

Full Length Research Paper

Assessment of impact of ecological elevation on grass species' diversity in Yabello Rangeland, Southern Ethiopia

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Received 26 August, 2019; Accepted 10 December, 2019

Elevation has great impact on species' diversity; it creates ecologically diverse vegetation. Studying species' richness patterns at different scales is very important both for ecological explanations and effective conservation design. In this study, grass vegetation data were collected using systematic sampling methods. 18 transects and 54 quadrants were laid, with 6 transects and 18 quadrants from each selected study kebele having 1 × 1 m² for grass. In each quadrant, the level of impact for each threatening factor was evaluated and a total of 26 grass species were recorded. The data were analyzed using SPSS and the average species' composition was assessed in relation to topographic variables. There was upper elevation observed in both richness and diversity of plant species compared to the others with significant $P < 0.05$. Grazing intensity also has significant impact on both species' diversity, density and area coverage. This shows that the area heavily grazed had less diversity richness and coverage compared to the less grazed ($p < 0.001$) area. From the data we can summarize that anthropogenic, topographic and climate factors were the leading causes of the overall shift of plant community structure in the study area.

Key words: Elevation, grazing intensity, grass composition, Kebele.

INTRODUCTION

Area topography and soil composition variation has great impact on plant type and richness, and all structures of plant community exist on that (Huston, 1994). For conservation and general understanding of ecological characteristics of a certain area, assessment of species type, composition and coverage is primary

and key for the next step of rangeland management (Fetene et al., 2006; Muhumuza and Byarugaba, 2009). Different scholars related linkage of topography with plant diversity including: (i) decline with higher altitude; (ii) increase with higher altitude; (iii) bulge at mid-altitude; (iv) dip at mid-altitude; or (v) have no clear

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relationship with altitude (Zhao et al., 2005). Rangeland plant species dynamics were influenced by climatic factors, topographical factors and also human interaction with different time and space. In rangeland area, slope variation had impact on type, composition, and the general status of rangeland in relation to its production potential and ecology (Angassa, 2014).

Former studies conducted in Borana rangeland, particularly at Yabello rangeland area mainly emphasized rangeland degradation excluding factors like topographic and anthropogenic influence, even if they have great impact on both diversity and density on the grass species of the study area (Acharya et al., 2011). For sustainable rehabilitation of degraded rangeland, gathering of basic information on the impact of such topographical factors is highly needed and this helps to reduce the rate of range land degradation. Assessing both composition and diversity of grass species in the study area is highly valuable to understate the current status of the area and to predict future conservation strategies and design (Feyera et al., 2014). In addition to the aforementioned factors, anthropogenic impact has become a major cause of range land degradation. This is due to changing the grazing land to other purpose like cultivated land, drought, shifting to plant species and imbalance between number of livestock and grazing land size (Leul et al., 2010).

Even though Yabello is the major semiarid rangeland area in the pastoral area of Southern Ethiopia, no study has been conducted on vegetation dynamic changes linked to diversity, richness and basal area cover regarding grass species in particular. Mainly ecological impact of elevation with regards to variation of herbage grass species has not been previously assessed. Therefore, the current study evaluated the impact of threatening factors basically topographic and anthropogenic on the general vegetation pattern of the Yabello Rangeland. The local communities and rangeland stakeholders found in the study area played a great role in accomplishing the aim of this study through providing key information compared to the current and past and also through design intervention techniques for managing grass species existing in the study area. Therefore, this study investigated the effect of elevation on the vegetation species' diversity of Yabello Rangeland. The following basic questions were answered: (1) is there a visible variation on vegetation pattern linked to topography? (2) How do we identify the leading topographic variables that affect vegetation pattern in the rangeland of the study area.

