Plant Species Composition and Diversity in *Dalbergia melanoxylon* Dominated Zones in Mitarure Forest Reserve in Kilwa District

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ABSTRACT

The study was designed to assess the plant species composition and diversity in the Dalbergia melanoxylon dominated zone in Mitarure Forest Reserve and the nearby community forests particularly Ngea and Nambawala in Kilwa District, Tanzania. Thirty (30) circular concentric plots were established in the forest reserve and fifteen (15) plots in each of the two-community forest and used to collect vegetation data. The plant species diversity was determined using Shannon-Wiener diversity index, evenness, richness and Simpson and their indices were compared using ANOVA. Plant species diversity and evenness assessed in Mitarure Forest Reserve did not differ significantly from those from community forests. However, the plant species diversity based on Simpson index and richness were significantly higher in the Mitarure Forest Reserve compared to those in community forests. A total of 56 plant species were recorded in Mitarure forest reserve, 39 plant species in Ngea forest and 36 plant species in Nambawala forest. Mitarure forest reserve and the nearby community forests have high plant species diversity with a good stand characteristic of a typical natural forest. However, with an intensive human disturbance, the tree species composition decreases that needs an intervention through local community involvement. This strategy may contribute in the future survival of species and the natural forests in Kilwa District. Data from this study stand as baseline information for the future monitoring of the performance of stands in the natural forest ecosystem in the Dalbergia melanoxylon dominated zones in Kilwa District.

INTRODUCTION

Plant biodiversity is the variation of plant species in a specific area, which influences healthy ecosystems (Luoga, 2000). This is because the existing minor variation in a stand is an indication of poor health as opposed to healthier ecosystem with wider variation in plant community composition and diversity (WWF-SARPO, 2001). Biodiversity of plant species also involves variation of life forms, structure, biomass accumulation and composition where by regenerative success of one or several species depends on the presence of other plant species in a community (Mafupa, 2006).

There has been an increasing interest to understand whether plant species composition and richness reported over the past ten (10) years in the southern forests of Tanzania still exist and to what extent the forest cover inform the need for intensified plant biodiversity conservation (Munishi et al., 2008). Plants biodiversity in the southern Tanzania forests particularly in Kilwa district, Lindi Region forms part of the global ecological importance because of high level of endemism, coastal climate stabilization effects and their roles they play as a source of livelihoods for local communities (Malimbwi et al., 2005; Monela, 2007).

Regardless of being ecological, important that command the highest conservation attention at global and regional scale, these forests face a big threat from exploitation and the associated impacts of human activities that include fire and clearance for cultivation (Malimbwi et al., 2005). These activities contributed to their degraded form and consequently affecting species composition and diversity. High intensity of human pressure impairs individuals of the plant species capacity to recover through natural regeneration. It was not known of the composition and diversity of plant species regenerating in the local community managed forests as opposed central government managed forests. This comparison understanding on the best option suitable for protecting valuable plant stands existing in forests of the southern part of coastal Tanzania.

Regenerative stability and conservation status of Mitarure forest reserves at Kilwa depends on its close proximity to the nearby community forests that absorb pressure from human activities in the reserves. The local community managed forest reserves around Mitarure are Nambawala and

Ngea (Malimbwi, 2002) and these provide for human needs under the control of community leaders while the national forest reserves are freely accessible that makes it heavily degraded (Malimbwi, 2002).

The commercial harvesting of forest resources by Mingoyo soul timber traders from Mitarure forest reserves is monitored by local community leaders where traders are licensed by the regional and district forest officers under the guidance of the ministry of forestry and natural resources (Malimbwi, 2002). This cooperation among stakeholders at all levels ensures sustainable exploitation of natural resource while conserving the national reserves in the study area. Malimbwi, (2002) pointed out that high plant species biodiversity in Mitarure forests can be achieved through maximum participatory conservation. It is 20 years up to this study whether we still have the same healthier forests with high plants biodiversity or low as result of over exploitation and habitat degradation. It was not known whether the local community-based forest resources that have been subjected to licensed harvesting, recover to maintain the same composition and diversity similar to that in the national based conserved forest reserve. It was indented in this study to explore the impacts of conservation at different levels on species composition and diversity and identify an effective alternative for forest resources conservation.

