

Addis Ababa University
School of Graduate Studies
Department of Biology

**Conservation of *Brachylaena huillensis* O.Hoffm
(Asteraceae) in Dindili Forest Reserve, Morogoro,
Tanzania**

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**M.Sc. thesis submitted to the school of graduate studies,
Addis Ababa University in the partial fulfilment of the
requirements of the Degree - Dryland Biodiversity**

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By

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DEDICATION

This work is dedicated to my parents Perfect and Mary Mrema whose ever present inspirations and love laid the concrete foundation of my education. I also dedicate it to my Aunt Adeline Lyaruu for endless support and prayers for my success.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS	i
DEDICATION	ii
LIST OF FIGURES	vi
LIST OF TABLES	vii
LIST OF PLATES	viii
LIST OF APPENDICES	ix
ABSTRACT	x
1.0 INTRODUCTION	1
1.1 PROBLEM STATEMENT AND JUSTIFICATION	2
1.2 OBJECTIVES OF THE STUDY	4
1.2.1 General Objective	4
1.2.2. Specific Objectives:	4
2.0 LITERATURE REVIEW	5
2.1 COASTAL FORESTS	5
2.1.1 Coastal Forests as a conservation unit	5
2.1.2 Problems Facing Coastal Forests	7
2.2 FLAGSHIP SPECIES	8
2.2.1 Flagship Species Concept	8
2.2.2 Flagship Species Fund	8
2.3 COMMUNITY INVOLVEMENT IN FOREST RESOURCE MANAGEMENT IN TANZANIA	9
2.4 ECOLOGY OF <i>Brachylaena huillensis</i>	10
2.4.1 Reproduction of <i>Brachylaena huillensis</i>	10
2.4.2 Spatial Distribution	13
2.4.3 Growth Rate of <i>Brachylaena Huillensis</i>	14

3.0 MATERIAL AND METHODS	15
3.1 STUDY AREA DESCRIPTION.....	15
3.2 DATA COLLECTION	18
3.2.1 Reconnaissance survey.	18
3.2.2 Forest Inventory	18
3.2.3 Ethnobotanical Data Collection	22
3.3 DATA ANALYSIS	24
4.0 RESULTS	27
4.1 FLORISTIC COMPOSITION	27
4.2 STANDING WOOD STOCKS	27
4.2.1 Density	27
4.2.2 Density Distribution by DBH Classes	28
4.2.3 Basal Area.....	30
4.2.4 Standing Volume	30
4.2.5 Importance Value Index (IVI)	31
4.3 HARVESTED WOOD.....	31
4.4 NATURAL REGENERATION.....	32
4.4.1 Coppicing Regeneration.....	32
4.4.2 Seedling and Sapling Density	33
4.5 DISTURBANCES	33
4.5.1 Fire	33
4.5.2 Illegal Harvesting.....	34
4.6 USE <i>Brachylaena huillensis</i> IN FULWE VILLAGE	35
4.7 MANAGEMENT OF <i>Brachylaena huillensis</i>.....	43
4.7.1 Status of <i>Brachylaena huillensis</i> from Respondents Point of View.	43
4.7.2 <i>Brachylaena huillensis</i> as an Agroforestry tree.	44
4.7.3 Planting <i>B. huillensis</i>	45
4.7.4 Participatory Forest Management	45

5.0 DISCUSSION	47
5.1 FLORISTIC COMPOSITION.....	47
5.2 STANDING WOOD STOCKS.....	47
5.3 HARVESTED WOOD.....	49
5.4 NATURAL REGENERATION.....	49
5.5 FIRE.....	50
5.6 USE OF <i>B. huillensis</i>.....	50
5.7 IN-SITU VERSUS EX-SITU CONSERVATION OF <i>Brachylaena huillensis</i>	51
5.8 PARTICIPATORY FOREST MANAGEMENT (PFM)	52
5.9 FLAGSHIP SPECIES POTENTIAL OF <i>Brachylaena huillensis</i>	53
6. 0 CONCLUSION AND RECOMMENDATIONS.....	56
6.1 CONCLUSION	56
6.2 RECOMMENDATIONS.....	57
7.0 REFERENCES.....	59
8. 0 APPENDICES	67

LIST OF FIGURES

Figure 1: The Zanzibar- Inhambane regional mosaic and the Coastal Forest belt	6
Figure 2: Climatic diagram for Dindili Forest Reserve	15
Figure 3: The location of Dindili Forest Reserve and surrounding public lands, Morogoro, Tanzania	17
Figure 4: The map of Dindili forest reserve showing boundary beacons, transect lines and plots.....	19
Figure 5: The percentage contribution of five woody species with highest density to woody species density of the Forest reserve.....	28
Figure 6: Density distribution by DBH classes of the forest reserve.....	29
Figure 7: Density distribution by DBH classes of <i>B. huillensis</i> in Dindili forest reserve.	29
Figure 8: The percentage contribution of five woody species with highest basal area to woody species basal area of the Forest reserve.	30
Figure 9: The percentage contribution of five woody species with highest standing volume to woody species standing volume in the forest reserve.....	31
Figure 10: The percentage contribution of woody species with highest harvested volume to volume of wood harvested from the forest reserve.....	32
Figure 11: The mentioned use categories of <i>Brachylaena huillensis</i>	36
Figure 12: Cultural value of <i>Brachylaena huillensis</i> in Fulwe village.	42
Figure 13: Status of <i>Brachylaena huillensis</i> in Dindili forest reserve from Respondents point of view.	43
Figure 14: Status of <i>Brachylaena huillensis</i> in farms, homesteads, private woodlots and public forests from Respondents point of view.	44
Figure 15: The reasons for not using <i>B. huillensis</i> as an agroforestry tree.....	44
Figure 16: Reasons for not planting <i>B. huillensis</i> in homesteads, farms and private woodlots.....	45
Figure 17: Sources of tree products in Fulwe village.	46

LIST OF TABLES

Table 1: The measurements taken within concentric plots.	20
Table 2: Preference ranking for ten highly preferred woody species for firewood.	37
Table 3: Preference ranking of ten woody species preferred for charcoal.	38
Table 4: Preference ranking of five preferred woody species for building poles.	39
Table 5: Preference ranking for five highly preferred woody species for carvings.	40
Table 6: Preference ranking of six highly preferred woody species for tools.	40
Table 7: Preference ranking of four most sold woody species in Fulwe village.	41
Table 8: Direct matrix ranking of woody species in Fulwe village.	42
Table 9: The evaluation of the flagship species potential of <i>Brachylaena huillensis</i> in Fulwe village.	55

LIST OF PLATES

Plate 1: <i>Brachylaena huillensis</i> tree.....	28
Plate 2: Fire burning in Dindili forest reserve	34
Plate 3: A charcoal kiln under construction in the forest reserve	35
Plate 4: A pit sawing area in the forest reserve.....	35
Plate 5: A house under-construction using <i>Brachylaena huillensis</i> poles in Fulwe village.	39
Plate 6: The dense grass layer in the periphery of Dindili forest reserve.	50

LIST OF APPENDICES

Appendix 1: Questions Administered to Households, Regional Catchment Forest Officer and the District Forest Officer	67
Appendix 2: A Checklist of woody species encountered Dindili forest reserve.	75
Appendix 3: Importance Value Index (IVI) of woody species in Dindili forest reserve..	78
Appendix 4: Standing volume of Woody species in Dindili forest reserve.....	81
Appendix 5: Harvested volume of woody species from Dindili forest reserve.....	84
Appendix 6: Coppicing potential of woody species in Dindili forest reserve.	85
Appendix 7: Use Values of multipurpose woody species in Fulwe village.	86

ABSTRACT

A flagship species is a species chosen to represent an environmental cause, such as an ecosystem in need of conservation, it is chosen for its vulnerability, attractiveness or distinctiveness in order to best engender support and acknowledgement from the public at large. *Brachylaena huillensis* O.Hoffm (Asteraceae) is a threatened economically important tree species commonly found in dry coastal forests of Tanzania and a potential flagship species in conservation of its habitat. The study was done around Dindili forest reserve, Fulwe village, Morogoro, to assess *B. huillensis* standing and harvested wood stocks, coppice regeneration, use, management and its flagship species potential in conserving its habitat. Data were collected using forest inventory, focus group discussion and quantitative ethnobotany (use values, direct matrix ranking, preference ranking and structured interview). The standing wood stock of *B. huillensis*, was found to be substantial as revealed by relatively high tree density (15 stems per/ ha), basal area (0.73m²/ha), volume (5.63m³/ha) and IVI (13.87). *B. huillensis* was found to be highly harvested as indicated by over one-third of previously standing wood stock already harvested. The observed preferential harvesting of female *B. huillensis* tree presents a serious ecological threat to its future successful reproduction. *B. huillensis* density distribution by dbh classes showed abnormal trend, which signify poor recruitment and regeneration. The results of coppice regeneration found *B. huillensis* to be a very poor resprouter. However, its regeneration from seed is promising in the forest reserve. The species (*B. huillensis*) was found to be known by 84% of respondents and used by 78% of them for different purposes. The species is intensively utilized for poles and posts as mentioned by 76% of respondents, its poles were claimed to be durable and extremely resistant to termites. Results of preference ranking showed that it is the most preferred species for building poles and the most sold tree species; it was also positioned second in carving use category. *B. huillensis* was found to be a useful multipurpose tree species as it was ranked second and fourth in direct matrix ranking and use values respectively. The ongoing Joint Forest Management (JFM) of the forest reserve does not show positive results, mainly due to lack of important socio-economic considerations during its inception. Frequent fires threaten the perpetuity of the studied coastal forest. Based on the developed criteria, *B. huillensis* was found to be an excellent flagship species in

conservation of its habitat. Among others, the study recommends research on *B.huillensis* sex-ratio, restoration of its normal regeneration trend in the forest reserve and review of JFM.

