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Conservation of plant biodiversity of Namatimbili forest in the southern coastal forests of Tanzania

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The aim of this study was to determine the ecological characteristic of Namatimbili Forest in terms of plant species composition, stem size class structure, stand biomass, diversity, and distribution and identify endemic and threatened plant species that are found within the forest. Data were sampled by using transect method that were established in various habitats within the forest. A total of 312 plant species were found in 62 families, where Fabaceae (51 species) was the highly represented of all families. Of all plant species recorded, 26 are cited under IUCN red list and 36 are endemic species of East African Coastal Forests.The woodlands were more diverse with a Shannon's index of 2.72 ± 0.21 followed by the riverine forest (1.64 ± 0.19), coral rags (2.28 ± 0.32) and closed canopy evergreen forest (2.32± 0.17) and this pattern was also applied to the species evenness and the difference among vegetation types was significant. The DCA ordination revealed a major variation at DCA-Axis1 where samples from riverine forest separated quite clearly and positioned on the right side of the ordination space. The coral rag habitat extended widely overlapping with other habitats because of high similarity in plant species composition. The woodland habitats separated from the evergreen forest habitat at DCA Axis 3 because of plant species composition differences between them, such that closed canopy trees and the understorey species characterized the evergreen habitats. The riverine forest had a density of 136 stems/ha with the DBH sizes between 41 and 292.99 cm and the stand biomass ranged from 0.1 to 876.06 m^3/ha. However, high density of trees with DBH sizes beyond 90 cm was observed in the riverine forest, regardless of all the vegetation typeshaving individual stems beyond this size class. The coral rag vegetation had 42 stems/ha, with diameter at breast height (DBH) sizes ranging from 41 to 95.5 cm and stand biomass in a range from 0.1 to 59 m^3/ha. The woodlands had 28 stems/ha with the DBH sizes between 41 and 77.38 cm with denser stems at the size class of 10-14 cm DBH and stand biomass in a range from 0.06 to 127.4 m^3/ha. There were 31 stems/ha in the evergreen forest with the DBH sizes from 41.40 to 108.28 cm and stand biomass between 0.06 and 64.42 m^3/ha. A significant difference exists in stand biomass, basal area, but no difference in crown cover among vegetation types. It can be concluded that, the heterogeneous habitat characteristics in Namatimbili Forest favour the performance of diverse plant species and determine their natural distribution patterns. Large proportion of plant species found in the forest is endemic to the East African Coastal Forests and some of these have been cited under various IUCN threat categories. However, exploitation of timber trees, fire, and clearance for cultivation negatively affected the plant species diversity, distribution and vegetation community structure in this forest. Based on the ecological importance of Namatimbili Forest, the forest need to be considered for gazetting for protection from habitat degradation caused by anthropogenic activities and it should be included in the natural resource management plans of the southern coastal forests of Tanzania.

Key words: Namatimbili forest, coastal forests, endemic, habitas, threats, IUCN, anthropogenic disturbance.

INTRODUCTION

Namatimbli is among natural forests found in Lindi region in the southern coast of Tanzania. The forest forms part of the Eastern African coastal forest mosaic with a number of fragments that are characterized by high biological diversity and are also very rich in species localized in available unique habitats that has resulted in their restricted distribution pattern (Burgess and Clarke, 2000). Efforts to identify and classify the coastal forests mosaic of Tanzania in combination with the adjacent Eastern Arc Mountains to be among important biodiversity conservation centers, date back to 1999 where the two ecoregions together were recognized as one of the 25 Global Biodiversity "Hotspots" because of their exceptionally high levels of biological diversity and endemism (Mittermeier et al. 1999). Revision of global biodiversity centers has continued over time where more ecoregions qualified the assessment criteria. To date the number of conservation centers has increased to 34 hotspots covering 15.7% of the Earth's land surface (Myers et al., 2000) and the coastal forests may stand as a Hotspot in its own right (Mittermeier et a., 2004). The Tanzanian coastal forests being part of the aforementioned hotspots are the leading among the world hotspots in terms of the plant species endemism per unit area and eighth in terms of levels of threat (Brooks et al., 2002; Brooks, 2010). Despite the position the coastal forests hold among the global biodiversity centers, many of the forest fragments' conservation status in the ecoregion is less known in terms of the plant species distribution patterns and their habitat characteristics and the level of protection. A number of forest fragments in the southern coast of Tanzania including the Namatimbili forest have no conservation status and hence not protected. This forest forms part of the 21 coastal forest fragments covering about 145 km^2 in Tanzania with unknown conservation status (Hall et al., 2004). The promotion of the conservation status of most coastal forests in Tanzania through gazetting into forest reserves was carried out before 1961 (during colonial periods). It appears that the process was not exhaustive to include a large part of the land cover that left behind many fragments including Namatimbili fragment ungazzetted. These forest fragments have diverse habitats harboring high plant species diversity and a number of the plant species are coastal endemic and threatened by anthropogenic activities (WWF 2012). One of the common habitats in the coastal forests include woodlands that form the largest vegetation cover interconnecting the various other habitats, including the closed canopy evergreen forest in the southern Tanzania coastal forest ecosystem. Many of the typical coastal forest fragments are less than 20 km^2 and widely scattered, but buffered by the adjacent continuum of woodlands (Hall, 2004).

The various habitats common in coastal forests favor an overlapping plant species assemblage with high ecological conservation value wealth protection. Regardless of the ecological conservation significance of most coastal forests of Tanzania, including the Namatimbili forest, they are threatened by a number of uncontrolled human activities. These activities include illegal exploitation of wood resource, clearance for farming, kaolin and gypsum rock mining, bush fire assisted hunting. These activities have continued illegally in many coastal forests including the Kilwa landscape where Namatimbili Forest is a part. While the northern part of the coastal forest in Tanzania (Tanga Region including Dar es-Salaam) have been cleared for agriculture and sisal estates that significantly reduced the coastal forest cover, some parts in the southern coastal forests particularly in Lindi Region were not largely affected by the large clearance for similar purposes with exceptions of a few small scale clearance for subsistence farming under shifting cultivation and reckless fires being a common phenomenon in the area accelerating the depletion of large cover of coastal forest. As forest loss continues across the coastal forest belt in Tanzania, the species confined to forest habitats including endemic species (Burgess et al., 1998; Burgess and Clarke 2000), will decline in their distribution range and population sizes overtime (Tabor, 2010). There has been a consistent land cover change in the coastal region overtime with increasing woodland and decreasing evergreen forest cover (Prins and Clarke 2007; Tabor et al., 2010). These changes have been accompanied with loss of species habitat that affects the plant populations and species distribution within the coastal forests. Namatimbili Forest being part of the coastal forests is also characterized with various attributes that determine its ecological values and the diverse habitats for biodiversity conservation. These ecological values and various attributes are important to draw an alarm for consideration of changing the conservation status of Namatimbili Forest. The aim of this study was to evaluate the ecological characteristic of Namatimbili Forest in terms of plant species composition; trees vertical size structure, biomass, diversity and distribution and identify plant species of ecological conservation value (threatened and endemic)

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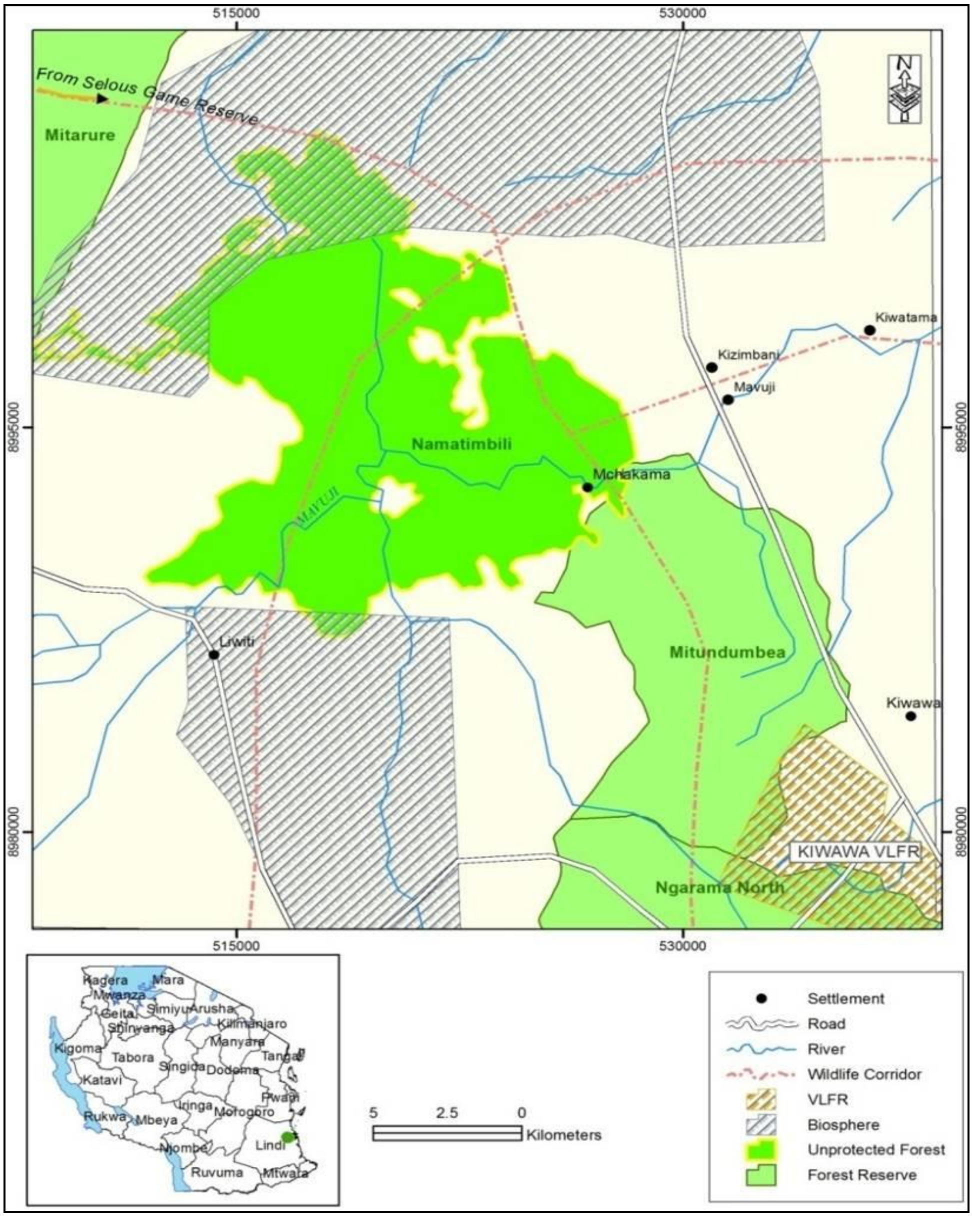

Figure 1. Location of Namatimbili Forest in Lind Region, southern coast in Tanzania.

found within the diverse habitats in this forest. Data on the ecological attributes that covered woodlands, riverine forest, coral rags and closed canopy evergreen forest provide the picture for the need to conserve and gazette Namatimbili Forest.

