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Influences of Human Activities on Tree Density and Diameter Distribution in Museve and Mutuluni Dryland Forest Fragments; Kitui County, Kenya

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Abstract

Forest fragments in Arid and Semi-Arid Lands are key water catchment areas and provide important ecosystem services. However, uncontrolled human activities are fast altering their stem density basal area and diameter structure resulting into forest degradation. Besides, information regarding tree density and diameter size-class distribution of dryland forest fragments such as Museve and Mutuluni is lacking. Thus, the purpose of this study was to document key human activities in Museve and Mutuluni forest fragments in Kitui, Kenya and comparatively investigate their influences on stem density, basal area and stem diameter size-class distribution. Two belt transect of 20 m wide and 500 m long, with contiguous sample plots of 20 m by 20 m and subplots of 10 m by 10 m were established in each forest. Evidence of human activities, abundances and diameter measurements for mature trees were assessed in the 20 m by 20 m plots while abundances and diameter measurements for saplings were in the subplots. Mann-Whitney, *t*-test and logistic regression were used for data analysis. Mutuluni forest exhibited significantly ($p<0.05$) high stem density compared to Museve however, basal area density was not different ($p<0.05$). Introduction of exotic species enhanced basal area and stem density ($p<0.05$) in Museve forest. Tree cutting reduced both basal area and stem density in Museve forest and only stem density in Mutuluni. Stem-density diameter distribution in both forests followed a reverse J-curve but with more fluctuations and irregularities observed in Museve compared to Mutuluni forest. Diameter size-class distribution did not differ ($p<0.05$) across the two forests. Therefore human activities significantly impacted on tree density in both forest fragments with high impacts in Museve. This study recommends formulation of appropriate protection and conservation strategies, especially for Museve, to control tree cutting and increase tree density.

Keywords: Basal area, diameter distribution, forest fragments, human activities, stem density

1. Introduction

Persistent land degradation in Arid and Semiarid Lands (ASALs) has resulted to fragmentation of forest cover into wide-spread forests fragments “dryland forests” (FAO, 2010). According to Gachathi (2012) most of these forest fragments in ASALs are localised around hilltops and hold unique flora and fauna. In addition, they provide vital ecosystem services such as habitat, water catchment, pasture, fuelwood, climate amelioration, medicine, timber and others (Gachathi, 2012; Kiruki et al., 2017). However, being located in ASALs, most of these forest fragments are characterized by poor tree density i.e. tree stems per hectare and basal area per hectare (KFS, 2012). Moreover, the increasing human population in ASALs and associated unsustainable land use practices further escalate vulnerability of these fragile ecosystems to degradation and desertification (Middleton and Thomas, 1997; Kigomo, 2003).

Similarly, Museve and Mutuluni hill-top forest fragments in Kitui are not exceptional. These ecosystems provide important services to the adjacent population like water, pasture, fuelwood, medicinal

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extracts, climate amelioration and air purification among others. Usually, the forest management through Kenya Forest Service (KFS) grants user rights to local communities on forest friendly activities upon agreement between the service and a registered community group (GoK, 2005). Basic user rights include grazing, grass and fodder harvesting, collection of medicinal herbs, seed collection, fuelwood collection, soil collection, bee keeping, ecotourism and recreational activities etc. (GoK, 2005; Mbuvi et al., 2010). The Museve and Kavonge Community Forest Association (CFA) is such a case in which participatory forest management is undertaken in Museve forest. However, illegal activities like logging, charcoal burning, fire and grazing have been reported in restricted areas within the forests (Mbuvi et al., 2010; Musau, 2016). Moreover, comprehensive information on tree density and diameter distribution for these forest reserves is not available. According to Westphal, et al. (2006), knowledge on diameter structure is an important parameter to guide managerial prescriptions like regeneration and harvesting needs. Besides, influences human activities on their tree density and diameter structure has never been evaluated for informed decision making. Thus, the two forest reserves risks degradation by adjacent human population that depend on them blindly for livelihoods (Mbuvi et al, 2010; GoK, 2014).

Normally, structurally stable forests are expected to have un-even aged mixed trees comprising individuals of all diameter size classes and constant rate of change of trees (the quotient "*q*") in successive diameter classes (Hett & Loucks, 1976; Rouvinen & Kuuluvainen, 2004). Human activities, some of them reported in the study area like tree cutting, overgrazing and introduction of invasive alien species are known to affect forest structure (FAO, 2010; Mutiso, et al., 2011). Cutting of mature trees in particular, may reduce their stem density and seeding capability (Omeja et al., 2004; Ndah et al., 2014; Kiruki et al., 2016). Consequently, alter their regeneration potential of the forest resulting to stands of poor tree density and diameter structures (Krebs, 1989; Hitimana et al., 2004; Omeja et al., 2004). Accordingly, such altered ecosystems and wildlife habitats may result into adverse and far-reaching effects on biodiversity conservation (Mutiso, et al., 2011; Kacholi, 2014).

