permanent settlement.

Three rangeland sites were selected for this study, the first site was close to the permanent settlement at the altitude of 1650 m (site I), the second was located between permanent and temporary settlement at the altitude of 1950 m (site II), and third was close to the temporary settlement at the altitude of 2300 m (site III). The duration of grazing season in the seasons grazing is about 210 days in the year of which first 90 days is in site I, following 60 days is in site III and remaining 60 days is in site I. Herds generally visit site II from both settlement from beginning of June to end of October. Site I and III have smooth steepness (10-15 % and 20-30 %, respectively) and the site II has moderate steepness (30-50 %). The long term average annual precipitation is 420 mm and annually average temperature is 6.2°C in around the permanent settlement.

Four composite soil samples were collected from surface layer of each site in 1999 and analyzed for physical and chemical properties. Particle size distribution was determined by the hydrometer method (Gee and Bauder, 1986), organic matter by the Walkey Black method (Schnitzer, 1982), pH and CaCO3 content using the Scheibler calcimeter (McLean, 1982), K content by the Pelkin Elmer method (Jackson, 1964), plant available-P by the Olsen method (Olsen and Sammers, 1982), and aggregate stability was measured according to Kemper and Rosenau (1986).

Botanical composition of range sites was determined for each year using the line intercept method developed by Canfield (1941). Four sub-samples each of 20 m in different part of a site were measured to represent a 80 m long transect and basal area was considered in the measurement. After determining the frequency of plant species, plants were grouped as grasses, legumes and other species. Total canopy coverage was applied to data calculated as the ratio of the total plant intercepts to the total length of transects (Gokkus *et al.,* 1995). The range condition score was determined for each range site using the botanical composition values (Koc *et al.,* 2003). An arc-sin transformation was applied to data for botanical composition and plant canopy cover. All data were subjected to analysis of variance based on general linear models. The LSD test was used for multiple comparison procedures and Pearson correlation analysis was used to test the relationships among variables using the SPSS statistical package (SPSS, 1999).

RESULTS

Vegetation properties

Summary of botanical compositions based on basic plant groups, canopy coverage ratio, and range condition score of the range sites are shown in Table 1. The percentage of grasses ranged from

29 % at site III to 50 % at site I. Legumes percentage changed between 21 and 29 % in range sites. But this change was statistically insignificant. The frequency of plant in other species was the lowest for the site I as compared to the other sites. Canopy coverage ratio was the highest for the site III, the lowest for site II and, moderate for the site I. The highest canopy coverage ratio in the site III can be attributed to short grazing period. Even if the plant is grazed heavily during grazing period, the plant might partly overcome this misuse during the spring growing period of the following year. The range condition score calculated based upon botanical composition values was higher for the site I than the others. This situation stemmed from higher grasses frequency in the botanical composition of site I, because grasses have great effects on range quality score than the other species, especially other species.

Soil properties

Values of measured soil properties were shown in Table 2. Clay content of the soils was the lowest for the site II, the highest for the site III and moderate for the site I. Organic matter content of the soils changed from 3.2 to 1.94 % among range site's soils. Although these differences were statistically insignificant, the lowest soil organic matter content in the site I can be attributed to heavy grazing pressure. Because heavy grazing decreases return of litter, which is the main component of soil organic matter. Aggregate stability was the greatest (85.72 %) in site III and the lowest in site I. This result was expected because higher content of clay and organic matter in the soil encourage aggregation where was higher in site III soil. Although plant available P was higher in the site III soil's than the other site, it was not sufficient for optimal plant growth, K content was sufficient in the sites. CaCO3 content and pH were not different among range sites and they were not any restricting effects on plant growth.

Vegetation and Soil relationships

Pearson correlation coefficients were given in Table 3. Grasses frequency in the botanical composition was negatively correlated with K, silt, clay content of the soil, and canopy coverage, the other species and legumes frequency of the vegetation, but positively related to sand content of the soil. This situation was opposite for legumes. The ratio other family species in the botanical composition was positively related to K content, aggregate stability, silt and clay ratio of the soil and

Table 1: Investigated vegetation properties among range sites

Site	G	L	OS	CCR	RCS
1.	50.04A	26.48	23.48B	36.41AB	4.45A
2.	38.64AB	21.32	40.04A	27.90B	3.21B
3.	28.97B	28.80	42.23A	40.14A	3.36B

Means shown by the same letter were not different at $P < 0.05$. G. grasses, L. legumes, OS. other species, CCR. canopy coverage, RCS. range condition score,

Table 2: Investigated soil properties among range sites

Site	SD	CL	S	OM	AS	pH	LM	P	K
1.	55B	24.00B	21.25B	1.94	60.52B	6.39	0.72	4.24A	45.78B
2.	70A	16.00C	14.00C	2.76	66.94AB	6.96	0.65	2.29B	47.57B
3.	42C	33.50A	24.75A	3.2	85.72A	7.13	0.65	1.38B	56.49A

SD. sand, CL. clay, S. silt, OM. organic matter, AS. aggregate stability, LM. lime, P. phosphorus, K. potassium canopy coverage of vegetation but it was negatively correlated with sand content of the soil. Canopy coverage increased with increasing clay and silt content of the soil but it decreased with increasing sand content of the soil. Range condition score increased with increasing plant available P content of the soil (P < 0.01). Aggregate stability was positively correlated the other species frequency (P < 0.01) and soil organic matter content (P < 0.05).