1.0 INTRODUCTION

Flagship species are those that appeal to the public and have other features that make them suitable for communicating conservation concern. Effective flagship species not only characterize diverse ecosystems, but also connect cultural, political and social value systems to nature (Bowen-Jones and Entwistle, 2000).

Silver oak is the common name for *Brachylaena huillensis*, (Family, Asteraceae, known as Muhuhu in Swahili (Choge, 2002). It is a threatened economically important timber species in Tanzania (Ruffo and Maliondo, 1990) and a potential flagship species to justify conservation of its habitat.

B. huillensis flowers define its name, on the flowers, the bracts surrounding the discs are shorter than flowers and are basis of generic name, which is based on Greek words meaning “short” and “cloak”. The specific name means “of huilla”, a place in Angola. Its capitula are small, white, cylindrical, up to 2.5cm long in capillary wood panicle. Fruits are small, winged achene in a white capitulum. Its leaves are entire or dentate, oblanceolate; apex acute; base long cuneate. Its bark is grey, smooth or rough with longitudinal cracks. It grows up to 35m tall with dbh of 85 cm under favorable conditions (AgroForestryTree Database, 2003).

This species occurs in Angola, Kenya, Mozambique, Tanzania and Uganda. In Kenya, it is found in upland semi-deciduous forest and lowland dry forest or thicket (Beentje, 1994). It is found in the Usambara steppe and coastal lowlands of Tanzania (WCMC, 1991). The species is dominant in ever-green bush, is common in dry coastal forests and Semi-deciduous dry upland forests (1500m-2000m) (FAO,1986b). The distribution of this species is patchy (Marshall and Jenking, 1994).

B. huillensis has been used for sleepers, flooring blocks, furniture, carving and turnery. Its trade name is “muhuhu” and main use internationally is now for wood carvings. It is commonly used in Tanzania for building posts. In Kenya, this species is only used in the carving industry and not for sawn wood (Marshall and Jenking, 1994). The timber is

used in England for flooring in areas of high pedestrian traffic and in hotels and public buildings because of its attractive look. India is reported to import small quantities of the wood to be used to substitute for sandal wood (*Santalum album*) in cremation (AgroForestryTree Database, 2003). The species is also used for perfumery and toilet preparations (Bryce and Chihongo, 1999).

Information about *B.huillensis* exploitation and conservation is lacking in Tanzania. In neighbouring country Kenya, much of the habitat of this species has been lost and the remaining trees are subject to increasingly heavy felling (WCMC, 1991). It is also suffering from habitat loss due to settlements and cultivation (FAO, 1986a). A recent inventory in Arabuko-Sokoke Forest reserve, Kenya confirmed a declining resource of the existing *B. huillensis* stock. The result indicated an existing stock of 2.7 m³/ha, of which only 50% was suitable for carving (CIFOR infobrief, 2002). Licences are issued to collect dead *B. huillensis* wood but most of trees removed are either newly dead (possibly ring barked trees) or illegally cut trees. (Marshall and Jenking, 1994). With the current illegal, unsustainable extraction from the forest estimated at over 2500m³ per year coupled with low growth rates for species (2.5% per year), the study concluded that the resource will be depleted in less that 2-3 decades (CIFOR infobrief, 2002).

B.huillensis is considered a priority for insitu conservation by FAO (1986a). Additionally, carvers in the Akamba handicraft cooperative in Mombassa, Kenya and local farmers have now developed alternative materials for carving needs using alternative species such as *Azadirachta indica* (neem) and *Mangifera indica* (Mango) referred to as “good woods”. However, most of the carvers are familiar with hardwoods and have few incentives to make a switch, carving hardwood is more convenient in the sense that there is no need to cure timber (Susanne, 2000).

1.1 PROBLEM STATEMENT AND JUSTIFICATION

The Convention on International Trade in Endangered Species (CITES) has been utilized for over twenty years as a tool to help conserve wild species which are traded internationally. CITES (1997) reported that *Brachylaena huillensis* can qualify for

appendix II of the CITES which means although the species is not necessarily threatened with extinction, may become so unless trade is strictly regulated in order to avoid utilization incompatible with its survival. The report, however, pointed out the paucity data to certainly include the species in CITES list of endangered species. In 2006 IUCN red list, *B. huillensis* is categorized as Lower Risk/ Near Threatened (LR/nt) based on assessment by WCMC (1998) using 1994 IUCN red list criteria, which means the species is not critically endangered, endangered or vulnerable, but close to qualifying as vulnerable due to ongoing selective logging and habitat loss (IUCN, 2006). The Lower Risk/ Near Threatened (LR/nt) category mentioned above is almost equivalent to nearly threatened category of new 2001 IUCN red list criteria. Additionally, data from World Conservation Monitoring Center (WCMC), shows that *B.huillensis* is either extinct, endangered, vulnerable or rare in Uganda (African Hardwoods, 2000).

In neighbouring country, Kenya, *B. huillensis* is the most intensively utilized wood carving species (Choge, 2002). The wood carving industry in Kenya generates an income of over US \$10 million each year for 60,000 carvers and their dependants (Susanne, 2000). The diameter profiles of *B.huillensis* logs entering the wood carving centers across the country are dominated by logs of 10-15 diameters. This targeting of juvenile tree sizes is an indication of scarcity hence a serious ecological threat to the conservation status of the species in the existing source areas. The decline of the *B.huillensis* populations in Kenya has led to massive illegal importation of *B.huillensis* logs from Tanzania in the recent years. For example, between 1998-2001, a proportion of 34% of the wood used by wood carving cooperatives was represented by *B.huillensis* logs smuggled from Tanzania (Choge, 2002). This is the warning signal that the species is subject to heavy exploitation in Tanzania.

The new Tanzania forest policy of 1998 reported that the narrow and declining resource base of *B. huillensis* is hampering development of artisanal wood-based products. It also propose that development of artisanal wood-based products is important in increasing employment and foreign exchange earnings through sustainable forest-based industrial development and trade (URT,1998). In spite of local, national and international value of

B.huillensis, little or nothing have been done on its conservation in Tanzania, most of the conservation activities of indigenous species have concentrated on *Dalbergia melanoxylon* (African Blackwood) through African Blackwood Conservation Project (ABCP) and Mpingo Conservation Project (MCP), neglecting this economically important threatened tree species.

Dindili catchment forest reserve is a typical coastal lowland forest in Tanzania, a forest type which was very much reduced during the last century (1990-1999). The dry forest is relatively intact, except for exploitation of *B.huillensis* for construction. Moreover; management proposals of this reserve requires control of illegal exploitation of *B. huillensis* and coppice regeneration of *B. huillensis* maintained and selected to raise good quality timber trees.(CELP, 2003). Bearing in mind that Dindili forest Reserve is close to Morogoro municipality and Dar es Salaam city where population pressure and carvings markets exists; also considering illegal exportation of *B. huillensis* to Kenya. There is a need to assess exploitation and conservation of *B.huillensis* in Dindili forest reserve and surrounding public lands. Knowledge on multiple utilization and management of *B. huillensis* will be used as a long-term basis for conservation of *B. huillensis* and its habitat.

1.2 OBJECTIVES OF THE STUDY

1.2.1 General Objective

The main objective of this thesis is to assess standing wood stocks, harvested wood, coppice regeneration, flagship species potential, utilization and management of *Brachylaena huillensis* by local people in Dindili forest reserve, Morogoro, Tanzania.

