Evaluation of communal rangeland condition under the East Griqualand veld type of Eastern Cape Province, South Africa

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Abstract

Rangeland condition is defined as the state of health of rangeland in terms of species diversity and the potential for producing good quality forage for livestock. However, these rangelands are gradually declining due to poor resource management, land degradation and climate change, which poses a serious threat to the natural resources and economic development of South Africa. The aim of the study was to assess communal rangeland condition in terms of species composition, to determine woody density, browsing unit (BU/ha) and tree equivalents of woody plants at Santombe communal grazing lands. The study was conducted in four sites, which were selected based on the similar land use. In each site 100m x 50m were demarcated, three parallel transects of 3m x 100m were measured per site. Within each belt transect, line transect of 100m were measured to determine grasses composition using step point method. Woody plants occurring within a belt transect were identified, counted and recorded to evaluate woody plant species composition, density, browsing unit and tree equivalents. Fifteen grass species were identified, 80% were increasers, 13% decreaser and 7% exotic species. Fourteen woody species were identified, 64% were acceptable and 36% were unacceptable to goats. *Rhamnus prinoides* and *Scutia myrtina* were the most dominant species. Site 2 (2508 plants/ha) and site 1 (2112 plants/ha) had the highest plant density, while site 4 (2310 BU/ha) had the highest browsing unit compared to site 1, 2 and 3. Abundance of increaser species was a clear indication of rangeland deterioration. High percentage of acceptable wood plants showed a great potential for sustainable goat production. It was recommended that farmers should establish rangeland farmer's association, which will assist in formulating rules and regulations for better utilisation of their feeding resources.

Keywords: browsing unit, density, equivalents, composition, relative abundance
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Introduction

Rangeland condition is the state of health of rangeland in terms its ecological status, resistance to soil erosion and the potential for producing forage for sustained optimum livestock production (Ndandani, 2016). The condition of these rangelands in South Africa are gradually declining, primarily due to poor resource management, land degradation and climate change (Hoffman & Ashwell, 2001). In communal areas, rangelands are shared by community members and everyone in the community has free access to the rangeland resources, but livestock management decisions are made in most cases by individual owners (Gxasheka *et al*., 2017). This practice however, has been shown to promote the loss of rangeland productivity and ultimately leads to poor livestock performance (Lesoli, 2008). Due to the impact of different veld management practices on rangeland vegetation composition and change over time, it remains important to continuously evaluate rangeland condition (Thackway *et al*., 2006). Rotational grazing is viewed as one of the basic grazing system that can be used as a management practice for rangeland conservation (Liu *et al*., 2009).

This practice involves the control of livestock movements during grazing mainly for optimal utilisation of rangeland resources and improved livestock performance (Gamoun, 2014). Well-managed rangeland in terms of grazing practices usually exhibits a higher biomass production with high forage quality, good soil cover and abundance perennial species (Fensham *et al*., 2010). The loss of rangeland productivity particularly in communal areas is linked with the continuous grazing and uncontrolled fires (Rutherford & Powrie, 2013).

These practices promote the disappearance of strong perennial grasses and establishment of undesirable woody plants species (Cingolani *et al*., 2005). Abundance of unacceptable or undesirable woody plants in a rangeland are associated with the decline of grazing capacity and outcompete grasses in terms of soil resources (Lesoli, 2008).

The Eastern Cape Province in South Africa has the highest index of land degradation (Ndou, 2013). A large portion of rangelands in the Eastern Cape are communal, and approximately 2.6 million hectares in the Province is severely degraded (Lesoli, 2008). Loss of rangeland productivity in communal areas is mostly driven by disregarding of grazing management practices (Hoffman & Ashwell, 2001) and therefore this current study aimed at assessing the composition of both grasses and woody plants, determine density, browsing unit and tree equivalents of woody plants. Currently, there is limited recent information on rangeland condition of communal areas, availability of such information is crucial for communal farmers to understand the importance of assessing rangeland condition.

