# Grazing effects on mountain rangeland diversity in north-eastern Tunisia

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# Grazing effects on mountain rangeland diversity in north-eastern Tunisia

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**Abstract.** Although the effects of controlled grazing, heavy grazing and no grazing on vegetation structure have been extensively studied in a wide range of ecosystems, the effects of grazing on mountain lands are still largely unknown in Tunisia. Two areas traditionally grazed by sheep and goats in northeastern Tunisia (continuously grazed and controlled grazing) and an ungrazed area were sampled to evaluate the effects of grazing intensity on mountain rangelands. We examined the respective effects of heavy grazing, controlled grazing and no grazing on total vegetation cover, species richness and the Shannon-Wiener diversity index. Sampling was done from 2009 using permanent transects under different grazing intensities. Results show that vegetation dynamics in mountain rangelands respond strongly to changes in grazing management. The controlled grazing impact maintains resilient rangelands and ensures a sustainable flow of rangeland goods and services to livestock. The resting periods in the controlled grazing allow plants to recover before they are grazed again. The vegetation cover, species richness, Shannon-Wiener diversity index and species composition were significantly greater on the un-grazed site and significantly lower on the heavily grazed site.

**Keywords.** Mountain rangelands – Grassing pressure – Richness – Diversity.

***L'effet du pâturage sur la diversité des parcours dans la montagne du nord de la Tunisie***

*Résumé. Bien que les effets du pâturage contrôlé, intensif et du non pâturage sur la structure de la végétation aient été largement étudiés dans les différents types d'écosystèmes, les effets du pâturage sur les terres de montagne sont encore inconnus en Tunisie. Deux zones traditionnellement pâturées par les moutons et les chèvres, dans le nord de la Tunisie (en pâturage intensif et pâturage contrôlé) et une zone non pâturée ont été échantillonnées pour évaluer les effets de l'intensité du pâturage sur les différents parcours. Nous avons examiné les effets du pâturage intensif, du pâturage contrôlé et du non pâturage sur le couvert végétal, la richesse en espèces et l'indice de diversité de Shannon-Wiener. L'étude a été faite pendant l'année 2009 en utilisant des transects permanents dans les différents systèmes de pâturage. Les résultats montrent que la dynamique de végétation dans le parcours en montagne réagit fortement aux changements du système du pâturage. L'impact du pâturage contrôlé permet de maintenir les parcours résilients et d'assurer la durabilité des parcours afin d'améliorer les biens et services à l'élevage. Les périodes de repos en pâturage contrôlé permettent aux plantes de récupérer avant qu'elles soient pâturées à nouveau. Le couvert végétal, la richesse en espèces, l'indice de diversité de Shannon-Wiener et la composition floristique du parcours étaient significativement plus élevés sur le site non pâturé et le site de pâturage contrôlé et significativement très faible sur le site pâturé d'une manière intensive.*

***Mots-clés.*** *Parcours de montagne – Pression de pâturage – Richesse – Diversité.*

## I – Introduction

In Tunisia, the northern rangelands are largely depopulated because many pastoralists have opted for livelihood opportunities in other sectors of the economy. Heavy grazing has been reported to reduce the diversity of herbs and shrubs in the range land (Zhao *et al.,* 2006), and while some species have disappeared, others have survived through the use of morphological or other adaptations (Wang *et al.,* 2002). Moderate grazing can be effective in promoting greater diversity in vegetation (Holechek, 1991). Species richness and diversity tended to decrease with increased grazing pressure, but the difference was not significant between

ungrazed and moderately grazed rangelands (Gamoun, 2014b). One of the objectives of this work was to evaluate the influence of rangeland utilization and management practices on plant communities. For this purpose, the three systems of heavy grazing, controlled grazing and ungrazed treatment were instituted to evaluate the effect of grazing intensity on plant communities in the mountain rangelands in northeastern Tunisia.

## II – Materials and methods

The study was carried out on the mountain rangelands of El Haouaria, which is a coastal ecosystem located in the peninsula of Cap Bon, in the eastern part of Tunisia. This mountain has an average altitude of 390 m above sea level and has a sub-humid Mediterranean climate.