MATERIALS AND METHODS

The location and description of the Namatimbili Forest

Namatimbili forest is located in Kilwa District, Lind Region in the southern part of Tanzania (Figure 1). It is part of the Kilwa biodiversity landscape that has been regarded as local center of endemism in Tanzania and is the second from that found in the border between Tanzania and Kenya (Clarke, 2001). It is located south-west of Kilwa town and about 6 km from the Mavuji village on the western side of the main road to Lindi and the immediate human settlement adjacent to it being Mchakama village (Figure 1). The Namatimbili Forest lies between longitudes 39□ 5’ and 39□ 16’ E and latitudes 9□ 0’ and 9□ 10’ S, covering approximately a surface area of 16,033 ha, based on the georeferenced map within an altitudinal range of between 136 and 164 above sea level (Figure 1). The forest is found on the southeastern side of the Mitarure Forest Reserve where a biosphere reserve separates between them. Namatimbili Forest borders Mitundumbeya Forest Reserve to the southern part as well as the biosphere reserve. The

Plate 1. The Namatimbili Gorge that provides a unique characteristics of Namatimbili forest.

forest is bisected by the Mavuji River, which meanders through the valley bottoms that narrows in the Namatimbili Gorge, an ancient coral rag escarpment where the river eventually leaves the forest through Mchakama village.

Namatimbili forest differs significantly in structure from the surrounding vegetation types due to diverse habitats that include the coral rags a unique feature in the coastal forests of the southern coast of Tanzania; apart from the woodland and evergreen forest that are commonly distributed among many coastal forest fragments in Tanzania (Burges and Clarke, 2000). Habitat complexity in this forest makes it support various types of vegetation communities. It is also characterized by undulating landscape with hilltops, valley slopes, valley bottoms, rocky cliffs that forms the unique feature of the Namatimbili Forest “Namatimbili Gorge” (Plate 1) and coral rags with characteristic plant species composition. The closed canopy evergreen forest (also known as Uchungwa) is relatively a pristine patch of natural vegetation on the southwest within Namatimbili Forest. Since all habitats are in a continuous matrix of a typical East African coastal forest vegetation characteristics, the evergreen forest begins as a mixed forest type in the southern part of Namatimbili Hills covering an approximate surface area of 1,000 ha. The woodland covers the largest portion of the Namatimbili on ridge tops, steep and gentle slopes of the rocky hills extending from the north to the southern parts in a matrix with small habitat characterized by bushes, thickets and scrub forest patches. The scrub habitats are scattered throughout the woodlands excluding the riverine, evergreen forest types and *Brachystegia* woodlands. The thickets or scrub forms are characterized by annual burns that provide the template of the scrub habitats. The woodlands begin as scattered trees in an open woodland structure with large grassland patches and then form closed woodland/bushland with juxtaposed patches of evergreen vegetation types. The woodland, therefore, consists of heterogeneous communities that are characterized by diverse plant species associations in the Namatimbili Forest. The coral rag habitat is found on the hillsides of the gorge and on the hilltops in most hills in the central part of the forest. This habitat extends to the eastern part from the Namatimbili hills and the nearby forests including the Mitindumbeya Forest Reserve. Riverine vegetation is found along Mavuji River and along the moist tributaries draining to the Mavuji River system and this represents the best-developed riverine forest in Coastal Tanzania. The Mavuji River supports the most critical riparian habitat and to date the river being sole important for the livelihoods of people in Mchakama village, including the inhabitants upstream. Currently, Namatimbili Forest is not gazetted as a conserved forest reserve such that people from the surrounding areas have full access and exploits the forest woody products from the forest including poaching and logging.

Vegetation sampling Procedure

A preliminary survey was done to identify and characterize the various habitats existing in the forest and this was followed by sampling of vegetation data. Based on the preliminary survey, four identifiable habitats were characterized and a total of four transects were established in Namatimbili Forest. The first transect was established from the Namatimbili Forest hilltop to the northern direction for representing the woodland and bushland habitats. The second transect was running from the Namatimbili hilltop to the western side to represent the closed canopy evergreen habitats and the third transect was established from the same starting point where other transect originated to the eastern direction across the Namatimbili River scarps representing the coral rag habitat. Each of the three transects established cut across various microhabitat conditions, including the hilltops, valley slope and valley bottom. The fourth transect was established following the direction of the Mavuji River system to represent riparian and wetland habitats. Along each transect, a series of nested plots as recommended by Stohlgren et al. (1995) were systematically established at the interval of 200 m. The sampling plots were positioned by alternating on the sides along transects following the method of Kasenene (1987). A plot of size 20 x 50 m was used to sample trees with >10 cm diameter at breast height (DBH), a plot of size 5 m x 2m nested in the larger plot was used for sampling of shrubs together with tree poles and saplings and a plot of size 2 m x 0.5 m nested in the 5 x 2m was used for assessment of herbs, seedling and grasses. The information recorded in the field were the plant species names, diameter at breast height (DBH) for trees, number of shrubs, poles and saplings and the percentage cover for grasses and herbs in relation to the plot sizes. Most plants were identified to species level in the field and those that were difficult to identify, specimen were collected, pressed and taken to the herbarium in the Department of Botany, University of Dar Es Salaam for identification by matching with herbarium specimens.

Data analysis

The trees were summarized in terms of the number of stems per hectare at different DBH size classes, stand biomass, height classes

Table 1. Plant species diversity, evenness and abundance among habitats in Namatimbili Forest.

Vegetation type	Shannon's Diversity	Simpsons' Diversity	Richness	Evenness
Woodland	2.72 ± 0.21	17.08 ± 5.30	240 ± 50	0.52 ± 0.04
Evergreen forest	2.32 ± 0.17	10.19 ± 1.99	160 ±27	0.45 ± 0.03
Coral Rag vegetation	2.28 ± 0.32	11.35 ± 3.91	170 ± 47	0.44 ± 0.06
Riverine forest	1.64 ± 0.19	4.57 ± 0.63	80 ± 17	0.31 ± 0.04
ANOVA	F = 3.76	F = 2.03	F = 2.59	F = 3.76
	P = 0.029	P = 0.145	P = 0.08	P = 0.029
	Significant	*Not signif.*	*Marginal*	*Significant*

and crown cover by species and these were compared among habitats using Analysis of Variance (ANOVA) (GraphpadInstat, 2003). Species diversity index was calculated from the composite plant species data based on Shannon and Wiener Diversity Index (Shannon and Wiener, 1948), and Simpson's diversity index. Species diversity indices including richness and evenness were then compared among habitat types in the Namatimbili Forest. The plant species distribution pattern was assessed by using Detrended Correspondence Analysis (DCA), an indirect gradient analysis (ter Braak and Smilauer, 2005). DCA was employed in this analysis on the assumption that plant species distribution patterns are determined by environmental variables. Furthermore DCA was used because the size of the forest is very small and the ranges of the environmental gradients captured were so small that the response might be colinear.

RESULTS

Plant species composition, diversity, richness and evenness among habitats in Namatimbili forest

A total of 312 plant species were recorded in Namatimbili Forest distributed among 62 families and a great variation was observed among forest habitat types (Appendix 1). Of these, 62 plant species have high conservation status, and 26 plant species are listed in IUCN red list and 36 are purely East African coastal forest endemic species. The most highly represented families were Fabaceae (51 species), Rubiaceae (21 species), Poaceae (18 species), Annonaceae (16 species) and other families had less than 14 plant species (Appendix 1). Species diversity (Shannon–Wiener diversity index, H^1), richness and evenness followed the order of Woodland > Evergreen forest > Coral Rags > Riverine forest (Table 1). Plant species diversity was in a range between 1.45 and 2.93 and the difference among habitats was significant based on single factor analysis of Variance (P<0.05). The plant species in woodlands had more evenly distributed individuals, followed by evergreen closed canopy forest, coral rags and the lowest was observed in the riverine forest. Among habitats, the woodland had the highest species composition among habitats with a richness of 240 plant species. Although species richness was highest in woodlands, than other habitats, the difference was significantly marginal based on one-way analysis of variance (F = 259, P = 0.08). The evergreen forest plant species richness was 160 species, which was lower than that in the coral rag habitat regardless of higher species diversity than the later. The lowest plant species richness was recorded in the riverine forest (80 species) and so did the species diversity, which was significantly lower than that in woodlands based on the Analysis of Variance (F = 3.76, P = 0.029) (Table 1).

The plant species distribution among habitats in Namatimbili forest

Ordination analysis showed decreasing variation in species composition among habitats from DCA-axis 1 to DCA-axis 4 (90.50, 64.36, 46.17 and 25.87% in that order). The major variation was depicted by DCA axis 1 where samples from riverine forest separated quite clearly and positioned at the highest gradient (7.8 eucledian units) on the right side of the ordination space than the rest of the habitats (Figure 2). The coral rag habitat extended widely in the forests overlapping with other habitats in terms of species composition. The woodland habitats separated from the evergreen forest habitat at DCA axis 3 (Figure 2), and this may be because of plant species composition differences between them, such that the evergreen habitats are characterized by closed canopy trees and the understorey species such that, plant species confined to this habitat are forest dependent.

Species composition in the riverine were characterized by moist dependent plants where the upper canopy layer was represented by Pteryogotaperrieri, Parkia filicoides, Uvariodendron gorgonis, Lettowianthus stellatus, Milicia excelsa, Khaya anthotheca, Ficus sur and Garcinia livingstonei whereas Barringtonia racemosa, Sorindeia madagascariensis, Newtonia paucijuga, Pachystella brevispica, Baphia kirkii, Ziziphus mucronata, Drypetes arguta, Diospyros kabuyeana, Drypetes natalensis and Breonardia salicina were the commonly represented

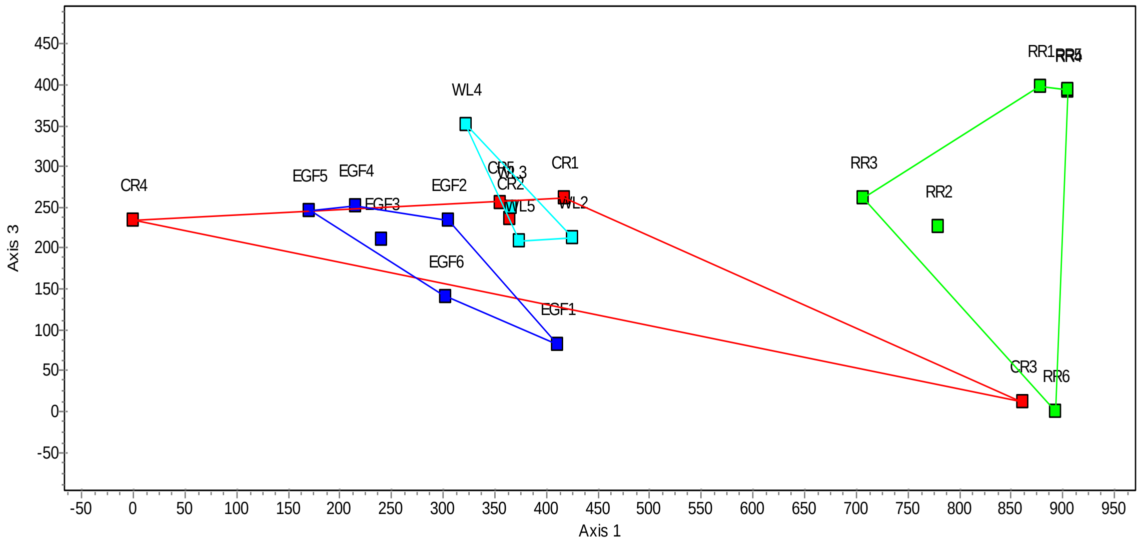

Figure 2. DCA ordination analysis showing the clusters of sites from difference habitats (1-6 = plot numbers, RR= riverine, CR= coral rag, EG= evergreen, WL= Woodland and the polygons marks the clusters of site samples).

understorey species. Within the riverine habitat Encephalartos hildebrandtii was an abundant shrub on *the basement of the cliffs of the Namatimbili Gorge and the understorey parts in riverine forest. Namatimbili forest represents the southernmost habitats threshold favourable for survival and performance of the cycad Encephalartos hildebrandtii. The permanently inundated area along Mavuji River, Phragmites mauritianus, Cyperus denudatus, Polysphaeria multiflora, Culcasiaorientalis* and *Syzygium guineense* were commonly widespread species. However, these species species are vulnerable to being cleared for the wetland cultivation and some of the quality timber trees (*Khaya anthotheca* and *Milicia excelsa*) have been selectively exploited from the riverine habitat. In the closed canopy evergreen forest, *Dialium holtzii*, *Haplocoeluminopleum*, *Hymenaea verrucosa, Strychnos henningsii, Markhamia zanzibarica, Vitex zanzibarensis, Pericopsis angolensis* and *Memecylon sanzibaricum* dominated the upper canopy tree layer and *Dichapetalum mosambicense, Baphia kirkii, Drypetes arguta, Tetracera litoralis, Dichapetalum stuhlmannii, Salacia madagascariensis, Salacia leptoclada* and *Uvaria acuminata* dominated in the understorey. There were small evergreen forest patches on the Namatimbili hillsides and on rocky outcrop escarpment where *Erythrina schliebenii* and *Cynometra gilmanii* were common co-existing with *Cynometra webberi, Cynometra suaheliensis* and *Tessmania stuhlmannii* which are coastal endemic species and vulnerable.