Materials and Methods

Site description

Veld condition assessment was carried out at Santombe communal grazing lands located in Mount Ayliff, Mzimvubu Municipality of the Eastern Cape, South Africa. The area is located at the following coordinates: 30°49′19.55489″S, 29°22′50.9726″E with an elevation of 920-1740 m. Mean annual precipitation ranges 620-816 mm per year. The mean annual temperatures range from 13°C to 29°C (Mucina and Rutherford, 2006). Santombe communal lands are shared by members of the community and grazed continuously with no restrictions on stocking rates. Santombe communal rangeland falls under the East Griqualand veld type and herbaceous layer is dominated by *Eragrostis plana, Aristida congesta, Sporobolus africanus, Heteropogon contortus, Themeda triandra and Felicia filifolia*. *Diospyros lycioides, Searsia lucida, Scutia myrtina, Coddia rudis, Vachellia Karoo* and *Ziziphus mucronata* are dominant wood species (Mucina & Rutherford, 2006). Soil parent material is that of mudstone and sandstone (Mucina & Rutherford, 2006).

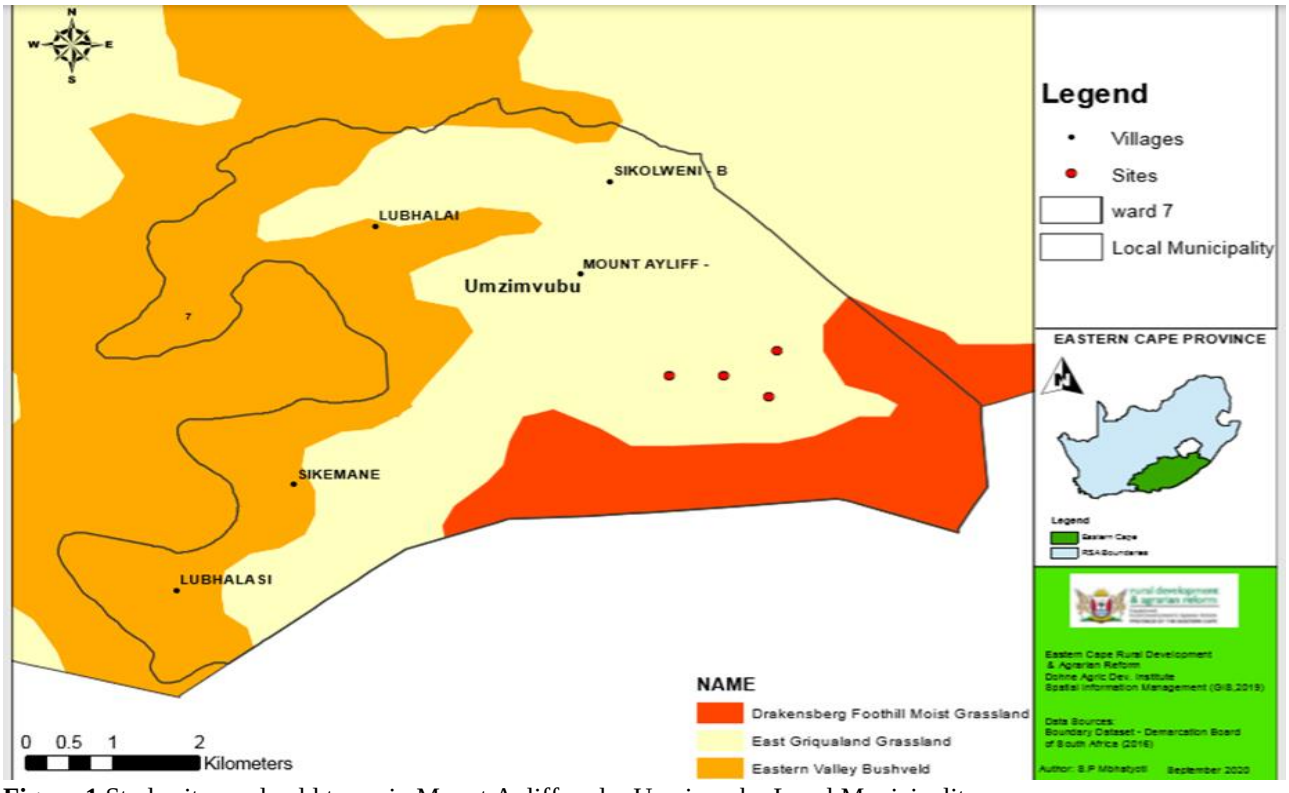

Figure 1 Study sites and veld types in Mount Ayliff under Umzimvubu Local Municipality

Data collection

In September 2020, vegetation sampling was carried out in four sites at Santombe communal rangeland. At each sites, 100m x 50m were demarcated and three parallel belt transect of 3m x 100m were measured per site with 15m between each belt transect. Three belt transects per sites were selected based on vegetation uniformity and similar land use which was mainly for grazing and browsing. All woody plant species occurring within each belt transect were identified, counted and recorded to evaluate woody plant species composition, browsing unit (BU) and tree equivalents (TE) Within each belt transect, 100m line transect were measured to determine grasses composition using step point method along the belt transect (Vetter *et al.*, 2006). A metal rod was lowered after every meter and herbaceous species nearest to the point were identified. In each belt transect, grasses were identified to species level using the method of Trollope (1989) other herbaceous plant species were also identified and recorded. Grass species were later grouped into (1) decreaser species, (2) increaser I, II and III species using the procedure of Trollope (1989). Grass species were also grouped according to their life form (annuals and perennial) (Tefera *et al.*, 2007).

