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Revitalising grasslands to sustain our communities

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DL Michalk, GD Millar, WB Badgery
& KM Broadfoot (Editors)

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Editors

David L Michalk

Geoffrey D Millar

Warwick B Badgery

Kim M Broadfoot

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The influence of geo-morphological landscape patterns on vegetation characteristics in Tajikistan grasslands

Mounir Louhaichi [A], Aziz Nubekov [B], Abdulla Madaminov [C] and Barbara Rischkowsky [D]

[A] International Center for Agricultural Research in the Dry Areas (ICARDA), Jordan.
[B] International Center for Agricultural Research in the Dry Areas (ICARDA), Uzbekistan
[C] Tajik Research Institute of Livestock, Dushambe, Tajikistan
[D] International Center for Agricultural Research in the Dry Areas (ICARDA), Ethiopia
Contact email: M.Louhaichi@cgiar.org

Abstract. Grassland ecosystems are affected by a combination of physical and environmental factors, as well as by grazing and human induced activities. The primary objective of this study was to examine the influence of geo-morphological landscape patterns on vegetation characteristics in Tajikistan where two sites were selected. The vegetation sampling took place in spring and fall. Vegetation characteristics were assessed using the line intercept method for vegetation cover and species composition and quadrat sampling for biomass production. An ANOVA using replicated trials in complete block design was used to determine the relationship between aspect and vegetation characteristics. Treatments included location (site), season (fall and spring pastures), and aspect. Site, season and aspect had significant impact on the species composition, cover, and biomass production (P<0.001). The present study emphasizes the strong relationship between vegetation coverage and surface temperature (potential direct incident radiation). Unfortunately, this parameter has been overlooked in the past and needs to be taken into account when considering options for rehabilitation and restoration measures of degraded grasslands.

Keywords: Grassland improvement, plant cover, aspect, evapotranspiration, wilting point, pasture productivity.

Introduction

Grassland ecosystems are affected by a combination of physical and environmental factors, as well as by grazing and anthropogenic activity (Vetter 2009). Topographic conditions, such as aspect and slope, affect pasture diversity and can have a crucial influence on its structure in terms of vegetation patterns and plant distribution (Walton *et al.* 2005). Moreover, aspect may have distinct effects on species richness and productivity, as well as on nutrient dynamics (Gong *et al.* 2008). In fact, aspect affects the amount and daily cycle of solar radiation received at different times of the year (Desta *et al.* 2004). In addition, net radiation is fundamental to drive the processes of evaporation, air and soil heating, as well as other smaller-energy consuming processes such as photosynthesis. Therefore, the relationship between aspect and solar radiation contributes to predicting plant distribution (Desta *et al*. 2004). The primary objective of this study was to examine the influence of season and aspect on vegetation characteristics and plant community dynamics in Tajik rangelands.

Methods

Description of study areas

The study was conducted at two sites in Tajikistan. The first site (Site 1) was located in Southern Tajikistan (37°50' 41"N, 69°33' 42"E), 487 m altitude where the climate is continental, moderately warm, with a short warm winter and hot, dry and long summer. The average annual precipitation is 251 mm. Average yearly temperature is 15.8°C. The second study area (Site 2) was located in Central Tajikistan (38°34'55" N; 69°22'32" E). It is located at an elevation of 1,357 m above sea level. The climate is medium continental with average annual rainfall of 652 mm. The average yearly temperature is 14.3°C.

Vegetation sampling

Herbaceous biomass*:* Twelve quadrats of 1m x 1m were randomly distributed across the landscape representing a particular aspect to estimate biomass production. Aerial biomass was harvested by manual clipping 2.5 cm above soil surface within each quadrat. All vegetative material was oven dried (48 hr, 70°C), and weighed. The percent of total standing biomass of the above ground parts was determined for all species present.

Vegetation cover using line-intercept method*:* The line intercept sampling technique was used to determine herbaceous cover. Cover was calculated as the percent of the transect line covered by each species.

Statistical analyses

Analysis of variance (ANOVA) using replicated trials in complete block design was used to study the relationship between aspect, season and vegetation characteristics. Treatments included location (site), season (spring and autumn), and aspect (north versus south). All statistical analyses were performed with SAS software for Windows

(SAS 2009).

Results

Aspect effect

Based on the results of the mean value of vegetation parameters including the biomass, plant cover, bareground, rocks and litter, aspect has a strong impact on the vegetation characteristics. In fact, north oriented slopes had nearly three times higher biomass productivity than south-oriented slopes (Fig. 1). Moreover, percent cover was almost nine times higher on the north oriented aspect compared to that on the south-oriented aspect while bareground was much more prevalent on the southern facing slopes. Rocks and litter were completely absent on the northern slopes (Fig. 2).