Therefore, with knowledge regarding the status of tree density and diameter structure of a forested ecosystem, the management can make informed decisions to prevent adverse likely ecosystem effects. Hence, it is for this reason that reliable knowledge about stem density, basal area and diameter size-class distribution for Museve and Mutuluni forest fragments is urgently needed. Further assessment of how human activities may have impacted diameter structure of the two forests fragments is equally needed, hence, the importance of this study. Reliable information is now available that will provide baseline data and essential knowledge required by forest managers to formulate sustainable forest management plans to effectively conserving Museve and Mutuluni dryland forests.

2. Methodology

2.1 The study area

The study was undertaken in Museve (48ha) Latitude 1^o 19$^/$35.94$^{//}$ S and Longitude 38^o 4$^/$17.81$^{//}$ E and Mutuluni (596 ha) Latitude 2^o 1$^/$0.16$^{//}$ S and Longitude 38^o 17.64$^/$ E forest reserves, Kitui County; Kenya (Figure 1). Both are dryland secondary forest fragments previously owned by local communities but evicted by colonial government in early 1900's (Mbuvi et al., 2010). Since then, Mutuluni forest was left to recover naturally while Museve forest underwent several human interventions including introduction of exotic tree species and enrichment planting by forest management (Mbuvi et al., 2010). As a result several remnant exotic species are integrated with natural regeneration in Museve forest (Musau, 2016). Besides Museve forest is more close to Kitui town and has higher adjacent human population density (197 people/km^2) compared to Mutuluni forest (24 people/km^2) (KNBS, 2010).

The area receives an annual average rainfall ranging from 750 mm to 1,150 mm distributed in two rainy seasons. Annual temperature range between 15.7^o C and 27.1^o C (MENR, 2002; GoK, 2014). The geology mainly consists of sedimentary plains which are usually low in natural fertility (MoA, 1983).

Popular indigenous tree species in Museve and Mutuluni forests include: *Acacia seyal*, *Combretum molle, Commiphora africana, Teclea nobilis*, *Erythrina abyssinica*, *Azanza gackeana, Rhus natalensis*, *Euclea divinorum* and *Antidesma venosum* (Musau, 2016).

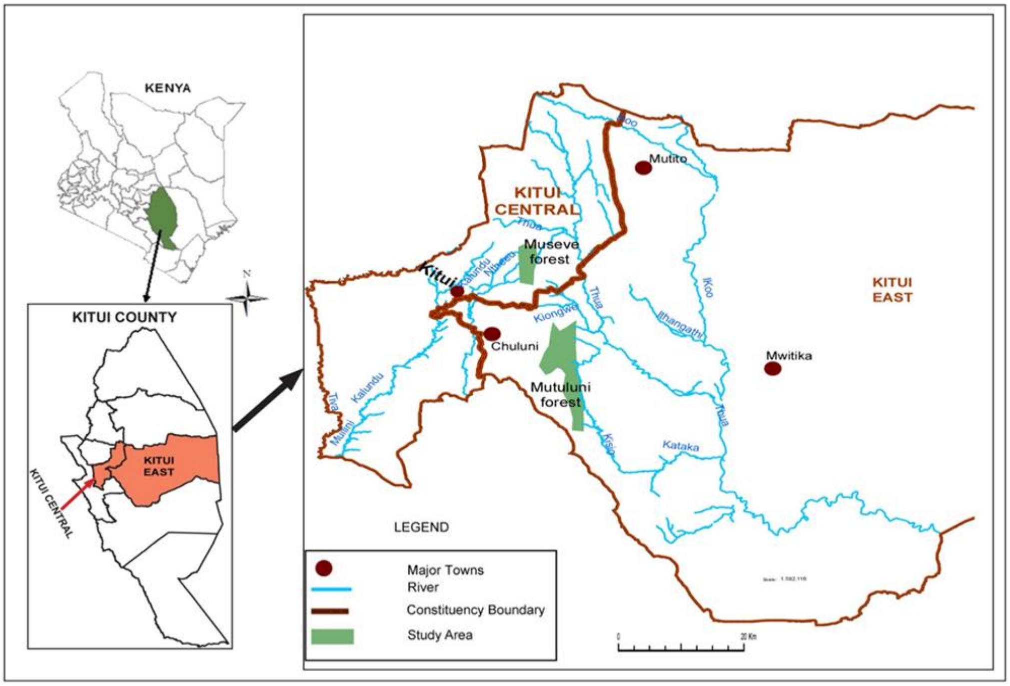

Figure 1: Museve and Mutuluni forest fragments; Kitui County, Kenya.