1.2.2. Specific Objectives:

- i. To estimate standingwood stocks of *B. huillensis* in the forest reserve.
- ii. To estimate harvested *B. huillensis* wood from the forest reserve.
- iii. To assess coppice regeneration of *B.huillensis* in the forest reserve.
- iv. To assess *B. huillensis* utilization and Management by the local people.
- v. To analyse the flagship species potential of *B. huillensis* in conserving its habitat.

2.0 LITERATURE REVIEW

2.1 COASTAL FORESTS

2.1.1 Coastal Forests as a conservation unit

Tanzania's Tropical Forest Action plan (TFAP, 1989) defined coastal forests as “forests of the coastal strip of eastern Africa” and neatly divides the country's closed forest resources into three separate blocks:

- The mangrove forests of the salt - water coast.
- The forests of mountain systems.
- The lowland forest patches - the Coastal Forests.

But setting the exact limits as to where “coastal”, “montane” and “woodland” start or end is rather difficult. Coastal Forest has not hitherto had a water tight definition. The Coastal Forests of eastern Africa are broadly synonymous with the forests of White (1983) Zanzibar- Inhambane regional mosaic (figure 1), but an examination of other attempts to classify these forests reveals a wide spectrum of opinions about their geographical distribution, their biological affinities and the main vegetation formation type to which they belong (Burgess and Clarke, 2000)

A distinct area of plant endemism (encompassing all vegetation types) along the coastal strip of eastern tropical Africa (between the Limpopo River and the equator) was first identified by White (1976) in 1974, and named as the Zanzibar-Inhambane floristic region. The delineation of this phytochorion was based on a high level of floristic endemism that was found to exist to about 200-300 km inland of the Indian Ocean (especially north of Mozambique town) where approximately 35% of the large woody plants were found to be endemic. Complex nature of the vegetation of this area, together with an initial low estimate of 131 endemic vascular plant species (later revised to at least several hundred species in White, 1983) led to the classification of the Zanzibar-

Inhambane as a "regional mosaic" rather than a "regional center of endemism" (White, 1976, 1983; Moll and White, 1978).

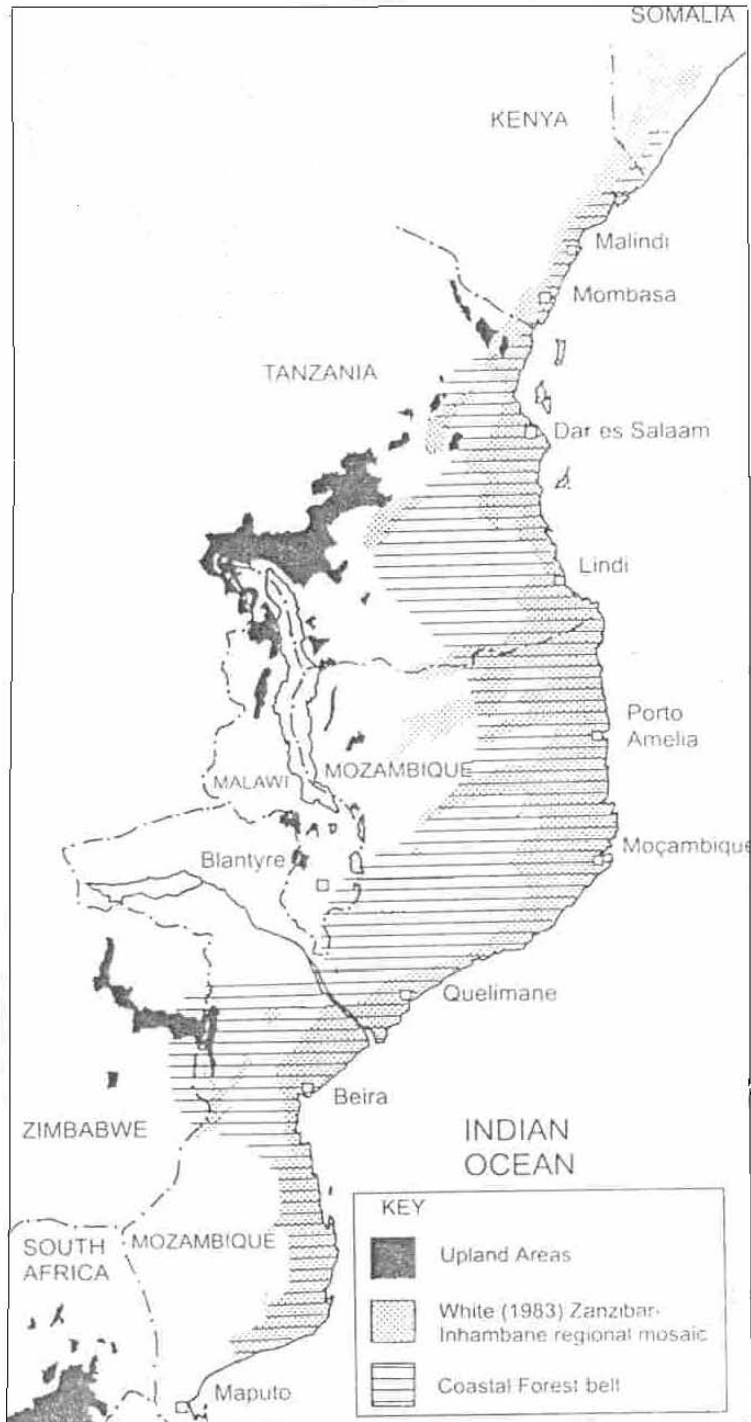


Figure 1: The Zanzibar- Inhambane regional mosaic and the Coastal Forest belt (Source: Burgess and Clarke, 2000).

Subsequent botanical collections and taxonomic studies confirm White's observation that the majority of the endemic plants of the Zanzibar-Inhambane regional mosaic occur to the north of Mozambique town, but have shown that endemic plant species are present in sufficiently high numbers (i.e. > 1000) to enable this northern part to be separated as a regional center of endemism in its own right, leaving a depauperate regional transition zone in the southern part (Burgess and Clarke, 2000). The low number of endemic plant species recorded from either Zanzibar Island or Inhambane province have meant that the name "Zanzibar- Inhambane" was deemed to be an in appropriate label for this floristic region, so that northern part of this region has been renamed as the "Swahilian regional center of endemism" with an adjacent "Swahilian/Maputaland regional transition zone" to the south (Burgess and Clarke, 2000). The Coastal forest hereafter encompasses both this regional center of endemism and the regional transition zone.

Defining the precise extent of the Coastal Forests (and the Swahilian region sensu lato in which they occur) is currently rather difficult since only limited data are available from the vegetation at the periphery of the Zanzibar-Inhambane regional mosaic (White, 1983) which is further complicated by the marginal intrusion of many typical Zanzibar-Inhambane forest plant species into the neighbouring Zambezian regional center of endemism (Burgess and Clarke, 2000).

2.1.2 Problems Facing Coastal Forests

According to Burgess and Clarke (2000), coastal forests epitomize difficulties of maintaining biodiversity values in the tropics, in that they show virtually all of the conservation problems faced by conservation planners and protected area managers. The coastal Forests are:

- Small and highly fragmented, consisting of many (over 250) separate forest patches, most of which are less than 500 ha in size.
- Surrounded by relatively impoverished rural communities with a high and growing demand for, and dependence on, natural resources.

- Individually distinctive, with a high level of local forest endemism, and a great array of different communities, making prioritization difficult.
- Without the national level pragmatic resource values such as timber or water catchments, which interest national and district governments. The presence of these resources would have allowed biodiversity values to influence their continuation.
- Relatively little protected by Government agencies.

2.2 FLAGSHIP SPECIES

2.2.1 Flagship Species Concept

A flagship species is a species chosen to represent an environmental cause, such as an ecosystem in need of conservation. These species are chosen for their vulnerability, attractiveness or distinctiveness in order to best engender support and acknowledgement from the public at large. Thus the concept of flagship species holds that by giving publicity to a few key species, the support given to those species will successfully leverage conservation of entire ecosystems and all species contained there in. Example of flagships species include the giant panda and Leather back Sea turtle (Wikipedia, 2006)

2.2.2 Flagship Species Fund

A flagship species Fund is a partnership between the Fauna and Flora International (FFI) and the UK government Department for Environment, Food and Rural Affairs with support from global companies including BP, Rio Tinto and Vodafone. Set up in 2001, its emphasis is on providing practical support to overseas governments and others working on frontline conservation activities. The fund focuses on a number of key taxonomic groups and the “flagship” species within them, in order to both engage public sympathy and ensure broader biodiversity benefits. Initial targets of funding are endangered primates and trees. Funds are directed to some of the poorest countries in the world with limited national resources to devote to nature conservation (UK-CHM, 2006)

2.3 COMMUNITY INVOLVEMENT IN FOREST RESOURCE MANAGEMENT IN TANZANIA

During the last decade (1990-1999), Tanzania, like many other eastern and southern African countries, has experienced a number of policy reforms. Most of these reforms were geared towards devolving common pool resources management from the state to lower levels (Alden Wily & Mbaya, 2001). More specifically, these policies underlined the need for community participation and empowerment in the management of natural resources in order to achieve sustainable development (Mniwasa & Shauri, 2001). In Tanzania, there are several reasons for the paradigm shift to people-centered forest management to effectively manage protected areas. Kajembe and Kessy (2000) outlined a number of reasons behind this shift, including the failure of the state agencies to manage protected areas effectively; the potential for cost-effective local management of forests; relevance of local knowledge of ecological dynamics to proper management; increased motivation for local communities to conserve forests following recognition of their critical role in the management, eventual increase in tangible benefits from the forest (economic incentives) and sense of ownership regained over their forest resources (empowerment) and the fact that foresters in recent years have begun to question whether the 'policing model' of forest management is the right way forward.