MATERIALS AND METHODS

Study area

The study area included Dida Tuyura, Danbal-Waccu and Arero kebeles of Yabello district, Borana zone, Southern Ethiopia (Figure 1). The study was done in 2018. The area is 566 km from the

capital city of the country, in the south direction and has area coverage of 5426 km²; it is located between latitude 4°30'55.81" and 5°24'36.39" in the north and between longitude 7°44'14.70" and 38°36'05.35" in the east. The altitude is about 1000 to 1500 m; its maximum altitude is 2000 m. The area experiences a bi-modal rainfall features which is the 73% rainfall that occurs in March to May (long rainy season), and 27% rainfall that occurs in September to November (short rainy season) (Dalle et al., 2015). The potential evapotranspiration is 700 to 3000 mm (Billi et al., 2015). The study area is dominated by savanna vegetation containing mixtures of perennial herbaceous vegetation. It is also confronted with the problem of bush expansion in the native savanna grass lands. Besides, the area is characterized by savanna grass land.

Sampling procedure and data collection

Collection of grass species data was done through purposive sampling techniques. 6 transects and 18 quadrants were laid from each selected study kebele; in total there were 18 transects and 54 quadrants in one growing season (From March to September, 2018) having altitude from 1000 to 1750 m. Vegetation data were collected from each sampling site. For grass species 1 × 1 m² quadrant size was used; identification and counting were done. For biomass determination based on the dry matter all available grass species were collected using hand cutting. They were oven dried at 105°C for 24 h. Basal area coverage of the site was also justified based on visual observation compared to the bare area (Angassa, 2014). From each plot composition of grass species was also calculated. From the total sampling quadrant, 26 grass species were identified. The rate of impact of each threatening factor was also visualized within each sampling area. Grazing and human intensity were estimated based on direct field observation and during grass sample collection. Information was obtained from both direct interview and previous research work. The value of intensity was given by the following (Kebrom et al., 1997): 0=Non-grazing; 1=slightly grazing; 2=moderately grazing; 3=over grazing. Altitudinal variation includes 1000-1250 m.a.s.l (lower altitude), 1250-1500 m.a.s.l (middle altitude), and 1500-1750 m.a.s.l (upper altitude). Slope locations: 1, 2 and 3 for lower (0-30%), middle (31-60%) and upper (61-90%) position in a slope, respectively were assigned.

Data analysis

The data were analyzed using SAS statistical software version 9.1 (SAS Institute, 2001) and ANOVA (Analysis of variance). Composition and area coverage of the vegetation in the study area was estimated using the formula developed by Mueller-Dombois and Ellenberg (1974).

$$\text{Density} = \frac{\text{number of individual}}{\text{area sampled}} \quad (1)$$

Species' diversity existing in the study was calculated as follows (Shannon and Wiener, 1949):

$$H' = - \sum_{i=1}^S P_i \ln(P_i) \quad (2)$$

where H'=Shannon diversity indices, S=the number of species, P_i=proportion of individual species and lnP_i=log proportion of individual species.

Evenness of vegetation in the study sites was calculated as follows (Magurran, 2004).