2.1 Data collection

Four belt transects, two in Museve forest and two in Mutuluni, each measuring 500 m long and 20 m wide were used. In each forest, the highest point was identified as the start point of the first transect (Transect 1) that run longitudinally along the forest stretch. From the start point, a distance of 50 m on the opposite direction was set to separate the two transects and mark the start of the second transect (Transect 2) which run in opposite direction. Since both forest fragments are strip-like, transects were purposely established in a longitudinal orientation so as to collect as much information as possible. A hand held Geographical Positioning System receiver was used to locate points of the transect corners.

Nested sampling design was adopted for this study. In each belt transect, 25 main sample plots of 20 m by 20 m and sub-plots of 10 m by 10 m nested within the main plots were established. This study design was preferred based on data requirements and to facilitate simultaneous collection of different data sets. In each 20 m by 20 m plot data on human activities and mature trees (≥5 cm dbh) was gathered. Information collected on human activities included abundances and/or evidences of predetermined human activities. These were; tree cutting, exotic species, grazing, footpaths, fire occurrences, grass cutting, pit sawing, human/livestock tree debarking and charcoal burning. Information gathered for mature trees included species identification, abundances and diameter measurements at Breast Height (dbh). Further, in the subplots measuring 10 m by 10 m, data on saplings (1 cm ≥ dbh < 5 cm) data was collected. This consisted of species identification and abundances. Only one out of the four 10m by 10m subplots was randomly selected from each 20 m by 20 m main plot.

Since the study focused only on trees and no other vegetation forms like herbs and shrubs, plant growth characteristics were used to identify tree species and/or distinguish trees from other plant life forms such as shrubs, herbs and grasses. According to Kocholi (2014), trees can be regarded as "woody plants" attaining a height of 5 m and above at maturity. Expert knowledge and plant growth characteristics from available botanical guides were used in trees species identification. Further, the dbh (cm) criteria was used to distinguish mature trees from saplings and seedlings. Mature trees were considered as trees attaining 5cm dbh (≥5 cm) while saplings 1 cm dbh and above but less than 5 cm, (1 cm ≥ dbh < 5 cm). Seedlings were considered as all tree individuals with less than 1 cm diameter reading at breast height and those with no dbh.

2.2 Methods of data analysis

Comparing levels human activity between Museve and Mutuluni forests

Information on human activities was summarized into frequency table, a two-sided test of equality for column proportions using z-test was used for comparison between the two forest fragments. Further, the number of trees cut in every 20 m by 20 m plot was converted into stems/ha and used to compare intensity of tree cutting within and across the two forest reserves.

Effects of human activities on tree density

Data on tree abundances for mature trees was used to calculate their stem density (Stems/ha) while that of diameter measurements used in estimation of basal area density (m^2/ha) in each 20 m by 20 m plot. The calculations were in accordance to Equation 1 and 2 respectively. The estimated stem density and basal area density data from the two transects in each forest was pooled together and tested for distribution. Where the data was normally distributed, t-test statistic was used for comparison within and across the two forests. Mann-Whitney test statistic was employed for data that did not conform to the normal distribution.

$$\text{Stem density} = \text{Number of trees} \div \text{unit area (ha)} \quad (1)$$

$$\text{Basal area density} = \text{Basal area } (m^2) \div \text{unit area (ha)} \quad (2)$$

where;

Basal area = $0.00007854d^2$;

d = Diameter at breast height (cm)

0.00007854 = Constant

To investigate the impacts of human activities on basal area and stem density, frequency data on human activities was coded “1” and “0” for presence and absence respectively. These was further regressed as independent input variables against the dependent variables; stem density and basal area density respectively using logistic regression. Results were presented in summary tables and inferences made.

Effects of human activities on stem diameter distribution

In order to compare stem diameter distribution between Museve and Mutuluni forests, all recorded stem diameter measurements were grouped into fifteen diameter size classes. The saplings constituted the lowest diameter class (<5 cm dbh) whereas trees (≥5 cm dbh) were grouped into three centimeter class intervals based on the data collected. The number of stems/ha in each diameter class in both forests was computed by dividing all trees in that diameter size class by the forest area (ha) sampled. A graph of stem/ha against diameter classes was plotted to assess if it conforms to the expected reverse J-curve diameter distribution. The derived data was further fitted to a power function model (Equation 3) used in describing diameter distribution in natural forests (Hett and Loucks, 1976). Regression coefficient of determination was then used to assess model fitness in each forest while Mann-Whitney u test was used to compare stem density-diameter distribution across the two forests.

$$Y = Y^{o} X^{-b} \quad (3)$$

where;

Y = The number of stems or saplings in any diameter class X

Y^{o} = The initial input into the population at time zero (At the smallest dbh)

b = Depletion rate with time

Further, diminution ratio coefficient (the quotient, "*q*") or the *q* factor of trees in successive diameter size classes was calculated (Equation. 4). The quotient, "*q*"was plotted against diameter size classes to compare recruitment of trees in successive diameter size classes (Hitimana et al., 2004; Meyer, 1943).

$$q = \frac{D1\text{-}i}{Di} \quad (4)$$

where;

$D1\text{-}i$ = Density in the lower class

Di= Density in the immediate upper class.