Two areas traditionally grazed by sheep and goats, one continuously grazed and one with controlled grazing, and one ungrazed area were sampled to evaluate the effects of grazing intensity on mountain rangelands. The vegetation measurements presented here were taken in spring 2009. Three parameters related to vegetation were analyzed in each area: (1) plant cover; (2) diversity; (3) species richness. In each measurement, the vegetation was surveyed using the permanent transect method (Daget and Poissonet, 1971). The Shannon's index of diversity H' (Shannon, 1948) is calculated from centesimal frequencies of species:

$H' = - \Sigma((f_i/ N) * \log_2(f_i/ N))$;

with $f_i$: the number of i species in the samples, and N: the overall number of species.

Effects of grazing intensity on cover and plant diversity were analyzed by one-way ANOVA, within an experimental error of 0.05. All data analyses were conducted using SPSS software. Accordingly, the chosen methods were Correspondence Analysis (CA) and Cluster Analysis (HA).

## III – Results and discussion

### 1. Results

A total of 57 species were recorded from the study site, respectively 12 species in continuously grazed areas, 48 species in controlled grazing areas and 52 in the ungrazed area. Species richness in ungrazed and grazed rangelands manifested a significant difference ($P < 0.001$). In the continuously grazed area the perennial species richness was of about 12 species, but there were about 16 species in the controlled grazing area and 24 species in the ungrazed area.

The continuous grazing negatively affects vegetation cover and highly desirable species and promotes the appearance of dominant species not appreciated by livestock. Results showed that grazing intensity significantly altered total vegetation cover ($F=164.730$, $P< 0.001$). Vegetation cover increased significantly on the ungrazed site (68.9 %). In contrast, vegetation cover decreased significantly in the heavily grazed or continuously grazed site (11.6 %).

The diversity index in the controlled grazed area (2.24) was always lower than that under the ungrazed condition (2.38), but much higher than that of the continuously grazed area (1.15). ANOVA analyses showed that there were significant differences in diversity index between grazing intensities ($F=64.976$, $P<0.001$).

Using multivariate analysis (CA) according to the diversity indicator, three groups of rangelands are distinguished following the grazing system (Fig. 1), which was justified by the Cluster Analysis. The dendrogram illustrating the presence of 03 groups using the analysis of 30 sites in the study area (Fig. 2). Cluster Analyses broadly divided the rangeland into three assemblies which could be clearly seen in two main branches of the dendrogram; (i) green: ungrazed, (ii)

red: continuously grazed, (iii) purple: controlled grazed (i). The vegetal rug is analyzed by three principal grazing systems.

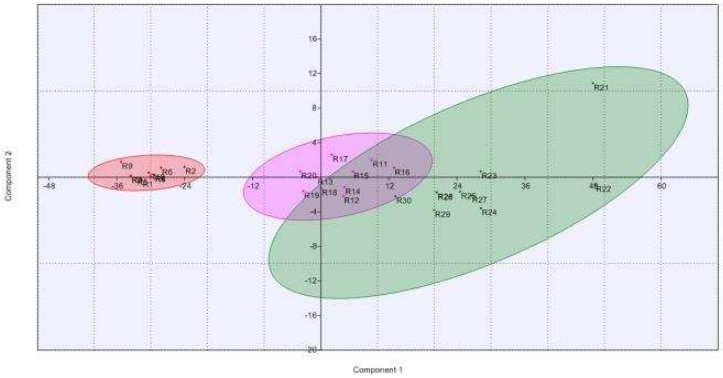


**Fig. 1. Correspondence analysis map of 30 sites species: (i) green: ungrazed site, (ii) red: continuously grazed site, (iii) purple: controlled grazing site.**

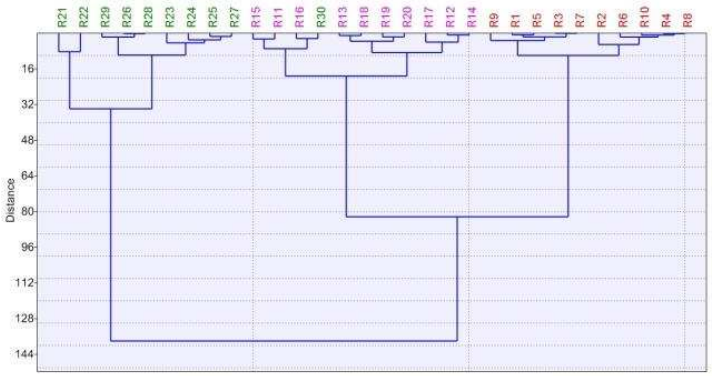


**Fig. 2. Dendrogram of 30 sites' species after Cluster Analysis: (i) green: ungrazed site, (ii) red: continuously grazed site, (iii) purple: controlled grazing site).**