Data analysis

The collected data was entered into Microsoft Excel to compute relative abundance percentages and average height of trees (descriptive statistics). Relative abundance percentage was estimated on the excel spreadsheet according to Trollope (1989), using the following equation:

$$\textbf{Relative abundance (\%)} = \frac{\text{Number of individual species}}{\text{Number of species population}} \times 100\%$$

Tree density, tree equivalent and browsing unit were estimated per site (50m x 100m) per belt transect (3m x100m). All trees within the belt transect of 300m^2 were counted and converted to plants per hectare. All counted trees in three belt transect per site were added to give number of trees per site. Tree density per hectare was estimated according to (Teague, 1989c) using the following equation:

Tree Density = Total trees counted per transect belt x 33

The value 33 was calculated by dividing 10 000 m^2 by 300m^2 (i.e. 1 hectare is equivalent to 10 000 m^2). Tree equivalents (TE) is defined as 1.5m tall or shrub. Tree equivalents was estimated according to (Teague, 1989c). Teague (1989c) highlighted tree equivalent values can be expressed in terms of canopy volume rather than tree height.

$$\textbf{Tree equivalent} = \frac{\text{Average height of trees per site}}{1.5\text{m}} \times \text{Number of trees per hectare}$$

Browsing unit

The browsing unit (BU/ha) represents the total browseable length of palatable trees and shrubs within 1.5m of the soil surface (the browsing height of goats). Browsing unit was estimated by adding together all acceptable trees or shrubs within 1.5m stratum (Teague, 1989c). Browsing unit in belt transect of 3m x 100m were converted to browsing unit per hectare.

Results and Discussion

Herbaceous vegetation composition

Fifteen grass species were identified, 80% were increasers (of which 67% of them were increaser II and 13% were increaser I), 13% decreasers grass species and 7% exotic species (Table1). The classification of herbaceous vegetation in terms of grazing value was 26% highly palatable, 33% average and 40% low, and all were perennials (Table 1). *Sporobulus Africanus* (18.25%), *Eragrostis plana* (15.00%) *Aristida congesta* (14.25%) and *Hyperrhenia hirta* (11.50%) were the most abundant species (Table 1). The abundance of increaser species such as *Sporobulus africanus, Eragrostis plana* and *Aristida congesta* it's a clear indication of rangeland deterioration due to negligence of veld management practices by land users. This is in line with Van Oudsthoorn (1992), who stated that abundance of increaser species is an indicator of fire suppression and overutilization or underutilization. However, the decline of these species can be influenced by veld resting and use of prescribed burning.

Paspalam dilatatum (0.25%), *Andropogon appendiculatus* (0.75%), *Eragrostis lehmanniana* (0.75%), *Elionurus muticus* (0.75%) were the least dominant grass species (Table1). The reduced abundance of decreaser species resemble a clear sign of selective grazing and uncontrolled fire use, especially during dry the season. These findings concur with result reported by Ward (2005), who stated that decreaser species dominate in well-managed veld but their proportion decline as selective or continuous grazing worsens. During data collection land users alluded that uncontrolled veld fires caused by hunters was the main problem at Santombe grazing lands. Overutilization of rangeland resource through overgrazing and exclusion of prescribed burning can accelerate the change of species composition (Tokozwayo, 2016). Poor veld management practices and climate related factors such as prolonged drought also influence the species composition. Ward (2005) reported that a gradual replacement of palatable grasses was also mainly influenced by climate change and poor veld management practices.

