



Seasonal grazing distributions of livestock in the communal rangelands of Namaqualand

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Abstract

The role of indigenous grazing management practices in flexible and sustainable resource use has been widely identified and recognised in the literature. However, these grazing management practices in the semi-arid pastoral areas in Namaqualand in South Africa have not adequately been studied in terms of GPS-based seasonal grazing distribution. This study aimed to assess the seasonal livestock grazing distributional patterns across three communal rangelands in Namaqualand using GPS collars. The objectives were to: 1) generate grazing distributional maps to identify patterns of seasonal rangeland use, 2) compare home range and grazing intensity of livestock between seasons, 3) delineate different grazing zones at different times of day known descriptive model of daily indigenous grazing management practices of Namaqualand and 4) contrast seasonal differences within these grazing zones regarding grazing activity. Catlog GPS collars were mounted on livestock and T-LoCoH R package and Google Earth was used to generate grazing distributions maps showing areas most frequently used by livestock (grazing intensity) and daily livestock movement patterns. The results showed that Namaqualand herds grazed a small proportion of their home range regardless of season. Wet-season herds had smaller home range. The area associated with high grazing intensities in both seasons was significantly smaller than at lower grazing levels. No significant differences in mean area associated with seasonal variation within each level of grazing suggests herders are not seasonally altering areas associated with grazing intensity to prevent seasonal over-exploitation of resources. Grazing activity is lower in the herded zones than in when unherded. Grazing activity and distance travelled in the herded zones is lower in the wet season but area covered is less as resources are abundant. This suggests that indigenous herding practices in Namaqualand requires vast ecologically aware decision-making processes associated with effective sustainable resource use. We argue that due to the flexibility and adaptability of indigenous grazing managements Namaqualand, herders may increase the area covered at high grazing intensities during the wet season will improve livestock productivity without compromising rangeland condition. Furthermore, contemporary of grazing management systems should be more inclusive of indigenous management as aspects of holistic grazing management have embedded in these practices for a long time.

Introduction

Poor grazing management in arid rangelands can lead to rangeland degradation through overgrazing. In Namaqualand, and South Africa more broadly, historical management practices were shaped by perceptions such as 'The Tragedy of the Commons,' which inaccurately blamed overgrazing on ineffective indigenous grazing systems (Hardin 1968). These misconceptions disrupted the transhumance mobility patterns of subsistence livestock owners, undermining their ability to adapt to changing environmental conditions (Samuels et al. 2008). As a result, indigenous communities were significantly hindered in their efforts to manage rangeland resources effectively.

Despite these perceptions the Namakwa herders maintained their highly mobile indigenous grazing management practices. Effective grazing management of communal rangelands requires mobility from both herders and their livestock across various spatio-temporal scales (Samuels et al. 2007). Indigenous communal farmers and herders navigate the landscape with their livestock, guided by ecological knowledge refined over generations (e.g., transhumance) (Allsopp et al. 2007). This mobility enables herders to flexibly adapt resource use to fluctuating ecological and environmental conditions."

While the flexibility and sustainable resource use of indigenous grazing management practices in Namaqualand have been widely recognized in the literature (Asheenafi and Leader-Williams 2005; Samuels et al. 2007; Allsopp et al. 2007), these practices have not been sufficiently represented through GPS-based seasonal grazing distribution maps. To better assess the flexibility and adaptability of these indigenous practices, it is crucial to investigate GPS maps of grazing distribution patterns.

This study aims to assess the livestock grazing distributional patterns across three communal rangelands in Namaqualand. The objectives of this study are to:

1. Generate grazing distributional maps to identify patterns of rangeland use between wet and dry seasons.
2. Use different times of the day within grazing course to delineate different grazing zones.
3. Contrast seasonal differences within these grazing zones regarding grazing activity.
4. Compare home range and grazing intensity of livestock between seasons.

Methods

To determine seasonal livestock grazing distribution patterns in space, two data collection field trips were undertaken in the wet season (Winter and Spring) and dry season (Summer), where two CatLog GPS (Global Positioning Systems) tracking devices were attached to two random adult animals (sheep and/or goat) in every herd.

Additionally, the Catlog GPS trackers also record animal velocity which is essential for determining the specific daily livestock activity along the grazing course based on the descriptive model of indigenous grazing practices model from Debeaudoin (2001) [Unpublished Master's thesis]. The collars were left to record daytime movements for duration about three months and GPS data was retrieved.