## 2. Discussion

A previous study has indicated that continuous grazing has a wide range of effects on the composition, diversity, and vegetation cover (Gamoun, 2014a, 2014b, 2015). Livestock grazing has caused severe degradation of vegetation both directly (by eating it) and indirectly (by trampling) (Gamoun, 2015). Excluding grazing improved plant cover and flora richness (Deng *et al.,* 2013; Gamoun, 2015). Under the overgrazing effects, the natural vegetation cover decreases, the unpalatable plants dominate and the ecosystem biodiversity is reduced (Vavra *et al.,* 2007). However, our results show that the controlled grazing leads to a remarkable regeneration of natural vegetation. Similar results were recorded by (Ayyad and El Kadi, 1982). In fact, controlled grazing can provide adequate forage for livestock while maintaining environmental quality. This management practice seems to be efficient for the sustainability of the floristic heritage and helps in nature conservation. Therefore, according to certain authors (Ayyad and El Kadi, 1982), controlled grazing might be of better consequences than full protection.The continuous grazing resulted in re-grazing of plants and overgrazing. There would

also be many plants that were completely ungrazed. There would be plants of low quality but in high quantity; similar results were reported by Gamoun (2014a).

## IV – Conclusions

This study indicates that controlled grazing facilitates greater plant species richness on grazing land than both heavy grazing and a complete absence of grazing. This study suggests that controlled grazing can be used as a beneficial management method to maintain species diversity and mountain rangelands productivity.


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## References


**Ayyad M.A. and EL-Kadi H.F., 1982.** Effect of protection and con-trolled grazing on the vegetation of a Mediterranean desert ecosystem in Northern Egypt. In: *Vegetatio*, 49, p. 129-139.

**Daget P. and Poissonet, J., 1971.** Une méthode d'analyse phytoécologique des prairies, critères d'application, In: *Annales Agronomiques*, 22, p. 5-41.

**Deng L., Sweeney S. and Shangguan Z.P., 2013.** Grassland responses to grazing disturbance: plant diversity changes with grazing intensity in a desert steppe. In: *Grass and Forage Science,* doi:10.1111/gfs.12065.

**Gamoun M., 2014a.**Grazing intensity effects on the vegetation in desert rangelands of southern Tunisia. In: *Journal of Arid Land*, 6, p. 324-333.

**Gamoun M. and Hanchi B., 2014b**. Natural Vegetation Cover Dynamic under Grazing Rotation Managements in Desert Rangelands of Tunisia. In: *Arid Ecosystems*, 4 (4), p. 277-284.

**Gamoun M., Patton B. and Hanchi B., 2015.** Assessment of vegetation response to grazing management in arid rangelands of southern Tunisia, In: *International Journal of Biodiversity Science, Ecosystem Services & Management*, DOI: 10.1080/21513732.2014.998284.

**Holechek J.L., 1991.** Chihuahuan Desert rangeland, livestock grazing and sustainability. In: *Rangelands*, 13, p. 115-120.

**Shannon C.E., 1948.** A mathematical theory for communication. *Bell System Technical Journal*, 27, p. 379-423.

**Vavra M., Parks C.G., Wisdom M.J., 2007.** Biodiversity, exotic plant species, and herbivore: the good, the bad, and the ungulate. In: *Forest Ecology and Management*, 246, p. 66-72.

**Wang Y.S., Shiyomi M., Tsuiki M.I., 2002.** Spatial heterogeneity of vegetation under different grazing intensities in the Northwest Heilongjiang Steppe of China. In: *Agriculture, Ecosystems and Environment*, 90, p. 217-229.

**Zhao W.Y., Li J.L., Qi J.G., 2007.** Changes in vegetation diversity and structure in response to heavy grazing pressure in the northern Tangshan Mountains china. In: *Journal of Arid Environments,* 68, p. 465-479.