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The Influence of Grazing on Vegetation and Soil of Asir Highlands in South Western Saudi Arabia

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ABSTRACT. Grazing by sheep and goats has a significant impact on species composition, plant biomass, and soil chemical, physical and bacterial properties in the cool semi-desert highlands of Asir, Saudi Arabia. The comparison between grazed and protected flats and hills revealed that the protected flats and hills maintain higher species diversity, plant biomass, plant heights, soil carbonates, cation exchange capacity, and electrical conductivity; but a relatively lower soil water content, organic matter, total nitrogen, and total number of bacteria.

Where water is available sheep, goats, camels and cows are raised in Saudi Arabia. Among the best ranges in Saudi Arabia are the highlands of Asir, the lowlands of Tihama along the Red Sea coast, and the seasonally wet wadis, valleys, depressions, and oases near wells and springs (Draz 1965, Drabbs 1967, and Allred 1968).

A diversity of platable grasses, herbs and shrubs produce large phytomass during years of good rain (Abulfatih 1979, 1981, 1984a, 1984b, Allred 1968). Sheep and goats are the prominent form of livestock on these highlands.

The Asir highlands cover a vast area in the south western part of Saudi Arabia and strech about 400 km in north-south direction, with variable width. Different plant community types are found on these mountains. The most common community types are: (1) open woodlands of *Juniperus procera* trees, (2) savanna vegetation of short grasses mixed with *Acacia* spp., and (3) semi-desert grasses, forbs and shrubs. The plant community in the study area is a mixture of the second and third types.

The Study Area

A protected area in Dalaghan National Park, 35 km south east of Abha (Fig. 1), and a grazed area 1 km to the east of the park were chosen to evaluate the floristic composition and soil characteristics. One square kilometer was studied in each of the areas. Two habitats were studied in each area flats and hills. The study was conducted during May 1984, the time of maximum plant growth (Abulfatih 1981).

Fig. 1. General view of Dalaghan National Park, showing the protected hills and flatlands. The grazed area is located one kilometer east of the park. *Acacia negrii* the dominant tree species is shown in the photograph.

The vegetation of Dalaghan National Park was protected as a consequence of government regulations to exclude grazing animals by prohibiting all kinds of disturbances of the wild life within the boundary of the park. Regulations were applied since the establishment of the park in 1979. The grazed area is visited on the average by one hundred sheep and goats three times a week.

The area under study is made of two major habitats, the rocky hills and the flatlands. The rocky hills are composed of large boulders and poorly developed sandy soils commonly found in crevices. The flatlands, on the other hand, are of poorly developed loam-sandy to loam soils mixed with small fragments of rocks.

Climate

The climate of Dalaghan National Park is characterized by cool summers and cold winters. Rainfall is expected throughout the year especially during spring and summer. Clouds form over the area almost every afternoon. The main factors influencing the weather are the prevailing uprising southwesterly winds and the high altitude of the area (2150 m above sea level). Climatic records of a nearby meteorological station at Abha city (35 km north west of Dalaghan National Park) show the following: mean monthly maximum temperature 22.4°C, mean monthly minimum temperature 13°C, mean monthly precipitation 27.7 mm, mean monthly maximum relative humidity 82.4, mean monthly minimum relative humidity 29.1, and mean annual wind speed 9.5 km/hr.

Materials and Methods

Vegetation

In each habitat type twenty 2×2 m plots, laid out at random, were analyzed. For each species in each habitat type an importance value index (Curtis and Mclntosh 1950) was calculated by adding together relative density, relative frequency and relative dominance. The average height of each species was also estimated from the heights of fifty individuals. Plant biomass was measured by harvesting twenty $1m^2$ plots in each habitat type and oven drying at 100°C until no further changes in weight occurred.

Soil

Four locations were randomly chosen in each habitat type and soil samples were taken to a depth of 5 cm. Samples were brought to the laboratory and analyzed for water content, pH, carbonate, organic matter, total nitrogen, cation exchange capacity, electrical conductivity, and texture. Chemical analysis followed the standard methods given by Faniran and Areola (1978) and U.S. Salinity Laboratory Staf (1954). Soil texture was determined by the hydrometer method (Brower and Zar 1977). Total number of bacteria per unit weight of soil was evaluated by planting the soil solution in a non-selective medium prepared according to the method of Erikson (1947). The plate count technique was made according to Collins and Line (1976).