MATERIAL AND METHODS
Description and location of the study area
Mitature forest reserve is located in Kilwa District, Lindi Region in the southern coast of Tanzania. Mitarure forest reserve covers an area of 60,484 ha. It is found between longitudes 38°53' and 39°14'E and latitudes 8º45'-9°03' N) and was described by the Kilwa District forestry records as forest containing miombo with 'good green thicket in places'. (Shechambo 2004). Mitarure Forest Reserve is surrounded by local community managed forests that include Ngea community forest found in Ngea village and Nambawala community forest found in Kipindimbi village.

Sampling of procedures
Thirty circular concentric plots with a radius of 20 m were laid out in Mitarure Forest Reserve and 15 in each of the community forests. The inventory design, which was used in this study, was purposive sampling. The reason for the selection of this design was based on the fact that, we

were interested on the plant species distributed in the *Dalbergia melanoxylon* ecological zone.

The plant species were identified to species level in the field and the total number of individuals per plot were enumerate recorded. However, in cases where species were not possible to identify in the field samples of the plant, species were collected, pressed and transported to the herbarium of the University of Dar es Salaam and identified using respective flora or by matching with dried herbarium specimens of known identity.

Data analysis
The plant species data were summarised and converted into Shannon's and Simpson's diversity indices. Shannon Diversity Index was computed as by the use of the formular H' = $\Sigma Pi*ln\ Pi$ where; H' is the index of diversity, Pi is the importance value of a species as a proportion of all species whereas the Simpson's Diversity Index was computed based on the formular C = $\Sigma Pi2$ where C is the diversity index and Pi as defined above (Munishi et al. 2008). The difference in diversity indices between the central government managed forest reserve and local community managed forests were compared using Analysis of Variance (ANOVA).

The plant species composition was computed for its Importance Values Index, which is the summation of the relative frequency, relative density and relative dominance (Curtis and McIntosh 1952).

Relative frequency, Relative density, and Relative dominance indicate different aspects of the importance of a species in a plant community. Therefore, the sums of these three values were used to give a good overall estimate of the importance value index of a tree species.

RESULTS
Plant species diversity in forest reserve and community forests in Kilwa District
The overall species diversity in terms of Shannon Diversity Index (*H*) was highest in Mitarure Forest Reserve (2.12), followed by those in Ngea community forest (1.90) and Nambawala community forest (1.88) registered the lowest (Table 1). The same pattern was observed in

evenness index values (J) where the highest value was recorded in Mitarure forest reserve (0.44), followed by Ngea forest reserve (0.392) and Nambawala forest reserve (0.39) (Table 1). However, based on the Analysis of Variance (ANOVA) the difference in species diversity and evenness between the forest reserve and the community forests were not statistically significant. It was observed highest Simpson diversity index values in Mitarure forest reserve (11.43) followed by Ngea community forest (9.51) and Nambawala community forest (7.11) (Table 1). Based on ANOVA, the difference in Simpson diversity indices in central government managed forest reserve was significantly higher than those in local community managed forests. The same pattern was observed in plant species richness such that Mitarure forest reserve (10.4) was significantly more plant species rich than Nambawala (8.55) and Ngea forest (7.83).

Table 1: The plant species diversity, evenness and richness in the reserve and community forests in Kilwa District.

Parameter	Forests			Statistical Test		
	MT	**NB**	**NG**	**F-Value**	**P-Value**	**Conclusion**
Diversity (H)	2.12	1.88	1.90	3.21	$P > 0.05$	Not Significant
Evenness (J)	0.44	0.39	0.392	3.20	$P > 0.05$	Not Significant
Richness	10.40	8.55	7.83	4.22	$P < 0.05$	Significant
Simpson	11.43	7.11	9.51	3.65	$P < 0.05$	Significant

MT = Mitarure forest reserve, **NB** = Nambawala community forest, **NG** = Ngea community forest

Plant species dominance in forest reserve and community forests in Kilwa District