Plant species that were common in the woodland included *Eleodendron buchananii, Sterculia appendiculata, Sterculia quinqueloba, Pterocarpus angolensis, Pteleopsis myrtifolia, Salacia madagascariensis, Mkilua fragrans,* with a few individuals of the scattered *Erythrina sacleuxi*. On the other hand, *Millettia stuhlmannii*, *Brachystegia spiciformis, Pterocarpus angolensis, Afzelia quanzensis, Strychnos henningsii, Lannea stuhlmannii, Haplocoelum inopleum, Vitex zanzibariensis* and *Ochna holstii* had densely packed stems in some parts in the woodlands. The valuable timber trees (*A. quanzensis, P. tinctorius* and *P. angolensis*) have been selectively exploited in the woodlands to some extent, which may have contributed to negative effect on their population structure and relative abundance. The coral rag habitat was characterized by rocky outcrops in many parts with scattered trees between them. *Cynometra gilmanii, Erythrina sacleuxi, Cola greenwayi, Erythrina schliebenii, Strychnos henningsii* and *Codyla africana* dominated the uppermost layer whereas the understorey habitat was dominated by *Encephalartos hildebrandtii*, *Monodora grandidieri, M. hastipetala* and *Drypetes reticulata***.** Observation showed a high level overlap among habitat generalist plant species and the discrimination among study sites through ordination was a function of habitat specialist plant species within the forest and this is because DCA is sensitive to habitat specialist plant species.

Population structure and size class distribution of trees among habitat in Namatimbili forest

The curves displaying the population size class structure for trees in most habitats were skewed to high size classes with high density progressively decreasing to large size classes (Figure 2). Among habitats, woodlands

Table 2. The basal area, woody biomass and crown cover among habitats in Namatimbili Forest (Mean ± SE).

Habitat type	Biomass(m^3/ha)	Basal Area (m^2/ha)	Canopy cover (m^2/ha)
Woodland	333 ± 153	20.4 ± 8.3	102700 ± 30100.3
Evergreen forest	492.2 ± 72	23.9 ± 3.3	113355 ± 12890
Coral rag vegetation	633.1 ± 248	21.0 ± 4.8	107754 ± 28748
Riverine forest	2917.6± 983	73.8 ± 21.5	1056010 ± 884400
F-ratio	5.05	4.41	0.5954
P-value	0.010	0.017	0.626
Conclusion	significant	significant	not significant

were represented by high density of stems of size class 10-14 cm DBH and this pattern was the same as in other habitats. The riverine habitat had high representation of individuals beyond DBH sizes of 90 cm, regardless of all the habitats with individual representation beyond this size class (Figure 2). Most tree stems in the woodland habitat had lower than 50cm DBH sizes but lower than 60 cm DBH from trees in evergreen closed canopy habitats. However, trees in coral rags and riverine forest had large number of individuals with DHB sizes of 70cm and 90cm respectively and had trees represented in most of the classified size classes in Namatimbili Forest.

The riverine forest had a total of 136 stems/ha where individuals had DBH sizes between 41 and 292.99 cm. *Khaya anthotheca* had high density of stem with large DBH sizes whereas other trees had individuals with DBH sizes below this range. The coral rag vegetation had a density of 42 stems/ha where *Bombax rhodognaphalon, Cordyla africana, Cynometra webberi, Khaya anthotheca, Pteleopsis myrtifolia, Scorodophloeus fischeri, Terminalia zambeziaca* and *Xerroderis stuhlmannii* had DBH sizes ranging from 41 to 95.5 cm while trees had DBH sizes below this range. The observed 28 stems/ha in woodlands were represented by trees with the DBH sizes between 41 and 77.38 cm. There were 31 stems/ha in the evergreen forest, which was represented by trees with the DBH sizes between 41.40, and 108.28 cm and many trees had DBH sizes lower than this ranges.

Basal area, stand biomass, height and crown cover in various habitats in Namatimbili forests reserve

The biomass in the woodlands ranged from 0.06 to 127.4 m^3/ha where trees that contributed large amount were *A. digitata, A. quanzensis, B. rhodognaphalon, D. hispidula, P. myrtifolia, S. birrea, T. zambeziaca* and *X. stuhlmannii* with the biomass in a range between 3.55 and 127.40 m^3/ha. In the evergreen forest, the range of biomass was between 0.06 and 64.42 m^3/ha where *Afzelia quanzensis, Cleistanhtus schlechteri, Combretum adenogonum, Hymenaea verrucosa, Dialium holtzii, Diospyros mesipliformis, Manilkara bicolor, Maytenus undata, Millettia stuhlmannii, Strychnos heningsii, Strychnos occoranum, Terminalia zambeziaca*and *Vitex zanzibariensis* contributed more of the total biomass in a range from 4.12 to 64.42 m^3/ha. The coral rag vegetation had a biomass in a range from 0.1 to 59 m^3/ha, and the major contribution was from trees with large DBH sizes including *Bombax rhodognaphalon, Cordyla africana, Cynometra webberi, Pteleopsis myrtifolia, Terminalia zambeziaca* and *Xerroderis stuhlmannii* with biomass between 4.64 and 59.72 m^3/ha. Trees in the riverine had the highest biomass than it was in other habitats (Table 2) that ranged from 0.1 to 876.06 m^3/ha whereas *Baringtonia racemosa, Ficus sur, Garcinia livingstonei, Khaya anthotheca, Milicia exelsa, Mimusops kummer, Pteleopsis myrtifolia, Sclerocarya birrea, Sorindeia madagascariensis*, *Sterculia appendiculata, Syzygium guineense* and *Terminalia zambeziaca* contributed more biomass between 4.64 and 876.06 m^3/ha such that, *S. appendiculata* had the highest contribution (876.06 m^3/ha) and other trees contributed below 216.48 m^3/ha. Analysis of Variance (ANOVA) showed significant difference in the overall biomass accumulation among habitats (Table 2). Regardless of low density, based on students t-test, the riverine habitat had more biomass than the woodlands (LSD = 258.42, q = 4.65, p<0.05), evergreen forest habitats (LSD = 242.54, q =4.53, p<0.05) and coral rag habitat (LSD = 228.45, q = 4.074, p<0.05). Similar pattern was observed for the trees basal area where the difference was significant among habitats (F= 4.41, P = 0.017) where the riverine habitat had significantly higher basal areas than the woodlands (LSD = 53.43, q = 4.17, P<0.05), evergreen forest habitat (LSD = 49.98, q = 4.09, P<0.05) and coral rag habitat (LSD = 52.83, q = 4.13, P<0.05).

Although biomass was high in trees of the coral rags than that in evergreen forest habitat, the trees basal area on average was lower than the aforementioned habitats. Trees in riverine habitat had extensive crown cover followed by that in evergreen forest habitat but the difference based on ANOVA was not significant (P>0.05) (Table 2). Most trees were in the height sizes between 6 and 25 m among habitats except in the riverine habitats where some trees were 55 m tall. The woodlands and

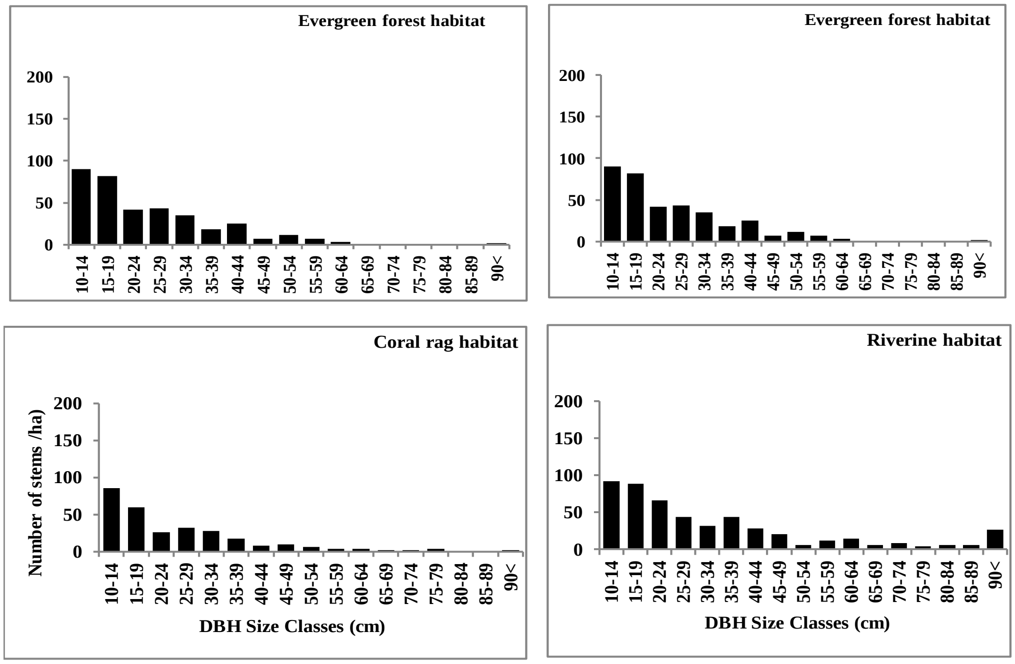

Figure 3. Size class distribution of trees in various habitats in Namatimbili Forest.

evergreen forest habitats had equal representation at the maximum height classes (Figure 3). The tree height classes beyond the aforementioned habitats were recorded in both coral rag and riverine habitats (Figure 3). The trees with the tallest stems in woodland were *Adansoniadigitata, P. myrtifolia, S. birrea, T. zambeziaca* and *X. stuhlmannii* with a range of heights between 20 and 25 m. The tallest trees in the evergreen forest included *D. holtzii, H. verrucosa, M. bicolor, N. paucijuga, T. zambeziaca* and *V. zanzibariensis* with the height between 21 and 25 m. The tallest trees in coral rag habitat were *C. webberi, K. anthotheca, B. rhodognaphalon, C. africana* and *S. fischeri* with heights from 51 to 55 m. In the riverine habitats *A. glaberrima, B. racemosa, K. anthotheca, Milicia exelsa, S. appendiculata* and *S. gueneense* had similar range of heights as those in some parts in coral rag vegetation.