Kajembe and Mgoo (1999) highlighted an additional reason for looking for an alternative model of managing forest resources. In the wake of declining budgets and the retrenchment of workers following the structural adjustment programmes of the 1980s and 1990s, government capacity to protect forests based on the policing model of management has progressively deteriorated and hence there was a need for change in forest management policy. Making the people living adjacent to forests the guardians of the forest resource in the neighbourhood appears to be the most viable, effective, cheaper and long-lasting way to manage natural forest resources (Kajembe *et al.*, 2003). Under the right conditions, such as appropriate legal framework and incentive structures, these people are likely to become the most effective managers and this should be far more cost-

effective. The burden of policing by the government should then fall away and the foresters should become technical advisers, not policemen and policewomen.

In Tanzania, community involvement in forest management entails mainly two concepts, namely Joint Forest Management (JFM) and Community Based Forest Management (CBFM). In JFM, the government is the owner but shares duty and benefits with local communities, while in CBFM local communities are both owners and duty bearers (that is, owners, users and managers) (Alden Wily, 1997). Currently, a number of government forest reserves have initiated participatory forest management and are at various stages in the process of implementing JFM. These reserves include, among others, Dindili and Kitulangh'alo in Morogoro region, Gologolo, Kipumbwi and Amani Nature Reserve in Tanga region, Udzungwa in Iringa region, Ufiome in Arusha region, Nkwenshoo in Kilimanjaro region. Examples of forests under CBFM include Duru-Haitemba in Manyara region, Mgori in Singida region and part of South Ruvu Forest Reserve in Coast region (Alden Wily & Mbaya, 2001). However, despite many efforts by governments and development organisations to establish and implement collaborative management, little is known about what has been achieved so far in terms of improving local people's welfare and the resource base condition (Adams & Hulme, 2001).

2.4 ECOLOGY OF *Brachylaena huillensis*

2.4.1 Reproduction of *Brachylaena huillensis*

Salisbury (1942) and Baker (1972) have analysed floras and shown that seed size increases with successional status. Garwood (1989) suggests that primary species, which germinate and establish in the shade area of understorey forest, are large seeded, shade-tolerant, slow growing and long lived. *Brachylaena huillensis* accords with the last three criteria but have very small fruits, typical of the Asteraceae. Many tropical trees possess large showy flowers with abundant nectar, whereas *B. huillensis*, especially its female flowers, offers limited rewards. *Brachylaena huillensis* presents a paradox. It is a long-lived canopy emergent tree of stable forest, but it possesses some characters that are more typical of pioneer species (Kigomo *et al.*, 1994)

i. Pollination

Kigomo *et al.*, (1994) pointed out; while it is possible that the small flies which parasitize the developing *B. huillensis* fruits, and other fly species, may transfer pollen it seems likely that they are not the main pollinators. Numerous bees collect pollen from the male flowers. No nectaries could be discovered, nor could nectar be collected using capillary tubes. Dissection of open buds reveals a trace of moisture at the base of the inflorescence of female flowers, and this may be sufficient reward for the tiny bees. Another possibility is that the bees are deceived into visiting the female flowers because they are visually similar to the males. Deceit pollination is not uncommon (Dafni, 1984). It has the advantage (for the flowers) that pollination is effected without expenditure of resources on rewards. If it is occurring here it would presumably depend on a great abundance of bees, overcoming the possibility of individual bees learning to avoid female flowers.

ii. Dioecy

Various hypotheses have been proposed for the evolution of dioecy (Thomson and Brunet, 1990) and among the correlations suggested is between dioecy and woodiness. A well-documented correlation is with small, inconspicuous or greenish flowers (Bawa, 1980). He found that these plants in tropical systems are served by small generalist insects, especially bees, and these insects are sensitive to flower number. He further suggested that small bees might tend to remain associated with individual plants, thus causing inbreeding depression in hermaphrodites, and dioecy would avoid this. The presence of numerous small flowers, abundant pollen and large numbers of small bees in the case of *B. huillensis* may give support to Bawa's hypothesis (Kigomo *et al.*, 1994).

iii. Fruit size and establishment.

Small fruit size of *B.huillensis* is typical in the family Asteraceae, but unusual in late succession canopy trees, where a larger 'embryonic capital' is regarded as desirable for establishment in shade (Baker, 1972). The successful establishment of numerous seedlings of *Brachylaena huillensis* may result from the sheer abundance of fruit and its regular biannual production.

iv. Reproductive effort

According to Kigomo *et al* (1994), *Brachylaena huillensis* is engaged in some stages of reproduction all year round, be it flower development or fruiting , and this must represent a substantial demand on resources. Its very slow growth may partly be explained by the large allocation to reproduction. A relationship between reproduction and slow growth rates has been reported for Douglas fir, grand fir and western white pine by Eis *et al* (1965). Holmsgaard (1956) showed that root and shoot growth in European beech is adversely affected by even small crops of fruits, and Steel (1976) found that in a good mast year 41% of total above ground dry weight production was allocated to reproductive structures, with a consequent reduction in leaf production in the following year. Massive and frequent flowering presumably, however, enhances the possibility of a successful outcome to reproduction.

v. Seed viability

Kigomo *et al* (1994) reported that, after shedding, deterioration of *Brachylaena huillensis* fruits is very rapid and in effect there is no persistent seed bank. There is a premium on rapid germination while the rainy season continues. He further argued that factors which lead to rapid seed loss are complex and require further investigation, it seems likely that high humidity, and consequent fungal and bacterial infection, are important. The rapid deterioration of seeds spread on dry leaves and exposed to the sun suggests that high temperature alone can also be lethal. Garwood (1989) cites several studies which indicate that seeds of primary species are very short-lived in the soil, so in this respect *B. huillensis* fits the pattern. Any attempt to manage this species with the aim of increasing its population artificially must pay particular attention to seed viability.

vi. Dispersal and migration

Kigomo (1994) indicated that the potential migration of *B. huillensis* is slow, no more than 20m per generation, and unidirectional. It is not known how old trees are before they begin producing fruits. An average tree of 30cm dbh is about 60 years old and has an ability to disperse fruits up to 15m. If 60 years is the approximate time at which fruits production begins it would take around 4000 years for a population to advance 1km into

a new area. The limited fruit dispersal is surprising in an emergent species which has fruits with a pappus which might be expected to enhance dispersal from this favorable position. However, possession of a pappus does not necessarily result in an efficient long-distance dispersal (Sheldon and Burrows, 1973). In an undisturbed forest, and given unlimited time, a short dispersal distance may not matter, but in the present context of isolated populations split into small areas by human activity it may have a profound effect on the species ability to survive and spread. Movement between patches will depend on rare events such as severe storms, or on deliberate human intervention.

2.4.2 Spatial Distribution

According to Kigomo *et al.*, (1991), adults and seedlings of *Brachylaena huillensis* are patchily distributed, or over-dispersed. Among possible explanations are (1) poor powers of fruits dispersal so that seedlings occur only around parent trees (Jones, 1955); (2) a patchiness in some environmental factors which results in seedling establishment and survival only in certain places (Kershaw, 1973), or (3) vegetative spread resulting in new shoots being restricted to the vicinity of the parents (Waisel, 1971). Rice (1984) among others, has suggested that allelopathy may be involved.

No evidence for *B. huillensis* vegetative spread exist and no proof for environmental patchiness either in soil characteristics, or of canopy gaps since seedlings become established in closed forest conditions. The distribution of the patches appears to rule out allelopathy. Possible causes remaining are (a) distribution of female trees. (b) poor fruit dispersal and (c) non-random fruit dispersal.

