



Research article

An assessment of the current status and regeneration potential of the traditional conserved forests (*Ngitili*) in Kishapu district, Tanzania

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[Accepted: 29 June 2020]

Abstract: The current study was carried out in the community forests conserved under the indigenous knowledge known as “*Ngitili*” in Kishapu district of Tanzania. The aim was to assess the current status and determine its regeneration potential in terms of plant species diversity, herbaceous productivity and tree stocking. A field survey was conducted for recording the current status while the phytosociological was carried to recognize vegetation composition and diversity. Regeneration potential was determined based on the population size of seedlings, saplings and adults. Disturbance index was used to calculate the level of disturbances while herbaceous productivity and tree stocking were estimated based on allometric models. Descriptive statistics for quantitative data was analysed using SPSS version 20. The study recorded a total of 10 *Ngitili* in Kishapu district, out of which, 9 still existing but highly threatened and disturbed, only 1 *Ngitili* was recorded to be dead (not existing). A total of 66 plant species were recorded of which 20 were grasses, 18 were forbs, and 28 species (17 genera and 13 families) were trees and shrubs. The dominant grass species were *Aristida funiculata* (28.9%) and *Cynodon dactylon*, while *Monechma debile* (4.6%) was the dominant forb. Similarly, *Acacia drepanolobium* (45.4) and *Balanites aegyptiaca* (42.9) trees dominated the area. The majority of tree species exhibited a “not regenerating” condition (51.8%) only a few (2.11%) showed a “good regeneration” condition while “newly regeneration” condition recorded 0.00%, with a diversity ranging from 1.86–2.44. Herbaceous and tree stocking potential was 1.23 ± 0.05 t DM ha⁻¹ and 5.66 ± 0.21 t Cha⁻¹ respectively, with a standing stem density (stems ha⁻¹) of 512.07 ± 193.86 . The study observed great degradation of the *Ngitili* characterized by low diversity and poor regeneration conditions. This signified that these community forests are currently threatened and its sustainability is highly at risk unless strong initiatives take place.

Keywords: Plant species diversity - Indigenous knowledge - Grazing pressure - Forest degradation - *Ngitili* - Kishapu.

[Cite as: Malunguja GK, Rubanza CKD & Devi A (2020) An assessment of the current status and regeneration potential of the traditional conserved forests (*Ngitili*) in Kishapu district, Tanzania. *Tropical Plant Research* 7(2): 336–356]

INTRODUCTION

Community conserved forests have been advocated as a proper means for forest management (Vipat & Bharucha 2014) and conservation of plant and animal species in different parts of the world (Kitalyi & Mlenga 2004, Khumbongmayum *et al.* 2005, Otsyina *et al.* 2008, Pala *et al.* 2013, Vipat & Bharucha 2014). The trend of recognizing the importance of community participation in forest management for protection of biodiversity, hydrological and nutrients cycles (Nyberg *et al.* 2015) as well as other forest-based resources which are

beneficial for the local inhabitants in terms of preventing soil erosion, control of flash flood and supply of food supplements, all over the globe are raising (Salunkhe *et al.* 2016). Conservation of nature and natural resources is an important part of the culture (Khumbongmayum *et al.* 2005, Konkane *et al.* 2018), associated with the indigenous communities inhabited around remote rural areas (Sala *et al.* 2000, Wade *et al.* 2003). Alteration of the ecosystem structure influence the respective ecosystem's goods and services derived from forest to change over time (Sala *et al.* 2000, Zhu *et al.* 2004) therefore, the involvement of communities in the conservation paradigm is essential.

Many countries extending from Asia, Africa, Europe, and America have adopted this community based traditional vegetation conservation system in various socio-cultural practices of ethnicity groups (Agarwal 2016). For instance, in India, the system is known as “*sacred groves*” conserved by the local people intertwined with their social-cultural (Ray *et al.* 2015), and religious practice (Khumbongmayum *et al.* 2005, Sukumaran *et al.* 2018). In the northwestern and central parts of Tanzania, the system is traditionally known as “*Ngitili*” and “*Oliriri*” among the Sukuma and the Maasai (Dery *et al.* 1999, Rubanza *et al.* 2006) respectively, the largest agro-pastoral and pastoral ethnic group in Tanzania.

The *Ngitili* involve setting aside and retaining a patch of standing vegetation during the beginning of the rainy season and open up for grazing during the dry (Malcolm 1953, HASHI-ICRAF 1997, Issae 1997, Dery *et al.* 1999). It is an indigenous knowledge of the *Sukuma* people, mainly to cater for acute fodder shortage during the dry period (Malcolm 1953). The system existed as earlier as during the colonial era, and later considered as an important strategy for forest management and land restoration in northwestern semi-arid parts of Tanzania in the 1980s. The recognition of indigenous knowledge (*Ngitili*) for land and forest restoration (Giliba *et al.* 2011), came into place after the declaration of the “*The Desert of Tanzania*” in 1984, by then the President Julius Nyerere, after touring Shinyanga region and shocked by the high extent of land degradation and deforestation resulted from several factors included; (i) vegetation clearing to eradicate tsetse flies program between 1925 to 1960s (ii) the villagization program of 1970s and (iii) expansion of cotton production for foreign markets (UNDP 2012, Selemani *et al.* 2012, Barrow 2016). Therefore, different strategies were taken to restore the situation, including the use of traditional indigenous knowledge.

Apart from its main roles *Ngitili*, on the other hand, has contributed a significant and great potential on improving the ecological conditions of the region (Jama & Zain 2005), in terms of communities' livelihoods, species diversity and soil erosion control (Barrow *et al.* 2002, UNFCC 2008). Others forest-based ecosystem goods and services such as climate change mitigation through enhanced carbon sequestration (Duguma *et al.* 2019), provisions of fuelwood, thatch grass, and diversification of nutrition options (fruits, vegetables, mushroom, edible insects, wild meat, ethnomedicinal) has been reported in the region (Malcolm 1953, Monela *et al.* 2005, Rubanza *et al.* 2006, Otsyina *et al.* 2008, Pye-Smith 2010, Chidumayo *et al.* 2011, Chirwa 2014). Furthermore, *Ngitili* improves household economies that supplement the income from agriculture (Monela *et al.* 2005, Zahabu 2008, Duguma *et al.* 2013). In so doing, *Ngitili* contributes to improving the ecological dynamics, provisions of ecosystem goods and services as well as act as the centre for biodiversity.

Unfortunately, information about the performance and sustainability of indigenous and traditional knowledge of the *Sukuma* people in conserving forest under *Ngitili* system in Kishapu district of Shinyanga region, are highly neglected in the literature. Although several studies are describing the role of indigenous knowledge including *Ngitili*, as one strategy for land and forest ecosystem restoration for biodiversity conservation and plant species biomass productivity as well as improvement of socio-economic wellbeing, for enhanced climate change mitigation in the region (Monela *et al.* 2005, Otsyina *et al.* 2008, Rubanza *et al.* 2006, Zahabu 2008, TaTEDO 2009, Pye-Smith 2010, Selemani *et al.* 2012, 2013, Chirwa 2014, Osei *et al.* 2015, Duguma *et al.* 2019), but information about the current status of *Ngitili*, their performance on species diversity, herbaceous primary productivity and trees regeneration as well as stocking potential, at specific administration ecological sites such as Kishapu district, was rarely discussed and missing in the literature despite the presence of potential *Ngitili* in the district. Therefore, the current study was carried out to bridge the prevailing gap by providing information about the current status of the available *Ngitili* and their performance in Kishapu district of Shinyanga region.

MATERIAL AND METHODS

Study area

The study was conducted in the Kishapu district located in the northeast of the administrative region of Shinyanga, Tanzania (Fig. 1). The district lies between 3° 15" and 4° 05" south of the equator and longitudes 31°

30°E and 34°15' E east of the Greenwich meridian (URT 2009). The district has a total area of 4,333 km², of which 101 km² is covered by forests. An area of about 47 km² is occupied by forests conserved under traditional knowledge (*Ngitili*) system.

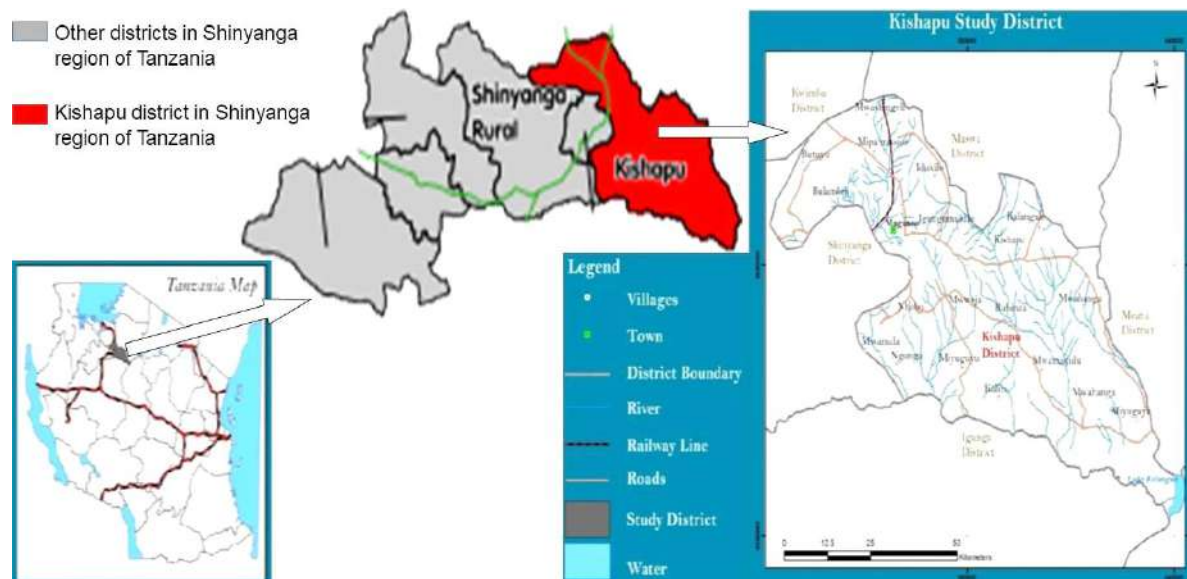


Figure 1. A map showing the location of Kishapu and other districts of the Shinyanga region, Tanzania. [Adopted from (Katunzi *et al.* 2016) with modification]

The district is characterized by a dry tropical (semi-arid) climate with temperatures ranging from 22°C to 30°C and 15°C to 18.3°C for maximum and minimum, respectively. It is a semi-arid area that receives 450 mm to 990 mm of rainfall per annum (Tanzania National Bureau of Statistics (NBS 2012), rainfall start in late October/early November and end in April/May while the dry season begins in June and last in October. According to Katunzi *et al.* (2016), the rainfall amount and distribution patterns are generally neither even nor expectable, meanwhile, there is decreasing of rainfall such that the district experiences a gap of rainfall between January and February.