DISCUSSION

Plant species composition, diversity and richness in Namatimbili forest

The variation in plant species composition among habitats in Namatimbili Forest implies that the vegetation communities need conservation attention like any other coastal forest in Tanzania. Clarke et al. (2000) pointed out that variation in plant species assemblage is determined by anthropogenic factors, rainfall patterns and soil characteristics. Also, Hall et al. (2004) pointed out that soil, geology and landscape characteristics might have significant impacts on the community structure of the vegetation in the coastal forests. Silt red, greyish and mixed soils were soil physical characteristics that determined the complex vegetation communities in the woodlands in Namatimbili Forest. The woodland habitat was characterized by diverse microhabitats in a matrix composed of bushland, shrublands, evergreen patches in a range of topographic positions (hilltops, hill slopes, valley bottom) that determined plant species preference in various organized communities. Plant species composition difference among communities is the outcome of the aforementioned landscape attributes found in Namatimbili forest. Some parts in the woodland are characterized by large cover of coral rag rocky outcrops which are widely distributed in most parts of the forests. The coral rag vegetation provides a unique characteristic of Namatimbili Forest and many other coastal forests in Lindi Region. Utumi (2002) reported high densities of *Encephalartos hildebrandtii* and endemic trees such as *Cynometra filifera*, *Cynometra gillmannii* and *Erythrina schliebenii* in the coral rag in the forests of Kilwa and Lindi districts, which is similar to the observation, made in this study. Few plant species may survive in certain habitats only and are regarded as habitat specialists whereas many plant species are habitat generalists.

According to Burgess et al. (2000), the dominance of ecologically generalist plants in coastal forests is attributed to small sized patches surrounded by mosaic habitats, which are generally dry for an extended period of the year. The riverine, evergreen, woodland and coral rags are habitats for both habitat specific and generalist species. The highest species evenness in woodlands implies high composition of generalist species because of unlimited habitat preference. Howell et al. (2012) pointed out that, *Pteleopsis myrtifolia, Terminalia zambesiaca, Strychnos heningsii, Millettia stuhlmannii* and *Zanthoxylum chalybeum* are habitat generalist species. The distribution of these species overlap among communities is because of of the similarity in their habitat conditions found within Namatimbili Forest. Similar observation was reported by Clarke (2011) in the study of the vegetation ecology of the coastal forests in Palma and Nangade District of Mozambique that a huge overlap exists in species composition among habitats and vegetation communities. Since this study was carried out in one of coastal forest fragments, the habitat types identified in Namatimbili Forest reflect the characteristic vegetation community types found in most coastal forests in Tanzania (Clarke and Robertson, 2000). The woodland, riverine, coral rag and evergreen forest are distinct habitat characteristics with well-represented vegetation communities in Namatimbili Forest. The woodland habitat has more evenly distributed species, which are continuously at wider scale than other habitats that are more fragmented with uneven distribution of individual trees. This is because random distribution of individuals and spatial heterogeneity of light resources created by various tree size classes offers an opportunity for multiple species co-existence as supported by Kohyana (1994). However, low evenness implies the existence of species microhabitat preference in habitats in Namatimbili Forest. Low evenness in the riverine vegetation may be contributed by discontinuity of habitat that supports similar kind of species. This causes the fragmented species distribution in some sections in the Mavuji River system that may have resulted into lowest evenness among habitats. The presence of floodplains which support *Khaya anthotheca, Milicia excels* and *Syzygium guineense,* differs from the rocky cliffs that support *Erythrina schliebenii* and *Encephalartos hildebrandtii*, and clay rich river banks in the upstream that supports heterogeneous vegetation communities commonly represented by *S. guineense, A. polyacantha* and *M. excelsa*. Each microhabita supports different community composition and that is why plant species are less evenly distributed along the riverine than in other habitats.

Species diversity is the most important ecological parameters determined for the purpose of designing and deliberating an area for biodiversity conservation purposes. *Alpha* diversity in Namatimbili forest was determined so as to scale out the importance of plant biodiversity conservation in the southern coastal Tanzania. Kent and Coker (1992) pointed out that, most habitats have Shannon's diversity index between 1.5 and 3.5, whereas Murali et al. (1996) pointed out that a habitat with diversity index between 2.56 and 2.86 as diverse. The diversity indices for Namatimbili Forest were between 1.45 and 2.93 which implies that high species diversity exists among habitats in this forest. The *alpha* diversity indices suggest a high species richness within habitats that is at the same level as those indicated by Kent and Coker (1992). This implies that diverse plant species assemblages exist among diverse habitats in the Namatimbili Forest that worth high conservation attention. Disturbance cannot be put outside the framework of discussing the conservation values of the southern coastal forests of Tanzania. Plant species diversity may be influenced by habitat heterogeneity and the varying levels of anthropogenic disturbances (Mligo et al., 2011) and this affects microsites for plant diversity (Hobbs, 1992). Although the woodland is selectively logged, the dominance of few trees may be reduced giving room for unrepresented species to expand in their distribution range. Halpern and Spies (1995) reported that the heavily disturbed habitats through logging favour dominance by ruderal species. However, Namatimbili Forest can be regarded as less disturbed except in some few areas such that the indigenous trees are responding to such disturbance in the same way as it occurs under natural vegetation dynamics in a forest. High level of disturbance lowers species richness (Armesto and Pickett, 1985). However, low species richness in the riverine habitat contributed by the dominance of a few trees that prevent light resource for other species. The environmental stress may only favour plant species that are capable of surviving by using the meagerly captured resources (Grime, 1979). A number of light stress tolerant plant species co-existed in the understorey within trees of the uppermost layer in the closed canopy evergreen forest and riverine habitats contributing to their current richness.

Mavuji River is important to the ecosystem as it provides permanent moist conditions in the riverine habitat, which favour continuous growth of plants and hence high biomass accumulation than in other habitats whose trees biomass are characterized by seasonal growth. The riverine condition favour plant species that are performing under perennial moist conditions where many of them are endemic to the Swahilian region. These conditions however are very rare in the coastal forests in general (Clarke and Robertson, 2000) and localized within the drainage system in the region, but may extend downstream according to the duration of the flows. There are substantial heterogeneous microhabitats in the woodlands, including scrub, bushland and thickets that do not correspond directly with the classification by Clarke and Robertson (2000). The habitat categories in Namatimbili Forest are the outcome of analysis of

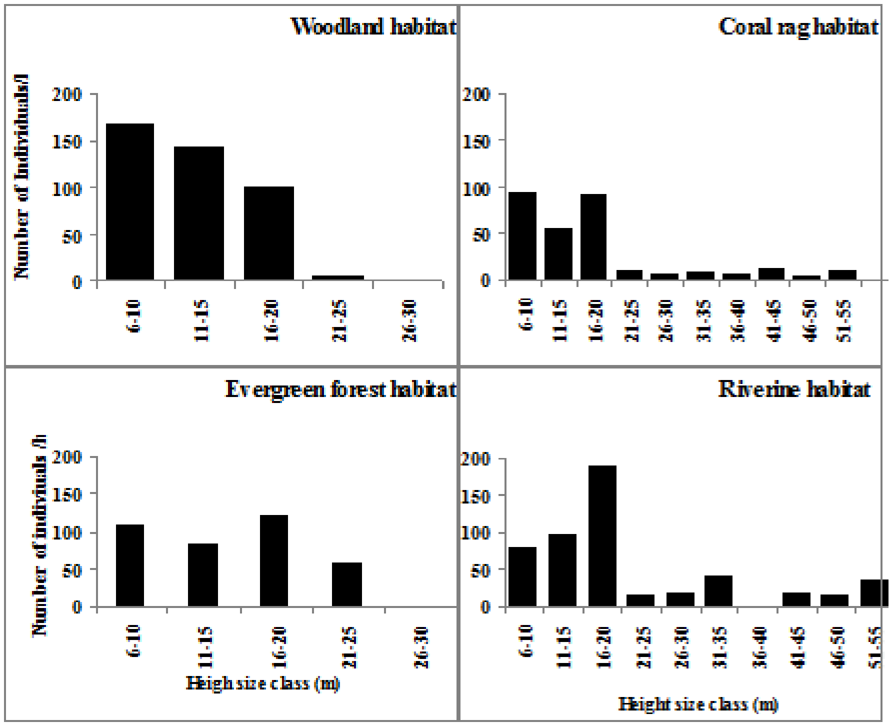

Figure 4. Variation in heght size distribution of trees among vegetation types.

complexity of vegetation community types under heterogeneous habitat conditions. This output provides simplicity in classifying habitats for understanding of the ecological characteristics of many coastal forest fragments that are found in Kilwa biodiversity conservation landscape.

Variation in plant population structure, basal area, biomass, height stratification and crown cover among habitats in Namatimbili forest

Tree population structures play an important role in the dynamics of forest ecosystem (Kohyama, 1994). It was considered that analyzing DBH size class distribution of trees among habitats could provide an understanding of population structure in Namatimbili Forest. According to Deb and Sandrily (2008); Kohira and Ninomiya (2003), tree size class distribution is associated with population trends; and this is an adequate measure of population dynamics (Kohyana, 1994; Bin, 2012). Because Namatimbili Forest is accrued with diverse local and regional endemic plant species, its future stability will depend on active recruitment under the influence of environmental factors in combination with anthropogenic activities. The difference in maximum DBH size classes of trees among habitats is a reflection of variation in microhabitat conditions where tree species adapt differently.

Some trees in woodland and evergreen forest do not grow beyond 25 cm DBH size classes (Figure 4) and this has been contributed by variation in habitats conditions where the riverine is favoured by perennial moist conditions than the intermittent conditions in the other habitats. Kumlachew et al. (2003) pointed out that, small sized individuals in a given population function as a significant reserve for replacing older individuals. A skewed curve to lower DBH size classes is an indication of community succession (Diekman, 1994). DBH size class variations among habitats show that tree populations are expanding with active recruitment at lower size classes that will replace ageing or dying trees in the forest. High representation of trees with large size classes among habitats was due to limited anthropogenic pressure in combination with their survival tactics under various environmental influences and these represent relics of the previous vegetation communities. Converting the forest to a reserve will prevent anthropogenic pressure and the vegetation community structure will be stable and provide ecosystem services under new conservation status. Regardless of the selective exploitation of trees in Namatimbili Forest, their populations are still stable and the level of degradation is considered low and therefore merits to be included among conserved reserves within the Kilwa biodiversity landscape. The patterns of DBH size class distribution in the study forest were contributed much by plant species from families Sapotaceae, Caesalpiniaceae, Sapindaceae, Fabaceae and Combretaceae. This means that plant species from these families play a big role in characterizing vegetation community structure, functions and dynamics among habitats in Namatimbili Forest. Although there is illegal and licensed chain sawing in the Namtimbili Forest and the nearby forest patches, the tree population size class distribution showed little indication of negative impacts of exploitation that may be affecting natural regeneration. For the purpose of forest conservation, trees are the most important life form to monitor because they determine the microhabitat conditions suitable for forest biodiversity. Being a dominant life form, trees are easy to locate precisely and count (Condit et al., 1998) and are also relatively better known taxonomically (Gentry, 1987). The diameter size class distribution determines the amount of stem, basal area and biomass accumulated by the tree species in the forest. The basal area was presented because it provides an understanding of the forest- wildlife habitat relationship and helps to determine the conservation and protection decision since it is in close proximity to the Selous Game Reserve and therefore a habitat buffer zone to the wildlife sanctuary in the southern coastal region of Tanzania. Microhabitat variation among habitat may be the cause of variation in biomass accumulation of individual tree species in Namatimbili Forest. The growth of trees in habitats with a constant supply of moisture, nutrient, and light are likely to continue. Trees with large DBH size classes are consistently intercepting large amount of light to accumulate large amounts of biomass. This may be the cause of extensively tall trees in the riverine where some stems had heights beyond 50 m and the understorey were trees adapted to diffuse light conditions. Because of these the richness was lower than other habitat and the riverine community was characterized by a large number of individuals represented only by few species. Trees with large biomass, basal area and crown cover that were found in the riverine habitat were contributed by the stable moist conditions caused by the presence of perennial flows from Mavuji River. The dominant trees that contributed largely to the basal area, biomass and crown cover included *Khaya anthotheca, M. excelsa, B. racemosa, S. guineense, P. filicoides, S. appendiculata* and *A. glaberrima*. These trees benefited from the favorable habitat conditions contributed by the flow dynamics in the river system.