The dispersed fruits of *B.huillensis* are non-randomly distributed around female parents (Kigomo *et al.*, (1991). *B. huillensis* has massive fruit production twice annually. Though fruits fall all around parent trees, wind direction during periods of fruiting determines the direction of dispersal and the majority are within 14m of the parent tree. This results in regeneration patches that are oval in shape, extending in one direction from the parent. So all three of the possible causes noted above may be involved in the production of patchiness in this species. One advantage of a patchy (clumped) distribution for a

dioeciously insect-pollinated species is that it ensures proximity of male and female trees and therefore enhanced effectiveness of pollination.

2.4.3 Growth Rate of *Brachylaena Huillensis*

Kigomo, (1994) reported that *Brachylaena huillensis* attain 40cm dbh in about 100 years (0.40cm y^{-1}), 45cm dbh in 130 years (0.38cm y^{-1}) or 60cm dbh in approximately 175 years (0.34cm y^{-1}) at its best rate of growth in natural conditions. This growth rate is fairly slow although this is not unique in tropical trees growing under natural conditions, similar estimates of growth rate of *Shorea robusta* in Uttar Pradesh, India (Mathauda, 1958) indicated rotations of 120 years for species growing in lower rainfall areas (1500mm) to achieve 60cm dbh. Rai (1987) estimated rotations of 214 and 178 years for *Dillenia Pentagyna* and *Grewia tiliaefolia*, respectively, to attain 60cm dbh, in a moist deciduous forest (annual rainfall 2500mm) of Karnataka. Weaver (1979) gives estimates of rates of diameter increment ranging from 0.31 to 0.91cm y^{-1} for trees growing in uneven tropical forests of Puerto Rico, Central America. Growth in natural conditions where rainfall is limiting should be lower than the rates quoted above. The rate of growth of *B. huillensis* is reasonably high considering that the mean annual rainfall within the semi-deciduous dry forests of Tanzania and Kenya is only about 1000mm.

The lack of free growth under natural conditions may explain in part the low rates of diameter increment of *B. huillensis*. Went (1957) concluded from his studies that shade-tolerant species are more competitive in shady environments through selection for low respiration rates and, hence, slow growth in all environments. *B. huillensis* flowers and produces profuse seed twice every year and is in flower almost continuously throughout the year. Energy investment into reproduction may therefore be too much to allow a balance of energy enough to support fast growth, and this factor too may contribute to the rates of growth indicated.

3.0 MATERIAL AND METHODS

3.1 STUDY AREA DESCRIPTION

i. Location and Boundaries

Dindili catchment forest reserve is a typical coastal lowland forest in Tanzania, which is about 180 km from Dar es salaam city. It is located at about latitude $6^{\circ} 42'$ S and longitude $37^{\circ} 52'$ E (figure 3). It is 25 km east north east of Morogoro town and occupy an area of 10.06 km². The reserve covers a north south running ridge in Fulwe village to an altitude of 849 m.

ii. Climate

Climatic diagram for Dindili forest reserve is shown by figure 2. The reserve experience oceanic rainfall with oceanic/continental temperatures. Its estimated rainfall is 700-1000 mm/year. Dry season is June to October. Maximum and minimum temperatures are 26°C (Dec) and 21°C (July) respectively.

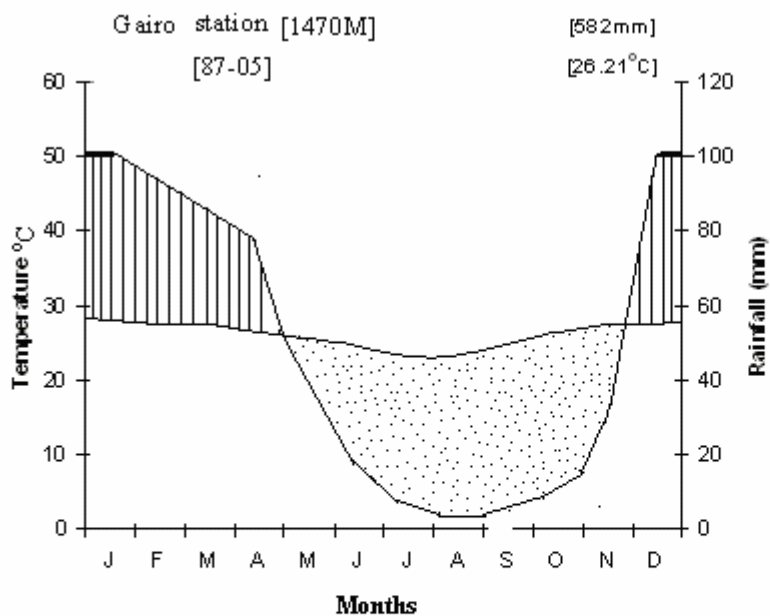


Figure 2: Climatic diagram for Dindili Forest Reserve

iii. Catchment Values

Seasonal streams supply water to the relatively densely populated area along Tanzam Highway. There are shallow wells on the eastern foothills for rural water supply. The western slopes drain into the Ngerengere river and to the Ruvu River.

iv. Vegetation

Woodland covers about 40% of the area, mostly the lower ridges and the drier western slopes. Dry evergreen forest covers 60% of the area on the wetter eastern slopes and summit ridge.

Woodland: The canopy is rich in species with: *Acacia hockii*, *A. senegal*, *Brachystegia boehmii*, *B. microphylla*, *B. spiciformis*, *Combretum zeyheri*, *Dalbergia melanoxylon*, *Diplorhynchus condylocarpon*, *Pteleopsis myrtifolia*, *Pterocarpus angolensis* and *Sclerocarya birrea*.

Dry forest: Tall closed forest with trees up to 30 m in valleys. The trees include: *Brachylaena huillensis* (dominant at many places), *Azelia quanzensis*, *Bombax rhodognaphalon*, *Diospyros consolata*, *Erythrina* spp., *Euphorbia candelabrum*, *E. nyikae* (both *Euphorbia* tall trees up to 20 m), *Scorodophloeos fischeri*, and *Teclea simplicifolia*.

v. Population and Livelihoods

Fulwe village is comprised of four sub-villages namely Dindili, Lukole, Newland A and Newland B. The population of the village is 6511 people and distributed in 1070 households. The dominant ethnic groups in the area are Kami and Luguru. The main economic activity in the village is farming. Furthermore, some of the villagers depend on small business and sale of forest products for their livelihoods. The major cultivated crops are maize, sorghum, cassava, beans and sweet potatoes.

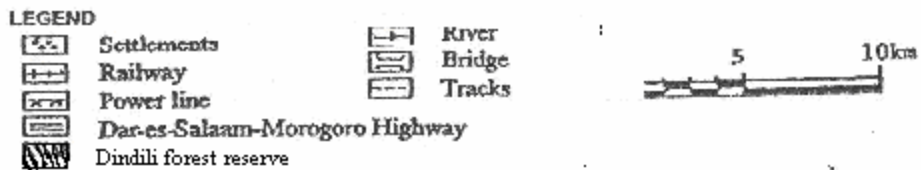
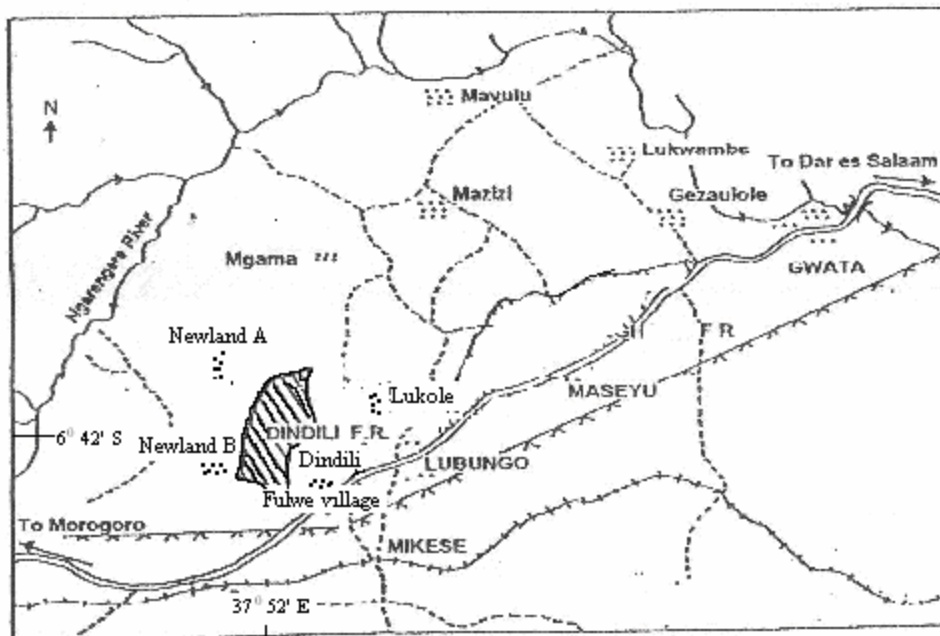
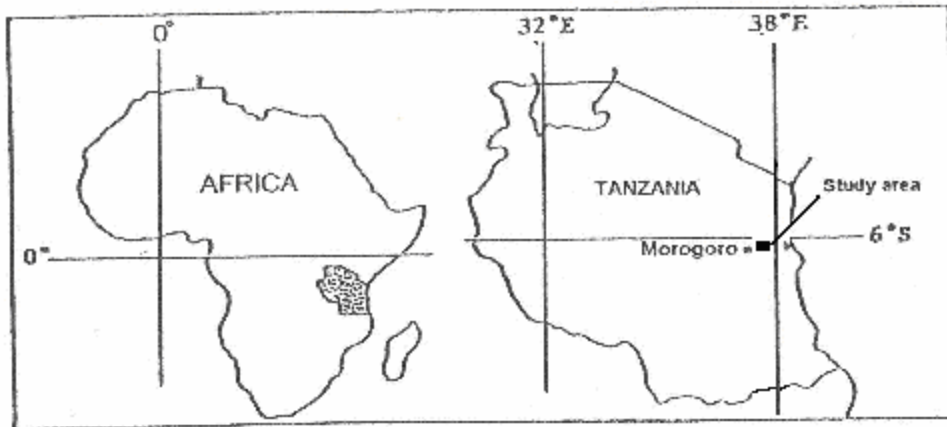