3. Results

3.1 Types of human activities recorded in Museve and Mutuluni forests

Only five out of the nine predetermined indicators of human activities were recorded in both Museve and Mutuluni forest. The five indicators were: presence of foot paths, grazing, debarking of trees, tree cutting and presence of exotic species. Three indicators; presence of foot paths, grazing and tree cutting occurred in both forests while tree debarking occurred in Mutuluni whereas presence of exotic species in Museve forest. A two-sided z-test of equality for column proportions indicated significant differences (p<0.05) in frequencies of human activities across the two forests with high intensity recorded Museve forest (Table 1). A t-test further revealed significant difference (t=2.69, p<0.05) in the number of trees cut/ha within Museve forest while no difference (Mann-Whitney test; p>0.05) was observed within Mutuluni forest. When compared between the two forests, Mann-Whitney test indicated a significant (p<0.05) differences in the number of trees cut/ha with high density in Museve forest.

Table 1: Types and frequencies of human activities recorded in Museve and Mutuluni forests.

Type of human activity		Count	Forest: Museve forest Count	Forest: Mutuluni forest Count
Tree Cutting	0	$0^{1,2}$	3_a	23_b
	1	$0^{1,2}$	47_a	27_b
Grazing	0	$0^{1,2}$	18_a	40_b
	1	$0^{1,2}$	32_a	10_b
Human/livestock debarking	0	$0^{1,2}$	50^2	44_a
	1	$0^{1,2}$	0^2	6_a
Footpaths	0	$0^{1,2}$	20_a	38_b
	1	$0^{1,2}$	30_a	12_b
Exotic species	0	$0^{1,2}$	3_a	50^2
	1	$0^{1,2}$	47_a	0^2

Note: Values in the same row and subtable not sharing the same subscript are significantly different at p<0.05 in the two-sided test of equality for column proportions. Cells with no subscript are not included in the test. Tests assume equal variances.

3.2 Stem density and basal area density in Museve and Mutuluni forests

The calculated mean stem densities for Museve and Mutuluni forests were 347.50 stems/ha and 639.50 stems/ha while basal area densities were 5.80 m^2/ha and 6.08 m^2/ha respectively (Figure 2 and 3). Within each of the forests, Mann-Whitney revealed no significant difference in basal area density and stem density (p>0.05). However, there was a significant difference in stems density across the two forests (p<0.05) while basal area density showed no differences (p>0.05).

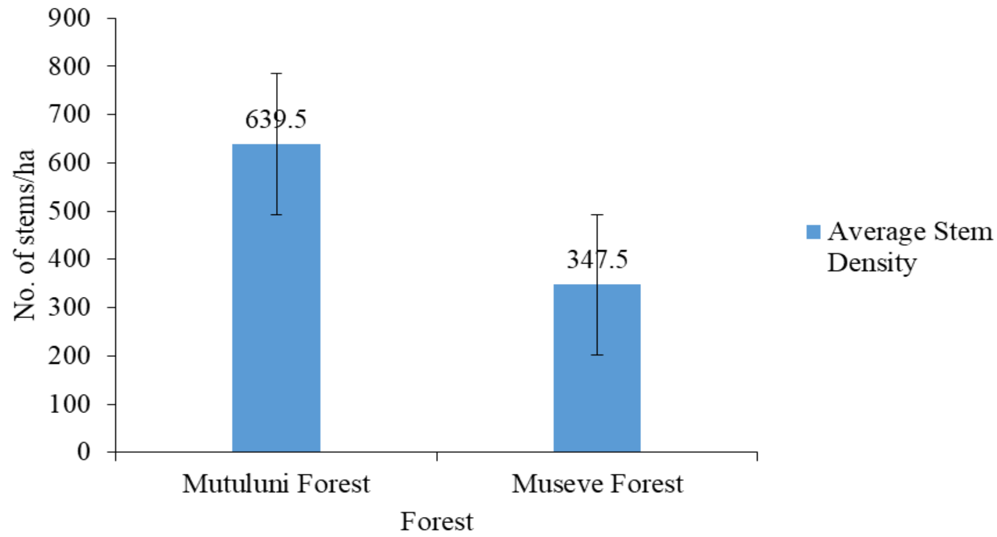

Figure 2: Comparison of stem densities between Mutuluni and Museve forests.