The district is characterized by flat and gently undulating plains covered with low and sparse vegetation, soil varies along with relief features such that on hilltops soils are moderately well drained greyish brown and sandy (KDP 2013) whereas, low-lying valley bottom soils are moderately deep well-drained and greyish brown sand. Most population in the district is engaged in crops and livestock production, major food crops grown includes maize, sorghum, millets, sweet potatoes, and paddy, while cash crop is cotton (Katunzi *et al.* 2016) similarly, livestock kept are cattle, shoats (sheep and goats) and poultry whereas, fishing is done during the rainy season.

Forest inventory and sampling design

In this study a systematic sampling was adopted, using concentric circular plots of 15 m radius along transects (comprised of sub-plots of 5, 10 and 15 m (Fig. 2A), modified from Malimbwi *et al.* (1994), Zahabu (2008), and Vesa *et al.* (2010). The enter plots and inter transects distances were maintained at 300 and 600 m, in between respectively. For studying and recording the current status of *Ngitili* in Kishapu district, a field survey was conducted. On the other hand, the phytosociological study was carried to recognize vegetation composition and plant species diversity using point sampling methods. In each plot data were collected in the following manner: within 5 m radius, all herbaceous species were assessed based on frequencies of the individual species (Rubanza *et al.* 2006) using 0.25 m², metal quadrat (Crowder & Chheda 1982) (Fig. 2B).

While herbaceous biomass productivity was estimated based on (Pieper 1988), tree stocking potential based on (Philip 1994, Malimbwi *et al.* 1994, Zahabu 2008, Vesa *et al.* 2010) allometric models. The use of allometric provides proper estimate with less ecological disturbances (Chave *et al.* 2014). The model for tree bio-volume was given by Philip (1994) as,

$$V = f \times g \times h$$

Where, g = Tree basal area at breast height (m²), h = Tree height and f = Form factor

The above-ground tree biomass (AGB) was computed based on the equation (Vesa *et al.* 2010),

$$\text{AGB (t Cha}^{-1}\text{)} = \frac{\text{Tree stem volume (m}^3 \text{ ha}^{-1}\text{)} \times \text{Tree wood density (kg m}^3\text{)}}{1000}$$

The belowground biomass was determined by multiplying the AGB by a factor of 0.25 (Kaonga & Bayliss-Smith 2009), the result was converted into carbon stock using the 'default carbon conversion factor' of 0.47 (Zahabu 2008, Pandya *et al.* 2013). Within the same sub-plot, seedling and sapling individuals species were identified for regeneration status [*i.e.*, seedling species (≤ 20 cm height) and saplings (> 20 cm, but < 1 m height)], and their density were recorded.

Within 10 m radius, all plants with ≥ 1 but < 5 cm diameter at breast height (dbh), were identified and recorded as shrub species. Furthermore, within 15 m radius all plant species (≥ 5 cm dbh), were recorded as tree species, (Fig. 2C). The tree dbh and heights were measured using the tree calliper and Suunto hypsometer respectively (Modified from Malimbwi *et al.* (1994) and Zahabu (2008).



Figure 2. A, Field plots layout; B, Assessment of herbaceous species using a 0.25 m² metal quadrat; C, Tree species identification and measurement of dbh using a calliper.

The regeneration status of plant species was determined based on the population size of seedlings, saplings and adults (modified from Good & Good 1972, Khumbongmayum *et al.* 2006, Iqbal *et al.* 2012). The regeneration status was considered as 'good' regeneration, if seedling $>$ sapling $>$ adults; 'fair' regeneration, if seedlings $>$ or $<$ saplings $<$ adults; and 'poor' regeneration, if the species survives only in sapling stage, but no seedling (saplings may be $<$, $>$ or $=$ adults). While, if the species is recorded only in adult form it was considered as 'not regenerating', similar species with individuals only in seedlings or saplings without any adult was considered as 'newly regenerating' species (Iqbal *et al.* 2012).

To quantify the level of disturbance, the disturbance score was calculated following Veblen *et al.* (1992) and Gillespie *et al.* (2000). The disturbance was qualitatively classified into four classes versus the degree of anthropogenic activities such as grazing pressure, wood fuel collection, agriculture, charcoal making, and fire outbreak. The anthropogenic activities were ranked as (1): for no evidence of anthropogenic activity; (2): for only one or two anthropogenic activities evidenced; (3): for three evidence of anthropogenic activities; and (4): for more than three evidence of anthropogenic activities in the study sites (modified from Khumbongmayum *et al.* 2006). The sum of all ranks provided the overall ranking of the anthropogenic disturbance, such that the low rank represents a low level of disturbance. Similarly, the disturbance index (DI) was calculated based on the number of individual cut stumps.

Data collection and analysis

Data on the status of the *Ngitili* was collected using field survey approach, while the phytosociological approach was used to collect data on the herbaceous composition and tree diversity using point sampling (Crowder & Chheda 1982, Rubanza *et al.* 2006). The collected data were computed using indices of diversity as per Shannon & Weaver (1949), Simpson (1949) and Pielou (1966). Meanwhile, species importance value index (IVI) was computed as the average of the relative basal area, density and frequency.

Data on herbaceous biomass productivity was computed following formulae given by Pieper (1988) and modified by Rubanza *et al.* (2006). Tree stocking parameters; basal area (m² ha⁻¹), standing bio-volume (m³ ha⁻¹), above-ground and below-ground biomass were estimated based on allometric models (Philip *et al.* 1994, Malimbwi *et al.* 1994, Zahabu 2008, Vesa *et al.* 2010, Pandya *et al.* 2013). Descriptive statistics for quantitative data were analyzed using Statistical Package for Social Sciences (SPSS) software version 20.

Botanical field manual books and taxonomists were consulted for the identification of both herbaceous and tree species. However, plant species that were not easy to identify in the field, voucher specimens were taken for further identification at the college of natural and mathematical sciences, department of biological sciences, the University of Dodoma, Tanzania.

RESULTS AND DISCUSSION

Current status of Ngitili in Kishapu district of Shinyanga region

Results on the current status of *Ngitili* in Kishapu district is presented in table 1. The current study recorded ten (10) *Ngitili* in the district covering an area of 6,112.98 hectares. Out of 10, 9 (4569.34 ha), are existing while 1 *Ngitili* (1543.64 ha) is no longer existing (dead *Ngitili*). Similarly, out of the 9 existing *Ngitili*, 4 (2750.13 ha), are threatened and turning into a desert-like appearance whereas, the remaining five (5) are highly disturbed.

Table 1. The current status of *Ngitili* in Kishapu district of Shinyanga, Tanzania.

Name of <i>Ngitili</i>	Village (s)	Size (ha)	Factors of disturbance					Measurement of disturbance		
			Grazing	Charcoal	Agriculture	Wood fuel	Fire	Disturbance score	DI	Status
Ikonda A	Ikonda	55	3	1	1	1	1	7	5.51	D
Mwamanota	Mwamanota	100.13	4	3	1	4	1	13	9.47	T
Bubinza	Bubinza	385	2	2	1	2	1	8	5.95	D
Shagihilu	Shagihilu	1168	2	2	2	2	1	9	4.59	D
Busongo	Busongo	475	3	2	2	4	2	13	6.49	T
Mihama	Mihama	500	4	2	2	3	2	13	9.19	T
Bulima	Bulima	1675	4	4	2	3	2	15	12.17	T
Lyabujije	Ng'wanima	1543.6	4	4	4	4	4	20	35.1	N
Ndoleleji	Ndoleleji	345	3	1	1	2	1	8	5.76	D
Nyasamba	Nyasamba	190.3	3	2	2	2	1	10	5.68	D
Total		6437.1								

Note: P: Protected; T: Threatened; D: Disturbed; N: Not existing; DI: Disturbance Index.

The highest disturbance score was recorded in *Lyabujije* (20), followed by *Bulima* (15) (Table 1). Similarly, cut stumps were more recorded in *Lyabujije*, *Bulima*, and *Mwamanota* with relatively high disturbance index (DI) (Fig. 3). This suggests the survival of the *Ngitili* with its plant species is at risk. The study observed various factors affecting the status and the available vegetation species composition in the studied *Ngitili*. The most common observed factors include conflict of interest and ineffective improvement strategies, fewer emphases and absence of incentive from the government as compared to a few years back. Also, the introduction of agroforestry which mostly uses alien plant species (with extra care, not palatable by livestock, fail to adapt harsh condition), and unrecognition of the traditional police locally known as *Sungusungu* who had their ways of implementing the by-laws and protecting the communities against invaders are among of the factors.