Results and Discussion

Vegetation

The comparison between the prominent herbaceous species of the grazed and protected flats shows the following:

1. Eleven herbaceous species were shared by the grazed and protected flats (Table 1).
2. Among all herbaceous species studied *Cynodon dactylon* recorded the highest importance value index (IVI). Its IVIs were 132 in the grazed flats and 41 in the protected flats. The second highest IVIs were recorded for *Plantago boissieri,* 98 in the grazed flats and 59 in the protected flats.

The comparison between the prominent herbaceous species of the grazed and protected hills showed the following:

1. Eight herbaceous species were shared by the grazed and protected hills (Table 1).
2. Ten herbaceous species were found on the protected hills and eight on the grazed hills.
3. On the grazed hills the grass *Tricholaena tenerrifae* recorded the highest IVI (180) followed by *Hypoestes forsskali* for which an IVI of 32 was recorded. IVIs of 114 and 53 were respectively recorded for these species on the protected hills.

The comparison between the prominent shrubs of the grazed and protected flats showed the following:

1. Two shrubby species were shared by the grazed and the protected flats. They were *Francoeuria crispa* and *Lycium shawii* (Table 1).
2. *Lycium shawii* recorded the highest IVIs on both grazed and protected flats. IVIs of 15 and 28 were respectively recorded on these flats.

The comparison between the prominent shrubs of the grazed and protected hills showed the following:

1. Six shrubby species were shared by the grazed and the protected hills (Table 1).
2. Seven shrubby species were found on the protected hills and six on the grazed hills.
3. The highest IVIs were recorded by *Clutia lanceolata.* IVIs of 38.5 and 21.6 respectively, were recorded on the grazed and protected hills. The second highest IVIs were recorded by *Rhamnus staddo.* IVIs of 8.8 and 21 were respectively recorde on grazed and protected hills.

The comparison among the four habitats on the basis of plant heights and biomass showed the following:

Table 1. Importance value index, average plant height and biomass of the prominent species found in grazed and protected areas. Rocky hills and flatlands were studied in each area. IVI based on 20 2×2m random quadrats, biomass on 20 1×1m random quadrats, and plant height on 50 randomly chosen individuals

Species	Grazed area				Protected area			
	Hills		Flats		Hills		Flats	
	IVI	Height cm	IVI	Height cm	IVI	Height cm	IVI	Height cm
Herbs								
Aizoon canariense			3	3				
Erodium laciniatum							15	4
Blepharis ciliaris					12.3	5	28.1	4
Centauria sinaica					7.5	70	10	70
Arnebia hispidissima			4	2			2	10
Cynodon dactylon			132	1			41	3
Paronychia desertorum			4	2			2	2
Plantago boissieri			98	2			59	3
Iflago spicata			5	2			20	2
Filago abyssinica			6	2			17	2
Medicago aschersoniana			4	4			14	6
Stipa capensis			3	8			10	10
Picris babylonica			4	7			10	15
Eragrostis papposa			2	8			7	15
Tricholaena tenerrifae	180	2			114	35		
Hypoestes forsskali	32	2			53	35		
Micromeria biflora	3	10			20	38		
Pennisetum setaceum	5.2	5			15.4	15		
Trachynia distachya	2	6			8.1	20		
Otostegia fruticosa	5.3	10			8	60		
Anarrhinum orientale	2	10			6	70		
Themeda triadra	2	8			6.2	30		
Cyperus rotundus			14	10			20	60
Shrubs								
Clutia lanceolate	38.5	26			21.6	42		
Euryops arabica	5.1	30			6	40		
Lavandula pubescens	3.5	10			14.5	50		
Rhamnus staddo	8.8	20			21	75		
Solanum incanum	2.2	40			5	80		
Solanum nigrum	8	60			4.5	60		
Periploca aphylla					8	80		
Onopordon sp.							12.9	7
Lycium shawii			15	30			28	45
Francoeuria crispa			4	6			10	50
Trees								
Ficus palmata	8.2	35			10.4	90		
Acacia negrii	10.2	105	29	45	16	150	50	400
Liana								
Asparagus nitis					4.5	200		
Total IVI	316		327		362		356	
Number of species	16		15		20		18	
Plant Biomass g m^{-2}	54.3 ± 22		7.2 ± 1.7		140.5 ± 53		85.5 ± 30	

1. Herbaceous plants and shrubs were generally taller on the protected hills and flats (Table 1).
2. Plant biomass recorded the highest value, 140.5 g m^{-2}, on the protected hills. The second highest plant biomass, 85.5 g m^{-2}, was recorded on the protected flats (Table 1). Plant biomass was relatively lower on the grazed habitats, recording 54.3 g m^{-2} on the grazed hills and 7.2 g m^{-2} on the grazed flats.