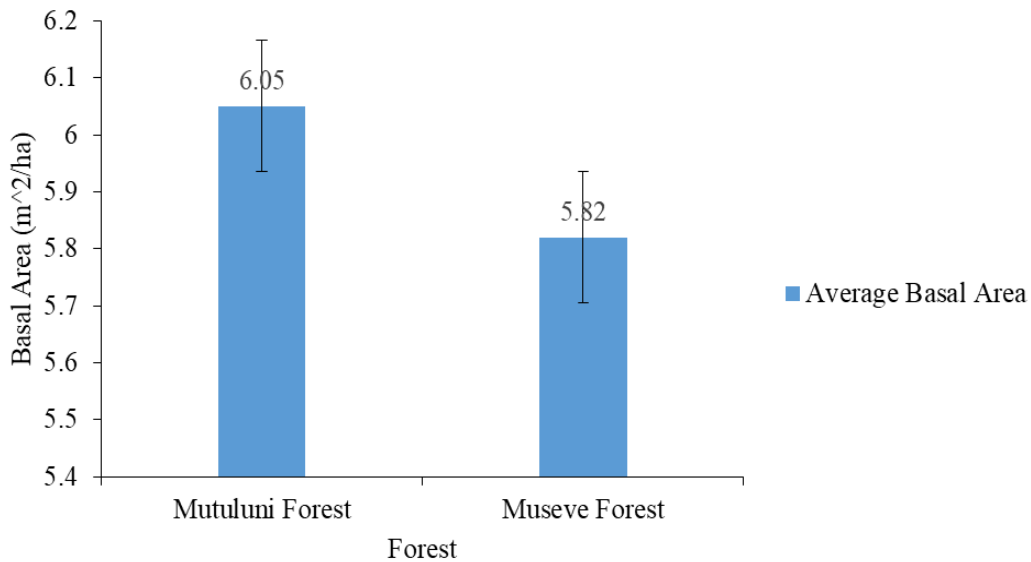

Figure 3: Comparison of basal area between Museve and Mutuluni forests.

3.3 Impacts of human activities on basal area and stem density

When the frequencies of footpaths, grazing, tree debarking and the number of trees cut/ha and exotic tree species/ha were regressed as predictor variables against stem density, the logistic regression test of parameter estimates indicated that tree cutting and introduction of exotic species had significant effects. Cutting of trees significantly reduced stem density in Museve forest (b=-0.01, Wald $\chi 2$=48.26, p <0.05) and Mutuluni forest (b<-0.01, Wald $\chi 2$=4.84, p<0.05). Introduction of exotic species on the other hand enhanced stem density ($b<0.01$, Wald $\chi 2=19.68$, $p<0.05$) in Museve forest (Table 2). Logistic regression coefficients for grazing, footpaths and tree debarking were not significantly different ($p>0.05$) and thus they did not have significant effects on stem density (Table 2).

Table 2: Test of parameter estimates for stem density in Museve and Mutuluni forests.

Forest	Parameter	b	Hypothesis Test		
			Wald Chi-Square	Df	Sig.
Museve forest	(Intercept)	6.45	2594.60	1	0.00
	Grazing	-0.01	0.02	1	0.88
	Footpaths	-0.16	2.45	1	0.12
	Trees cut/ha	-0.01	48.26	1	0.00
	No. Exotics species/ha	<0.01	19.68	1	0.00
Mutuluni forest	(Intercept)	6.52	294.94	1	0.00
	Grazing	0.03	0.03	1	0.87
	Footpaths	-0.05	0.05	1	0.83
	Human/livestock debarking	0.15	0.31	1	0.58
	Trees cut/ha	<-0.01	4.84	1	0.03

When grazing, footpaths, human-livestock debarking, trees cut/ha, number of exotic species/ha were regressed against basal area density, Wald Chi-Square test statistic revealed a significant influence on basal area density in Museve forest but not in Mutuluni. Tree cutting significantly reduced basal area density ($b=-0.01$, Wald $\chi 2=10.79$, $p<0.05$) while introduction of exotic tree species on the other hand enhanced stem density ($b<0.01$, Wald $\chi 2=61.61$, $p<0.05$) in Museve forest (Table 3). In Mutuluni forest, regression coefficients for all parameter estimates were not significantly different from zero (Table 3). Thus, human activities documented in Mutuluni had no significant influence on basal area.

Table 3: Parameter estimates tests for basal area in Museve and Mutuluni forests.