DISCUSSION

Low range condition score and abundance in frequency of undesirable species in botanical composition implied that the study site rangelands were away from climax. The main reason for rangeland degregation in sites studied, as in all around Turkey, is that the rangelands in Turkey have been heavily grazed since 1950's because half of the rangelands of Turkey were converted into arable land during that period (Koc *et al.* 2000). Grasses are the dominant species in the climax plant communities of the rangelands with good quality (Holechek et al. 2004). Grasses frequency was less than 50% in all range sites. Almost all forbs (legumes + the other species) in the sites consisted of unpalatable species, and the most common forb was thorny milkvetch (belongs to legumes, Astragalus microcephalus Wild.) because palatable forbs are usually less resistant to grazing than grasses (Vermeire and Bidwell, 2002). The contribution of plant groups were different in each site (data not shown), therefore, we did not find any relationships between plant group and range condition score. For example, sheep fescue (*Festuca ovina* L.), a shortgrass of moderate quality, was the main component (more than 70 %) of the grasses at site I, however, contribution this species to botanical composition was lower in the other sites. High sheep fescue ratio in the site I might be attributed to heavy grazing because short grasses resistant to grazing and their ratio in the botanical composition increase under heavy grazing conditions (Vermeire and Bidwell, 2002). Therefore, low range quality and undesirable botanical composition in site I might be attributed to heavy grazing pressure because this site suffers from heavy grazing pressure.

Table 3: Correlation among the relevant soil and vegetation variables

	G	L	OS	CCR	RCS	SD	CL	S	OM	AS	LM	P
K	-.72**	.38	.80**	.44	-.39	-.59*	.70*	.48	.47	.81**	.21	-.61*
P	.39	.11	-.53	-.10	.81**	.26	-.30	-.09	-.56	-.80**	-.24	
LM	-.14	.25	.35	.44	.15	-.31	.30	.17	-.04	.36		
AS	-.53	.27	.71**	.41	-.42	-.57	.51	.30	.61*			
OM	-.41	.23	.33	.09	-.43	-.10	.25	.01				
S	-.64*	.63*	.79**	.81**	.17	-.87**	.92**					
CL	-.82**	.73**	.94**	.86**	.03	-.91**						
SD	.77**	-.67*	-.90**	-.83**	-.15							
RCS	.16	.41	-.16	.32								
CCR	-.71*	.84**	.79**									
OS	-.89**	.62*										
L	-.62*											

*and ** are significant at P < 0.01 and 0.05, respectively.

G. grasses, L. legumes, OS. other species, CCR. canopy coverage, RCS. range condition score,
SD. sand, CL. clay, S. silt, OM. organic matter, AS. aggregate stability, LM. lime, P. phosphorus, K. potassium

Although grazing pressure was lower at sites II and III, compared to site I, the degradation in these sites might be attributed to ecological condition and heavy grazing in the past. Runoff erosion and heavy grazing are important factors affecting low range condition score and undesirable botanical composition at site II. In addition to the lowest canopy coverage, clay content of the soil was the lowest at site II also (Table 2). Augmented slope decreases water recharge and encourages soil erosion due to increased runoff. Therefore lower clay content and canopy coverage is an indicator of runoff erosion (Oztas *et al.,* 2003).

Although there was no early or late grazing heavy grazing pressure on rangelands of the site III, practiced during grazing season in this site. The heavy grazing during the season and adverse climatic conditions might be caused to degradation in the site III vegetation. This site has the highest elevation among the sites. High elevation rangelands are more sensitive to grazing pressure than the low elevation rangelands (Thilenius, 1979; Vallentine, 1990).

Canopy coverage ratio was below the critical value, which is considered to be 30 % for rapid water erosion (Marshall, 1973), in the site II. In addition to the lower canopy coverage, lower clay content and aggregate stability of the soil in the site II implied that this site soils subjected to more severe by erosion than the other sites. Higher sloppiness is another reason for these adverse situations in addition to heavy grazing in the site II. Although grazing pressure lower in the site II than the other sites, our results showed that the higher degradation became in this site. Therefore, heavy grazing pressure must be reduced immediately to advisable level by introducing suitable range management plan in this site and the other sites. Because there are no rangelands saved their quality under heavy grazing pressure on the world (Holechek *et al.,* 2004).

In conclusion, the rangelands in the study sites are under overgrazing pressure as in all around Turkey. The fate of the rangelands under semi-nomadic animal raising conditions is not different than the other rangelands of Turkey. Decreasing canopy coverage due to heavy grazing in the rugged range sites encourage runoff erosion that cause both further degradation in the site and pollution in stream-water by sediment carrying. Therefore, the utilization of rangeland according to suitable management principles must be established and taken into rehabilitation program for saving rangelands further degradation. Otherwise, this misuse of our rangelands will cause to further decline in productivity and biodiversity and finally desertification will happen.

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