Figure 3: The location of Dindili Forest Reserve and surrounding public lands, Morogoro, Tanzania (Modified from Luoga *et al* (2002))

3.2 DATA COLLECTION

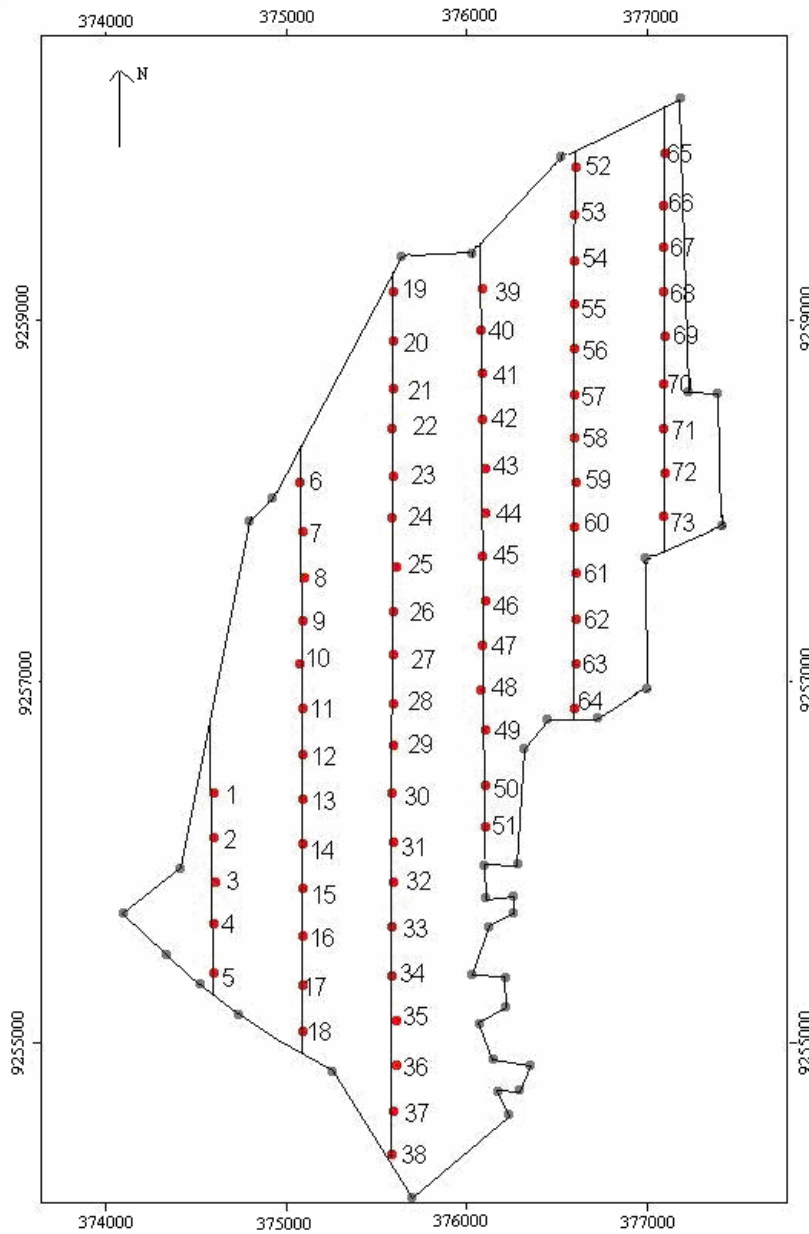
Data was collected using forest inventory, quantitative ethnobotany (use values, direct matrix ranking, preference ranking, questionnaire survey), direct observation and focus group discussions.

3.2.1 Reconnaissance survey.

Dindili forest reserve was visited for reconnaissance survey. The mission during this time was to: Get acquainted to the area; Get prior information about forest reserve; Inform local administration and leaders about the objectives of the intended study; Make logistical arrangements e.g. when to do forest inventory, identify sub-villages that may be part of the ethnobotanical survey.

3.2.2 Forest Inventory

The existing Dindili forest map No JB 2069 does not have Universal Transversal Mercator (UTM) coordinates, therefore the forest boundary beacons were surveyed using Global Positioning System (GPS) to establish UTM coordinates. Systematic allocation of sample plots along the transect lines was applied. Advantage of this design is better coverage of the whole population and easy allocation of sampling plots (Nduwamungu, 1997). The recommended sampling intensity for use in natural forests inventory fall within a range of 0.5% to 0.7% (Malimbwi, 1997). The sampling intensity of 0.5% was used in this study, in which distance between transect lines and plots was 500m and 250m respectively, which resulted in covering 73 plots. The map of transect lines and plots is shown in figure 3. Allocation of sample plots in the forest reserve was based on this map with help of GPS.



Legend

- Plots
- Boundary beacons.

Figure 4: The map of Dindili forest reserve showing boundary beacons, transect lines and plots (Drawn based on field GPS data)

Circular sample plots were adopted for data collection. The choice of circular plot was motivated by the fact that it has advantage of reducing edge effect in the sample (Krebs, 1989). The boundary length; area ratios are noted to be lowest in circular as compared to square and rectangular quadrats and therefore sampling error is thought to be less for circular shaped plots (Bonman,1989). Circular plots are not uncommon as they have been used by Nduwamungu (1997), Issango (2004) and Moyo (2005) among others. Each of circular sample plot measuring 0.07ha (700m²) had a circular sub- plot inside measuring 0.003 ha (28m²) . The two plots had radii of 3m and 15m. The measurement taken in each plot are summarised in the table 1;

Table 1: The measurements taken within concentric plots.

<i>Plot radius (m)</i>	<i>Measurements</i>
3	Identification, counting and measurement of seedlings and saplings.
15	Measurements concerning trees (≥ 4 cm Dbh) and stumps i.e. total height, diameter at breast height (Dbh) , basal diameter and height of stumps, number of resprouts from each stump

Voucher specimens of woody species were pressed and brought to the Herbarium at the University of Dar es salaam Botany Department for identification. Species that were identifiable in the field were identified on the spot and recorded in the field notebook. Species that had proved difficult to be identified in the field were taken for identification at the University of Dar es salaam Botany Department using Flora of Tropical East Africa and by matching with species specimens available in the Herbarium. Additionally, local knowledge was employed in identification woody species.

i. Standing wood stocks

Within the plots; all *B. huillensis* trees and other wood species of diameter at breast height (Dbh) ≥ 4 cm were identified and diameter at breast height Dbh (cm) and height (m) measured using Diameter calliper and Suunto hypsometer respectively. The choice of the lower Dbh limit as 4 cm for assessing trees and shrubs was adopted from Kielland-Lund (1990) who suggested that this diameter corresponds roughly to minimum Dbh needed to survive grass fires. The basal diameter of trees at 30cm height from the ground was measured for closest, biggest and smallest tree.

ii. Harvested wood

Number of felled trees were recorded from identified stumps of *B. huillensis* and other woodspecies. In each case, basal diameter (BD) and height (h) of identified stumps was measured. The stumps of *B. huillensis* and other wood stumps were identified using coppice growth, bark and wood characteristics. Main purpose of removal was established with aid of two local elders knowledgeable with aspects of wood utilization. Most of the identified stumps were those of newly felled trees with identification evidences.

ii. Seedlings and saplings

B. huillensis and other woodspecies individuals of 0 to < 1 cm diameter were counted and categorised as seedlings following Luoga *et al* (2002). Seedlings are newly established plants that have not yet been damaged and thus have never resprouted. Saplings which are defined as individuals with diameters of 1 to < 4 cm (Luoga *et al.*, 2002) were also counted and measured.

iii. Coppice regeneration

The number of coppice shoots (resprouts) from each stump were counted and height at which they coppiced measured.