Forest	Parameter	b	Hypothesis Test		
			Wald Chi-Square	df	Sig.
Museve forest	(Intercept)	1.86	76.57	1	0.00
	Grazing	0.17	2.16	1	0.14
	Footpaths	0.02	0.02	1	0.89
	Trees cut/ha	-0.01	10.79	1	0.00
	No. of Exotic species/ha	<0.01	61.61	1	0.00
Mutuluni forest	(Intercept)	1.24	2.11	1	0.15
	Grazing	0.39	0.78	1	0.38
	Footpaths	-0.20	0.22	1	0.64
	Human/livestock debarking	0.71	1.09	1	0.30
	Trees cut/ha	-0.01	3.14	1	0.08

3.4 Stem diameter size class distribution in Museve and Mutuluni forests

When stem density was plotted against diameter size classes, the shape of the graph followed a reverse J-curve distribution (Figure 4). Stem densities were high in lower diameter size classes and decreased with increasing diameter sizes. This indicated that trees within the two forest reserves varied in age and that most of the trees were young. There was no significant difference in the distribution of tree stem densities across the diameter classes in both Mutuluni and Museve forest reserves (Mann-Whitney test; $p>0.05$).

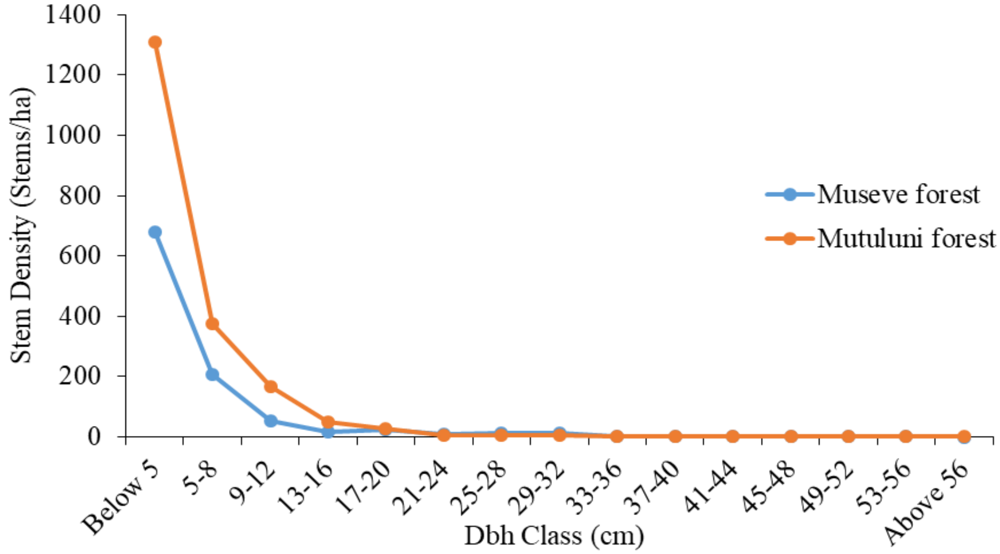

Figure 4: Successive diameter size-classes in Museve and Mutuluni forests.

Least squares fit of the power function model on scatter plots of stem density against diameter classes revealed strong goodness of fit (R^2>0.9) (Figure 5). Regression coefficients (*b*) were significantly (p<0.05) different from zero (0) in both forests, a validation that the model could adequately predict and explain more than 90% (R^2>0.90) variation in stem density-diameter size distribution in both forests. The *q* values indicated a fluctuating and irregular curve in both Museve and Mutuluni forests when plotted against dbh size classes (Figure 6). Museve forest demonstrated a highly fluctuating and irregular curve compared to Mutuluni.

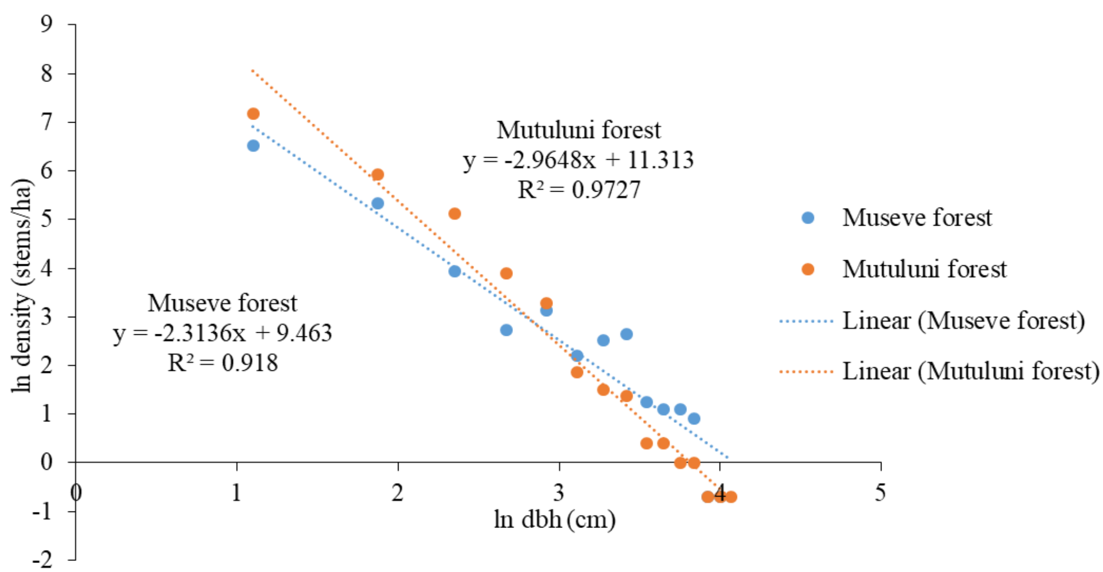

Figure 5: Least squares fit of the power function of stems/ha against dbh in a log-log scale in Museve and Mutuluni forests.