The impacts of human activities on distribution of plant species in Namatimbili Forest

Species distribution in Namatimbili Forest is largely contributed by the existing habitat characteristics in combination with the anthropogenic activities. *Erythrina schliebenii, Cynometra webberi, Encephalators hildebrandtii* and *Cynometra gulmanii* are commonly found in the forest coral rag habitats and *Scorodophloeus fischeri, Coffea pseudozanguebarica, Leptactina papyrphloea* and *Vitex zanzibariensis* were common in habitats with silt loam and reddish soils in the hillslopes. On the sandy soils of the floodplains were found *Milicia excelsa*, *Khaya anthotheca*, *Sorindeia madagascariensis* and *Polysphaeria parvifolia*. However, observation showed that both natural and anthropogenic disturbances play a big role in shaping the vegetation community structural organization among habitats in the Namatimbili Forest. Hall et al. (2004) pointed out that anthropogenic activities result in scrub, wooded grassland, grassland and forest edge habitats in coastal forests. Disturbance is known to affect microsites for plant diversity (Hobbs 1992). Part of the evergreen closed canopy is being transformed to other habitat types including woodlands and bushlands. Open canopy allows colonization by short lived and opportunistic species that accumulate combustible fuel in a short period and favor fire occurrence. Frequent burning reverts the forest into woodland and grassland, but fire controlled habitat can recover to woodland (Peterson, 2001). The already affected areas may revert to woodland and lost coastal forest characteristics if Namatimbili Forest is gazetted and protected.

A number of anthropogenic activities are transforming the forest into a degraded habitat where the evergreen forests are changing into scrubs, bush lands and thicketed wooded grasslands. The frequent fires that emanate from the forest surrounding villages may be the cause of increased grassland patches and scrub in woodlands. The reserve is surrounded by various kinds of land use types including crop cultivation in the Mavuji riparian habitat. This is an important agricultural area for production of vegetables for livelihood of Mchakama villagers and the surrounding communities. Intrusion to the natural habitat upstream has been a common phenomenon. Logging, pole extraction and exploitation for timber are among the ongoing illegal activities in this forest that is targeting important timber species including *K. anthotheca, A. gummifera, P. angolensis, D. melanoxylon, M. excelsa, P. tinctorius, A. quanzensis* and *M. stuhlmannii.* Some of the evergreen forest parts are now reduced to patchy bushland with only few less valuable timber tree species remaining in the fragments. The riparian trees were still dominated by *K. anthotheca* but low density of large sized *M. excelsa*. The area is close to human settlement and contains regenerating *Scorodophloeus fischeri* and *Cynometra webberi* that are highly prized for use as building poles and if not gazetted and protected will be depleted following the increased demand that aggravated intensive exploitation.

The existing variation in vegetation community structure within forests partly was contributed by logging that depleted the populations of the target species that might have lead to the present conditions in the forest. When large timber trees are removed the forest canopy is opened up thereby enabling more widespread species to regenerate and making the forest more vulnerable to fire. Although woodlands are usually tolerant to low temperature fires, most forest species are sensitive to fire and easily destroyed by fire. This makes all the forest habitats destroyed by fire that affects species diversity and distribution patterns.

The impact of habitat degradation on the plant species with high ecological conservation status inNamatimbili Forest

There are various habitats identified in this forest where species with high conservation status have been found, securing survival resources, maintaining their minimum population sizes through interacting with both biotic and abiotic resources. The best conservation management option is that which takes into account of preserving species habitats to maintain the population stability. While both natural and anthropogenic disturbance are the major concerns for the species habitat loss, the latter is more stringent and have negative impacts to habitat with species of high conservation concern. Expanding agri-culture provides threat to the Namatimbili forests' natural habitats because of clearance of pristine parts that causes habitat destruction. The closed canopy evergreen and riverine habitats have fertile soils and therefore more vulnerable than in the woodlands. *Sesamum indicum* cultivation has rapidly grown within the last three years (2011-2014) following the availability of potential market where the previous practiced subsistence farming has changed to agribusiness. This has been accompanied by opening up of large land areas for the said crop cultivation and large part of Namatimbili Forest has been encroached. The ongoing clearance of the forest contributed to the current degradation of the potential natural habitats that accommodate endemic and threatened species. With a particularly heavy logging in Kilwa and Lindi Districts, Namatimbili Forest may not be exceptional making it unfavorable for forest dependent plant species. The impact of logging particularly was observed in the woodlands (*D. melanoxylon*, *A. quanzensis*, *P. angolensis*), riverine (*M. excelsa* and *K. anthotheca*) and closed canopy evergreen forest with selective removal of large trees that affects the plant species co-existence and degraded the habitats.

Fire impact is a common phenomenon in Namatimbili forest, which affects biodiversity habitat. It may escape during land clearance or ignited deliberately by illegal hunters to drive animals for easy hunting in the woodlands. The availability of wildlife has been possible because Namatimbili Forest is in close proximity with Selous Game Reserve and animals are unaware of the landscape borders. The habitat for the forest dependent plant species may undergo total destruction affecting species that are not adapted to fire. The degraded habitat remains behind with only fire-adapted species and the previously evergreen forests may change to woodlands and grasslands. The expanding woodlands cover in the east southern Namatimbili Forest is a result of frequent burning accelerated by exploitation of woody resources and hunting. The unprotected Namatimbili Forest will result into negative effect to plant species with restricted habitat requirements (endemic) and threatened plant species. The identified threatened plant species included *C. gilmanii, C. webberi, C. suaheliensis*, *T. stuhlmannii* and *V. zanzibarensis* in evergreen vegetation; *Uvariodendron gorgonis, Lettowianthus stellatus, Milicia excelsa*, *Khaya anthotheca, Newtonia paucijuga, Baphia kirkii* and *Encephalartos hildebrandtii* in the riverine; *Zanthoxylum chalybeum*, *Monanthotaxis trichantha, Ophrypetalum odoratum, Erythrina sacleuxi, Vitex zanzibariensis* in the woodlands and *Cynometra gilmanii, Erythrina sacleuxi,Cola greenwayi* and *Erythrina schliebenii* to mention a few in the coral rag vegetation. These species are coastal forest endemics and are also cited under various IUCN threat categories (IUCN, 2011). While *Cynometra gillmannii*, *Erythrina schliebenii* are the IUCN critically endangered species, *Vismia pauciflora, Uvariodendron gorgonis*, *Tessmannia densiflora*; *Uvariodendron gorgonis* are endangered species. On the other hand, the vulnerable plant species are *Erythrina sacleuxii, Khaya anthotheca, Baphia kirkii, Cynometra webberi, Mkilua fragrans, Vitex zanzibarensis, Zanthoxylum holtzianum, Dialium holtzii, Ophrypetalum odoratum, Khaya anthotheca, Newtonia pucijuga, Coffea pseudozanguebariae, Gardenia transvenulosa, Vitex zanzibarensis* and the near threatened are *Encephalartos hildebrandtii, Milicia excelsa* and *Lettowianthus stellatus* (Appendix 1). The identified threatended plant species from Namatimbili Forest forms 8.33% of the total number of plant species recorded in this forest. Since many plant species are coastal forests endemics (Appendix 1), in total they formed 11.53% of all the plant species recorded in Namatimbili Forest. Because of the unprotected nature of Namatimbili Forest, the habitats of threatened species will be degraded and destroyed, consequently resulting into decrease of their population sizes. This will affect further their already restricted distribution pattern in the coast forest ecosystem and their genetic diversity within populations. The ongoing anthropogenic disturbance may negatively affect populations of *K. anthotheca, B. kirkii, C. webberi, V. zanzibarensis* and *M. excelsa* through timber production and the rest may be cleared for agricultural or destroyed by fire. Exploitation of canopy trees for timber may expose the understorey species to new environment that are not the habitat attribute for their performance and therefore fail to survive. Also, the microclimatic conditions that could be maintained by the upper most tree layer in the vegetation stand cannot be available to understorey layer and hence the community can be interrupted in favour of pioneer, invasive and sun loving plants. Clarke (2001); Prins and Clarke (2007) reported a number of local endemics in Kilwa Landscape, to include *Trichilia lovettii, Baphia keniensis* and *Leptactina oxyloba.* Perkin et al. (2008) pointed out *E. schliebenii, M. trichantha*, *C. gillmannii*, *C. filifera*, *C. pulchella* and *D. magogoana* as endemic to the Lindi landscape. Based on the data in Appendix 1 on this study, 36 plant species were coastal endemic and their habitats are frequently burnt, degraded through exploitation of timber trees and destroyed through clearance for cultivation. However, the discrepancy of data among the afore-mentioned studies shows insufficient information to conclude about actual distribution pattern of plant species with high ecological conservation value within the landscape and the difficulty to quantify the magnitude of threat to endemic plant species from the ongoing anthropogenic activities. There is heavy extraction of timber in the nearby forest reserve such as the Mitarure (Ball, 2004), such that this may not rule out the impacts of the same in Namatimbili Forest which is in close proximity to Dar es salaam- Lindi main road and easily accessible. The significant threat comes from the recent inclusion of the northern part of the Uchungwa/Namatimbili forest to be a potential site for bio-fuel farming (Perkin et al. 2008), where large proportion of the forest may be cleared for *Jatropha curcas* farming. It is expected that a large portion of the woodland habitats of Namatimbili Forest to be converted to a plantation and this is expected to be potential threat to conservation of biodiversity in the Kilwa Landscape.

With the existing limited information available so far describing the conservation management status for most of the southern Tanzania coastal forest fragments, data on the unprotected Namatimbili Forest fragment adds up to the existing knowledge gap regarding the current ecological conservation value. The ecological conditions of the forest fragment, particularly linking the diverse habitat and vegetation community structure among habitats in the forests forms the basis for the protection of ecological values present in the forest. Clarke *et al.,* (2000) pointed out that the conservation value of most coastal forests is because of richness in species with restricted distribution. Namatimbili Forest fragment can be recognized of high conservation value because of high proportion of endemic species. Also, the presence of large proportion of plant species under various IUCN threat categories may highlight the ecological importance of protection of Namatimbili Forest.

Conservation management implication of Namatimbili forest

Namtimbili Forest is currently not in any conservation and management ownership from either local community or the central government authority to guarantee its protection where the resources are extracted illegally. Although the pressure on forest resources and the encroachment of the forest has not been quantified, observation in the field confirmed the existence of degraded forest habitats. Blomley *et al.,* (2008) pointed out that participatory forest management is the strongest technique for biodiversity conservation in coastal forests of Tanzania. However, the local communities are not conscious enough to play their role in the conservation of the Namatimbili forest. This is because there is no available organ to establish agreement among parts to share efforts in conserving the forest that involve local community participation which may prevent further forest degradation. The anthropogenic activities that have negative impacts on species with specialized habitats in Namatimbili Forest include the extraction of forest resources such as building poles, timber, illegal wildlife poaching, clearance of the pristine forest for crop cultivation and reckless fires. Since there are no forest boundaries that may be used to prevent access to the forest resources; clearance of land for crop farming may continue unlimited. With gradual increase in cultivation of *Sesamum indicum* and opening up biofuel crop plantations'*Jatropha curcas"* for external market purposes more clearance of the pristine forest is expected unless the forest is gazetted, boundaries are clearly marked and the local community is well educated enough to recognize that forest resources need to be conserved or sustain ably utilized if possible. The future of the southern coastal forests of Tanzania including Namatimbili Forest rests on the efforts to demarcate boundaries from forest encroachment and protection of habitat and gazzeting it as conserved forest reserve. A map used in this article may provide the base for establishment of boundaries along the already predetermined boundaries of the forest reserve since this forest is among many forest patches in southeastern Tanzania that are not gazetted and therefore unprotected.