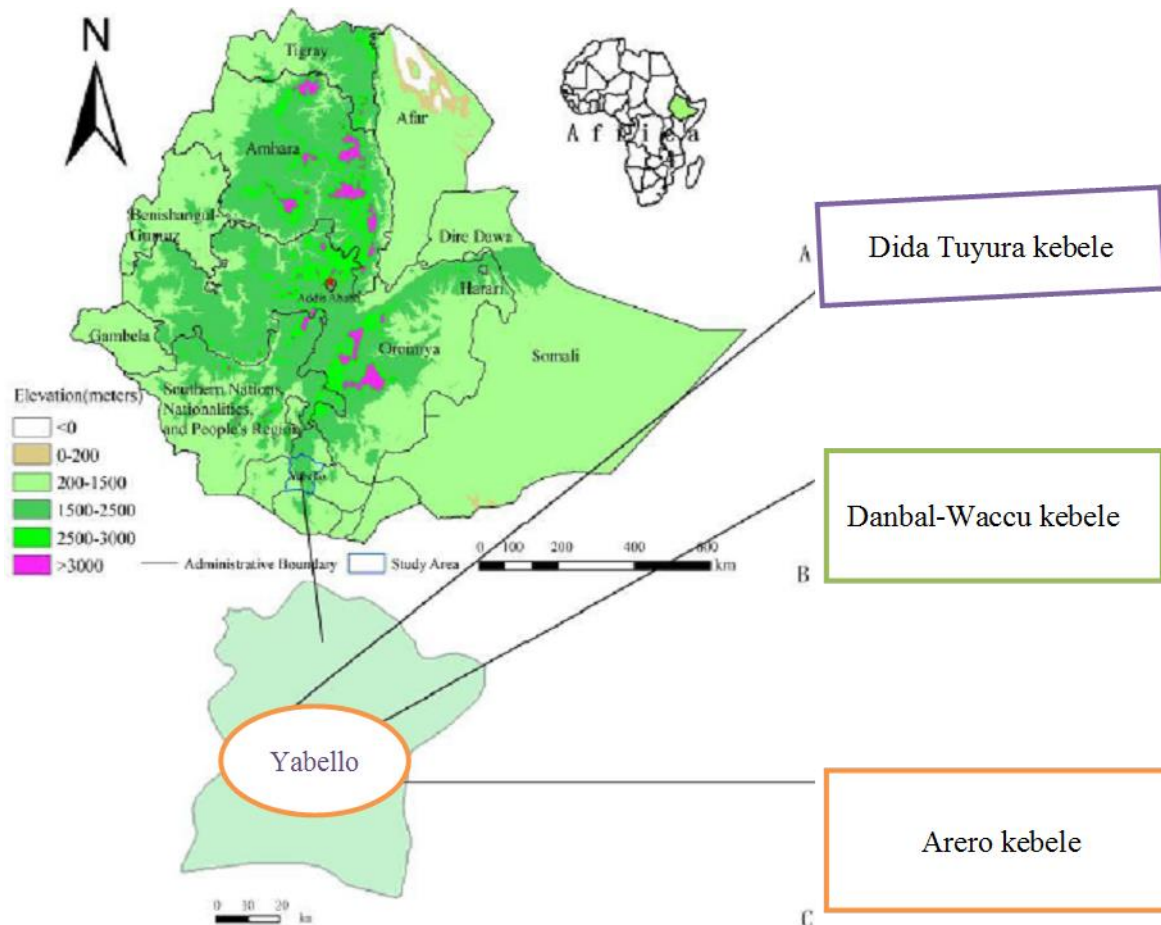


Figure 1. Map of the study site.

$$E = \frac{H'}{H_{\max}} = \frac{\sum_{i=1}^S p_i \ln p_i}{\ln s} \quad (3)$$

where H' = Shannon diversity indices, S = the number of species, and H_{\max} = the maximum level of diversity possible within a given population. Pearson correlation analysis was used to correlate the environmental variables and diversity. Linkage of vegetation diversity with climate factors was assessed through regression analyses method.

RESULTS AND DISCUSSION

Herbage grass species identified in the study site

All grass species were identified in each sampling plot using random harvesting techniques. The identified grass species were grouped as decrease (going to reduce), increase (likely to increase) and invaders (species that substitute the native species) based on the grazing intensity of the study site according to the succession theory (Tainton, 1986). From the study site, 26 grass species were recorded and both their scientific and local names were identified. The species and their average

coverage of the study site are shown in Table 1. *Chloris roxburghiana* and *Chrysopogon aucheri* grass species had the highest average single species coverage of over 30% for all the sites and high abundance compared to other species. Of all the grass species recorded from the project area, 30.8% were categorized as highly desirable, 53.8% as desirable and 15.4% as less desirable. The ratio of grass species that were identified as highly desirable and desirable was high compared to less desirable grass species. This resulted from timely degradation of available forage on the study site as most grass species became highly desirable species over time. And also we understand that over grazing reduces ground cover and composition of herbage species in the study area. Among the threatening factors mainly occurring in the study site drought and grazing intensity were the primary factors due to reduction of vegetation status in the study site over time (Alemayehu, 2006; Aynekulu et al., 2009). As shown in Table 1, only four grass species are highly dominate in all the study sites and this accounts for only 15.4% of the total recorded grass species. This indicates that almost all of the grass

Table 1. List of grass species identified in the rangeland in all elevation sites and their desirability.