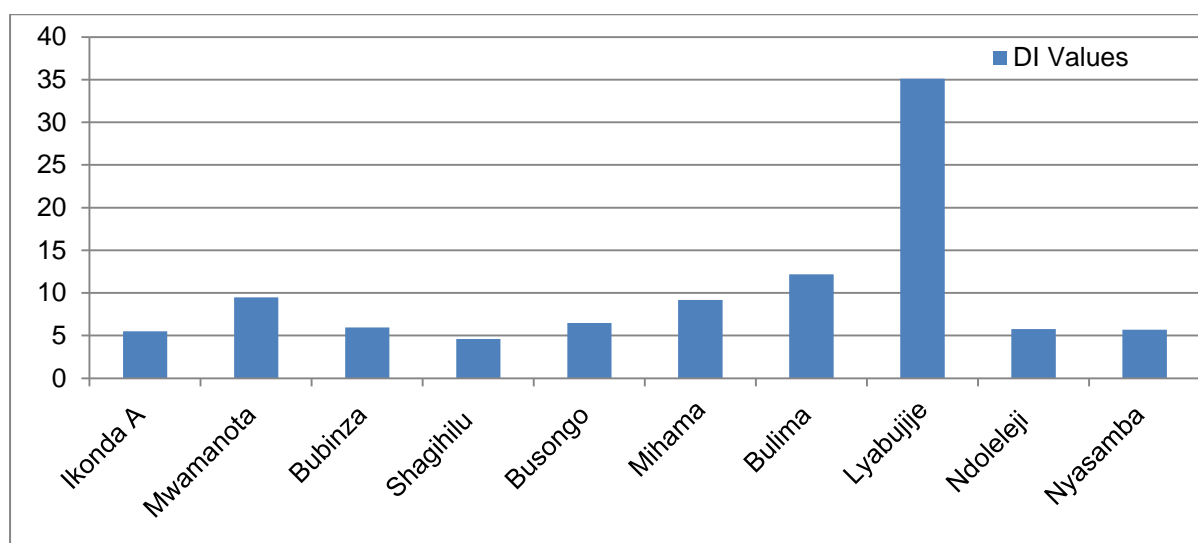


Figure 3. Disturbance Index scores recorded in studied *Ngitili* of Kishapu district, Tanzania.

The reduced powers of the Elders and the *Sungusungu* has been attributed for the disappearance of *Lyabujije Ngitili* in *Ng'wanima*, due high level of human right consideration as it was reported by Minja & Machanya (2010) whereby, cases related to misuse of *Ngitili* related resources are now handled by government police, who

usually discourage the action taken by *Sungusungu*, under the fact that is not legally recognized. Other recorded factors, included the ceasing of financial and technical support from supporting agents such as NORAD, cutting of tree for charcoal making to sustain livelihood and family economy, climate change, natural disturbance, grazing pressure, improper cultivation practices, deforestation, fires outbreak, extensive fuelwood collection and logs demand (Fig. 4). The same information has also reported by Gillespie *et al.* (2000) and Tefera *et al.* (2007) in Ethiopia.



Figure 4. A, Picture to show the observed agriculture activity taking place within Ngitili; B, Picture to show the observed cut stump in Ngitili; C, Picture to show the observed charcoal making within Ngitili; D, Picture to show the observed wood fuel collection within Ngitili.

Similar information was reported by (Kamwenda 2002, Rubanza *et al.* 2006, UNDP 2012) in Khama, Shinyanga rural and Meatu district respectively. On the other hand, Pye-Smith (2010) in Shinyanga region reported information on the human population and its threat to the existence of the ecosystem. Factors like the serious competition of land for human settlement, agriculture and livestock grazing (Chirwa 2014) have been attributing to high *Ngitili* degradation in Shinyanga.

An intense dependence on forest-related goods is attributed to poverty and few options for resource acquisition due to increased population. The World Agroforestry Centre highlighted the growing urban demand for charcoal, has accelerated the degradation of *Ngitili*. Furthermore, other observation that has been reported by other scholars in the Shinyanga region includes a tendency of the communities to shift from previously practised communal to private *Ngitili* (Selemani *et al.* 2012). The reasons for such movement is that the communal *Ngitili* provide low economic return mainly because of unequal sharing of benefits, poor land security, poor grazing management, and conflicts are unavoidable (Adams *et al.* 2003) as decisions are made by village government leaders on behalf of community members as compared to private *Ngitili*. Similarly, (Wilkie & Countries 2010) reported increased livestock and crop production threaten the existence of any ecosystem.

Plant species regeneration potential in conserved Ngitili of Kishapu

Regeneration status: The current study observed the majority of plant species (51.85%) in the studied *Ngitili* exhibited “*Not regeneration*” condition followed by “*Poor regeneration*” (25.41%), followed by “*Fair regeneration*” (20.74%) and lastly with lower percentage was “*Good regeneration*” (2.11%). While “*Newly regeneration*” was not recorded in the studied *Ngitili* (0.00%) (Table 2).

The study recorded a mean standing stem density of 512.07 ± 193.86 stems ha^{-1} , for trees with greater than 5 cm diameter at breast height, similarly an average of 8.12 cm and 4.67 m, for diameter at breast height (dbh) and tree heights respectively. The findings of the current study observed a “*Not regenerating*” followed by a “*Poor regeneration*” status to dominate in the studied *Ngitili*. This portrayed a significant indicator of locally ecological extinction of some plant species soon. Apart from such observation, the findings of this study agree to Selemani *et al.* (2013) who reported 578.38 ± 70.69 stems ha^{-1} with an average height of 3.24 m, for tree stems density and heights respectively, in Shinyanga rural and Meatu districts.

However, the findings of the current study contradict the findings reported Monela *et al.* (2005) who reported the higher range of 1964 to 6553 stems ha^{-1} and 6.7 to 27.2 cm, for tree stem density and diameter at breast height respectively, as compared to this study. Also, the findings contracted to a report by Otsyina *et al.* (2008) who observed a range of 1053 to 1360 stems ha^{-1} , in the districts of the Shinyanga region. Therefore, the sustainability of the *Ngitili* is questionable, as they are threatened by the illegal utilization of species by communities to sustain their livelihood. According to Barrow & Shah (2011), unstable climate

and edaphic variability provide an associated with poor regeneration of individual species. Similarly, Selemani *et al.* (2012) reported lower ecological carrying capacity due to scarcity of grazing land and low adaptability of some species to the degraded ecosystem contributed to the degradation of *Ngitili* in Shinyanga. On the other hand, the regeneration of species could have been affected by anthropogenic factors and natural phenomena (Iqbal *et al.* 2012).

Table 2. Plant species regeneration status of *Ngitili* in Kishapu district of Shinyanga, Tanzania.

Botanical Name	Status of individuals plant species (m2)						Regeneration status
	Height (m)	dbh (cm)	No. of trees	No. of shrubs	No. of seedlings	No. of saplings	
<i>Acacia angustissima</i> (Mill.) Kuntze	5.6	10.9	2	2	1	0	NR
<i>Acacia concinna</i> (Willd.) DC.	6.4	8.8	151	81	21	43	GR
<i>Acacia drepanolobium</i> Harms ex Y.Sjöstedt	4.4	5.5	315	135	326	432	GR
<i>Acacia nilotica</i> (L.) Del.	6.8	18.5	124	41	38	67	FR
<i>Acacia polyacantha</i> Willd.	7.4	16.8	15	15	3	11	NR
<i>Acacia bethamii</i> Meisn.	4.3	9.5	15	3	4	6	NR
<i>Acacia senegal</i> (L.) Willd.	5.9	11.3	6	5	0	2	PR
<i>Acacia tortilis</i> (Forssk.) Hayne	7.1	15.8	102	28	9	16	FR
<i>Adasonia digitata</i> L.	-	-	23	2	0	0	NR
<i>Albizia amara</i> (Roxb.) Boiv.	2.6	5	1	10	13	6	FR
<i>Azadirachta indica</i> A.Juss.	4.6	6.7	2	1	1	2	NR
<i>Balanites aegyptiaca</i> (L.) Delile	6.1	8.8	142	40	21	18	FR
<i>Capparis tomentosa</i> Lam.	2.7	5	3	44	0	3	NR
<i>Cassia abbreviata</i> Oliv.	3.7	6.4	2	1	0	0	NR
<i>Colotropis procera</i> (Aiton) W.T.Aiton	1.6	3.6	1	7	13	24	FR
<i>Combretum fraxgrans</i> F. Hoffm	5.4	5.8	1	14	0	0	NR
<i>Combretum obovatum</i> F.Hoffm.	3.9	5.1	1	5	0	0	NR
<i>Dichrostachys cinerea</i> Wight et Arn.	3.6	5.2	101	95	87	65	GR
<i>Diospyros fischeri</i> Gürke	3.2	6	6	5	1	3	NR
<i>Euphorbia ingens</i> E.Mey. ex Boiss.	4.2	6.2	1	12	7	9	FR
<i>Euphorbia tirucalli</i> L.	5.3	7.9	2	1	0	0	NR
<i>Grewia bicolor</i> . Juss	3.6	5.1	1	7	2	6	NR
<i>Lannea humilis</i> (Oliv.) Engl.	4.3	10.2	2	125	37	123	GD
<i>Leucaena leucocephala</i> (Lam.) de Wit	5.3	5.3	6	19	13	21	FR
<i>Ormocarpum kirkii</i> S. Moore	2.8	6.5	7	21	6	19	FR
<i>Senna siamea</i> (Lam.) de Wit	5.7	8.7	1	1	17	5	FR
<i>Senna singueana</i> (Delile) Lock	3.1	5.8	1	6	0	0	NR
<i>Tamarindus indica</i> L.	6.5	13.6	2	1	0	6	PR

Summary

NR = 51.85; PR = 25.41; FR = 20.74; GR = 2.11
 Standing stem density = 512.07±193.86 stems ha⁻¹
 Average height = 4.67 m
 Average dbh = 8.12 cm

Note: NR: no regeneration; PR: poor regeneration; FR: fair regeneration; GR: good regeneration; dbh: diameter at breast height.