Namatimbili Forest, including the neighbouring forest patches have "charismatic" plant species assemblages which make them being of high biodiversity conservation importance in the southern coast of Tanzania. For appropriate protection of Namatimbili Forest, it needs to be part of the conserved southern coastal forest ecosystem covering habitats with relatively closed canopy evergreen habitats, the unique coral rag (of the southern coastal forests) and the integrated riverine forest within Kilwa Landscape of the southern coast of Tanzania. The existence of vegetation communities with a large number of coastal forest endemic plant species and threatened plant species signify the conservation importance of the Namatimbili Forest fragment and other fragments in Kilwa biodiversity landscape. Conserving plant populations in this forest will contribute to the preserving genetic diversity remaining in the southern coast of Tanzania. Since a large part of the coastal forest cover has now gone, the decision to conserve and protect the remaining few fragments of which Namatimbili Forest is part that needs to be prioritised. This will make the forest habitat in the Kilwa-Lindi landscape thoroughly connected for conservation of high species richness and this may have high conservation implications to forest dependent species that require a large dynamic area for performance. The study forest is among interconnected valuable coastal forest fragments to include the Mitundumbeya, Mineature, biospheres, Mbarawala and Ngarama and the mangrove populations in a continuous matrix. The interconnected habitats may have been the cause of the existing wildlife corridors and Namatimbili Forest being the junction for these corridors in Kilwa-Lindi landscape, where wildlife migrate among the inter-connected coastal forests and Selous Game Reserve in Lindi Region. The major wildlife corridor originates from the southern part of Selous Game Reserve through Mitarure FR and biospheres to Namatimbili Forest. The corridor then radiates to the south, forming two arms that go through Mbarawala plateaus to Pindiro Forest Reserve. One sub corridor is a few kilometres north of Mavuji River-bridge, the second is located at Mavuji Bridge and the third passes south of Hoteli tatu up to Namakongoro in the Mangrove forest. Therefore, conservation management by protecting Namatimbili Forest will maintain the existing wildlife corridors among forest patches and Selous Game Reserve. Also increasing the matrix of conserved forest fragments within Kilwa-landscape provides adequate dynamic areas to various biodiversity components in the southern coastal ecoregion of Tanzania.

On the other hand, protecting Namatimbili Forest will ensure preservation of landscape values based on the observed plant biodiversity potentials and the forest gorge. The magnificence of the Namatimbili forest gorge provides a unique landscape feature that is unparalleled along the entire eastern African coast that increases the forests' conservation value. The presence of the forest gorge and a well-developed riparian forest cover along Mavuji River provide a unique characteristic of Namatimbili Forest in comparison with other coastal forests in Tanzania. Namatimbili forest gorge and caves under the coral rag limestone rocks in combination with the sacred forest with the hippo pool at Nyange River in Makangaga village provide long-term tourist potentials in the Kilwa landscape. The easy accessibility of the gorge from the main road increases its potential as a tourist destination linking between the coastal cities of Kilwa Kivinje, the ruins of Kilwa Kisiwani and the wildlife of the Selous Game Reserve which together increase the ecotourism potential of the Namatimbili forest and the Kilwa Landscape.

Conclusion

Namatimbili Forest has a number of habitats harbouring diverse plant species compositions. Although the woodland had high plant species diversity, it was represented by forest generalist species that were more evenly distributed than in the riverine and coral rag that had habitat specialist species with large biomass. The tree size class distributions are related to the habitat types and their performance are determined by respective habitat conditions in the forest. Bin (2012) pointed out that tree size distribution has long being of interest to ecologists and foresters because they reflect fundamental demographic processes. Although plant size class structures may provide insufficient basis for conservation management decisions (Virillo et al., 2010), the information gathered showed the presence of various size classes at different demographic levels, which gives a sufficient criterion for categorization of Namatimili as a forest reserve with adequately conserved and protected habitats. The size class distributions among the forest habitats reflect shade tolerance strategies and indicated that many populations were stable because of the limited major disturbance events within Namatimbili Forest. Wright et al. (2003) pointed out that shade-tolerance, demographic traits (fecundity, seedling mortality, recruit-ment, sapling growth and sapling mortality rates) is related to population size structure. However, Virillo et al. (2010) found no empirical evidence that population size structures are related to changes in population size. This implies that individuals of a cohort that begins at the same level of growth structure may pattern in a very different growth direction with time and growth resources resulting in different vegetation community structures. Multiple vegetation community structure in an ecosystem provides refuge to a number of species with different ecological requirements that has been portrayed in Namatimbili Forest. A successful biodiversity conservation model is that which takes into consideration of preservation of diverse habitats that are found in Namatimbili Forest similar to the adjacent coastal forests within Kilwa- Lindi landscape. The habitats in Namatimbili Forest are natural and therefore depict similar characteristics of the ecological rich coastal forest region making it of high conservation concern. From the ecological and biodiversity conservation context, the forest cannot be separated from the efforts to conserve the whole Kilwa-Lindi landscape and southern coastal forest. Based on findings from this study, the responsible organs may use this data in combination with various guidelines, including the biodiversity conservation convention of 2010 in strategic planning for protecting Namatimbili Forest. The appropriate zoning of all the unprotected fragments, including Namtimbili Forest as forest reserve by gazetting them will be assured of its protection under the regulation of forest reserves. This will minimize unsustainable conservation practices that have been operating in Kilwa landscape. The most effective and least expensive way of preserving biodiversity is by maintaining native species in their habitats where there is a greater chance of success in ensuring the long-term conservation (Rodrigues et al., 2007). Tanzania is currently limited of conserved forest reserves and this need promoting the unprotected forests to a conserved status so that biodiversity conservation objectives can be met. Like any other coastal forest in Tanzania, Namatimbili Forest cannot be treated in isolation rather the conservation efforts in the region should be inclusive with other forests adjacent to it. Regardless of the available information on the general characteristics of the southern coastal forests of Tanzania (Frontier, 2001; UTUMI, 2002; Howell et al., 2012), some forest patches are yet exhaustive. Based on the detailed characteristics of Namatimbili Forest high-lighted, the diverse ecological attributes may contribute to the decision to conserve aforementioned coastal forest fragments. The minimum area required for protecting endemic species in the coastal forests needs to include multiple habitat types along the southern coastal strip of Tanzania. Protecting the threatened, endemic and the near-endemic species require a matrix of interconnected patches with properly managed corridors and habitats. This should involve prioritisation of patches that are close to each other in one landscape for easy management. Namatimbili Forest is connected to the rest of the forest patches and hence the inclusion of this patch among conserved forests would benefit from the overall conservation of the southern coastal forest ecosystem of Tanzania. Species at greatest risk are those with restricted range and narrow habitat preference. Some species that were previously documented as extinct such as *Karomia gigas* and *Erythrina schliebenii* have been rediscovered in the Kilwa landscape (Clarke et al., 2011). The distribution of both species faces immediate negative fire impacts and human activities that points out the importance of habitat conservation in the region. *Karomiagigas* is more threatened because its habitats are directly affected by human activities than those of *Erythrina schliebenii* that are threatened by fire impacts (Howell et al., 2012). Consideration of biodiversity conservation should be regional specific because of the nature of the distribution pattern of plant species that are characterized by the high level of localized habitats. The principles that can be developed to conserve any ecological regions should not apply to the coastal forest conser-vation. This is because of the existing fragmented forests that are sufficiently isolated from one another and some of the plant species are localized within these forest patches resulting into low evenness for forest dependent species. Conservation in coastal forest should be holistic that takes into consideration of the interconnected habi-tats in a landscape. This will guarantee the protection of many species that are localized within some of the fragments, including those species that might have not been in contact with scientist eyes in the course of scanning the coastal forest biodiversity and demarcating biospheres for conservation in Tanzania. The conser-vation consideration should target the largest cover that is inclusive of the existing fragments within the landscape.

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Appendix 1. Plant species composition and distribution among habitats in Namatimbili forest.

S/N	Family	Plant species names	Author	Conservation status		Woodland habitat	Evergreen Forest	Coral rag Habitat	Riverine Habitat
				Endemism	**IUCN Thtreat**				
1	Acanthaceae	*Asystasia gangetica*	(L) T Anderson			x	x		X
2	Acanthaceae	*Barleria spinulosa*	Klotzsch			x	x		
3	Acanthaceae	*Blepharis affinis*	Lindau			x			
4	Acanthaceae	*Blepharis ciliaris*	(L) B L Burtt			x	x		
5	Acanthaceae	*Dicliptera aculeata*	C B Clarke			x		x	X
6	Acanthaceae	*Justicia stachytarphetoides*	(Lindau) C B Clarke			x	x	x	X
7	Adiantaceae	*Acrostichum aureum*	L			x		x	
8	Anacardiaceae	*Lannea stuhlmannii*	(Engl) Engl			x	x		
9	Anacardiaceae	*Lannea schimperi*	(A Rich) Engl			x	x	x	
10	Anacardiaceae	*Rhus glaucescens*	A Rich			x			
11	Anacardiaceae	*Rhus natalensis*	Krauss			x			
12	Anacardiaceae	*Sclerocarya birrea*	A Rich			x			
13	Anacardiaceae	*Sorindeia madagascariensis*	DC			x			X
14	Annonaceae	*Annona senegalensis*	Pers			x	x		X
15	Annonaceae	*Asteranthe asterias*	(S Moore) Engel & Diels	√	NT	x	x		
16	Annonaceae	*Asteranthe lutea*	Vollesen			x	x	x	
17	Annonaceae	*Cleistochlamys kirkii*	(Benth) Oliv			x		x	
18	Annonaceae	*Lettowianthus stellatus*	Diels	√	NT	x		x	x
19	Annonaceae	*Monanthotaxis buchananii*	(Engl) Verdc			x		x	
20	Annonaceae	*Monanthotaxis trichocarpa*	(Diels & Engl) Verdc	√	LC	x	x	x	
21	Annonaceae	*Monanthotaxis trichantha*	(Diels) Verdc	√	Vu	x	x	x	
22	Annonaceae	*Mkilua fragrans*	Verdc	√	vu	x	x		x
23	Annonaceae	*Monodora grandidieri*	Baill			x	x		
24	Annonaceae	*Ophrypetalum odoratum*	Diels	√	vu	x	x	x	x
25	Annonaceae	*Uvaria acuminata*	Oliv	√	LC	x	x		
26	Annonaceae	*Uvaria kirkii*	Hook f	√	NT	x	x		
27	Annonaceae	*Uvaria lucida*	Benth			x	x		
28	Annonaceae	*Uvariodendron gorgonis*	Verdc	√	en	x	x	x	x
29	Annonaceae	*Xylopia latipetala*	Verdc	√		x	x		
30	Amaryllidaceae	*Boophone disticha*	(L f) Herb			x		x	
31	Apocynaceae	*Ancylobothrya petersiana*	(Kl) Piarre			x			
32	Apocynaceae	*Diplorhynchys condylocarpon*	(Mull Arg) Pichon			x			