List of species (Scientific name)	Local name	Family	Desirability	Composition status
<i>Chrysopogon aucheri</i> *	Alaloo	Poaceae	HD	D
<i>Dactyloctenium aegyptium</i>	Ardaa	Poaceae	LD	LC
<i>Xerophyta humilis</i>	Areedoo	Poaceae	DS	C
<i>Aristida kenyensis</i>	Biilaa	Poaceae	LD	LC
<i>Eragrostis capitulifera</i>	Biilaa	Poaceae	DS	C
<i>Harpachne schimperi</i>	Biilaa	Poaceae	DS	C
<i>Leptothrium senegalense</i>	Biilaa diidaa	Poaceae	DS	LC
<i>Melinis repens</i>	Buuyyoo xirooftuu	Poaceae	HD	C
<i>Themeda triandra</i>	Gaaguroo	Poaceae	DS	C
<i>Digitaria milanjana</i>	Hiddoo	Poaceae	HD	C
<i>Chloris roxburghiana</i> *	Hiddoo luucolee	Poaceae	HD	D
<i>Digitaria naghellensis</i>	Ilmogorii	Poaceae	DS	LC
<i>Panicum maximum</i>	Loloqaa	Poaceae	HD	D
<i>Bothriochloa insculpta</i>	Luucolee	Poaceae	DS	LC
<i>Cenchrus ciliaris</i> *	Mata guddeessa	Poaceae	HD	C
<i>Pennisetum mezianum</i>	Ogoondhichoo	Poaceae	LD	LC
<i>Eragrostis papposa</i>	Saamphillee	Poaceae	DS	C
<i>Sporobolus discosporus</i>	Saamphillee kootichaa	Poaceae	DS	C
<i>Grewia tenax</i>	Saarkama	Tiliaceae	DS	C
<i>Grewia tenax</i>	Saarkama	Tiliaceae	HD	D
<i>Cyperus sp.</i>	Saattuu	Cyperaceae	DS	LC
<i>Cyperus bulbosus</i>	Saattuu arbaa	Cyperaceae	LD	LC
<i>Sporobolus pellucidus</i>	Salaqoo	Poaceae	DS	C
<i>Cynodon dactylon</i>	Sardoo	Poaceae	HD	C
<i>Heteropogon contortus</i>	Seericha	Poaceae	DS	LC
<i>Loudetia flavida</i>	Seericha gaaraa	Poaceae	DS	C

HD= highly desirable, DS= Desirable, LD= Less desirable; D= Dominant (> 35%), C= Common (10-35%), LC= less common (<10%).

species are very sparsely distributed and in less amount. Those highly dominate grass species were recommended by the local people, and also previous studies have shown the high importance of rehabilitating degraded rangeland areas.

Species diversity and evenness

Impact of elevation difference on species' variation and composition

Altitudinal difference had great impact on diversity and density of grass species in the study site. The upper altitude had a significant variation index compared to middle and lower altitude gradient (Table 2). This is due to top-climatic factors like season, slope and elevation (Getachew et al., 2008). Altitude is the independent factor that affects both the environmental and grazing land sustainability. This is the major cause of the general vegetation pattern (Alemayehu, 2003) linked with

other living and non-living threatening factors (Otypkova et al., 2011; Tibebe and Teshome, 2015) and results of diversity and richness of grass species along with altitudinal difference. According to Sharma et al. (2009) and Bruun et al. (2006) as altitude increases, richness of vegetation declines as a result of harsh climatic condition in the upper altitude caused by restriction in species' expansion. Mid-latitude is used as threshold level to compare vegetation pattern (RDCT, 2015). And this makes them more sustainable due to their enhanced fitness at higher altitude compared to the rest (Ole et al., 2002). Based on the interaction of abiotic and biotic factors the vegetation pattern (diversity and evenness) may either rise or decline or at threshold in each topographic level. From this, we can understand that altitude variation is the primary determinate issue of vegetation pattern in the grazing area of Yabello rangeland (Acharya et al., 2011; Ru and Zhang, 2012; Zhang et al., 2013). It is not only the topographical nature but also less human interface with vegetation on high altitude lead to increment of both diversity and composition

Table 2. Mean (\pm SE) of the general vegetation pattern in Yabello Rangeland.