3.2.3 Ethnobotanical Data Collection

i. Structured and Semi-structured interview.

Structured interviews were conducted with local people. More than 5% of households were picked for interview. According to Kajembe (1994) a random sample should at least constitute 5% of the total population to be representative of the population. The questionnaires were pre-tested before conduction of structured interview. The sampling unit was head of household and housewife. The selection of household to be interviewed was done using systematic sampling where every third house was interviewed in, west–east direction, this was done with help of GPS. The study interviewed equal number of males and females. The interview was alternate between gender, in which after head of household (mostly male) was interviewed in one event, the next event the housewife was interviewed (appendix 1(a)). Structured interview involved a total of 70 respondents. Semi-structured interviews were administered to Regional Forest Catchment Officer (RFCO) (appendix 1b) and District Forest Officer (DFO) (appendix 1c).

i. Direct observation

Direct observation of important indicators was done to crosscheck findings. The indicators were used to generate on-the-spot questions to local people without formal questionnaires. Example of indicators used was charcoal kilns indicating charcoal extraction from the forest reserve.

ii. Focus group discussions

Discussions were held on predetermined topics, with male group, female group and Village forest commetee. Thorough preparation was made before discussions. The participants were asked to discuss differerent issues pertaining to utilization and management of *Brachylaena huillensis* and Dindili forest reserve as the whole.

iii. Preference ranking

This technique was used to determine the highly preferred woody species based on informant's understanding or interest of such species for a particular use. Preference ranking involved asking people to think about some items and arrange them according to a given criterion (Martin, 1995). In this study, scores of 1 for fair, 2 for good and 3 for very good were used. Eight respondents were selected randomly from a group of key informants (people with good ethnobotanical knowledge) for this activity in each sub-village. The total numbers of key-informants were 32 in this activity. The woody species which were frequently mentioned by villagers as being suitable for each use category were ranked.

iv. Direct matrix ranking

This method was used to compare qualities of *Brachylaena huillensis* plus seven preferred multipurpose woody species in the area against various utilities such as fuelwood, charcoal, timber and medicinal value. The seven preferred multipurpose woody species were chosen by villagers who are knowledgeable with aspects of utilization of tree species. Direct matrix ranking method is based on multiple dimensions whereby informants order series of objectives considering several attributes at a time. Individual respondents ranked the species according each use-category, using numeral scale of 1, 2, and 3; in which highest number is equal to 'best' objective and lowest number to the 'worst'. This activity involved a total of 33 informants.

v. Use Values

This technique was used for the analysis of the relative usefulness of different woody species to people. The use values, according to Philips and Gentry (1993), are estimated based on the degree of consistency between repeated interviews of each informant and among different informants. This activity was done during the whole course of data collection. The species which their use values were worked out are the multipurpose ones as perceived by villagers and those represented by stumps in the forest reserve. Sixteen respondents were involved in this activity (7 of them were field assistants).

3.3 DATA ANALYSIS

The information collected through structured interview was edited and coded. The coded answers were tabulated and analysed. Contingency tables were used to establish relationships between various community opinions by gender in which Fisher's exact test was used as the analytical tool (Zar, 1999). Regression analysis was used to establish the relationship between Dbh, height and Basal diameter.

i. Density

The following formula was used to determine density of seedlings, saplings and trees per hectare. $N = n/a$, Where N = number of stems per hectare, n = number of seedlings, saplings or trees, a = plot area (ha).

ii. Density distribution by Dbh classes

5cm Dbh class size was used in construction of density distribution by diameter classes starting from 4cm dbh (Kigomo *et al.*, 1990a). The classes used were 4-8.9, 9-13.9, 14-18.9, 19-23.9, 24-28.9, 29-33.9, 34-38.9, 39-43.9, 44-48.9, 49-53.9, 54-58.9 and 59-63.9.

iii. Basal area

Basal area of trees and shrubs with DBH \geq 4cm was calculated by using the formula:

Basal area = $\sum (DBH)^2/4$. Basal area was divided by sample area (5.16ha) to obtain Basal area per hectare.

iv. Volume

Volume of standing *B. huillensis* and other trees was calculated using two parameter volume equation. The advantage of two parameter volume equation is the reduced bias as another parameter (height) is added to it. The two parameter volume equation, $V = G*H*0.45$ according to Malimbwi *et al.*, (2002) was used, Where G = basal area per hectare (m^2/ha), H = height of tree (m) and 0.45 is a form factor

v. The Importance Value Index (IVI)

The Importance Value Index (IVI) for each species was calculated according to Lamprecht, (1989) and Kent and Coker, (1994) with three components as follows: Relative density = (Density of a species /Total density X 100); Relative frequency=(Frequency of a species /Total frequency x100) and Relative dominance= (Basal area of a species /Total basal area x 100). IVI= Relative density + Relative frequency+ Relative dominance.

vi. Estimation of harvested wood

The basal diameter of stumps (BDS) were converted to DBH of standing trees before harvesting using linear relationship developed for all species:

$$DBH = 0.712 + 0.848 BD (r^2=0.99)$$

(DBH =diameter at breast height, BD=basal diameter)

The developed DBH of stumps were used to generate height (H) of standing trees before harvesting using linear relationship developed for all species:

$$H = 3.99 + 0.337 DBH (r^2=0.85)$$

(H =Height of tree, DBH= Diameter at breast height).

The same volume equation $V = G*H*0.45$, Where G = basal area per hectare (m^2/ha),

H = height of tree (m) and 0.45 is a form factor was used establish volume of wood harvested.

vii. Coppice regeneration

The percentage of stumps of *B. huillensis* and other woodspecies that resprouted was calculated. Coppicing effectiveness was calculated as mean number of coppice shoots per stump. Coppicing effectiveness of each species was expressed as percentage with species with highest coppicing effectiveness values taken to be 100% and other species expressed proportionally. The mean of the two percentage (percentage of highest coppicing effectiveness and percentage of resprouting stumps) was then used to categorise

each species, thus 80-100% = very high resprouter, 60—79%= high resprouter , 40-59%= Average resprouter, 20-39%= low resprouter, <20%= very low resprouter and 0=non-resprouter (Luoga *et al.*, 2004).

viii. Use Values

The use-values were calculated according to Philips and Gentry (1993). The formula for estimation of the use-value of a given species for single informant is given as : $UV_{is} = U_{is}/n_{is}$, where UV_{is} =use value of a species S for informant i , $\sum U_{is}$ = the number of uses mentioned in each event by informant i , and n_{is} = number of events for species S with informant i. According to Phillips and Gentry (1993), an event is defined as the process of asking one informant on one day about the uses he knows for one species. The overall estimate of use- value for each species (UVs) was computed by the formula, $UV_s = \sum UV_{is}/n_s$ Where n_s = number of informants interviewed for species S.

ix. Flagship species potential

Criteria which were used for analysis of *B. huillensis* flagship potential are those generated by Bowen-Jones and Entwistle (2002), which are: geographical status, conservation status, ecological role, recognition, existing usage, charisma, cultural significance, positive association and traditional knowledge.

4.0 RESULTS

4.1 FLORISTIC COMPOSITION

A total of 129 woody species belonging to 41 families were identified during the study. A complete list of woody species encountered in the study area is given in appendix 2. Fabaceae, Euphorbiaceae, Combretaceae, Sapindaceae and Ebenaceae were the most dominant families having 28%, 9%, 5%, 5%, and 5% of woody species respectively. Twelve families were represented by three or more woody species, Seven families were represented by two woody species and the remaining twenty two were represented by single woody species.

4.2 STANDING WOOD STOCKS

4.2.1 Density

The density of woody species in the forest reserve was 374 stems per hectare. *Brachylaena huillensis* (Plate 1) had density of 15 stems per hectare and the fifth in terms of the highest density per hectare. Other species with high density per hectare are *Scorodophloeus fischeri* (46 stems/ha), *Garcinia huillensis* (25 stems/ha), *Combretum schumannii* (22 stems/ha) and *Croton pseudopulchellus* (19 stems/ha). The percentage contribution of five woody species with highest density to woody species density of the Forest reserve is shown in figure 5. *Brachylaena huillensis* had 4% contribution to density of woody species in the forest reserve, *Scorodophloeus fischeri* (12%), *Garcinia huillensis* (7%), *Combretum schumannii* (6%) and *Croton pseudopulchellus* (5%).