Plant species composition and diversity status in conserved *Ngitili* of Kishapu: A total of 66 plant species were identified in the studied *Ngitili* of Kishapu district of the Shinyanga region in Tanzania. Of which, 20 species (19 genera and 3 families) were grasses, 18 species (18 genera and 11 families) were forbs, and 28 species (17 genera and 13 families) were trees and shrubs (Table 3). The findings from the current study observed few species as compared to 152 different plant species recorded by Monela *et al.* (2005) in the surveyed *Ngitili* forests of the Shinyanga region.

The result of grass and forb species composition as indicated in table 3 showed that the more dominant grass species were, *Aristida funiculata* Trin. & Rupr (28.93%) and *Cynodon dactylon* (L.) Pers. (12.9%). (Fig. 5). Other grass species with relatively high frequencies include *Dactyloctenium aegyptium* (L.) Willd. (6.1%) and *Eragrostis curvula* (Schrad.) Nees (4.2%), while dominant forb species were *Monechma debile* (Forssk.) Nees (4.6%), *Leucas martinicensis* (Jacq.) R.Br. and *Commelina benghalensis* L. (Fig. 6). Grass species were more diverse (58%) as compared to forb species (42%) in the study site. The reported dominant herbaceous species in the current study denote species that are native to a disturbed ecosystem, as it was observed by Pratt & Gwynne (1971), in semi-arid and disturbed landscapes of East Africa.

Table 3. List of plant species identified in *Ngitili* of Kishapu district, Shinyanga, Tanzania.

Categories	Botanic Name	Composition (%) /IVI
Category 1: Grass species	1 <i>Aristida funiculata</i> Trin. & Rupr	28.9
	2 <i>Branchiaria mutica</i> (Forssk.) Stapf	2.1
	3 <i>Cenchrus ciliaris</i> L.	3.2
	4 <i>Chloris barbata</i> Sw.	1.5
	5 <i>Chloris gayana</i> Kunth	0.6
	6 <i>Cynodon dactylon</i> (L.) Pers.	12.9
	7 <i>Cyperus esculentus</i> L.	2.7
	8 <i>Dactyloctenium aegyptium</i> (L.) Willd.	6.1
	9 <i>Digitaria scalarum</i> (Schweinf.) Chiov.	0.8
	10 <i>Echinochloa colona</i> (L.) Link	0.1
	11 <i>Eragrostis curvula</i> (Schrad.) Nees	4.2
	12 <i>Heteropogon contortus</i> (L.) P.Beauv	0.4
	13 <i>Urochloa panicoides</i> P.Beauv.	0.2
	14 <i>Panicum trichocladum</i> Hack. ex K. Schum.	0.7
	15 <i>Rhynchelytrum repens</i> (Willd.) C.E.Hubb.	1.7
	16 <i>Rottboellia exaltata</i> L. f.	0.3
	17 <i>Setaria verticillata</i> (L.) P.Beauv.	1.4
	18 <i>Sorghum bicolor</i> (L.) Moench	0.2
	19 <i>Sporoborus spicatus</i> Kunth	1.8
	20 <i>Themada quadrivalvis</i> (L.) Kuntze	0.9
Category 2: Forb species	21 <i>Monechma debile</i> (Forssk.) Nees	4.6
	22 <i>Leucas martinicensis</i> (Jacq.) R.Br.	3.5
	23 <i>Commelina benghalensis</i> L.	3.3
	24 <i>Ipomoea batatas</i> (L.) Lam.	2.8
	25 <i>Tribulus terrestris</i> var. <i>inermis</i>	2.3
	26 <i>Amaranthus spinosus</i> L.	2.2
	27 <i>Oxygonum sinuatum</i> (Hochst. & Steud.)	2.2
	28 <i>Lycopersicon lycopersicum</i> (L.) H. Karst.	1.8
	29 <i>Sonchus luxurians</i> (R. E. Fr.) C. Jeffrey	1.5
	30 <i>Cucumis anguria</i> L.	1.1
	31 <i>Corchorus capsularis</i> L.	0.8
	32 <i>Solanum incanum</i> L.	0.8
	33 <i>Sphaeranthus suaveolens</i> (Forssk.) DC.	0.7
	34 <i>Abelmoschus esculentus</i> (L.) Moench	0.5
	35 <i>Cleome gynandra</i> L.	0.5
	36 <i>Convolvulus prostratus</i> Forssk.	0.4
	37 <i>Sida spinosa</i> L.	0.2
	38 <i>Datura stramonium</i> L.	0.1
Category 3: Tree and shrub species	39 <i>Acacia angustissima</i> (Mill.) Kuntze	6.77
	40 <i>Acacia bethamii</i> Meisn.	6.09
	41 <i>Acacia concinna</i> (Willd.) DC.	25.51
	42 <i>Acacia drepanolobium</i> Harms ex Y.Sjöstedt	45.37
	43 <i>Acacia nilotica</i> (L.) Del.	6.63
	44 <i>Acacia polyacantha</i> Willd.	16.99
	45 <i>Acacia seyal</i> Delile	13.74
	46 <i>Acacia senegal</i> (L.) Willd.	15.53
	47 <i>Acacia tortilis</i> (Forssk.) Hayne	33.2
	48 <i>Albizia amara</i> (Roxb.) Boiv.	1.63
	49 <i>Azadirachta indica</i> A.Juss.	5.53
	50 <i>Balanites aegyptiaca</i> (L.) Delile	42.96
	51 <i>Capparis tomentosa</i> Lam.	0.57
	52 <i>Cassia abbreviata</i> Oliv.	1.79
	53 <i>Colotropis procera</i> (Aiton) W.T.Aiton	0.98
	54 <i>Combretum fraxgrans</i> F.Hoffm.	1.84
	55 <i>Combretum obovatum</i> F.Hoffm.	2.66
	56 <i>Dichrostachys cinerea</i> Wight et Arn.	23.38
	57 <i>Diospyros fischeri</i> Gürke	2.57
	58 <i>Euphorbia ingens</i> E.Mey. ex Boiss.	1.43
	59 <i>Euphorbia tirucalli</i> L.	8.32
	60 <i>Grewia bicolor</i> Juss	2.29

61	<i>Lannea humilis</i> (Oliv.) Engl.	33.57
62	<i>Leucaena leucocephala</i> (Lam.) de Wit	2.07
63	<i>Ormocarpum kirkii</i> S. Moore	3.86
64	<i>Senna siamea</i> (Lam.) de Wit	1.5
65	<i>Senna singueana</i> (Delile) Lock	1.43
66	<i>Tamarindus indica</i> L.	5.53

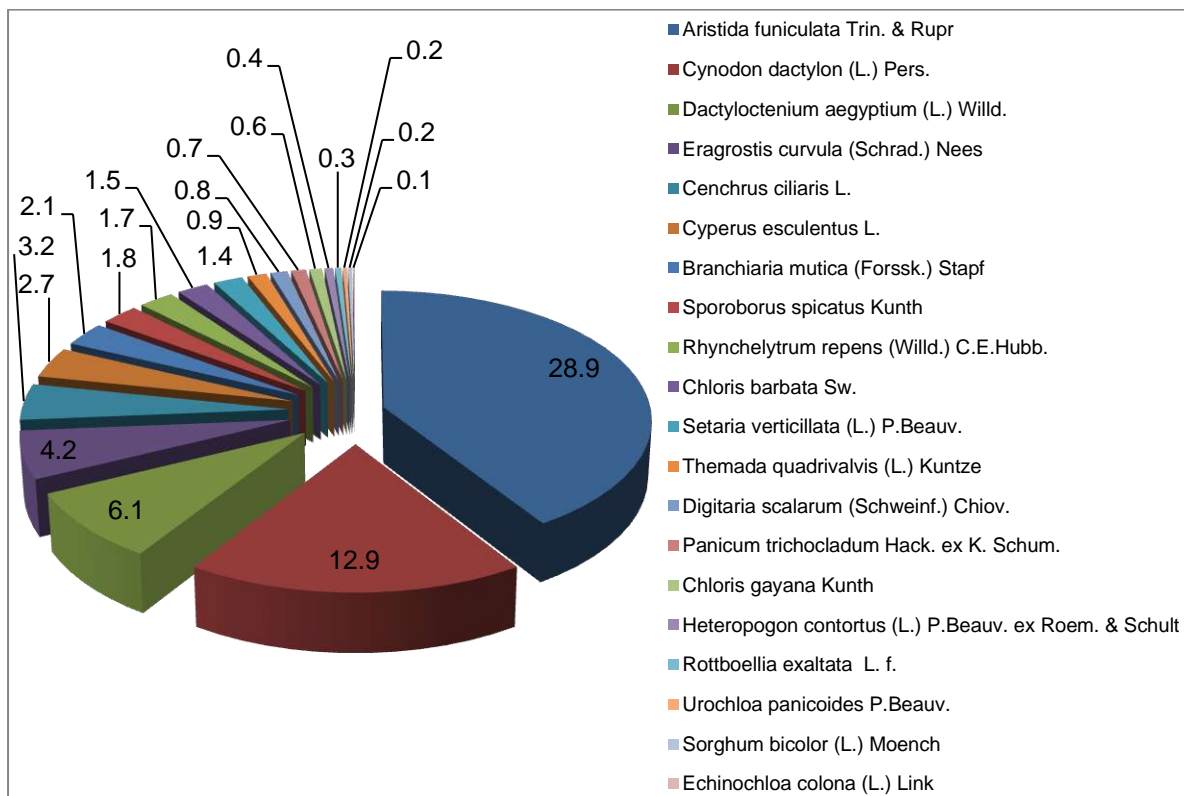


Figure 5. Grass species composition recorded in Ngiti of Kishapu district, Tanzania.