Topographical variation	Composition	Variation	Evenness (J)
High altitude	16.28 ^a	2.2 (\pm 0.06) ^a	0.79 (\pm 0.02)
Middle altitude	12.21 ^b	1.91 (\pm 0.08) ^b	0.79 (\pm 0.01)
Lower altitude	10.04 ^b	1.87 (\pm 0.07) ^b	0.82 (\pm 0.02)
P value	<0.001	0.009	0.28
Slope gradients			
Lower	11.24 (0.84)	1.90 (\pm 0.06) ^a	0.82 (0.01)
Middle	13.64 (0.90)	2.04 (\pm 0.07) ^b	0.79 (0.01)
Upper	13.62 (1.87)	2.04 (\pm 0.12) ^b	0.81 (0.01)
P value	0.13	0.33	0.42

Table 3. Mean \pm (SE) of livestock per household at Yabello Rangeland area.

S/N	Livestock species	Mean \pm (SE)/household
1	Cattle	9.41 \pm 0.03
2	Goat	9.4 \pm 0.33
3	Sheep	0.9 \pm 0.08
4	Donkey	0.3 \pm 0.33
5	Camel	0.11 \pm 0.03

species compared to lower altitude (Yohannes et al., 2015). We can conclude that environmental issues are the bottleneck on the general vegetation pattern in Yabello Rangeland.

From the Table 2, we can see that topographical difference has no significant ($P>0.05$) impact on the vegetation distribution (evenness). This indicates that slope variation has no observable influence on vegetation (grass) distribution at Yabello Rangeland area. Even though it has slight variation among the three slope gradients, noticeably the top and middle have slightly highest species richness value of 13.6 compared to the lower (11.24) (Table 2).

Impact of grazing intensity on species' richness and diversity index

Livestock holdings and composition in the grazing site: Cattle ranked first in the dominance of livestock composition (9.41 \pm 0.03) in Yabello Rangeland followed by goat (9.4 \pm 0.33), sheep (0.9 \pm 0.08), donkey (0.3 \pm 0.33) and camel (0.11 \pm 0.03), respectively. This shows uniformity in all the elevation levels (Table 3). This result is in agreement with Sisay (2006) who studied the qualitative and quantitative aspects of animal feed in different agro ecological areas of North Gonder. However, impact of livestock grazing intensity on both composition and variation of species is significant

($P<0.001$). It means that if the rate of grazing is high the overall vegetation pattern would decrease. There was higher type, composition and distribution at the place where there is no (nil grazing rate) disturbance (Table 4). From this, we can conclude that livestock grazing rate had great impact on the vegetation pattern of the Yabello Rangeland. And this result shows human and livestock settlement distance with vegetation general pattern has a direct effect. It means that the place where humans settle and livestock graze repeatedly has less vegetation in all aspect of its pattern compared to areas with less frequent grazing. Due to area variation with production, diversification of habitat and contacting determinant factors mainly anthropogenic factors like farming practice, firing, and over harvesting of forage have a direct impact on the grass species (Brinkmann et al., 2009; Maestre, 2004; Feyera et al., 2014). Generally, the observed vegetation variation linked to topographical difference shows the degradation level of the grazing site and its biodiversity composition (Gunnar and Ove, 2001; Oba, 2011; Tessema et al., 2011; Angassa, 2014). Some studies show that duration of livestock grazing at a certain grazing area highly impacts vegetation density and variation and this may cause sustainability of the plant community within the rangeland site (Amsalu, 2000; Hoshino et al., 2009). This result is also in agreement with Aynekulu et al. (2009)'s study conducted in Northern Ethiopia. The primary determinant factor of rangeland

Table 4. Mean (\pm SE) of general vegetation pattern with level of grazing intensity in Yabello Rangeland area.

