INFILTRATION CAPACITY AND SOIL BULK DENSITY DIFFERENCES BETWEEN GRAZED AREA AND OFF-ROAD TRACK AT PAYA (KAGHAN VALLEY).

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ABSTRACT

Paya subalpine rangelands are used for livestock grazing and recreation during Summer. Both livestock grazing and off-road vehicle movement effect the soil physical properties. Infiltration capacity and soil bulk density differences were investigated in grazed area and off-road vehicle track at Paya (Kaghan) subalpine rangelands in June 1994. Ten samples for each of infiltration and soil bulk density were randomly studied on off-road track and grazed area. The infiltration capacity (mm/hr) was significantly higher on grazed area than on off-road track while the average soil bulk density (gms/cm^3) was higher on off-road track as compared with grazed area.

INTRODUCTION

The subalpine/alpine rangelands are multiple use areas. Livestock concentrate on these areas in Summer and continuously graze there untill fall. The tourists visit these areas in Summer for recreation and drive vehicles on the off-road tracks. Both livestock grazing and vehicle movement on rangelands compact the top soil by exerting pressure and thus alters the vegetation as well as soil physical properties. Generally vehicle moving on rangelands compact soil more than the livestock trampling.

The continuous heavy grazing lowers the infiltration capacity and increases the soil bulk density (Branson et al 1981 and Blackburn et al 1982). Heavy and early season livestock grazing had greater impacts on soil compaction, infiltration and soil bulk density (Naeth et al 1990). Soil bulk density was appreciably higher on grazed than that of ungrazed areas (Taboada & Lavado 1988; and Bauer et al 1987). The effects of vehicle movement on forest soil showed substantial reduction in the infiltration and appreciable increase in soil bulk density (Donnelly and Shane 1986; Olsson 1986; Fernandz 1985; and Dannowski 1987).

The effects of heavy continuous livestock grazing and off-road vehicle use on the hydrological properties especially infiltration and soil bulk density of subalpine/alpine rangelands have been documented, but have not been quantified so far in the country. This research study was designed to compare and quantify the effects of continuous traditional livestock grazing and vehicle movement at Paya.

MATERIAL AND METHODS

The study area is situated in Lower Kaghan Forest Division, District Mansehra. Paya is about 7 km from Shogran at an elevation of 3200 m. The grazing management study in subalpine/alpine rangeland watersheds sponsored by Forestry Research Support Programme for Asia and the Pacific (FORSPA), FAO, was initiated at Paya in 1992. Paya a community land of Ghanul village is connected by a dirt road with Kawai. About 150 livestock heads graze on the area daily from June-September each year. About 25 tourists vehicles visited the area daily in June 1994. Similarly the area was subject to continuous grazing during summer.

The average annual precipitation varies from 630 to 1000 mm. Growing period is limited to the Summer months. The soil is deep and is rich in organic matter contents, pH is about 5.6. The soil texture is silt loam.

Data collection on infiltration

Double ring in-filtrometer was used to prevent lateral movement of water during measuring the infiltration. The inner and outer rings had a diameter of 20 cm and 30 cm, respectively. Both the rings of the infiltrameter were fixed at a sampling point firmly with a hammer, to avoid soil disturbance. A nail was fixed in the center of inner ring 5 cm. high or from the ground surface. The water was poured untill the head of the nail and water surface came to the same level. The water level in both the rings was kept at the same level.

At each sampling point infiltration was run for 3.5 hours. The water head upto the nail in the inner ring was maintained by pouring the water, using a graduated cylinder of 1000 milliliters. The data were recorded at 5, 10, 15, 30 and 60 minutes intervals. Three readings were taken for 5, 10 and 15 minutes, two for 30 minutes and one for 60 minutes. The last one hour reading was used to calculate infiltration capacity. Infiltration data were collected on ten locations (sites) on each of grazed area and off-road vehicle track. The infiltration capacity (mm/hour) was calculated by:

$$\textit{Infiltration capacity } (mm/hr) = \frac{\textit{water infiltrated } (ml) \times 10}{\textit{cross-sectional area of inner ring of infiltrometer}}$$

Sampling of soil bulk density

Compact soil samples were taken by driving the steel samplers close to the infiltration sampling point. The diameter of the sampler was 4 cm and length 15 cm. At each location the sampler was inserted in-to the soil using a hammer. Core sampler was taken out by a mattock. All the excess soil around the sampler was removed. Each sample was labelled and kept in polythene bag, after recording the weight by a balance. Ten soil bulk density samples were collected from each of grazed area and off-road vehicle track.

The soil samples alongwith sampler were oven-dried for 24 hours at 105°C. The ovendry weight of each soil sample was taken and recorded after deducting the weight of steel sampler. The soil bulk density was calculated by:

$$\textit{Soil bulk density } (gm/cm^3) = \frac{\textit{Net ovendry weight of soil sample}}{\textit{Volume of the soil sample}}$$

The paired t-test appropriate to the data was used to compare the effects of grazing and offroad vehicle movement on infiltration capacity and soil bulk density.