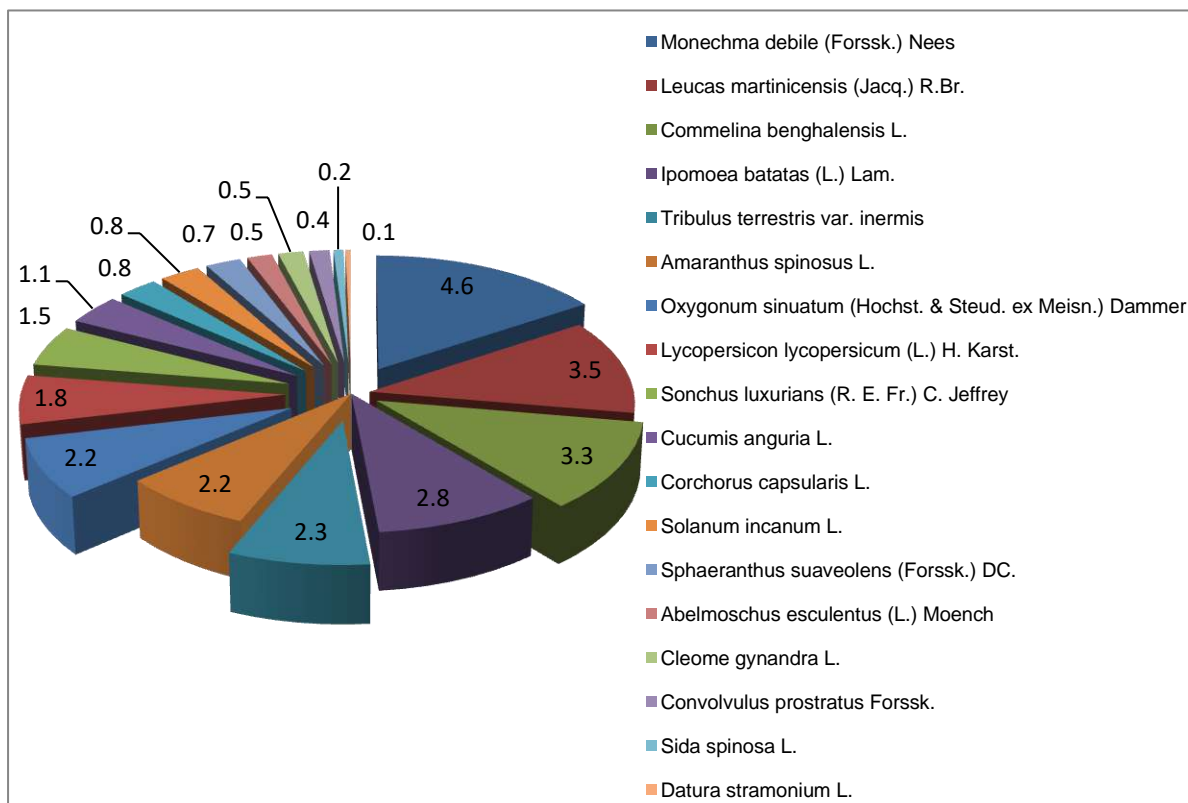


Figure 6. Forb species composition recorded in Ngiti of Kishapu district, Tanzania.

The presence of dominant forb species such as *Abelmoschus esculentus* (L.) Moench, *Convolvulus prostratus* Forssk., *Oxygonum sinuatum* (Hochst. & Steud. ex Meisn.) Dammer and *Sida spinosa* L., denote disturbed soil characteristics and could be attributed to certain forms of land degradation due to different factors including overgrazing and other anthropogenic activities. Heavy grazing pressure could have resulted in the disappearance of other herbaceous species and leads to the domination of the recorded species due to their great tolerate and regeneration potential under harsh conditions. Grass species such as *Aristida* spp. and *Cenchrus* spp. are good indicators of disturbed, aridity and semi-aridity zones (Monela *et al.* 2005, Otsyina *et al.* 2006, Rubanza *et al.* 2008, Selemani *et al.* 2012). A study by Rubanza *et al.* (2006) in Meatu reported the decline of some palatable herbage species “decreasers” as well as the emergence of less nutritious unpalatable species “increasers” that tend to dominate the place. The study observed the variation of soils, attributed to the presence of a particular dominant grass species. For instance, species such as *Sorghum* spp., *Digitaria* spp., and *Rhynchelytrum* spp. were found to be dominant in black clay soil locally known as *Mbuga*.

Other grass species such as *Aristida* spp., *Cenchrus* spp., *Heteropogon* spp., *Chloris* spp., and *Branchiaria* spp. were localized in clay loam soil locally known as *Ibushi*. Water-loving species like *Cynodon dactylon* (L.) Pers. were found dominant in heavy clay vertisol soils (black cotton soil) characterized by high holding capacity and the associated water logging which favours water-loving grass species. Factors related to soil infertility as the cause of *Ngitili* degradation and distributions of species was also reported by Machanya *et al.* (2003).

Results on dominant tree and shrub species and their diversity are indicated in table 4. The dominant tree and shrub species recorded in the current study were from the genus *Acacia*. Other genera with relatively high dominant include, *Dichrostachys*, *Lannea* and *Balanite*. The study recorded dominant tree and shrub species such as *Acacia drepanolobium* Harms ex Y.Sjöstedt., *Acacia tortilis* (Forssk.) Hayne., *Acacia concinna* (Willd.) DC. *Acacia polyacantha* Willd. and *Acacia senegal* (L.) Willd. as well as other species such as *Balanites* spp. (desert plum).

In order of importance value index (IVI), the dominant tree and shrub species were *Acacia drepanolobium* Harms ex Y.Sjöstedt (45.37) and *Balanites aegyptiaca* (L.) Delile (42.96), with a diversity ranging from 1.9 to 2.5 and 0.07 to 0.12, for Shannon’s (H’) and Simpson’s (Ds) indices diversity respectively, in Kishapu district. There was a positive dominance relationship between tree and shrub species in the study as shown in figure 7. The domination of the observed species has been connected with their less valuable for timber markets and charcoal production as well as thorny nature that prevents them from frequently grazed by the domesticated animal.

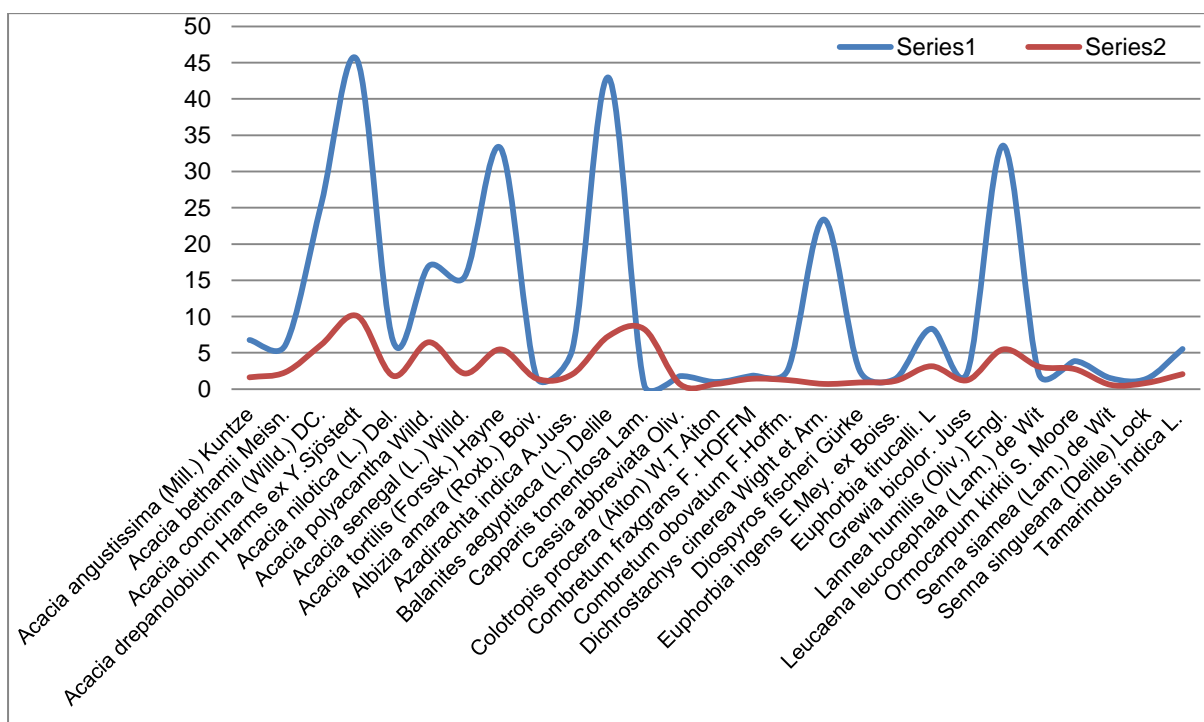


Figure 7. F relationship between tree and shrub species dominance recorded in Ngitili of Kishapu district, Tanzania. [Series 1 stands for trees and Series 2 stands for shrubs]

Table 4. Dominant tree and shrub species and their diversity in *Ngitili* of Kishapu district, Shinyanga, Tanzania.