Grazing intensity	Composition	Variation	Evenness (J)
Nil	17.84 (0.95) ^a	2.27 (\pm 0.09) ^a	0.79 (\pm 0.02)
Slight	13.37 (1.15) ^b	2.05 (\pm 0.06) ^{ab}	0.81 (\pm 0.01)
Moderate	9.09 (1.04) ^c	1.73 (\pm 0.1) ^c	0.80 (\pm 0.02)
Heavy	10.45 (0.60) ^c	1.88 (\pm 0.07) ^{bc}	0.81 (\pm 0.02)
P value	<0.001	<0.001	0.78

Table 5. Mean (\pm SE) of area coverage of grass species in different topographical elevation in Yabello Rangeland area.

Topographical variation	BA (m ² /ha)
Top altitude	10.15 (\pm 0.60) ^a
Middle altitude	6.48 (\pm 0.96) ^b
Lower altitude	6.40 (\pm 1.38) ^b
P value	0.001
Slope gradients	
Lower slope	5.97 (\pm 0.81)
Middle slope	7.81 (\pm 0.96)
Upper slope	7.25 (\pm 1.89)
P value	0.37

degradation is the combination effect of all agricultural expansion, drought, infestation of invasive plant species and climate change in general (Alemayehu, 2007).

Impact of elevation on basal area grass species coverage

Topographical elevation variation has significant impact ($P=0.001$) on the vegetation area coverage (Table 5). Elevation has a direct impact on the composition and density of vegetation in general and grass species in particular at the Yabello Rangeland. Our finding is in agreement with the study conducted by Markos and Simon (2015). The mean basal areas for lower altitude, middle altitude and upper altitude were 6.40, 6.48 and 10.15 m²/ha, respectively. The top elevation had more area coverage compared to the others (middle and lower), and density of grass vegetation had better performance when the elevations of rangeland increased as livestock and human interference reduced when elevation became higher. The study conducted by Markos and Simon (2015) shows that altitude variation affects the general abundance and area coverage of rangeland due to environmental variation within each attitude, like temperature, moisture,

sunlight, etc.

Impact of grazing intensity on individual grass species density

The livestock grazing duration had a significant impact ($P<0.001$) on basal area coverage of grass vegetation and number of individuals within a study site. Rangeland site almost free from livestock grazing had great number of grass species within (382.30 \pm 26.04) (Table 6) compared to rangeland site that is degraded due to overgrazing, caused by both anthropogenic and climatic influence. This may occur in rangeland site located near human settlement, making it appropriate for continues livestock grazing.

Regeneration status of grass species across topographic variables

Livestock grazing intensity of rangeland also highly impacts the recovery of vegetation species and determines the composition of mature vegetation, intermediate and seeding stage of the existing grass species in Yabello Rangeland. As a result the most mature and intermediate stage vegetation/ha was observed

Table 6. Mean (\pm SE) number of individuals related to grazing intensity in Yabello Rangeland area.

Grazing intensity	Individuals/ha
Nil	382.30 (\pm 26.04) ^a
Slight	211.68 (\pm 15.81) ^b
Moderate	160.22 (\pm 13.41) ^c
Heavy	142.72 (\pm 14.97) ^c
P value	<0.001

Table 7. Mean (\pm SE) of mature grass, middle stage and seedlings of different grazing intensity in Yabello rangeland area