A total of 108 different plant species were identified and recorded during the survey in Mitarure forest reserve and nearby community forest of Ngea and Nambawala in Kilwa District. (Trees and shrubs contributed 56 plant species in Mitarure forest reserve, 39 plant species in Ngea community forestforest and 36 plant species in Nambawala community forest. Of the plant species identified in Mitarure forest reserve a total of 29 trees, 19 shrubs, 4 herbaceous and 4 grasses. Plant species with the highest Importance Value Index (IVI) were those represented with high density (Fig 1). Ten tree species with highest IVI were *Dalbergia melanoxylon, Brachystegia longifolia, Combretum molle, Bauhinia tomentosa, Acacia spp, Acacia nigrescens, Albizia petersiana, Brachystegia boehmii, Ochnasp* and *Albizia harveyi* (Figure 1). On the

other hand, *Markhamia zanzibarica, Maytenus senegalensis, Ochna moss, Ochna mossambicensis, Sterculia quanzensis, Dichrostachys cinerea, Doberaloranthi folia, Manilkaramochisia, Mimusops spp and Ochna holstii* were the least dominant tree species.
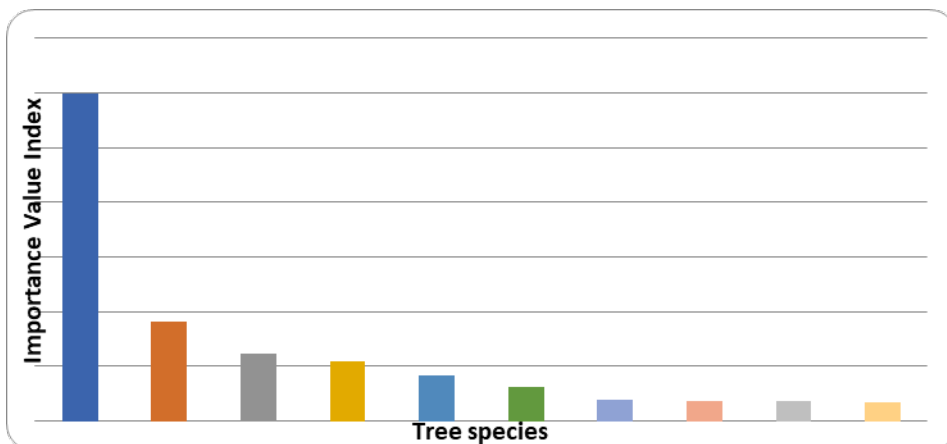

Figure 1: Tree species richness in Mitarure forest reserve in Kilwa

A total of 29 trees, 9 shrubs and 1 grass were identified and recorded during the survey in Ngea forest. The maximum trees Importance Value Index (IVI) (Fig 2) in Ngea forest were represented by *DalbergiaMelanoxylon* followed by *Combretum zeyheri, Crossopteryxfebrifuga, Diplorynchoscondylocarpon, Commiphoraafricana, Acacia nigrescens, Terminalia kaiserana, Acacia nilotica, Tamarindusindica*and *Diospyros loureinana*while the other plant species had IVI values lower than 6.0.
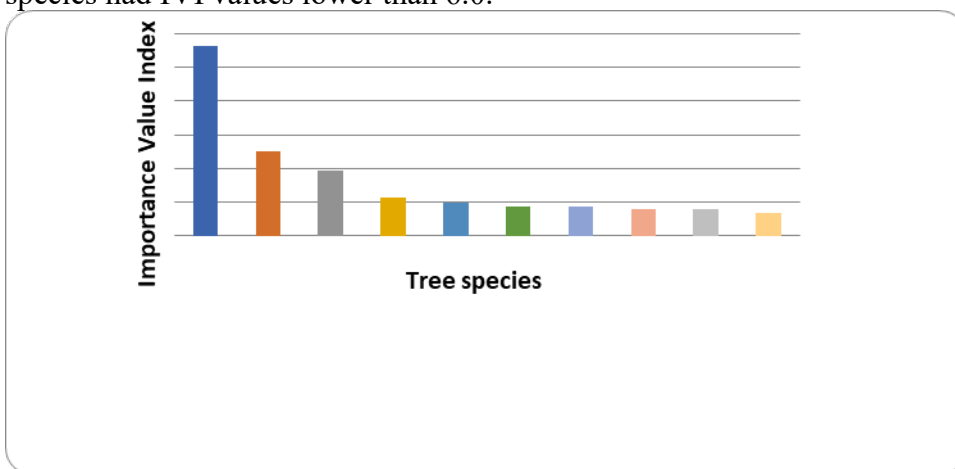
Figure2: Tree species richness in Ngea community forest in Kilwa