Botanical Name	Important value index (IVI)	
	Tree	Shrub
<i>Acacia angustissima</i> (Mill.) Kuntze	6.77	1.62
<i>Acacia bethamii</i> Meisn.	6.09	2.33
<i>Acacia concinna</i> (Willd.) DC.	25.51	6.12
<i>Acacia drepanolobium</i> Harms ex Y.Sjöstedt	45.37	10.08
<i>Acacia nilotica</i> (L.) Del.	6.63	1.82
<i>Acacia polyacantha</i> Willd.	16.99	6.46
<i>Acacia senegal</i> (L.) Willd.	15.53	2.15
<i>Acacia tortilis</i> (Forssk.) Hayne	33.2	5.47
<i>Albizia amara</i> (Roxb.) Boiv.	1.63	1.44
<i>Azadirachta indica</i> A.Juss.	5.53	2.06
<i>Balanites aegyptiaca</i> (L.) Delile	42.96	7.29
<i>Capparis tomentosa</i> Lam.	0.57	8.26
<i>Cassia abbreviata</i> Oliv.	1.79	0.66
<i>Colotropis procera</i> (Aiton) W.T.Aiton	0.98	0.71
<i>Combretum fraxgrans</i> F.Hoffm.	1.84	1.42
<i>Combretum obovatum</i> F.Hoffm.	2.66	1.24
<i>Dichrostachys cinerea</i> Wight et Arn.	23.38	0.71
<i>Diospyros fischeri</i> Gürke	2.57	0.91
<i>Euphorbia ingens</i> E.Mey. ex Boiss.	1.43	1.13
<i>Euphorbia tirucalli</i> . L	8.32	3.15
<i>Grewia bicolor</i> . Juss	2.29	1.22
<i>Lannea humilis</i> (Oliv.) Engl.	33.57	5.47
<i>Leucaena leucocephala</i> (Lam.) de Wit	2.07	3.09
<i>Ormocarpum kirkii</i> S. Moore	3.86	2.75
<i>Senna siamea</i> (Lam.) de Wit	1.5	0.58
<i>Senna singueana</i> (Delile) Lock	1.43	0.85
<i>Tamarindus indica</i> L.	5.53	2.06
Summary		
Parameters	Value	
Total species richness	66	
Tree and shrub species richness	28	
Grass species richness	20	
Forb species richness	18	
Shannon's index	1.96–2.45	
Simpson's index	0.07–0.12	
Pielou's evenness index	0.6	
Effectiveness number of species	6	

On the other hand, they have great adaptation and thereby represent tree species that are well adapted to arid and semi-arid regions with annual rainfall ranging from about 400 to 800 mm. A study by Monela *et al.* (2005) highlighted the high regeneration potential of species like *Dichrostachys cinerea* Wight et Arn. and *Ormocarpum trichocarpum* (Taub.) Engl., indicates degraded areas. The recorded dominant tree and shrub species have similarly been reported in other parts of the (Monela *et al.* 2005, Rubanza *et al.* 2006, Otsyina *et al.* 2008, Selemani *et al.* 2013) in Shinyanga rural, Shinyanga urban, Meatu and Kahama districts, respectively. However, the current study has recorded fewer dominant tree species as compared to other districts in the region.

This might have been influenced by a high level of degradation and deforestation observed in the studied *Ngitili*. A study by Selemani *et al.* (2013) reported the predominant of plant species like *Acacia*, reflect an overgrazed land, as *Acacia* spp. can tolerate heavy grazing pressure and thrive well in degraded rangelands. According to Barbour *et al.* (1999) the larger the value of H' the greater the species diversity and vice versa in the scale of 1 to (Magurran 1988). While the lower the dominance index value (D_s), the lower the dominance of a single species (Giliba *et al.* 2011) and the greater the value of the index of dominance the lower the species diversity and vice versa in the scale of 0 to 1 (Misra 1989). The recorded diversity (1.8 to 2.4) in the current study, portray low species diversity, characterized by the domination of a few species in the study area.

The lower species diversity and regeneration in most of the *Ngitili* in the study area have been attributed

by a short period of protection of *Ngitili* before grazing season, which may not offer sufficient time for vegetation recovery and transfer their trait to next-generation (Selemani *et al.* 2013). Instead of increases, the rate of species degradation and lowering their diversity (Zhu *et al.* 2004) observed on the forest fragmented forests in southern Yunnan. The predominant of species of the genus *Acacia* in the study areas may reflect an overgrazed land, which should perhaps not be expected to demonstrate high species diversity. The findings from the current work contradict the findings reported (Monela *et al.* 2005, Nyadzi *et al.* 2003) in different districts of Shinyanga region that showed relatively high values of both H' and D_s .

Plant species biomass productivity potential: Results on herbaceous primary biomass productivity are given in table 5. The current study recorded a mean of 1.098 ± 0.0306 t DM ha⁻¹, ranging from 0.00 to 3.68 t DM ha⁻¹ for minimum and maximum, respectively. The recorded biomass productivity concurs to the previous findings which were reported from other districts of the region ranged from 0.02 to 3.32 t DM ha⁻¹ (Rubanza *et al.* 2006) in the Meatu district and 0.92 to 3.87 t DM ha⁻¹ by Otsyina *et al.* (2008) in Shinyanga rural. However, the current study recorded a slightly lower average mean of biomass as compared to others (Issae 1997, Rubanza *et al.* 2006, Otsyina *et al.* 2008). The slight variations on herbaceous biomass productivity observed in the current study could be partly explained by constant grazing activities as well as differing in forest management aspects associated with overexploitation, which influenced herbaceous species composition and stocking potential to lower their recovery and productivity potential. The study observed some parts of the *Ngitili* were highly degraded such that, there were no herbaceous species to be recorded on it (bare ground; Fig. 8). Anthropogenic disturbances including resource exploitation, deforestation, and overgrazing, have altered the understory forest structure and species composition making a serious impact on future herbaceous diversity and productivity.

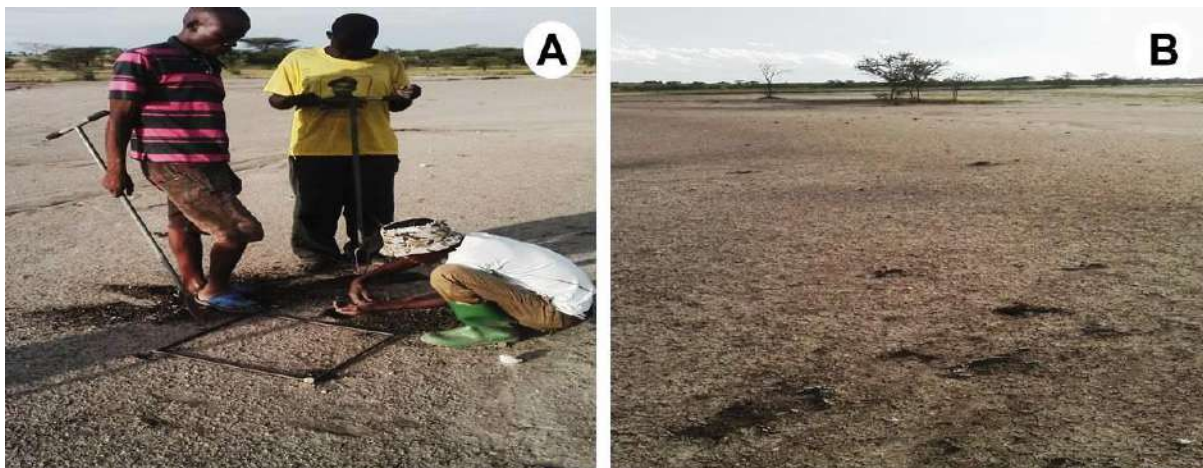


Figure 8. A, Bare ground with no grass covers recorded in Bubinza *Ngitili*; B, Bare ground with no grass cover recorded in Shagihilu *Ngitili* of Kishapu district.

Table 5. Herbaceous biomass productivity in *Ngitili* of Kishapu district, Shinyanga, Tanzania.

Plots	FWT(g)	DWT(g)	DM (%)	Biomass (g DM ⁻¹ ha ⁻¹)	Biomass (t DM ⁻¹ ha ⁻¹)
1	51.57	36.89	71.53	1475600	1.48
2	105.92	57.16	53.97	2286400	2.29
3	101.66	51.75	50.90	2070000	2.07
4	43.2	21.92	50.74	876800	0.88
5	12.48	8.38	67.15	335200	0.34
6	19.82	11.7	59.03	468000	0.47
7	37.94	21.92	57.78	876800	0.88
8	39.79	22.94	57.65	917600	0.92
9	52.86	28.16	53.27	1126400	1.13
10	43.05	25.06	58.21	1002400	1.00
11	24.98	16.94	67.81	677600	0.68
12	28.18	18.87	66.96	754800	0.75
13	55.94	22.34	39.94	893600	0.89
14	112.67	55.87	49.59	2234800	2.23
15	77.52	43.15	55.66	1726000	1.73
16	28.8	19.43	67.47	777200	0.78
17	54.17	21.55	39.78	862000	0.86

18	49.2	19.98	40.61	799200	0.80
19	27.32	16.65	60.94	666000	0.67
20	34.16	20.01	58.58	800400	0.80
21	68.4	31.54	46.11	1261600	1.26
22	43.5	25.87	59.47	1034800	1.03
23	84.03	43.54	51.81	1741600	1.74
24	101.34	51.89	51.20	2075600	2.08
25	28.09	19.64	69.92	785600	0.79
26	54.1	21.35	39.46	854000	0.85
27	42.23	19.97	47.29	798800	0.80
28	92.01	47.23	51.33	1889200	1.89
29	49.2	19.98	40.61	799200	0.80
30	27.32	16.65	60.94	666000	0.67
31	34.16	20.01	58.58	800400	0.80
32	68.4	31.54	46.11	1261600	1.26
33	37.94	21.92	57.78	876800	0.88
34	39.79	22.94	57.65	917600	0.92
35	52.86	28.16	53.27	1126400	1.13
36	43.05	25.06	58.21	1002400	1.00
37	38.54	25.76	66.84	1030400	1.03
38	33.06	27.64	83.61	1105600	1.11
39	20.07	18.25	90.93	730000	0.73
40	40.69	24.53	60.29	981200	0.98
41	36.68	30.03	81.87	1201200	1.20
42	38.77	33.97	87.62	1358800	1.36
43	39.97	34.81	87.09	1392400	1.39
44	50.6	41.25	81.52	1650000	1.65
45	26.82	24.69	92.06	987600	0.99
46	25.03	22.43	89.61	897200	0.90
47	53.56	28.7	53.58	1148000	1.15
48	34.52	31.84	92.24	1273600	1.27
49	43.81	29.95	68.36	1198000	1.20
50	32.28	28.87	89.44	1154800	1.15
51	20.91	18.79	89.86	751600	0.75
52	34.18	31.13	91.08	1245200	1.25
53	38.46	27.76	72.18	1110400	1.11
54	119.78	54.62	45.60	2184800	2.18
55	30.43	26.27	86.33	1050800	1.05
56	33.25	26.9	80.90	1076000	1.08
57	27.01	25.19	93.26	1007600	1.01
58	27.09	24.58	90.73	983200	0.98
59	28.51	23.01	80.71	920400	0.92
60	20.14	17.65	87.64	706000	0.71
61	36.99	29.99	81.08	1199600	1.20
62	35.34	27.48	77.76	1099200	1.10
63	24.17	20.71	85.68	828400	0.83
64	31.9	26.21	82.16	1048400	1.05
65	17.12	15.29	89.31	611600	0.61
66	21.42	18.36	85.71	734400	0.73
67	14.91	12.58	84.37	503200	0.50
68	29.24	27.93	95.52	1117200	1.12
69	17.38	15.21	87.51	608400	0.61
70	17.01	15.01	88.24	600400	0.60
71	18.62	16.63	89.31	665200	0.67
72	21.32	19.35	90.76	774000	0.77
73	0.00	0.00	0.00	0.00	0.00
74	0.00	0.00	0.00	0.00	0.00
75	0.00	0.00	0.00	0.00	0.00
76	0.00	0.00	0.00	0.00	0.00
77	30.06	26.38	87.76	1055200	1.06
78	31.18	28.39	91.05	1135600	1.14
79	28.35	25.43	89.70	1017200	1.02