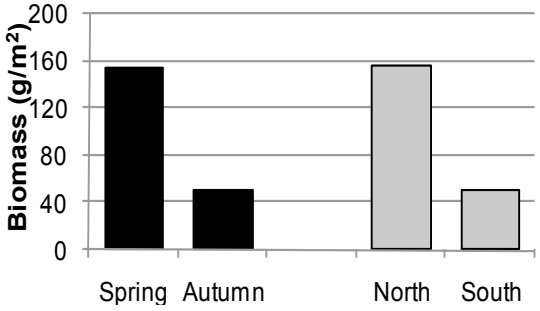

Figure 1. Impact of season (spring, fall) and aspect (north, south) on biomass productivity (g/m^2) in Tajikistan.

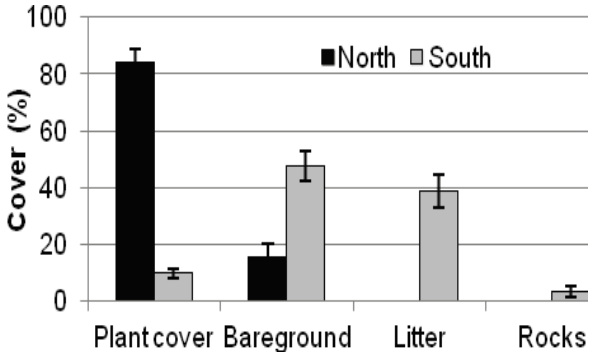

Figure 2. Impact of aspect on percent (%) of plant cover, bareground, litter and rocks in Tajikistan.

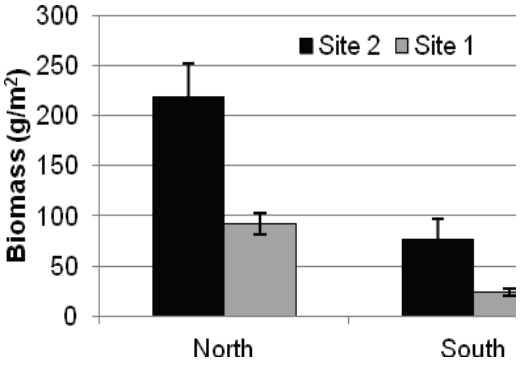

Figure 3. Impact of sites on biomass productivity (g/m^2) of two aspects (north and south).

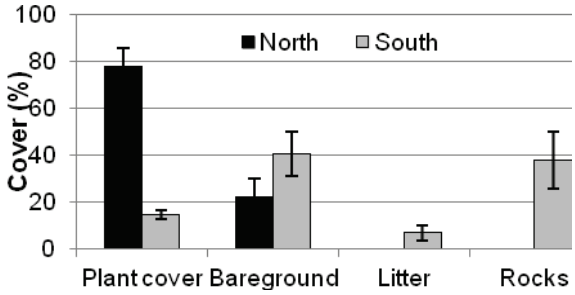

Figure 4. Impact of aspect on percent (%) of plant cover, bare ground, litter and rocks at Site 1.

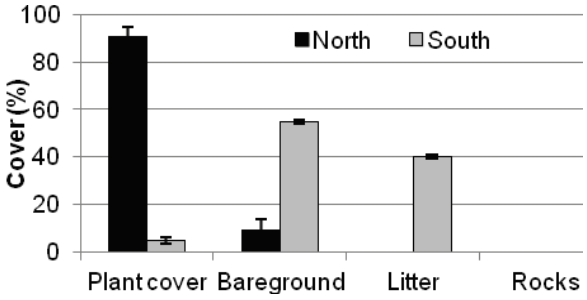

Figure 5. Impact of aspect on percent (%) of plant cover, bare ground, litter and rocks at Site 2.

As site also proved significant, the impact of aspect on biomass productivity and vegetation characteristics was confirmed by the analysis of these vegetation parameters for each site separately. In both sites north oriented slopes had significantly higher biomass productivity than south oriented slopes. The difference was about three and four times for site 2 and site 1 respectively (Fig. 3). For Site 1, plant cover of the northern slopes were almost five times higher than that of southern slopes, while bareground was by 50% greater on the southern slope compared to that on the northern slope. Rocks and litter were completely absent on the northern slopes (Fig. 4). Plant cover for Site 2 was almost eighteen times greater on northern than on southern slopes. However, south facing slopes had six times higher bareground than north facing slopes and litter was completely absent on the north aspect (Fig. 5).