These findings correspond to a certain extent with many research works conducted in desert and semi-desert areas of the world. For instance, in the semi-desert savanna of south Africa periodic heavy or over-grazing reduced the number of palatable species (Walker *et al.* 1981). In a semi-arid savanna of south-eastern Rhodesia it was shown that perennial grasses were dominating an area of moderate grazing (Kelley and Walker 1976). In the Mediterranean desert of Egypt and in Northern Sudan, density and cover of perennials, frequency and presence of annuals, and total phytomass increased as a result of protection and controlled grazing (Halwagy 1982, Kassas 1970, and Ayyad and El-Kadi 1982). Seven years of protection of steppic vegetation in the Mediterranean arid zone of southern Tunisia have caused an increase in cover of the perennial species (Floret 1981). Grazing also caused changes in species composition in southwestern Arizona (Smith and Schmutz 1975), reduced species diversity of annuals in the Sonoran Desert (Waser and Price 1981), decreased cover of perennials in the Mohave Desert (Webb and Stielstra 1979), and lowered productivity in the semi-arid regions of Afghanistan (Hassanyar 1977).

Soil

Chemical analysis revealed that water content, organic matter, and total nitrogen were relatively higher in the soils of the grazed flats when compared with that in the soils of the protected flats (Table 2). These findings correspond with those of Ayyad and El-Kadi (1982) in the Mediterranean Desert of Egypt. The improvement of soil nitrogen content of the grazed habitats can be attributed to the fact that the passage of herbage through the guts and out as feces speeds the nitrogen cycle. Moreover, the amount of organic matter in these habitats might be increased as a result of trampling and laying of standing dead materials by grazing animals. Such activities by grazers could also inhance the growth of microorganisms in the soil.

Soil mechanical analysis determined by the hydrometer method showed that soils of the protected and grazed hills were mostly sandy loam, while those of the protected and grazed flats were generally loamy soils. Sandy soils can also be found in small patches on the flatland.

The study of soil bacteria revealed that relatively more bacteria were present

Table 2. Chemical, physical and bacterial analyses of soil samples collected from grazed and protected areas. Data based on 4 soil samples from each site, 0-5 cm deep

Habitat	Water content g %	Soil pH	Carbonate meq %	Organic matter meq %	Total nitrogen meq %	Cation exchange capacity meq %	Electrical conductivity µmho / cm	Number of bacterial colonies/g	Soil texture
Grazed flats	0.01 ± 0.008	7.5 ± 0.11	1.70 ± 0.24	1.49 ± 1.01	0.60 ± 0.41	36.46 ± 0.84	118 ± 30	1140×10^4	Loam
Protected flats	0.002 ± 0.0008	7.5 ± 0.17	2.38 ± 0.77	1.167 ± 0.48	0.48 ± 0.19	48.48 ± 1.16	147 ± 29	880×10^4	Loam
Grazed hills	0.008 ± 0.0004	7.54 ± 0.15	1.03 ± 0.266	1.73 ± 0.39	0.73 ± 0.08	35.12 ± 0.97	65 ± 12	1370×10^4	Sandy loam
Protected hills	0.002 ± 0.0008	7.5 ± 0.11	1.86 ± 0.83	0.64 ± 0.26	0.25 ± 0.09	37.82 ± 1.07	80 ± 19	970×10^4	Sandy loam

in the soils of grazed flatlands (1140 × 10^4 colony/g) and hills (1370 × 10^4 colony/g) than in soils of protected flatlands and hills (Table 2).

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تأثير الرعي على الغطاء النباتي والتربة فوق مرتفعات عسير في الجنوب الغربي للمملكة العربية السعودية

حسين علي أبو الفتح و حمدي عمارة و عبد العظيم حشيش

قسم علوم الحياة ـ كلية التربية ـ جامعة الملك سعود ـ فرع أبها ـ ص. ب ٩٣٢ ـ أبها
المملكة العربية السعودية

يتبين من خلال المقارنة بين المناطق الخاضعة لرعي الأغنام والماعز والمناطق المحمية بأن هناك اختلافات واضحة في أنواع النباتات والإنتاج النباتي والصفات الكيميائية والفيزيائية والبكتيرية للتربة.

فقد تبين من هذه الدراسة المقارنة أن كلاً من التلال المحمية والمسطحات المحمية تتميز بزيادة في أنواع النباتات والإنتاج النباتي وأطوال النباتات وكربونات التربة وقابلية تبادل الأيونات الموجبة والتوصيل الكهربائي في التربة، مع انخفاض في نسبة الماء والمادة العضوية والنيتروجين والبكتريا في التربة.