80	31.24	28.26	90.46	1130400	1.13
81	31.81	26.04	81.86	1041600	1.04
82	30.91	27.75	89.78	1110000	1.11
83	26.24	22.79	86.85	911600	0.91
84	24.66	22.68	91.97	907200	0.91
85	0.00	0.00	0.00	0.00	0.00
86	0.00	0.00	0.00	0.00	0.00
87	0.00	0.00	0.00	0.00	0.00
88	0.00	0.00	0.00	0.00	0.00
89	32.4	18.85	58.18	754000	0.75
90	26.97	21.08	78.16	843200	0.84
91	83.91	28.14	33.54	1125600	1.13
92	53.84	28.19	52.36	1127600	1.13
93	34.16	20.01	58.58	800400	0.80
94	68.4	31.54	46.11	1261600	1.26
95	37.94	21.92	57.78	876800	0.88
96	39.79	22.94	57.65	917600	0.92
97	24.17	20.71	85.68	828400	0.83
98	31.9	26.21	82.16	1048400	1.05
99	17.12	15.29	89.31	611600	0.61
100	21.42	18.36	85.71	734400	0.73
101	31.24	28.26	90.46	1130400	1.13
102	31.81	26.04	81.86	1041600	1.04
103	30.91	27.75	89.78	1110000	1.11
104	26.24	22.79	86.85	911600	0.91
105	24.98	16.94	67.81	677600	0.68
106	28.18	18.87	66.96	754800	0.75
107	55.94	22.34	39.94	893600	0.89
108	112.67	55.87	49.59	2234800	2.23
109	48.66	32.67	67.14	1306800	1.31
110	39.32	32.34	82.25	1293600	1.29
111	41.21	33.15	80.44	1326000	1.33
112	21.29	17.37	81.59	694800	0.69
113	27.51	24.79	90.11	991600	0.99
114	31.44	25.99	82.67	1039600	1.04
115	26.05	23.58	90.52	943200	0.94
116	23.58	17.88	75.83	715200	0.72
117	36.53	30.56	83.66	1222400	1.22
118	27.62	23.84	86.31	953600	0.95
119	32.42	26.69	82.33	1067600	1.07
120	27.61	24.11	87.32	964400	0.96
121	29.79	24.12	80.97	964800	0.96
122	67.2	34.85	51.86	1394000	1.39
123	43.5	31.92	73.38	1276800	1.28
124	64.7	26.25	40.57	1050000	1.05
125	26.01	18.94	72.82	757600	0.76
126	30.37	27.05	89.07	1082000	1.08
127	29.18	24.31	83.31	972400	0.97
128	33.16	20.87	62.94	834800	0.83
129	33.75	22.33	66.16	893200	0.89
130	33.42	20.52	61.40	820800	0.82
131	54.07	34.65	64.08	1386000	1.39
132	77.62	33.61	43.30	1344400	1.34
133	55.44	37.31	67.30	1492400	1.49
134	36.13	26.42	73.12	1056800	1.06
135	42.35	30.54	72.11	1221600	1.22
136	46.36	32.66	70.45	1306400	1.31
137	27.12	25.9	95.50	1036000	1.04
138	27.51	24.79	90.11	991600	0.99
139	31.44	25.99	82.67	1039600	1.04
140	26.05	23.58	90.52	943200	0.94
141	23.58	17.88	75.83	715200	0.72

142	22.88	19.13	83.61	765200	0.77
143	38.8	23.03	59.36	921200	0.92
144	38.3	21.48	56.08	859200	0.86
145	16.93	14.57	86.06	582800	0.58
146	20.54	17.09	83.20	683600	0.68
147	15.16	13.07	86.21	522800	0.52
148	33.56	29.04	86.53	1161600	1.16
149	24.94	13.8	55.33	552000	0.55
150	18.33	13.18	71.90	527200	0.53
151	32.48	20.88	64.29	835200	0.84
152	21.03	17.01	80.88	680400	0.68
153	34.02	27.49	80.81	1099600	1.10
154	42.49	30.32	71.36	1212800	1.21
155	31.89	23.08	72.37	923200	0.92
156	59.83	37.47	62.63	1498800	1.50
157	62.79	36.91	58.78	1476400	1.48
158	63.33	32.92	51.98	1316800	1.32
159	28.93	26.25	90.74	1050000	1.05
160	68.39	41.56	60.77	1662400	1.66
161	35.13	30.06	85.57	1202400	1.20
162	37.87	32.73	86.43	1309200	1.31
163	22.03	19.01	86.29	760400	0.76
164	17.53	16.02	91.39	640800	0.64
165	89.4	61.18	68.43	2447200	2.45
166	41.65	30.43	73.06	1217200	1.22
167	105.94	43.11	40.69	1724400	1.72
168	60.88	42.41	69.66	1696400	1.70
169	27.52	21.3	77.40	852000	0.85
170	35.47	30.42	85.76	1216800	1.22
171	35.51	28.18	79.36	1127200	1.13
172	48.66	32.67	67.14	1306800	1.31
173	39.32	32.34	82.25	1293600	1.29
174	41.21	33.15	80.44	1326000	1.33
175	21.29	17.37	81.59	694800	0.69
176	54.39	38.02	69.90	1520800	1.52
177	30.4	25.26	83.09	1010400	1.01
178	38.23	30.02	78.52	1200800	1.20
179	36.87	31.22	84.68	1248800	1.25
180	66.64	33.38	50.09	1335200	1.34
181	57	42.58	74.70	1703200	1.70
182	63.59	37.8	59.44	1512000	1.51
183	87.7	53.48	60.98	2139200	2.14
184	45.05	26.35	58.49	1054000	1.05
185	129.26	56.63	43.81	2265200	2.27
186	32.46	28.26	87.06	1130400	1.13
187	55.67	34.1	61.25	1364000	1.36
188	33.18	28.89	87.07	1155600	1.16
189	31.49	22.71	72.12	908400	0.91
190	80.11	38.01	47.45	1520400	1.52
191	126.89	49.75	39.21	1990000	1.99
192	28.48	22.12	77.67	884800	0.88
193	18.08	16.52	91.37	660800	0.66
194	22.04	17.82	80.85	712800	0.71
195	20.73	17.71	85.43	708400	0.71
196	31.6	17.59	55.66	703600	0.70
197	25	19.97	79.88	798800	0.80
198	24.62	13.15	53.41	526000	0.53
199	27	21.26	78.74	850400	0.85
200	16.24	13.08	80.54	523200	0.52
201	104.87	54.34	51.82	2173600	2.17
202	36.18	28.57	78.97	1142800	1.14
203	70.68	35.19	49.79	1407600	1.41

204	40.35	24.98	61.91	999200	1.00
205	16.57	13.9	83.89	556000	0.56
206	29.75	21.23	71.36	849200	0.85
207	21.97	15.43	70.23	617200	0.62
208	19.03	18.91	99.37	756400	0.76
209	19.81	16.7	84.30	668000	0.67
210	25.6	21.97	85.82	878800	0.88
211	17.83	13.45	75.43	538000	0.54
212	26.9	20.6	76.58	824000	0.82
213	79.27	48.49	61.17	1939600	1.94
214	45.73	35.64	77.94	1425600	1.43
215	34.11	29.09	85.28	1163600	1.16
216	40.52	31.38	77.44	1255200	1.26
217	46.66	34.65	74.26	1386000	1.39
218	74.81	29.18	39.01	1167200	1.17
219	41.46	24.52	59.14	980800	0.98
220	56.56	21	37.13	840000	0.84
221	30.76	22.7	73.80	908000	0.91
222	38.9	28.57	73.44	1142800	1.14
223	29.01	26.77	92.28	1070800	1.07
224	41.46	29.81	71.90	1192400	1.19
225	51.11	30.78	60.22	1231200	1.23
226	24.37	22.64	92.90	905600	0.91
227	27.05	16.51	61.04	660400	0.66
228	57.31	37.11	64.75	1484400	1.48
229	40.76	27.51	67.49	1100400	1.10
230	26.94	23.28	86.41	931200	0.93
231	35.66	25.49	71.48	1019600	1.02
232	27.62	24.13	87.36	965200	0.97
233	28.57	20.57	72.00	822800	0.82
234	25.17	19.39	77.04	775600	0.78
235	18.06	14.4	79.73	576000	0.58
236	24.57	21.86	88.97	874400	0.87
237	16.88	14.11	83.59	564400	0.56
238	15.66	13.69	87.42	547600	0.55
239	18.97	15.73	82.92	629200	0.63
240	22.71	18.97	83.53	758800	0.76
241	43.35	21.58	49.78	863200	0.86
242	36.41	21.69	59.57	867600	0.87
243	17.52	15.51	88.53	620400	0.62
244	116.13	41.37	35.62	1654800	1.65
245	24.56	22.09	89.94	883600	0.88
246	26.81	23.6	88.03	944000	0.94
247	25.93	23.48	90.55	939200	0.94
248	39.68	27.65	69.68	1106000	1.11
249	26.66	21.24	79.67	849600	0.85
250	17.49	13.43	76.79	537200	0.54
251	20.9	18.6	89.00	744000	0.74
252	28.53	24.46	85.73	978400	0.98
253	64.01	54.34	84.89	2173600	2.17
254	32.4	30	92.59	1200000	1.20
255	28.6	25.4	88.81	1016000	1.02
256	29.49	26.89	91.18	1075600	1.08
257	60.4	56.2	93.05	2248000	2.25
258	54.6	50.2	91.94	2008000	2.01
259	39.76	35.88	90.24	1435200	1.44
260	42.4	39.03	92.05	1561200	1.56
261	24.76	20.99	84.77	839600	0.84
262	41.24	38.42	93.16	1536800	1.54
263	19.04	16.84	88.45	673600	0.67
264	21.33	17.04	79.89	681600	0.68
265	18.03	16.94	93.95	677600	0.68