33	Apocynaceae	*Holarrhena pubescens*	G Don			x		x	
34	Apocynaceae	*Landolphia buchananii*	(Hallier f) Stapf				x		
35	Apocynaceae	*Landolphia kirkii*	Dyer			x	x		
36	Apocynaceae	*Pleiocarpa pycnantha*	(K Schum) Stapf			x	x		
37	Apocynaceae	*Saba comorensis*	(A DC) Pichon				x		x
38	Apocynaceae	*Strophanthus kombe*	Oliv			x	x	x	
39	Araliaceae	*Cussonia arborea*	A Rich				x		x
40	Araceae	*Zamioculcas zamiifolia*	(Lodd) Engl				x		
41	Asclepidiaceae	*Secamone parvifolia*	(Oliv) Bullock			x		x	
42	Asclepidiaceae	*Parquetina nigrescens*	(Afz) Bullock				x		
43	Liliaceae	*Asparagus africanus*	Lam			x	x	x	
44	Liliaceae	*Asparagus falcatus*	Lam			x	x	x	
45	Liliaceae	*Asparagus aethiopicus*	Lam			x	x		
46	Balanitaceae	*Balanites aegyptiaca*	(L) Delile			x			
47	Balanitaceae	*Balanites maughamii*	Sprague	√		x	x		
48	Baringtoniceae	*Baringtonia racemosa*	(L) Spreng			x			x
49	Bignoniaceae	*Kigelia africana*	(Lam) Benth			x			
50	Bignoniaceae	*Markhamia lutea*	(Benth) K Schum			x			
51	Bignoniaceae	*Markhamia obtusifolia*	(Baker) Sprague			x	x		
52	Bignoniaceae	*Markhamia zanzibarica*	(DC) K Schum			x			
53	Bignoniaceae	*Stereospermum kunthianum*	Cham			x		x	
54	Bombacaceae	*Adansonia digitata*	Lim			x		x	
55	Bombacaceae	*Bombax rhodognaphalon*	K Schum			x	x	x	
56	Burseraceae	*Commiphora africana*	(A Rich) Engl			x		x	
57	Burseraceae	*Commiphora madagascariensis*	Jacq			x	x		
58	Burseraceae	*Commiphora zanzabarica*	(Baill) Engl			x			
59	Capparaceae	*Boscia salicifolia*	A Rich			x			x
60	Capparaceae	*Boscia angustifolia*	A Rich			x	x	x	
61	Capparaceae	*Pseudocladosternon kirkii*	Oliv Pax & Gilg			x	x		
62	Capparaceae	*Maerua angolensis*	DC			x			x
63	Capparaceae	*Maerua grantii*	Oliv			x	x		
64	Capparaceae	*Maerua triphylla*	A Rich			x	x		
65	Capparaceae	*Thylachium densiflorum*	Gilg-Ben & Benedict			x		x	
66	Capparaceae	*Capparis tomentosa*	Lam			x			
67	Capparaceae	*Capparis fascicularis*	DC			x	x		
68	Celastraceae	*Elaeodendron buchananii*	(Loes) Loes			x		x	
69	Celastraceae	*Maytenus undata*	(Thunb) Blakelock			x		x	

70	Celastraceae	*Maytenus mossambicensis*	(Klotzsch) Blakelock			x		x	
71	Celastraceae	*Mystroxylon aethiopicum*	(Thunb) Loes			x			x
72	Celastraceae	*Salacia elegans*	Oliv			x			x
73	Celastraceae	*Salacia leptoclada*	Tul			x	x		x
74	Celastraceae	*Salacia madagascariensis*	(Lam) DC			x	x		
75	Chrysobalanaceae	*Parinari curatellifolia*	Planch ex Benth			x			
76	Combretaceae	*Combretum aculeatum*	Vent			x		x	
77	Combretaceae	*Combretum fragrans*	F Hoffm			x			
78	Combretaceae	*Combretum collinum*	Fresen			x		x	
79	Combretaceae	*Combretum constrictum*	(Benth) M A Lawson			x			x
80	Combretaceae	*Combretum apiculatum*	Sond			x			x
81	Combretaceae	*Combretum hereroense*	Schinz			x			
82	Combretaceae	*Combretum molle*	G Don			x			
83	Combretaceae	*Combretum zeyheri*	Sond			x		x	
84	Combretaceae	*Terminalia kaiserana*	F Hoffm			x		x	
85	Combretaceae	*Terminalia sambesiaca*	Engl & Diels			x		x	
86	Combretaceae	*Terminalia sericea*	DC			x			
87	Combretaceae	*Terminalia boivinii*	Tul			x		x	
88	Commelinaceae	*Commelina benghalensis*	Wall			x	x	x	x
89	Commelinaceae	*Commelina africana*	L			x	x	x	x
90	Commelinaceae	*Cyanotis foecunda*	Hassk			x	x		x
91	Compositae	*Aspilia mossambicensis*	(Oliv) Wild			x	x		
92	Compositae	*Brachylaena huillensis*	O Hoffm			x	x		
93	Compositae	*Bidens pilosa*	L			x			x
94	Compositae	*Dichrocephala integrifolia*	(L f)Kuntze			x	x		
95	Compositae	*Dicoma tomentosa*	Cass			x		x	
96	Compositae	*Ethulia conyzoides*	L f			x	x		
97	Compositae	*Pluchea dioscorides*	(L) DC			x			x
98	Compositae	*Sphaeranthus suaveolens*	(Forsk) DC			x			x
99	Compositae	*Tridax procumbens*	L			x			x
100	Compositae	*Vernonia perrottetii*	Sch Bip ex Walp			x			x
101	Compositae	*Vernonia glabra*	(Steetz) Vatke			x			x
102	Compositae	*Vernonia amygdalina*	Delile			x			x
103	Convolvulaceae	*Ipomoea obscura*	(L) KerGawl			x			x
104	Crassulaceae	*Kalanchoe lanceolata*	(Forssk) Pers			x		x	
105	Cycadaceae	*Encephalartos hildebrandtii*	A Br & Bouche var	√	NT	x	x	x	
106	Cyperaceae	*Cyperus alopecuroides*	Rottb			x	x	x	x

107	Cyperaceae	*Cyperus alternifolia*	L			x			x
108	Cyperaceae	*Cyperus exaltatus*	Retz			x			x
109	Dichapetalaceae	*Dichapetalum mossambicense*	(Klotzsch) Engl			x	x		x
110	Dichapetalaceae	*Dichapetalum macrocarpum*	M Krause			x	x		x
111	Dichapetalaceae	*Dichapetalum stuhlmannii*	Engl			x	x		
112	Dichapetalaceae	*Dichapetalum braunii*	Engl & K Krause	√		x			x
113	Dilleniaceae	*Tetracera boiviniana*	Baill			x	x	x	
114	Dilleniaceae	*Tetracera litoralis*	Gilg	√		x	x		
115	Ebenaceae	*Diospyros consolatae*	Chiov			x	x		
116	Ebenaceae	*Diospyros mespiliforms*	A DC			x	x		
117	Ebenaceae	*Diospyros squarrosa*	Klotzsch			x	x		
118	Ebenaceae	*Diospyros kirkii*	Hiern			x	x		
119	Ebenaceae	*Diospyros mafiensis*	FWhite			x	x		
120	Ebenaceae	*Euclea natalensis*	A DC			x	x		
121	Ebenaceae	*Euclea racemosa*	(A DC) F White			x			
122	Euphorbiaceae	*Alchornea hirtella*	Benth			x		x	
123	Euphorbiaceae	*Alchornea laxiflora*	(Benth) Pax & K Hoffm			x	x		
124	Euphorbiaceae	*Antidesma venosum*	Tul			x	x		
125	Euphorbiaceae	*Bridelia cathartica*	G Bertol			x	x		
126	Euphorbiaceae	*Croton megalocarpoides*	Friis & Gilbert			x			
127	Euphorbiaceae	*Drypetes arguta*	(Müll Arg) Hutch			x			x
128	Euphorbiaceae	*Drypetes natalensis*	(Harv) Hutch			x	x		
129	Euphorbiaceae	*Drypetes usambarica*	(Pax) Hutch			x			x
130	Euphorbiaceae	*Euphorbia candelabrum*	Kotschy			x		x	
131	Euphorbiaceae	*Euphoribia grantii*	Oliv			x		x	
132	Euphorbiaceae	*Flueggea virosa*	(Willd) Voigt			x			x
133	Euphorbiaceae	*Spirostachys africana*	Sond			x			x
134	Euphorbiaceae	*Suregada zanzibariensis*	Baill			x	x		
135	Euphorbiaceae	*Uapaca nitida*	Mull Arg			x			
136	Fabaceae	*Abrus precatorius*	L			x			x
137	Fabaceae	*Acacia polyacantha*	(A Rich) Brenan			x			x
138	Fabaceae	*Acacia sieberiana*	DC			x			
139	Fabaceae	*Afzelia quanzensis*	Welw			x			
140	Fabaceae	*Albizia glaberrima*	Schum & Thomm			x			x
141	Fabaceae	*Albizia versicolor*	Welwex Oliv			x			x
142	Fabaceae	*Baphia wollastonii*	Bak f			x	x		
143	Fabaceae	*Baphia punctulata*	Harms			x	x		

144	Fabaceae	*Baphia kirkii*	Baker	√	vu		x		x
145	Fabaceae	*Tylosema fassoglensis*	(Schweinf) Torre & Hillc			x			
146	Fabaceae	*Bauhinia tomentosa*	L			x		x	
147	Fabaceae	*Brachystegia boehmii*	Taub			x			
148	Fabaceae	*Brachystegia microphylla*	Harms			x			
149	Fabaceae	*Burkea Africana*	Hook			x			
150	Fabaceae	*Cassia abbreviata*	Oliv	√		x			
151	Fabaceae	*Cassia astrofistula*	(Holmes) Brenan			x			
152	Fabaceae	*Cordyla africana*	Lour			x			
153	Fabaceae	*Craibia brevicaudata*	(Vatke) Dunn			x			
154	Fabaceae	*Crotalaria goodiiformis*	Vatke			x			x
155	Fabaceae	*Cynometra webberi*	Baker f	√	Vu	x		x	
156	Fabaceae	*Cynometra gillmanii*	J Leonard	√	Cr		x		
157	Fabceae	*Cynometra greenweyi*	Brenan	√			x	x	
158	Fabaceae	*Dalbergia arbusifolia*	Baker			x			
159	Fabaceae	*Dalbergia nitidula*	Baker			x			
160	Fabaceae	*Dialium holtzii*	Harms	√	vu	x			
161	Fabaceae	*Dolichos oliveri*	Schweinf			x			
162	Fabaceae	*Entada abyssinica*	Steud			x	x		
163	Fabaceae	*Erythrina sacleuxii*	Hua	√	vu	x		x	
164	Fabaceae	*Erythrina schliebenii*	Harms	√	ex	x		x	
165	Fabaceae	*Erythrophleum suaveolens*	(Guill & Perr) Brenan			x		x	
166	Fabaceae	*Macrotyloma axillare*	(E Mey) Verdc			x	x		
167	Fabaceae	*Lonchocarpus bussei*	Harms			x			
168	Fabaceae	*Lonchocarpus capassa*	Rolfe			x			
169	Fabaceae	*Millettia impressa*	Harms			x	x		
170	Fabaceae	*Mundulea sericea*	(Willd) A Chev			x	x		
171	Fabaceae	*Newtonia paucijuga*	(Harms) Brenan	√	vu	x	x		x
172	Fabaceae	*Parkia filicoides*	Oliv			x	x		
173	Fabaceae	*Pilliostigma thonningii*	Schumach			x			
174	Fabaceae	*Pterocarpus angolensis*	DC		LR/nt	x			
175	Fabaceae	*Pterocarpus rotundifolius*	(Sond) Druce			x			
176	Fabaceae	*Rhynchosia hirta*	(Andr) Meikle & Verdc			x			x
177	Fabaceae	*Rhynchosia minima*	(L) DC			x	x		x
178	Fabaceae	*Scorodophloeus fischeri*	(Taub) J Leonard	√		x	x		x
179	Fabaceae	*Senna singueana*	(Del) Lock	√		x			x
180	Fabaceae	*Sesbania sesban*	L			x			x