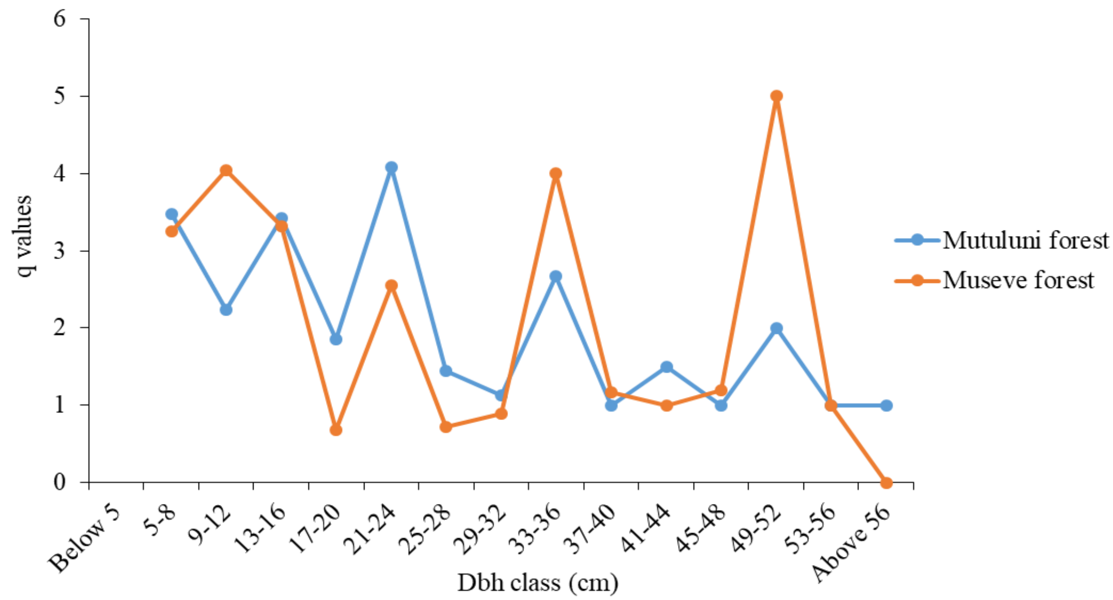

Figure 6: Comparison of *q* values against diameter size classes in Museve and Mutuluni forest.

4. Discussion

From the nine predetermined human activities, only five were recorded. These were tree cutting, introduction of exotic species, grazing, human tree debarking and presence of foot paths. The study could not differentiate illegal activities from the legal ones given the understanding that the forest management allows collaborative forest management with the surrounding community and illegal human activities have also been reported (Mbuvi et al., 2010). Rather, it focused on documenting information about key human activities across the two forest, tree density, diameter structure and investigate how these human activities (both legal and illegal) has affected tree density and diameter structure. From the five categories of human activities recorded, three were common across the two forests (tree cutting, grazing and presence of foot paths) indicating their prevalence within the study area. These findings are also supported by reports Middleton and Thomas (1997) that overgrazing and deforestation are the most notable factors to de-vegetation and degradation in Sahel countries especially areas falling within ASALs. In fact, the results revealed that tree cutting resulted into significant reduction on basal area and stem density in both forests. Further, the impacts were much bigger in Museve forest compared to Mutuluni. On average, tree cutting reduced stem density by -0.01stems/ha in Museve and <-0.01stems/ha in Mutuluni forest. This can be linked to the findings that Museve forest recorded higher frequencies of tree cutting compared to Mutuluni forest. Thus, a reason why Museve forest recorded low stem density compared to Mutuluni. Similar findings have been reported by Hitimana et al. (2004), Omeja et al. (2004) and Kacholi (2014) who indicated that human activities like tree cutting resulted into low tree density and regeneration potential in forest reserves.