266	19.04	17.85	93.75	714000	0.71
267	20.08	18.04	89.84	721600	0.72
268	34.36	31.87	92.75	1274800	1.27
269	54.1	50.74	93.79	2029600	2.03
270	47.31	45.03	95.18	1801200	1.80
271	39.07	36.99	94.68	1479600	1.48
272	56.73	53.33	94.01	2133200	2.13
273	33.41	21.69	64.92	867600	0.87
274	57.94	54.72	94.44	2188800	2.19
275	77.47	70.94	91.57	2837600	2.84
276	81.42	71.04	87.25	2841600	2.84
277	35.69	31.49	88.23	1259600	1.26
278	39.43	33.14	84.05	1325600	1.33
279	43.44	38.92	89.59	1556800	1.56
280	69.16	66.09	95.56	2643600	2.64
281	21.64	18.03	83.32	721200	0.72
282	31.43	28.69	91.28	1147600	1.15
283	46.69	43.33	92.80	1733200	1.73
284	39.17	32.1	81.95	1284000	1.28
285	96.01	70.94	73.89	2837600	2.84
286	101.33	92.07	90.86	3682800	3.68
287	89.76	80.14	89.28	3205600	3.21
288	110.09	76.03	69.06	3041200	3.04
289	39.79	22.94	57.65	917600	0.92
290	24.17	20.71	85.68	828400	0.83
291	31.9	26.21	82.16	1048400	1.05
292	17.12	15.29	89.31	611600	0.61
293	32.4	30	92.59	1200000	1.20
294	28.6	25.4	88.81	1016000	1.02
295	29.49	26.89	91.18	1075600	1.08
296	0.00	0.00	0.00	0.00	0.00

Summary**Parameters****Values
Biomass (t DM⁻¹ ha⁻¹)**

Minimum	0.00
Maximum	3.6828
Mean	1.098266
Std. Error	0.0306072
Mean ±SE (t DM ⁻¹ ha ⁻¹)	1.098±0.0306

Note: FWT: Flesh weight; DWT: Dry weight; DM: Dry matter content (%).

On the other hand, the current study recorded a tree stocking potential of 5.657 tC ha⁻¹, with an average mean of 0.209±0.047 tC ha⁻¹ as shown in table 6. The study recorded low stocking potential, which describes how the *Ngitili* in the woodlands is characterized by a small-sized tree with low dbh and height that act as an important parameter for stocking. The high degree of disturbance particularly illegal tree cutting evidenced by the observed a larger number of stump cut trees and young regeneration potential might have influenced the recorded stocking. Plant species with relatively high stocking potential were *Acacia polyacantha* Willd. (0.99 tC ha⁻¹) and *Acacia tortilis* (Forssk.) Hayne (0.68 tC ha⁻¹). The reason behind the maximum carbon storage potential could be explained by the high dbh and height as well as wood density, associated with adaptation in the dry and degraded ecosystem. The recorded data portrayed a poor value of the current *Ngitili* for enhanced climate change mitigation and carbon dioxide (CO₂) offset through carbon sequestration. Thereby, its role to reduce the effects of global warming is highly low and impaired (Pandya *et al.* 2013).

The current study contradicts the findings given by Monela *et al.* (2005), Otsyina *et al.* (2008) and Zahabu (2008) who observed a relatively higher tree stocking potential in different districts of Shinyanga region. The low stocking potential observed in the current study could be due to the high level of forest degradation and deforestation observed in the study site. On top of that, the findings from the current study show similarity with the findings observed by Osei (2014), but with slight variations, probably because his study was so specific to certain plant species in private reserved *Ngitili*.

Table 6. Tree biomass stocking potential in *Ngitili* of Kishapu district, Tanzania.

Botanical Name	Tree biomass stocking parameters				
	AV (m ³ ha ⁻¹)	AGB	BGB	TB	C (tC ⁻¹ ha ⁻¹)
<i>Acacia polyacantha</i> Willd.	3.381	1.691	0.423	2.11	0.993
<i>Acacia tortilis</i> (Forssk.) Hayne	2.331	1.166	0.291	1.46	0.685
<i>Balanites aegyptiaca</i> (L.) Delile	2.122	1.061	0.265	1.33	0.623
<i>Albizia amara</i> (Roxb.) Boiv.	1.374	0.687	0.172	0.86	0.404
<i>Euphorbia tirucalli</i> . L	1.317	0.658	0.165	0.82	0.387
<i>Acacia nilotica</i> (L.) Del.	1.231	0.616	0.154	0.77	0.362
<i>Tamarindus indica</i> L.	1.041	0.52	0.13	0.65	0.306
<i>Acacia bethamii</i> Meisn.	0.951	0.475	0.119	0.59	0.279
<i>Acacia angustissima</i> (Mill.) Kuntze	0.897	0.448	0.112	0.56	0.263
<i>Azadirachta indica</i> A.Juss.	0.737	0.368	0.092	0.46	0.216
<i>Acacia seyal</i> Delile	0.673	0.337	0.084	0.42	0.198
<i>Acacia concinna</i> (Willd.) DC.	0.489	0.244	0.061	0.31	0.144
<i>Combretum fraxgrans</i> F. Hoffm	0.299	0.15	0.037	0.19	0.088
<i>Combretum fraxgrans</i> F. Hoffm	0.275	0.138	0.034	0.17	0.081
<i>Dichrostachys cinerea</i> Wight et Arn.	0.254	0.127	0.032	0.16	0.075
<i>Grewia bicolor</i> . Juss	0.235	0.117	0.029	0.15	0.069
<i>Ormocarpum kirkii</i> S. Moore	0.234	0.117	0.029	0.15	0.069
<i>Senna siamea</i> (Lam.) de Wit	0.228	0.114	0.029	0.14	0.067
<i>Combretum obovatum</i> F.Hoffm.	0.171	0.085	0.021	0.11	0.05
<i>Euphorbia ingens</i> E.Mey. ex Boiss.	0.159	0.079	0.02	0.1	0.047
<i>Leucaena leucocephala</i> (Lam.) de Wit	0.152	0.076	0.019	0.1	0.045
<i>Diospyros fischeri</i> Gürke	0.148	0.074	0.018	0.09	0.043
<i>Acacia drepanolobium</i> Harms ex Y.Sjöstedt	0.143	0.071	0.018	0.09	0.042
<i>Lannea humilis</i> (Oliv.) Engl.	0.133	0.066	0.017	0.08	0.039
<i>Capparis tomentosa</i> Lam.	0.129	0.065	0.016	0.08	0.038
<i>Senna singueana</i> (Delile) Lock	0.118	0.059	0.015	0.07	0.035
<i>Colotropis procera</i> (Aiton) W.T.Aiton	0.038	0.019	0.005	0.02	0.011
Total	19.26	9.63	2.41	12	5.66
Tree parameters' summary	Value				
Height (m)	4.67				
Tree volume (m ³)	19.26				
AGB (t B ha ⁻¹)	9.63				
BGB (t B ha ⁻¹)	2.41				
Total biomass (t B ha ⁻¹)	12.04				
Carbon stocking (t C ha ⁻¹)	5.66				

Note: AV: Average Volume; AGB: Aboveground biomass; BGB: Belowground biomass; TB: Total biomass; C: Carbon; tC: Tons of carbon.

CONCLUSION

From this study, it can be concluded that most of the available *Ngitili* in Kishapu district are threatened and being on the condition of disappearing shortly. An anthropogenic activity such as overexploitation of resources in the *Ngitili*, grazing pressure and deforestation has a direct impact on their existence. The observed degraded and threatened *Ngitili* due to overexploitation has accelerated the “*Not regeneration condition*” as well as poor biomass productivity and stocking potential which could reflect bad future upon the existence of the planned forest ecosystem for enhanced biodiversity and low value for atmospheric carbon dioxide mitigation. Therefore, effective’s measures such as government intervention, formulation of the task forces (special groups) for both financial and technical support to rescue these restorative ecosystems is inevitable.

ACKNOWLEDGEMENTS

The authors sincerely thank; *Sandu Peter, Mhija Budeba* and *Mbwiga Emmanuel* for their tired less, as the field crew who made the exercise of data collection possible. We are grateful to the Laboratory technician, *Madam. Rosy Njawala* from the department of Natural Resources Management and Agroforestry Centre (NAFRAC) of the Shinyanga Region for her time in lab sample preparation and organization. Thanks to staff members at Tanzania Forestry Research Institute (TAFORI), Shinyanga centre for their heartfelt assistance and friendly cooperation. Last but not least, to Kishapu district council forest department for permitting us to work in their forest reserved areas. We just say, thanks and appreciated you all.

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