GPS positional data from each animal was extracted and analysed using the CatLog Software and the R package Time Local Convex Hull (T-LoCoH) (Getz and Wilmsers 2004) to generate isopleths which represent the varying proportions of the total grazing distributional extent used by the animals of interest. Google Earth Pro (2023) was used to map the isopleth data.

T-LoCoH is an R package that creates isopleth diagrams showing an object's range in space and time using the Minimum Convex Polygon (MCP) method. Each polygon within the isopleth represents the extent of the areas utilized and the frequency of use over time at each location (Gusha et al. 2018; Gwate 2018). These polygons, or hulls, were assigned categorical classes (iso levels) and color codes to indicate the proportion of the total area utilized and the corresponding frequency of use. Based on the iso levels and their color codes, grazing intensity was categorized into three levels: high, moderate, and low

Two-way Wilcoxon-Mann-Whitney t-tests or Kruskal-Wallis tests and a relevant post-hoc tests were used to analyse significant seasonal variations spatio-temporal variables.

Results

Livestock movement during the wet season and dry seasons in the study area

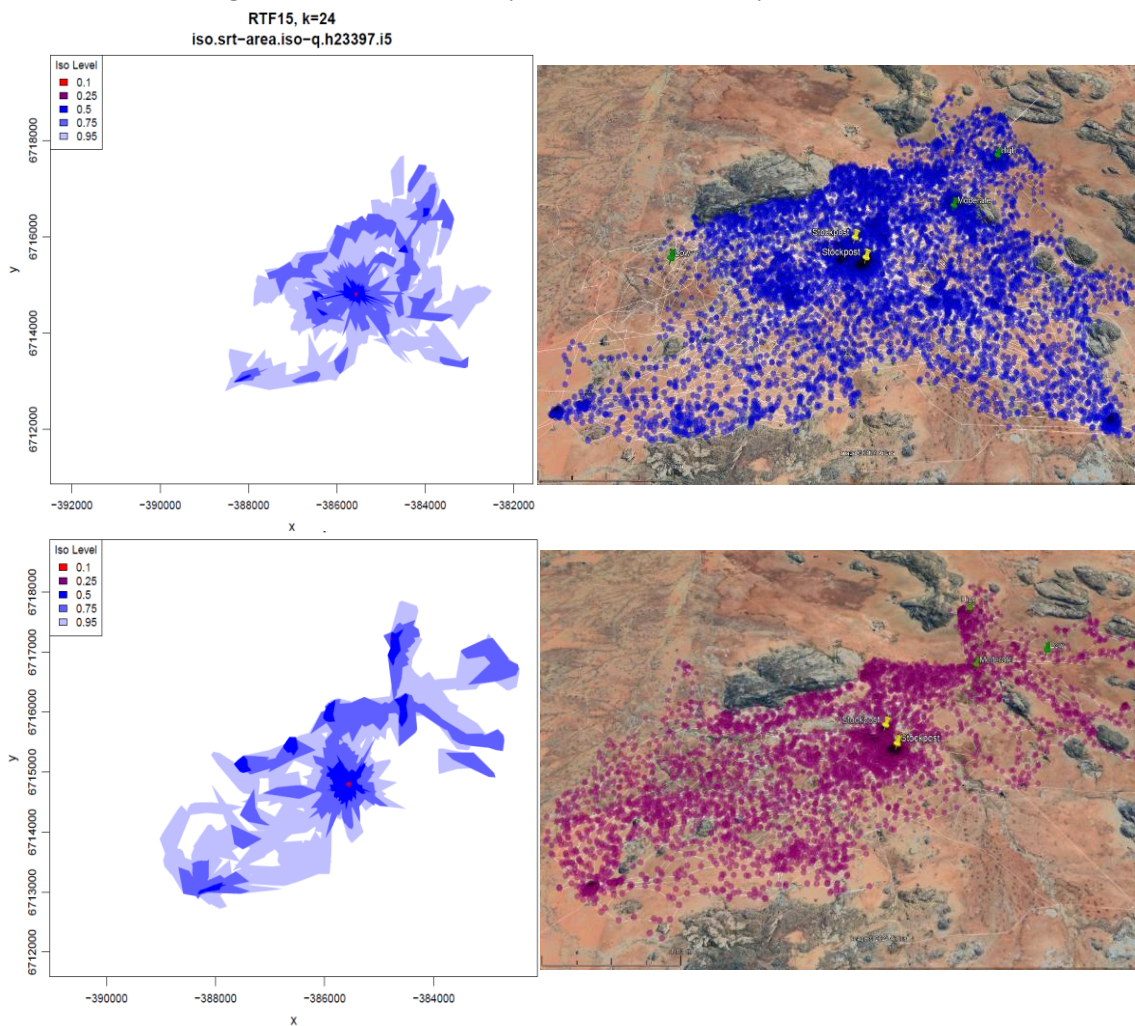