The estimated basal area of 6.05 m^2/ha and 5.82 m^2/ha for Mutuluni and Museve forests respectively was not significantly different across the two forests. This can be attributed to the findings that human activities impacted differently on basal area across the two forests. Whereas tree cutting resulted to reduction on basal area, introduction of exotic tree species enhanced basal area in Museve forest. In fact, results revealed that on average introduction of exotic tree species enhanced basal area density by <0.01 m^2/ha in Museve forest. It is worth noting that some of the exotic species (*Eucalyptus spp* and *Cupressus lusitanica*) recorded in Museve forest attain high height and large diameter at maturity compared to most of the native species (Beenje, 1994). In addition, according to KFS (2009) *Eucalyptus* *spp* have high coppicing ability and efficiency in water use for biomass accumulation. Thus, they resulted to increase in basal area in Museve forest, a reason why possibly there was no significant differences in basal area across the two forests. Also, the estimated basal area across the two forests was notably low if compared to what has been reported in other tropical forests. This can be linked to the findings that tree cutting resulted into reduction in basal area and the fact that they are located in ASALs which are associated with poor tree density. This concurs to the findings by Mullah et al. (2011) and Mutiso et al. (2013) that pressure from deforestation and other human activities has bearing on basal area density. Therefore, destructive human activities like tree cutting would increase their vulnerability to forest degradation. Being already fragile ecosystems, the impacts are like to be un-proportional.

Stem-density diameter distribution in both forests followed a reverse J-curve as expected of a natural forest or secondary forests without disturbances for long (Leak, 2002; Rouvinen and Kuuluvainen 2004). According to Weiner (1990) this distribution is attributed to factors like gene pool, age, size, competition, growth rate, herbivore and environmental heterogeneity. Data from both forests adequately fitted the power function model used in describing diameter distribution in natural or near natural forests (Hett and Loucks, 1976). Therefore both forests were composed of un-even aged trees associated with continuous regeneration and recruitment as reported by Davis and Johnson (1987) and O'Hara (1998). However, the findings that *q*-values in successive diameter classes deviated from the constant *q* factor was an indication that the both forests were not structurally stable. Structurally stable forests exhibiting a typical reverse J-curve are expected to display constant *q* factor (Meyer, 1943). Any deviations or irregularities as exhibited in this study indicate significant influence diameter distribution. According to Meyer (1943) and Poorter et al., (1996) an irregular and fluctuating q factor indicate absence or insufficient regeneration and recruitment while a regular and fluctuating *q* factor indicates good but discontinuous regeneration.

Since disturbances on forest structure can result either from natural causes or human induced activities, it is worth noting that this study focused only on human activities. Therefore, possible human activities that may have led to fluctuating q-values include tree cutting and tress species introduction. Tree cutting was shown to reduce stem density in the study area which probably affected diameter distribution. According to Omeja et al. (2004) tree cutting especially when mother trees are targeted can reduce their density and affect regeneration potential of a forest. This is often the case with trees of high social-economic importance is a specific area. Hence, resulting into insufficient and/or discontinuous regeneration. Tree planting like the deliberate introduction of exotic tree species recorded in Museve forest resulted into more irregular and fluctuating q-values observed in the forest. Besides, alien species may result to unnecessary competition whereas grazing and footpaths may result to browsing and trampling of seedlings which may influence regeneration and mortality trends of tree individuals in the study area (Hitimana et al., 2004; Mutiso et al., 2013). Hence, influence tree diameter distribution in successive diameter size-classes resulting into fluctuating and irregular *q* values. The highly fluctuating and irregular q values recorded in Museve forest compared to Mutuluni indicated that human activities impacted higher on diameter distribution in the forest. This is also in line with the findings that Museve forest recorded high intensity of human activities compared to Mutuluni forest which also resulted into higher impacts on stem density and basal area. Lastly, the findings that the two forests exhibited J-curve diameter distribution despite recording human influences is not unusual. Similar studies Hitimana et al. (2004) and Mutiso et al. (2013) have shown that it is possible for a forest experiencing anthropogenic disturbances to exhibit reverse J-curve diameter distribution. Nonetheless, it is important to note that the fitness depends on the nature and extent of such disturbances (Leak, 2002).

5. Conclusion

From the five documented human activities in Museve and Mutuluni forests, only tree cutting and introduction of exotic tree species significantly impacted stem density, basal area and diameter distribution. Museve forest recorded high frequencies of human activities that resulted to greater impacts compared to Mutuluni forest. Presence of grazing, foot paths and tree debarking did not have significant impacts. Introduction of exotic species in Museve forest enhanced both basal area and stem density whereas tree cutting reduced both basal area and stem density in Museve forest. Thus, this study concludes that human activities have significant impacts on stem density, basal density and diameter distribution in the two dryland forest fragments. If not checked, this is likely to degrade diameter structure and conservation values of the two forests. Therefore, appropriate protection and conservation measures should be urgently put in place especially for Museve to control tree cutting and increase tree density. In addition, there is need for further research on the impacts of natural factors to diameter structure on both forests. Further, assessment on the effects of introduced exotic species in altering regeneration and ecological processes within dryland forest fragments such as Museve forest is needed.

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