Grazing rate	Mature	Middle age	Seedling
Nil	1478.84 (\pm 99.18) ^a	4100.00 (\pm 393.21) ^a	3230.76 (\pm 270.41) ^a
Slight	920.31 (\pm 107.82) ^b	2362.50 (\pm 205.92) ^b	1506.25 (\pm 182.68) ^b
Moderate	552.27 (\pm 58.52) ^c	1254.54 (\pm 250.22) ^c	1081.81 (\pm 138.05) ^b
Heavy	509.09 (\pm 64.43) ^c	1109.09 (\pm 154.99) ^c	1313.63 (\pm 114.96) ^b
P value	<0.001	<0.001	<0.001

at the rangeland area where the grazing intensity is almost none or nil. From this, we can understand that grass rehabilitation time highly impacted the livestock grazing duration (Table 7). Disturbances such as intensive grazing, explanation of agricultural practice, infestation of invasive alien plant species and drought had great impact on the recovery of rangeland grass species (Leul et al., 2010). Also the anthropogenic activities also had a great impact on the recovery of grass species in the rangeland area. This result is in agreement with the report done by Leul et al. (2015). All the recovery of vegetation in the study site is highly impacted by both climatic and human factors (Markos and Simon, 2015). According to the data reported by Adane (2011), the recovery and rehabilitation rate of rangeland vegetation is primarily influenced by topographical variation, site location, rate of grazing intensity, human interference in the rangeland and combination of all the determinant factors. Both livestock and human interference had a direct impact on rangeland vegetation growth, recovery rate, rate of degradation and development in general (Austrheim, 2002; Zhang et al., 2015; Sproull et al., 2015).

Recovery status of grass vegetation in the studied rangeland area is high in higher elevation compared to the middle and lower elevation (Table 8). This is due to favorable condition of living and non-living determinant factors observed at the higher elevation area. This helps to speed up the regeneration rate of the grass species found in the top elevation sampled area compared to other elevation (Melese and Wendawek,

2016). Abundant existing matured grass species were high at the upper elevation area compared to the lower elevation area. This is due to the high impact of livestock grazing intensity combined with other environmental issues. And in the upper elevation the grazing site is not more appropriate for livestock to graze frequently. This helps the existence of more mature grass species both in abundance and type. In addition, elevation also had impact on the rangeland moisture status. This has great influence on the recovery and rehabilitation status of the vegetation in the study area (Sorumessa et al., 2004). The impact of human disturbance at higher elevation is lower compared to lower elevation. This resulted regeneration status of grass vegetation in the lower slope is slow compared to the higher one. This becomes the primary cause for the increasing trend of recovery and rehabilitation status of rangeland vegetation as elevation increases. The recovery status of grass species in Yabello Rangeland is highly influenced by both topographical difference, human and environmental factors. This result is in agreement with the data reported by Deribe (2006).

Relationship between grass species' patterns and environmental factors

In the study area, elevation variation and anthropogenic factors had impact on the general vegetation pattern and recovery status over time and space (Alexander and Millington, 2000). In Yabello Rangeland area,

Table 8. Mean (\pm SE) of mature grass abundance, sampling and seedlings/ha at different topographical sites in Yabello Rangeland area.

Altitudinal gradients	Mature/ha	Middle age/ha	Seedling/ha
Top altitude	1386.11 (\pm 98.08) ^a	3605.55 (\pm 346.45) ^a	2683.33 (\pm 290.17) ^a
Middle altitude	721.05 (\pm 75.95) ^b	1968.42 (\pm 233.96) ^b	1384.21 (\pm 169.21) ^b
Lower altitude	503.00 (\pm 57.08) ^c	1080.00 (\pm 142.94) ^c	1292.00 (\pm 108.61) ^b
P value	<0.001	<0.001	<0.001
Slope gradients			
Lower slope	628.44 (\pm 80.99) ^b	1379.31 (\pm 170.86) ^b	1313.79 (\pm 129.20) ^b
Middle slope	924.00 (\pm 92.78) ^a	2484.00 (\pm 310.73) ^a	2032.00 (\pm 216.08) ^a
Upper slope	1237.50 (\pm 194.45) ^a	3400.00 (\pm 611.49) ^a	2250.00 (\pm 519.27) ^a
P value	0.003	<0.001	0.01

Table 9. Impact of determinant factors (environmental variation, human interference and grazing rate) on the general vegetation pattern in Yabello Rangeland.