A total of 21 tree species, 14 shrubs species and 1 herbaceous species were identified and recorded during the survey in Nambawala community forest. Considering IVI as an indicator of dominance, the results showed that *Dalbergia melanoxylon* was the most dominant species with the highest dominance values in Nambawala community forest, followed by *Commiphora africana, Markhamia zanzibarica, Ehretia amoena, Spirostachys africana, Tamarindus indica, Diplorynchos condylocarpon, Capparis tomentosa, Pseudolachnosty maproneifolia* and *Combretum molle.*
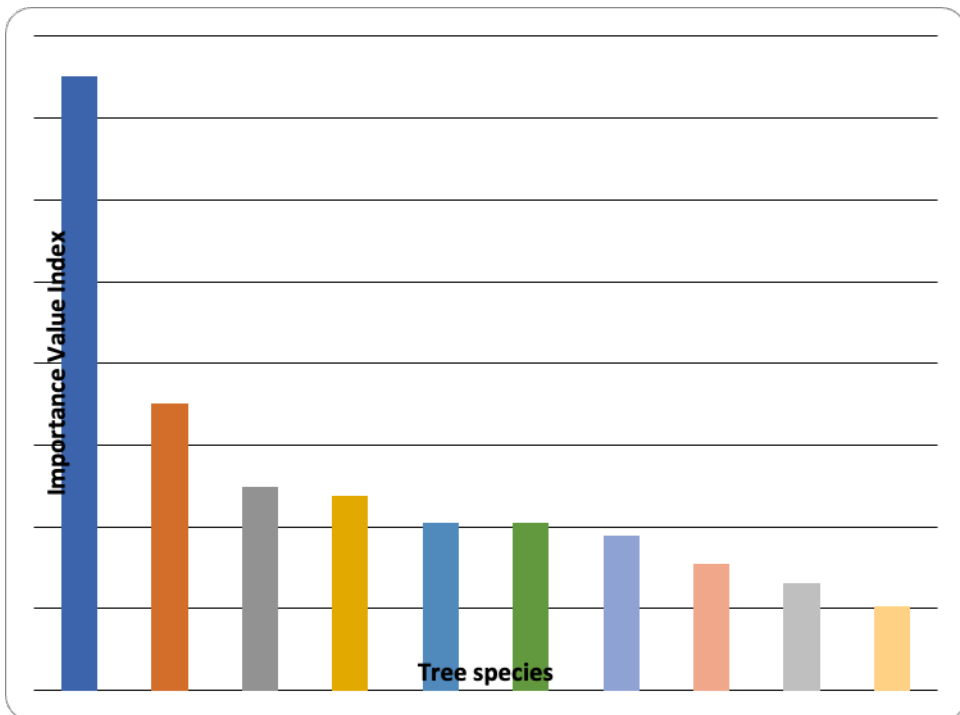

Figure3: Tree species richness in Nambawala community forest in Kilwa

DISCUSSION

Species diversity and composition are the most commonly used representation of ecological diversity and can be measured from the number of species known as species richness, relative abundance of individual within each species known as species abundance, species

evenness and Importance Value Index (Hamilton, 2015). Therefore, species diversity and composition may be used as an indicator for assessing the biodiversity (Husch et al., 2002). The difference in species diversity is associated with climatic condition, edaphic variability and anthropogenic activities (Chidumayo, 1989).

The present study revealed observable variation in plant species diversity between Mitarure forest reserve and nearby community forests namely Ngea and Nambawala in Kilwa district that are well known for their highest abundance of *Dalbergiamelanoxylon*. The results indicate the negative impacts of the anthropogenic activities since trees cutting were observed in Mitarure, Ngea and Nambawala forests. The number of coppices observed from stumps indicating that *Dalbergiamelanoxylon* stems were cut. According to Malambo and Syampongani (2008), illegal and selective logging of valuable species such as *Dalbergiamelanoxylon* contributes to over exploitation. The observed variation in plant species diversity highlights the important discrepancy in effectiveness in managing forest resources among different levels of conservation management organizations in Kilwa District. However, the central government managed forest registered highest species diversity than those in community forests. This observation can be supported by a number of studies which reported that protected areas accommodate diverse plant species, evenness and density than the unprotected areas (Dhaou et al., 2010). This assumes that habitat protection reduces plant resource extraction and consequently maintains higher plant species richness than in unprotected areas (Bruner et al., 2011; Andam et al., 2008; Joppa et al., 2008).