Fig. 1: Isopleth diagrams produced from hulls arranged by area denoting the frequency of occurrence and proportions of the total area occupied by an adult *Capra hircus* during the wet season (bottom left) and *Ovis aries* in the dry season (top left) in Concordia. Google Earth maps (right) depicting the grazing distribution of a *Capra hircus* (purple dots) during the wet season and *Ovis aries* (blue dots) during the dry season in Concordia. Stock post (Yellow pin) and grazing intensity levels (Green pins).

The home range appears larger in the dry season compared to the wet season in Fig. 1.

Spatial data: and grazing intensity during dry seasons of the study area

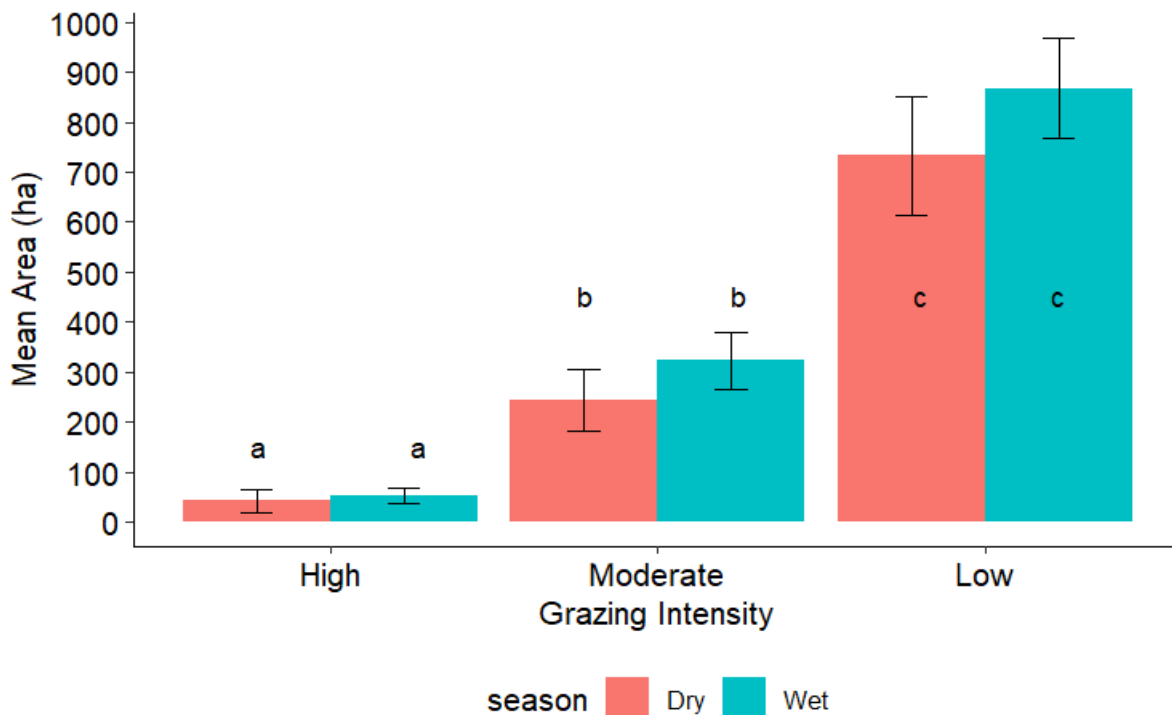


Fig. 2: Mean area grazed at every level of grazing intensity between wet and dry seasons across all three communal areas.

Fig. 2, shows there are significant differences in mean area covered at different grazing intensities ($X^2 = 46.327$, $df = 2$, $p\text{-value} < 0.05$). Mean area covered is lowest at high grazing intensity (48.1 ± 13.5 ha) and there are no significant differences in mean area associated with seasonal variation within each level of grazing ($z\text{-value} = 0.785$, $p\text{-value} = 0.432$).

In Fig. 3, each of the grazing zones indicate particular time classes within a daily grazing course. The Excitement/appetite moderation zone (EAM) is between 07:00 – 11:00, Target Zone and waterpoint (T) is between 10:00 – 14:30 and the Late Afternoon Meal zone (LAM) is between 14:30 -17:00.