Season effect

Biomass production of the spring season was almost three times higher than that of the fall season (Fig. 1). Plant cover and litter were abundant during the spring season while the bareground and rocks were dominant in the fall season (Fig. 6). The effect of season on vegetation characteristics was then examined for each site separately. Biomass productivity was two to three times greater in the spring season compared to the autumn season for Sites 1 and 2, respectively (Fig. 7).

The percentage of plant cover and litter for site 1were higher in spring in comparison with autumn while bare-ground and rocks were scarce and almost absent during the spring (Fig. 8). For Site 2, plant cover was significantly higher during the spring while bareground was abundant in the fall season. No significant difference between rocks and litter in spring and fall was observed (Fig. 9).

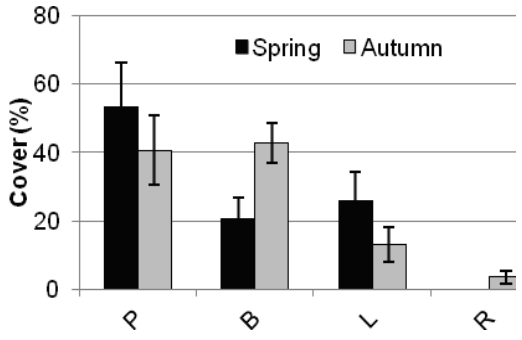

Figure 6. Impact of season on percent (%) of plant cover, bare ground, litter and rocks in Tajikistan.

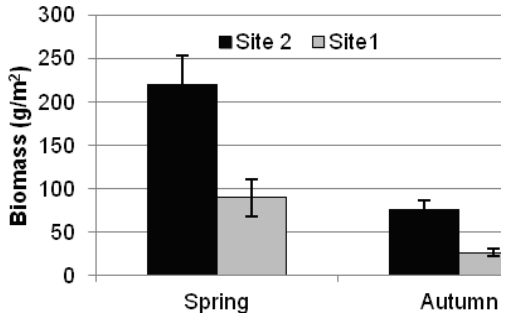

Figure 7. Impact of sites on biomass productivity (g/m^2) of two seasons (spring and autumn).

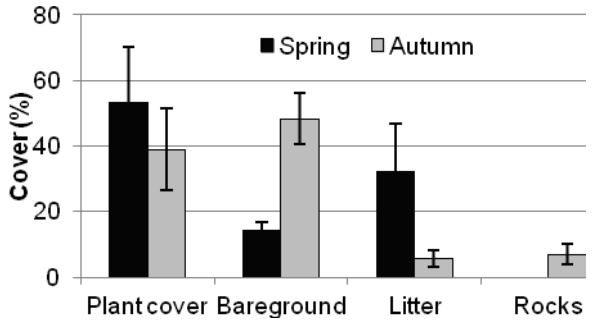

Figure 8. Impact of season on percent (%) of plant cover, bare ground, litter and rock at Site 1.

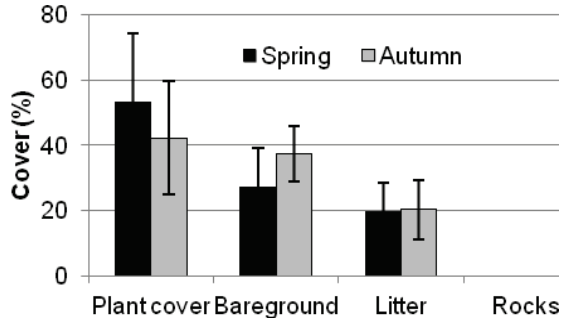

Figure 9. Impact of season on percent (%) of plant cover, bareground, litter and rock at Site 2.

Discussion

The differences in vegetation parameters indicate a strong effect of aspect and season on site productivity. Biomass and plant productivity of north oriented slopes was higher than that of south oriented slopes and biomass was higher during the spring compared to the autumn season. Consequently, this indicates that the aspect and the season of the year are important parameters affecting soil water availability which leads to the observed variations in site productivity. These results are in accordance with previous studies noting that on south facing slopes soil water availability primarily limits plant growth as the soil dries more quickly and reaches wilting point faster after rainfall events (Gong *et al.* 2008).

Conclusion

Better vegetation growth occurs on north facing slopes where shade is more predominant than sun and evapo-transpiration is less. This environmental factor has been ignored in the past and needs to be taken into account when considering options for rehabilitation and restoration measures of degraded grasslands. Management strategies for sustained grassland production need to incorporate biophysical information and integrate local communities in decision-making.

Acknowledgements

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