Variable	BA		Individual		H		S		J	
	r	p-value	r	p-value	r	p-value	r	p-value	r	p-value
Altitudinal gradients	0.44	<0.001	0.78	<0.001	0.44	<0.001	0.64	<0.001	-0.15	0.25
Slope gradients	-0.05	0.72	0.46	<0.001	0.21	0.09	0.28	0.03	-0.11	0.4
Grazing intensity	-0.3	0.01	-0.69	<0.001	-0.41	<0.001	-0.59	<0.001	0.09	0.48
Human	-0.3	0.01	-0.67	<0.001	-0.4	<0.001	-0.57	<0.001	0.08	0.5

r=Correlation coefficient value; BA= basal area; H= Shannon diversity index; S=species richness; J=evenness.

environmental factors such as slope variation, human daily activity and livestock grazing rate highly impacted the general pattern and rehabilitation status of grass species. Vegetation composition and variation had a direct linkage with elevation and human interference (Jin et al., 2013). The livestock grazing duration was inversely related with the abundance of vegetation on the rangeland site ($r = -0.59$, $P < 0.001$), but elevation (slope) variation was directly related with the number of individuals/ha ($r = 0.46$, $P < 0.001$). Human interference also had a negative impact on both existing number of grass species, abundance and diversity of grass/ha in the Yabello Rangeland site ($r = -0.67$, -0.4 and -0.57), respectively (Table 9). Elevation difference is the factor that highly impacted the grass species type in the Yabello Rangeland. Our result is in agreement with the data reported by Zhang et al. (2006), Muhumuza and Byarugaba (2009) and Chawla et al. (2008). Slope also has a significant impact on grass species vegetation in the study site. This is because as elevation varies, the humidity and temperature vary also. This result is in line with the data reported by Lovett et al. (2006), Zhang and Zhang (2007), Jin-Tun et al. (2016) and Virtanen et al. (2010). Range land basal area coverage with livestock grazing rate and human interference had a negative

linkage ($r = -0.3$, $P = 0.01$) and a direct linkage with altitude ($r = 0.44$, $P < 0.001$) (Table 9). Altitude and slope have an equally strong significant ($p < 0.0001$) effect on basal area of species (Markos and Simon, 2015). Although, the linear trend explains a significant amount of the variability in basal area on the altitude gradient (Carpenter, 2005). Altitude has strong correlation with species' richness and Shannon diversity index of grass; it has great impact especially on rangeland vegetation distribution (Zewde, 2014). Species' richness, Shannon diversity index and evenness all significantly correlated with elevation and grazing gradients. Grass species' composition, diversity and distribution pattern generally are significantly correlated with environmental gradients that exhibit heterogeneity over space and time, such as topography and grazing intensity (Brinkmann et al., 2009; Zhang et al., 2013). This was observed in the Yabello Rangeland area.

Conclusion

Declining of grass vegetation composition and variation Shannon grass species in the rangeland were the

outcomes of the altitudinal variation and other topographic factors. Our result concluded that altitudinal difference has great impact on the general vegetation pattern of Yabello Rangeland area. Elevation variation, human activity and livestock grazing rate played a key role in herbage grass species' variation account. This is because with altitudinal gradients, human activity and grazing rate affect species' variation and density difference. It was concluded that decline in grass vegetation pattern had a direct effect on human daily activity, grazing intensity and altitudes in the Yabello Rangeland area, and this highly affected the growth, variation, composition and recovery rate and population structure of the grass species. Measures such as managing livestock grazing rate and human activity, monitoring rangeland diversity change, and effective management should be done in this rangeland area.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

This study was funded by Science and Technology partnership program, Ministry of Science and Technology of China (KY201702010), and China-Africa Joint Research Center project of the Chinese Academy of Science (SAJC201610).

ABBREVIATIONS

ANOVA, Analysis of variance; **BA**, basal area; **J**, species evenness; **S**, species richness; **R**, correlation coefficient; **H**, Shannon diversity index; **SAS**, statistical software; **SE**, standard deviation; **MASL**, meter above sea level; **H max**, maximum level of diversity.

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