Table 1 Botanical name, ecological status, perenniality, grazing value and relative abundance (%) of grass species at Santombe communal rangeland

Botanical name	Ecological status	Perenniality	Grazing value	Relative abundance (%)
Alloteropsis appendiculatus	Decr	Perennial	High	0.75
Aristida congesta	Inc II	Perennial	Low	14.25
Cynodon dactylon	Incr II	Creeper	Average	3.50
Cymbopogon plurinodis	Incr I	Perennial	Low	1.25
Elionorus muticus	Incr III	Perennial	Low	0.75
Eragrostis chloromelas	Incr II	Perennial	Average	5.00
Eragrostis curvula	Incr II	Perennial	High	3.50
Eragrostis lehmanniana	Incr II	Perennial	Average	0.75
Eragrostis plana	Incr II	Perennial	Low	15.00
Heteropogon contortus	Incr II	Perennial	Average	2.50
Hyperrhenia hirta	Incr I	Perennial	Average	11.50
Paspalam dilatatum	Exotic	Perennial	High	0.25
Sporobulus africanus	Incr III	Perennial	Low	18,25
Themeda triandra	Decr	Perennial	High	9.00
Microchloa caffra	Incr II	Perennial	Low	1.25

Decr: decreaser, Incr I: increaser I, Incr II: increaser II, Incr III: increaser III

Woody plant composition

In this study, fourteen woody plant species were identified, 64% were acceptable (*Vachellia mearnsii, Vachellia Karoo, Erehia Rigida, Grewia Occidentalis, Scutia myrtina*, and *Maytenus polycantha*) *and 36% unacceptable (Aloe ferox, Artemisia afra, Coddia rudis, Diospyros lycioides, Euclea undulata, Olea europaea, Rhamnus prinoides and Searsia lucida*) to browsers (Table 2). High percentage of acceptable woody plants showed a great potential for sustaining goat production depending on their availability and accessibility to browsers. However, unplanned use of fire and overutilization can suppress the abundance of acceptable trees, subsequently allowing unacceptable species to dominate in an ecosystem. Ward (2005) reported that overutilization and frequent burning promote the recruitment of *Vachelli*a species through seed scarification. With regards to relative abundance percentage the species were as follows *Rhamnus prinoides* (site 1 = 24.7%, site2 = 38.6%, site 3 = 37.8% and site 4 = 7.8%) *Scutia myrtina* (site 1 = 12.3%, site2 = 24.6%, site 3 = 15.6% and site 4 = 0%), *Searsia lucida* (site 1 = 24.7%, site 2 = 12.2 %, site 3 = 11.2% and site 4 = 53.1%), and *Vachellia karoo* (site 1= 4%, site 2 = 1.8%, site 3 = 2.2% and site 4 = 15.7%) were the most dominant wood plant species (Table 2). In literature there was no clear data, which talks to the dominance of *Rhamnus prinoides* species in communal rangelands of the Eastern Cape. Most reported dominant species in Eastern Cape were *Vachellia karoo*, *Euryops floribundus* and *Pteronia incana* (Palmer and Ainslie, 2007; O'Connor *et al*. 2014; Gxasheka *et al*., 2017).

The dominance of unacceptable species in a rangeland tends to have more influence on the grazing capacity as compared to browseable species. Survival of unpalatable tree species in an ecosystem could lead to more recruitment and ultimately a decline of grazing capacity (Modukanele, 1996). *Scutia myrtina* and *Vachellia karoo* were amongst dominant species that are highly acceptable but a high density of these trees may restrict the free movement of livestock because of their defence mechanism through spines. Moreover, Ward (2005) suggested that increased colonies of woody plants may be ascribed to low densities of grasses competing against trees. High grazing pressure due to uncontrolled grazing is the key determinant of trees invasion because it creates an opportunity for colonization, thus, permitting woody recruitment in a grass-dominated ecosystem.

Table 2 Relative abundance (%), acceptability and spines at Santombe communal rangeland

	Relative abundance (%)					
Botanical name	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Acceptability**	**Spines**
Aloe ferox	1.4	1.7	-	-	Unacceptable	-
Artemisia afra	-	-	8.9	-	Unacceptable	-
Coddia rudis	10.9	-	-	18.7	Acceptable	-
Diospyrosis Lysiodes	17.8	7	13.3	-	Unacceptable	-
Ehretia rigida	-	-	-	4.7	Acceptable	+
Euclea undulata	-	-	-	4.4	unacceptable	-
Grewia Occidentalis	-	1.8	-	-	Acceptable	+
Maytenus polycantha	1.4	0	-	-	Acceptable	+
Olea europaea	2.8	3.6	2.2	-	Acceptable	-
Rhamnus prinoides	24.7	38.6	37.8	7.8	Unacceptable	-
Searsia lucida	12.3	24.6	15.6	-	Acceptable	-
Scutia myrtina	24.7	12.2	11.2	53.1	Acceptable	+
Vachellia karoo	4	1.8	2.2	15.7	Acceptable	+
Vachellia mearnsii	-	8.7	4.4	-	Acceptable	