Results and Discussion

The infiltration capacity; and average soil bulk density on grazed area and off-road track; and results of statistical analysis (t-test) are shown in Table 1 & 2, respectively. Average infiltration rates (mm/hr) at all the time intervals i.e 5 minutes to 60 minutes were substantially higher on grazed area than those on off-road track (Fig.1). The infiltration rate became constant at 45 minute on off-road track where as it became constant on 120 minutes, on grazed area.

The infiltration capacity on the grazed area varied from 6.05 mm/hr to 120.64 mm/hr; while it varied on off-road track from 0.64 mm/hr to 3.82 mm/hr; at different sampling locations (Table 1). The average infiltration capacity on grazed area was 43.93 mm/hr while on off-road track it was 2.24 mm/hr (Fig. 2). The infiltration capacity was significantly ($P \leq 0.02$) higher on grazed area when compared with off-road track (Table 2).

The soil bulk density varied from 1.03 to 1.7 gm/cm^3 on grazed area and from 1.21 to 1.93 gm/cm^3 on off-road track, respectively (Table 1). The average soil bulk density was 1.25 gm/cm^3 on grazed area and 1.58 gm/cm^3 on off-road track (Fig.3). The soil bulk density was highly significantly lower on grazed area as compared with off-road track ($P \leq 0.01$).

The statistical analyses of the data revealed that the effect of vehicle movement on infiltration capacity and soil bulk density was higher as compared to the trampling of grazing animals on Paya subalpine rangelands. The results of this study are consistent with the earlier research on infiltration and soil bulk density (Branson et al 1981; Blackburn, et al 1982, Naeth et al 1990; Toboada and Lavado 1988; Bauer et al 1987; Donnelly and Shane 1986; Olsson 1986; Farnandz 1985; Danuowski 1987; and Brawnack 1986).

Table 1: Infiltration capacity (mm/hr) and soil bulk density (gm/cm^3) on grazed area and off-road track at Paya in June 1994.

Sample No.	Infiltration capacity (mm/hr)		Soil bulk density (gm/cm^3)	
	Grazed area	Offroad track	Grazed area	Off-road track
1	120.64	1.91	1.35	1.59
2	16.23	1.91	1.03	1.32
3	38.54	0.64	1.16	1.49
4	16.55	1.43	1.32	1.87
5	24.51	2.23	1.46	1.65
6	6.05	2.86	1.19	1.53
7	70.98	1.91	1.70	1.33
8	108.54	3.18	1.14	1.85
9	10.82	2.55	1.03	1.93
10	26.42	3.82	1.16	1.21
Average	43.93	2.24	1.25	1.58

Table 2. Results of t-test for infiltration capacity (mm/hr) and soil bulk density (gm/cm^3)_ on grazed area and off-road track at Paya in June 1994.

Parameter	Treatment	Degrees of freedom	Mean	Standard deviation	t-calculated
Infiltration capacity (mm/hr)	Grazed area	9	43.93	41.57	3.17*
	off-road track		2.24	0.91	
Soil bulk density (gm/cm^3)	Grazed area	9	1.25	0.21	3.30*
	Off-road track		1.58	0.25	