Regardless of high plant diversity in *Dalbergia melanoxylon* dominated zone in Mitarure forest reserve, valuable timber tree species such as *Pterocarpus angolensis* and *Afzelia quanzensis* were not found because of nature of the soil that were not conducive for their growth.

The Shannon-Wiener diversity index values recorded in Mitarure forests reserve, suggest that centralization in managing forest resources may be better approach than local community-based approach. Shannon wiener diversity indices greater than 2 signify medium to high diversity of species as pointed out by Barbour et al. (1987). On the other hand, all community forests in this study had Shannon-Wiener indices values lower than 2 which signify low plant species diversity as opposed to unprotected

forests. These results indicate that conserving natural forests based on local community participation approach are less effective protected compared to national centralized management approach. Okland (1990) pointed out that less protected areas are vulnerable to anthropogenic disturbance such as grazing pressure, cultivation, fire and extraction of timber and non-timber products, which tend to their degradation. For example, Ngea which is one among local community managed forests were heavily disturbed by cultivation, exploitation of plant resources and other forms of disturbance that contribute to habitat heterogeneity that provides a nurse effect for the establishment of diverse plant types and hence high species diversity and richness in unprotected areas.

Since the study was conducted in *Dalbergia melanoxylon* ecological zone, which is one of the valuable timber tree species, there was much illegal harvesting in forests reserve than community forest to the extent that lead to reduction of plant diversity. Similarly, the study revealed that charcoal making is a crucial activity in Ngea and Nambawala community forests since there was availability of species frequently used for charcoal such as *Combretum molle* and *Brachystegia sp*.

Other factors such as climate, genetic and edaphic could also account for the differences in the diversity of plant species between the forest reserve and community forests. However, these factors were not assessed in the present study though their role is considered important.

The results presented in Fig 1 indicateranking of plant species based on their Important Value Index (IVI) from the highest to the lowest found in *Dalbergiamelanoxylon* dominated zones in Mitarure Forest Reserve.

The IVI is also used for prioritizing species conservation whereby species with low IVI value need high conservation priority compared to those with high IVI (Kacholi, 2013). The high IVI exhibited by *Dalbergia melanoxylon* in Mitarure forest reserve is largely due to its higher relative frequency, density, and dominance compared to other species. *Dalbergia melanoxylon* grows habitat with poor soils (Högberg, 1986). It also inhabits rainforests and open miombo woodlands with marginal rainfall patterns and dryland areas (Washa et al., 2012). The dominance by *Dalbergia melanoxylon* in terms of IVI is mainly due to its higher basal area or relative dominance with large number of stems compared to other species in the study area. The presence of many species with low IVI

values in the study area is an indication that *Dalbergia melanoxylon* tolerates and performs better than other species.

CONCLUSION

The study revealed that the Miombo woodland of Mitarure forest reserve and nearby community, forests of Ngea and Nambawala have a reasonably good trees, shrubs and grass species composition and richness. Since the study carried out in Dalbergiamelanoxylon dominated zone, *Dalbergia melanoxylon* was noted to be both dominant and with high species diversity followed by *Brachystegia longifolia, Combretum molle, Bauhinia tomentosa, Acacia sp, Acacia nigrescens, Albizia petersiana, Brachystegiaboehmii, Ochnaholstii and Albizia harveyi.* However, the impacts of anthropogenic disturbances were highly observed and expected to increase further with the growing population and enhanced accessibility. Mitarure forest reserve had a reasonable number of young seedlings of Dalbergiamelanoxylon than the community forests of Ngea and Nambawala. Despite the fact that Mitarure forest reserve and nearby community forests still hold an important proportion of trees species richness, there is a need to prevent further human disturbance within the forest so that it can sustain its ecological function. Strict law enforcement on exploitation of forest should be encouraged. On the other hand, restoration of the ecosystem through reforestation in most degraded areas of the forest should also be given immediate attention by forest management authorities.

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