A plus (+) denotes present of spikes, a minus (-) absent of spikes and a dash (-) absent of species in sites

Tree density, tree equivalent and browsing unit

According to Table 3, site 2 (2508 plants/ha) and site 1 (2112 plants/ha) had highest density respectively as opposed to site 3 (1881 plants. ha-1) and site 4 (1485 plants/ha). The density of 2508 plants/ha in site 2 indicate that this site was encroached (Table3). This assumption was supported by Abate *et al*. (2012) who demonstrated that 2500 plants/ha is a barrier between bush encroachment and non-encroached rangeland. This suggests that even though site 1, 3 and 4 had trees but they were not encroached because tree density at these sites falls below 2500 plants/ha according to Gemedo *et al*. (2006).

The density of trees per hectare particularly in site 1 and 2 might negatively affect the grazing capacity if it's not controlled or monitored. Nevertheless, bush clearing, prescribed burning can be used in tandem with goats for controlling the proliferation of woody plants. Nyamukanza and Scogings (2008) proved that bush clearing and prescribed burning can reduce tree phytomass and goats used as follow up treatment. Site 4 (2310 BU/ha) and site 1 (1188 BU/ha) had high browsing unit compared to site 2 (957 BU/ha) and site 3 (429 BU/ha) according to Table 3. The results indicate that acceptable trees can be controlled by use of goats because most of trees were less than 1.5m height (i.e. reachable height for browsing). However, the effectiveness of this control measure is always determined by the current stocking rate and the extent of encroached area.

Mndela (2013) proposed that one mature goat can browse about 2000 BU/ha. This suggest that site 4 and site 1 had more trees, which were browseable within the reachable height of 1.5m, and these findings were supported by (Teague, 1989c). Site 2 had browsing unit of 957 BU/ha, with high tree density compared to other sites, this trend was influenced by the abundance of unacceptable species (*Rhamnus prinoides*).

Tree equivalents at site 4 (195 TE/ha) and site 2 (152 TE/ha) were higher as compared to site 1 (95 TE/ha) and 3 (94 TE/ha) respectively, based on the results in table 3. Tree equivalents in all sites indicate no encroachment because all the values were less than 2500TE/ha according to Table 3. Richter *et al*. (2001) alluded that if tree equivalents of an area is less than the threshold of 2500 TE/ha, therefore that area should be considered as non-encroached.

Table 3 Tree density (plant/ha), browsing unit (BU/ha) tree equivalent (TE/ha) at Santombe communal rangeland

Site	Tree density (plants/ha)	Browsing unit (BU/ha)	Tree equivalent (TE/ha)
1	2112	1188	95
2	2508	957	152
3	1881	429	94
4	1485	2310	195

Conclusion and Recommendations

The high percentage of relative abundance for increaser species at the expense of highly palatable species is a clear indication of rangeland deterioration. Uncontrolled fires, overutilization of grasses through continuous grazing and selective grazing were main factors, which contribute to the loss of rangeland productivity. Dominance of *Rhamnus prinoides* is alarming; this might influence grazing capacity and the composition of herbaceous vegetation. However, woody plant species composition displayed a great potential for browsing because of the abundance of acceptable species (64%) compared to unacceptable species (36%). Most of these woody plant species were within reachable browsing height of 1.5m for goats. Due to sharing of rangeland resources by communal farmers at Santombe village, it was recommended that farmers should establish rangeland farmer's association for setting up rules and regulations to manage the utilisation of rangeland resources. These rules and regulations should be based on the management of livestock movements and proper application of veld management practices such burning and rotational grazing. Proliferation of undesirable species such as *Rhamnus prinoides, Felicia filifolia* should be controlled through bush clearing or burning. All goats of the community must be directed to the rangeland to ensure efficient consumption of woody species in order to maintain the dominance of herbaceous stratum above woody stratum. For grazing management, communal farmers have limited resources and thus always depend on governmental assistance, which involves delivery camps demarcation and building of water points, which permit easy application of veld management practices.

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Author's contributions

Conception: ST, TT and NN, Data collection: ST, TT, SM, NN, TL, SG, TM, LQ and BG. Data analysis: TS, Critical revision and final approval of version to be submitted: ST, TT, SM, NN, TL, UG, SG and TM.

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