*Significant at $P \leq 0.02$, $t_{0.05} = 2.262$

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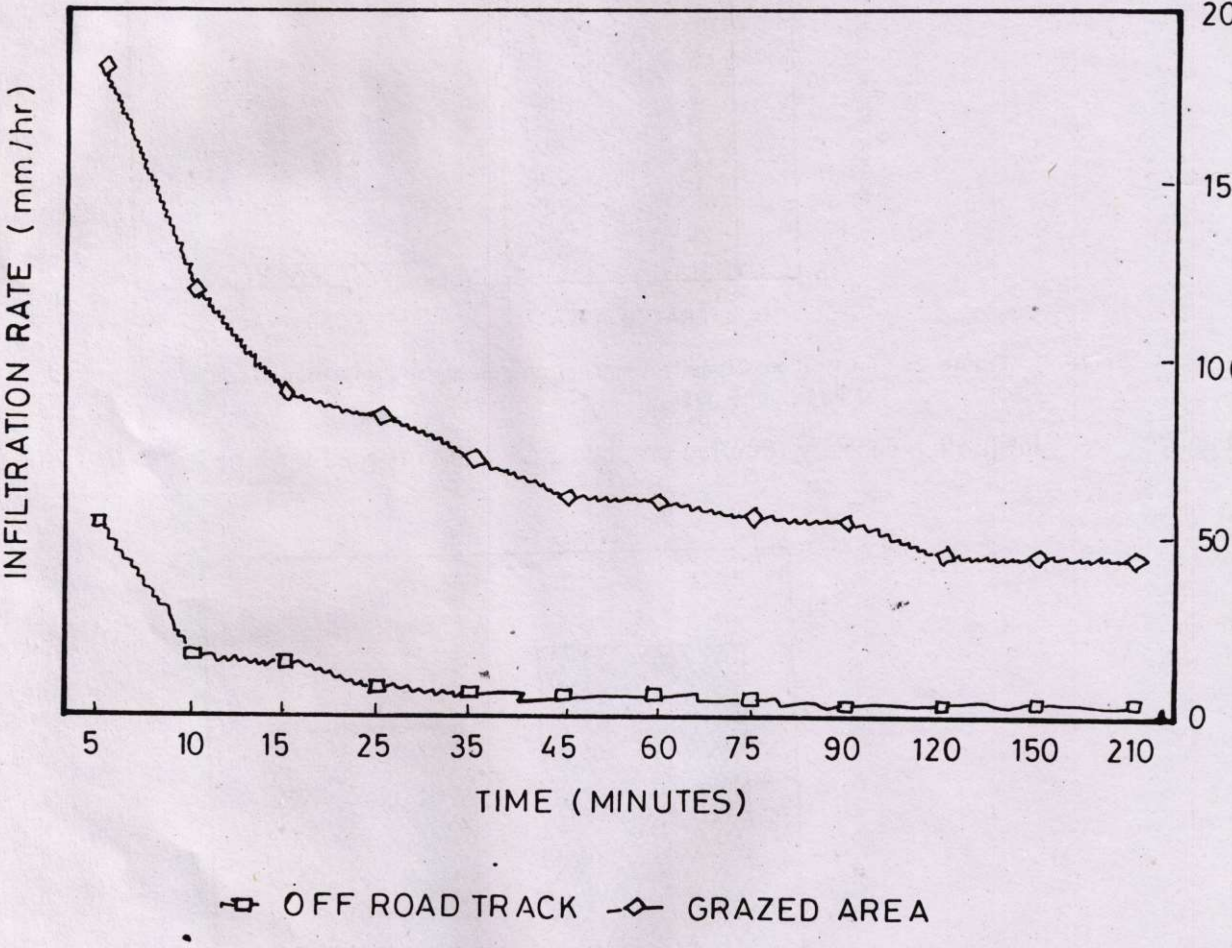

Figure 1: Infiltration rates (mm/hr) at different time intevals on grazed area and off-road track at Paya, June 1994.

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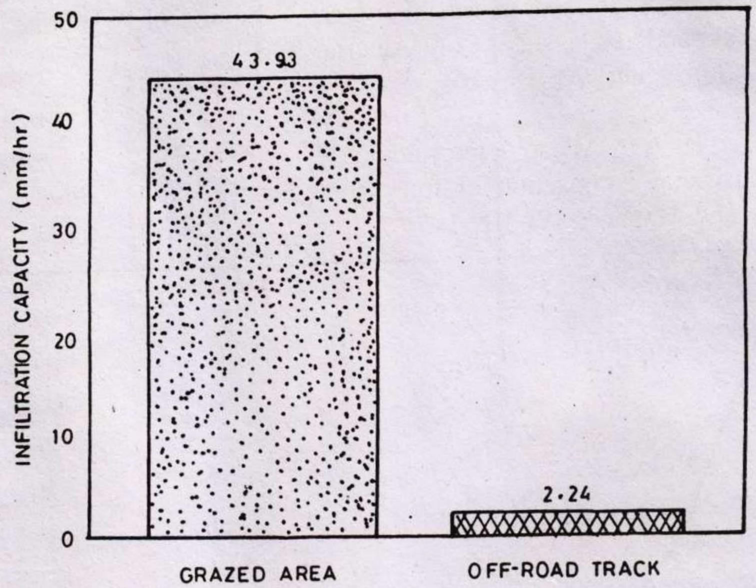

Figure 2: Infiltration Capacity (mm/hr) on grazed and off-road track at Paya, June 1994.

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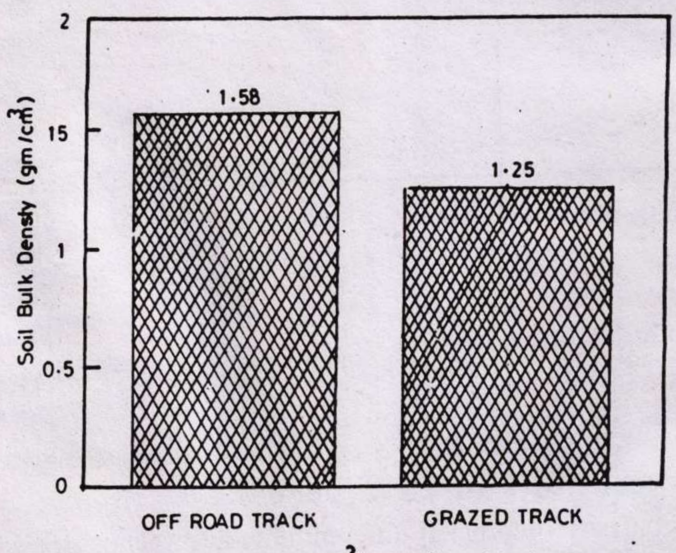

Figure 3 Average soil bulk density (gm/cm3) on offroad track and grazed area at paya, june 1994.

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