Fig. 3A, indicates the mean speeds of livestock associated with grazing zones along the daily grazing route in Namaqualand. The bar plot shows mean speed is significantly slower in LAM (0.852 ± 0.0010 km/h) than in the other zones (both $p\text{-values} < 0.05$).

Fig. 3B, shows there is significant difference in mean grazing speeds between seasons only at EAM and T zones only ($p\text{-value} < 0.05$), where livestock move faster during the wet season (Wet: 0.945 ± 0.006 , Dry: 0.907 ± 0.008).

Grazing activity of livestock and speeds along daily grazing course during the wet and seasons

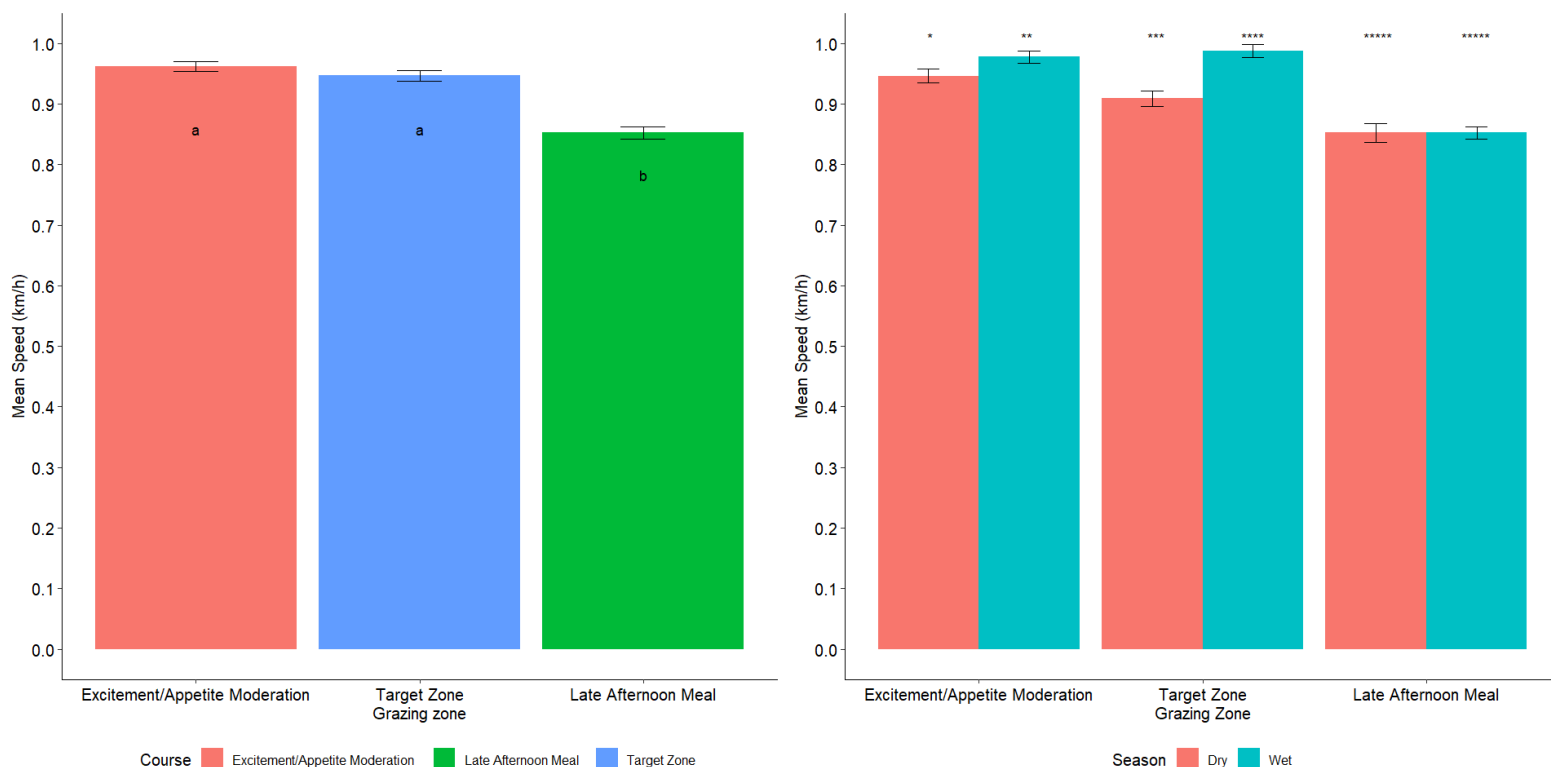


Fig. 3: Shows the differences in mean grazing speeds of livestock at different time specific zones along daily grazing route. (A) depicts the grazing speeds across all seasons. (B) indicates the grazing speeds between seasons. Letters (a, b) and (*) indicate significant differences in bar plots A and B respectively.