181	Fabaceae	*Tamarindus indica*	L			x			
182	Fabaceae	*Tessmania densiflora*	Harms	√	en	x	x		
183	Fabaceae	*Xerroderis stuhlmannii*	(Thau) Mendonca & Sousa			x	x		
184	Fabaceae	*Dichrostachys cinerea*	(L) Wight & Arm			x			
185	Fabaceae	*Millettia usaramensis*	Lam	√		x	x		
186	Flacourtiaceae	*Apodytes dimidiata*	E Mey ex Arn			x			
187	Flacourtiaceae	*Casearia engleri*	Gilg			x		x	
188	Flacourtiaceae	*Caloncoba welwitschii*	(Oliv) Gilg			x	x		x
189	Flacourtiaceae	*Dovyalis hispidula*	Wild			x			
190	Flacourtiaceae	*Flacourtia indica*	(Burm f) Merr			x	x		
191	Flacourtiaceae	*Homalium abdessammadii*	Asch & Schweinf			x	x		
192	Flacourtiaceae	*Xylotheca tettensis*	(Klotzsch) Gilg	√		x			
193	Flagellariaceae	*Flagellaria guineensis*	Schumach			x			
194	Gramineae	*Bambusa vulgaris*	Wenell			x		x	
195	Gramineae	*Chloris virgata*	Sw			x			x
196	Gramineae	*Echinochloa colona*	(L) Link			x			x
197	Gramineae	*Echinochloa haploclada*	(Stapf) Stapf			x			x
198	Gramineae	*Eleusine indica*	(Kenn-O'Byrne) SMPhillips			x			
199	Gramineae	*Eragrostis aspera*	(Jacq) Nees			x			x
200	Gramineae	*Hyparrhenia variabilis*	Stapf			x			x
201	Gramineae	*Heteropogon contortus*	(L) Roen & Schult			x		x	
202	Gramineae	*Imperata cylindrica*	(L) Raeusch			x			x
203	Gramineae	*Loudetia simplex*	(Nees) C E Habb			x	x		
204	Gramineae	*Panicum maximum*	Jacq			x			x
205	Gramineae	*Panicum trichocladum*	K Schum			x			x
206	Gramineae	*Pennisetum purpureum*	Schumach			x			x
207	Gramineae	*Setaria sphacelata*	(Schum) M B Moss ex Stapf & C E Hubb			x			x
208	Gramineae	*Themeda triandra*	Forssk			x			
209	Guttiferae	*Garcinia livingstonei*	T Anderson			x			
210	Guttiferae	*Garcinia volkensii*	Engl			x			x
211	Guttiferae	*Vismia pauciflora*	Milne-Redh	√	en	x	x		x
212	Guttiferae	*Psorospermum febrifugum*	Spach			x		x	
213	Lamiaceae	*Basilicum polystachyon*	(L) Moench			x		x	
214	Lamiaceae	*Hoslundia opposita*	Vahl			x			x

215	Lamiaceae	*Plectranthus seretii*	(De Wild) Vollesen			x			x
216	Liliaceae	*Sansevieria gracilis*	N B E Br			x		x	
217	Liliaceae	*Drimiopsis perfoliata*	Baker			x	x		
218	Liliaceae	*Dracaena mannii*	Baker			x	x		
219	Liliaceae	*Sansevieria fischeri*	DC			x		x	
220	Linaceae	*Hugonia grandiflora*	N Robson			x	x		x
221	Loganiaceae	*Strychnos cocculoides*	Baker			x			
222	Loganiaceae	*Strychnos henningsii*	Gilg			x			
223	Loganiaceae	*Strychnos innocua*	Del			x			
224	Loganiaceae	*Strychnos madagascariensis*	Poir			x			
225	Loganiaceae	*Strychnos pototorum*	Lf			x			
226	Malvaceae	*Azanza garckeana*	(FHoffm) Exell & Hillc			x	x		
227	Melastomataceae	*Memecylon sansibaricum*	Taub			x			
228	Meliaceae	*Khaya anthotheca*	(Welw) CDC	√	vu				x
229	Moraceae	*Ficus lutea*	Vahl						x
230	Moraceae	*Ficus exasperata*	Vahl						x
231	Moraceae	*Ficus ingens*	(Miq) Miq						x
232	Moraceae	*Ficus natalensis*	Hochst						x
233	Moraceae	*Milicia excelsa*	(Welw) Benth & Hook f	√	Ln/nt			x	x
234	Myrtaceae	*Syzygium guineense*	(Welw) CC Berg						x
235	Ochnaceae	*Ochna holstii*	Engl				x		
236	Ochnaceae	*Ochna mossambicensis*	Klotzsch				x		
237	Olacaceae	*Olax dissitiflora*	Oliv				x		
238	Olacaceae	*Olax petandra*	Sleumer				x		
239	Olacaceae	*Ximenia americana*	L			x			
240	Onagraceae	*Ludwigia stolonifera*	(Gill & Perr) P H Raven						x
241	Orchidaceae	*Microcoelia exilis*	Lindl						x
242	Palmae	*Borasuss aethiopum*	Mart						x
243	Palmae	*Phoenix reclinata*	Jacq			x			x
244	Palmae	*Hyphaene compressa*	HWandl						
245	Passifloraceae	*Schlechterina mitostemmatoides*	Harms			x	x		
246	Rhamnaceae	*Ziziphus mucronata*	Willd			x			
247	Rubiaceae	*Chassalia umbreticola*	Vatke			x	x		
248	Rubiaceae	*Catunaregam spinosa*	(Thunb) Tirvengadum			x			
249	Rubiaceae	*Coffea sessiliflora*	Bridson	√		x	x		
250	Rubiaceae	*Coffea pseudozanguebaricae*	Hiern	√	vu		x		
251	Rubiaceae	*Crossopteryx febrifuga*	(G Don) Benth			x	x		

252	Rubiaceae	*Gardenia transvenulosa*	Verdc	√	vu	x	x		
253	Rubiaceae	*Hymenodictyon parvifolium*	Oliv			x	x		
254	Rubiaceae	*Keetia venosa*	(Oliv) Bridson			x	x		
255	Rubiaceae	*Keetia zanzibarica*	(Klotzsch) Brindson			x	x	x	
256	Rubiaceae	*Lamprothamnus zanguebaricus*	Hiern			x			
257	Rubiaceae	*Leptactina platyphylla*	(Hern)Wernham					x	
258	Rubiaceae	*Leptactina delagoensis*	K Schum			x		x	
259	Rubiaceae	*Leptactina papyrophloea*	Verdc			x			
260	Rubiaceae	*Mitragyna rubrostipulata*	(K Schum) Havil			x			
261	Rubiaceae	*Oxyanthus pyriformis*	(Hochst) Skeels			x	x		
262	Rubiaceae	*Oxyanthus speciosus*	DC			x	x		
263	Rubiaceae	*Polysphaeria multiflora*	Hiern						x
264	Rubiaceae	*Rothmania whitfieldii*	(Lindl) Dandy				x		x
265	Rubiaceae	*Rystignia decussata*	(K Schum) Robyns				x		
266	Rubiaceae	*Uncaria africana*	G Don						x
267	Rubiaceae	*Vangueria infausta*	Burch			x			
268	Rutaceae	*Vepris lanceolata*	(Lam) G Don			x			
269	Rutaceae	*Vepris nobilis*	(Delile) Mziray			x	x		
270	Rutaceae	*Vepris glomerata*	(F Hoffm) Engl			x	x		
271	Rutaceae	*Clausina anisata*	(Willd) Benth			x			
272	Rutaceae	*Teclea nobilis*	Delile			x			
273	Rutaceae	*Teclea simplicifolia*	(Engl) Verd			x			
274	Rutaceae	*Zanthoxylum chalybeum*	Engl			x			
275	Rutaceae	*Zanthoxylum holtzianum*	(Engl) PGWaterman	√	vu	x			
276	Salvadoraceae	*Dobera loranthifolia*	(Warb) Harms			x			
277	Sapindaceae	*Allophyllus africanus*	P Beauv			x			x
278	Sapindaceae	*Deinbollia borbonica*	Scheff			x			
279	Sapindaceae	*Haplocoelum inopleum*	Radlk			x	x		
280	Sapindaceae	*Haplocoelum foliosum*	(Hiern) Bullock			x	x		
281	Sapindaceae	*Lepisanthes senegalensis*	(Poir) Leenh			x			
282	Sapindaceae	*Macphersonia gracilis*	O Hoffm			x			
283	Sapindaceae	*Majidea zanguebarica*	JKirk			x			
284	Sapindaceae	*Pancovia golungensis*	(Hiern) Exell & Mendonça			x	x		
285	Sapindaceae	*Paullinia pinnata*	L			x	x		
286	Sapindaceae	*Zanha africana*	(Radlk) Exell			x			
287	Sapotaceae	*Englerophytum natalense*	(Sond) T D Penn			x			

288	Sapotaceae	*Malacantha alnifolia*	(Baker) Pierre			x	x		
289	Sapotaceae	*Manilkara discolor*	(Sond) J H Hemsl			x			
290	Sapotaceae	*Manilkara sansibarensis*	engl			x	x		
291	Sapotaceae	*Mimusops fruticosa*	Lam			x	x		
292	Sapotaceae	*Mimusops kummer*	A DC			x	x		
293	Sapotaceae	*Mimusops schliebenii*	Mildbr & G M Schulze			x			
294	Sapotaceae	*Synsepalum brevipes*	(Baker) Pennington			x	x		
295	Schizaeaceae	*Lygodium microphyllum*	(Cav) R Br			x			
296	Simaroubaceae	*Harrisonia abyssinica*	Oliv			x			x
297	Sterculiaceae	*Cola discoglyoremnophylla*	Brenan & A P D Jones					x	
298	Sterculiaceae	*Cola greenwayi*	Brenan					x	
299	Sterculiaceae	*Dombeya rotundifolia*	(Hochst) Planch			x	x		
300	Sterculiaceae	*Dombeya shupangae*	K Schum			x			
301	Sterculiaceae	*Pterygota perrieri*	Hochr			x			
302	Sterculiaceae	*Sterculia appendiculata*	K Schum ex Engl			x			
303	Sterculiaceae	*Sterculia quinqueloba*	(Garcke) K Schum			x			
304	Tiliaceae	*Grewia bicolor*	A Juss			x			
305	Tiliaceae	*Grewia conocarpa*	K Schum			x			
306	Tiliaceae	*Grewia microcarpa*	K Schum			x			
307	Tiliaceae	*Grewia platyclada*	Mast			x			
308	Tiliaceae	*Grewia similis*	K Schum			x			
309	Tiliaceae	*Triumfetta rhomboidea*	Jacq						x
310	Ulmaceae	*Trema orientalis*	(L) Blume			x			
311	Verbenaceae	*Vitex mombassae*	Vatke			x	x		
312	Verbenaceae	*Vitex zanzibariensis*	Vatke	√	vu	x	x		
				36	26	281	122	62	85