Discussion, Conclusions & Implications

Some of the historical perceptions indigenous herders derived from the ‘tragedy of the commons’ on indigenous herders is that they are selfish and do not have the skills to manage communal rangelands effectively.

However, the data shows that indigenous herders in Namaqualand are practicing ecologically sustainable grazing management (Fig. 3). This is because the mean area grazed differs at every level of grazing intensity such that high grazing intensities occupy the smallest areas (Fig. 3). Although this may be because palatable succulent karoo vegetation is limited to small patches, it is more likely that high intensity grazing is spatially limited by herders to allow for longer resting periods to conserve these palatable patches.

Furthermore, there is evidence (Fig. 3) that Namakwa herders are ecologically aware regarding sustainable use of resources not just in space but also in time as the mean areas grazed at all grazing intensity levels remains unchanged across seasons. This suggests that herders are preventing seasonal exploitation of resources to promote accumulation of available forage for their livestock. This allows flexibility for potential future exploitation of palatable plants.

Therefore, the spatial and temporal restrictions on grazing within the home range by Namakwa herders while maintaining livestock production improves the quality of both the livestock and rangeland condition. These are principles similar to those in holistic and adaptive grazing management (Mann and Sherron 2018) though these concepts are already embedded into the vast indigenous ecological knowledge of Namakwa herders. The success of this though requires vast ecological knowledge at various spatio-temporal scales by Namakwa herders and, contrary to historical perceptions, is an example of effective grazing management.

Furthermore, this study indicates that there are significant differences in mean speeds of livestock differs in the mid-afternoon (T) along a daily grazing route (Fig. 2A-B). This finding is similar to that found in the Richtersveld National Park by Hendricks (2004), where there was a significant difference in herd speeds between morning and afternoon. Speeds in different zones (Fig. 2) suggest variations in grazing activity, with slower speeds indicating more intense grazing activity. The reduced speed from the mid-afternoon reflects peak grazing activity during this time. This is likely because the animals are unherded during this time as studies by Debeaudion (2001) and Samuels (2006) show many Namakwa herders leave their animals once they reach the (T) in the afternoon as they have other duties to perform. This ensures animal well-being through limited free-range grazing on good quality forage and allowing for effective rumination.

Conversely, in the morning and early afternoon grazing activity is lower because animals are moving faster as they are being actively herded. This is similar high intensity short-duration grazing (Chaplot et al. 2016; Louhaichi et al. 2021), where herders take all their and are constantly moving. This permits longer resting periods and evenly distributes grazing impacts. This emphasises the flexibility and adaptability of the indigenous grazing management system in Namaqualand.

Additionally, grazing activity changes in the herded zones (EAM and T) between seasons (Fig. 2B), where grazing activity is lower in the wet season. Moreover, distance travelled may also be inferred from speed as a greater speed suggests more ground is covered in the same time. Thus, herds travelled further in the wet season but this is contrary to many studies which state livestock should instead travel further in the dry season as resources are limited (Lawrence et al. 1988; Hulbert et al. 1996; Sieff 1997; Samuels 2006; van Beest et al. 2011).

However, this finding aligns with existing literature only when seasonal resource availability and spatial perceptions are correctly interpreted (Fig. 2B). Specifically, it is essential to distinguish between the distance travelled and the area covered. For instance, during the wet season, when resources are abundant, livestock may travel further but cover a smaller area due to the concentrated availability of palatable vegetation. Conversely, in the dry season, when resources are scarce, livestock may not travel as far but cover a larger area as they forage for dispersed vegetation. The alignment of this observation with broader literature underscores that Namakwa herders have preserved their seasonally adaptive farming practices over time, despite evolving perceptions.

Effective grazing management in Namaqualand requires deep ecological knowledge across scales. As climate variability intensifies (Thornton et al. 2014), adaptive indigenous grazing practices offer valuable insights for mitigating climate change impacts. Modern management strategies should prioritize indigenous knowledge and involve local communities in shaping future approaches.

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