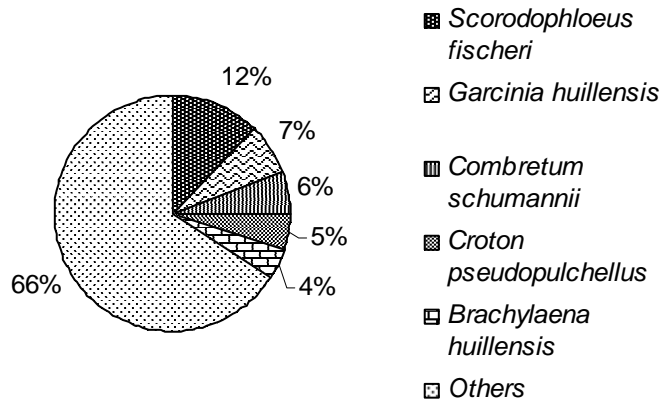


Figure 5: The percentage contribution of five woody species with highest density to woody species density of the Forest reserve.



Plate 1: *Brachylaena huillensis* tree.

4.2.2 Density Distribution by Dbh Classes

Density distribution of woody species by dbh classes in the forest reserve (Figure 6), follows a normal reversed J-shape common in natural forests. However, density

distribution of *B. huillensis* by Dbh classes (Figure 7), does not follow a characteristic inverted J-shape. There is abnormal increase in density of *B. huillensis* from class 4-8.9, 9-13.9 and 14-18.9. A drop is observed in class 19-23.9, thereafter an increase in Dbh class 24-28.9. Finally, irregular representation of *B. huillensis* individuals is observed in higher Dbh classes (≥ 29 cm).

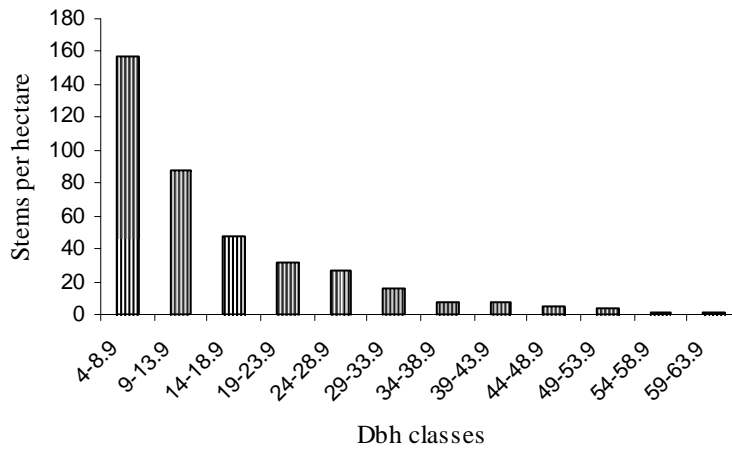


Figure 6: Density distribution by Dbh classes of woody species in the forest reserve

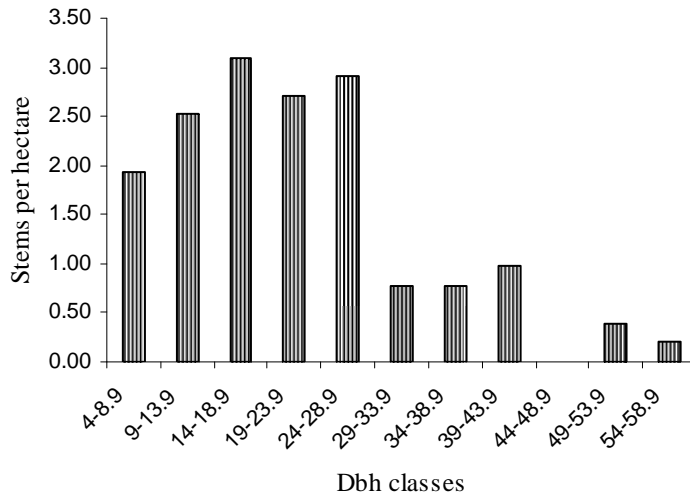


Figure 7: Density distribution by Dbh classes of *B. huillensis* in Dindili forest reserve.

4.2.3 Basal Area

The basal area of the forest reserve was 10.78m²/ha. *Brachylaena huillensis* had basal area of 0.73m²/ha and in the fourth position in terms of highest basal area. Other species with high basal area in the reserve are *Garcinia huillensis* (1.67m²/ha), *Sterculia quinqueloba* (0.85m²/ha), *Scorodophloeus fischeri* (0.81m²/ha) and *Combretum schumannii* (0.57m²/ha). The percentage contribution of five woody species with highest basal area to woody species basal area of the forest reserve are shown in figure 8. *B. huillensis* contributed 7% of the total basal area of the forest reserve, *Garcinia huillensis* (15%), *Sterculia quinqueloba* (8%), *Scorodophloeus fischeri* (8%) and *Combretum schumannii* (5%).

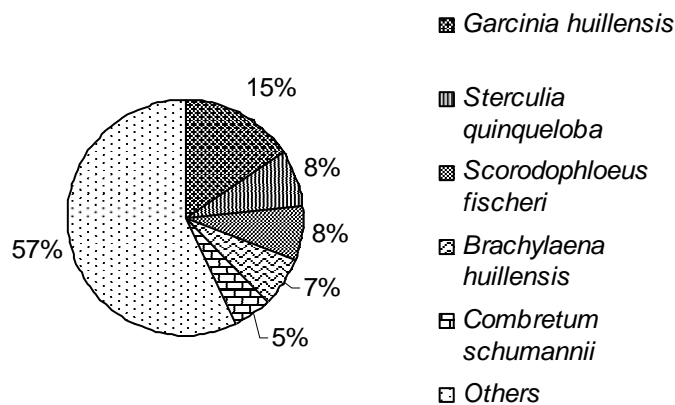


Figure 8: The percentage contribution of five woody species with highest basal area to woody species basal area of the Forest reserve.

4.2.4 Standing Volume

The results of standing volume of woody species in the forest reserve are shown in appendix 4. The standing volume of woody species in the forest reserve was 83.63 m³/ha. *Brachylaena huillensis* had the mean volume of 5.63m³/ha and third in position in terms of highest standing volume. The species with higher mean volume compared to the former were *Sterculia quinqueloba* (12.91m³/ha) and *Garcinia huillensis* (12.80m³/ha). Other species with high volume were *Scorodophloeus fischeri* (4.19 m³/ha) and *Terminalia sambesiaca* (3.58 m³/ha). Figure 9, shows the percentage contribution of five woody species with highest standing volume to woody species standing volume in the

forest reserve. *Brachylaena huillensis* had 7% contribution, *Sterculia quinqueloba*(15%), *Garcinia huillensis*(15%), *Scorodophloeus fischeri* (5%), and *Terminalia sambesiaca* (4%)

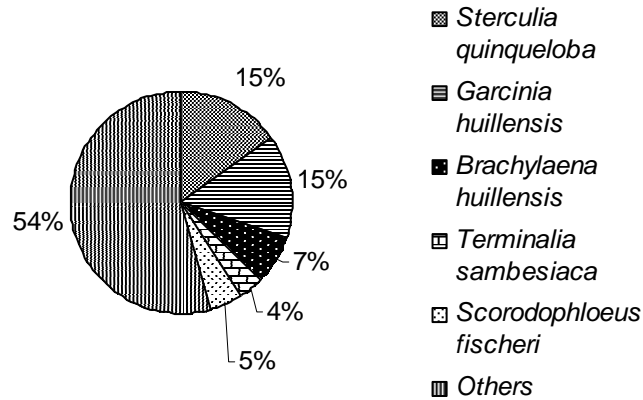


Figure 9: The percentage contribution of five woody species with highest standing volume to woody species standing volume in the forest reserve

4.2.5 Importance Value Index (IVI)

Results in appendix 3, show the Importance Value Index (IVI) of woody species. *Brachylaena huillensis* was ranked number 3 in terms of Importance Value Index (IVI) with the value of 13.87. The tree species which had higher IVI compared to the former are *Garcinia huillensis* (25.78) and *Scorodophloeus fischeri* (23.02). Other species with high IVI were *Combretum schumannii* (13.79) and *Commiphora africana* (10.13).

4.3 HARVESTED WOOD

Results concerning harvested wood volume are shown in appendix 5. The volume of felled woody species from the forest reserve was 11.65m³/ha. *Brachylaena huillensis* had highest number of stumps per hectare (5 stumps per hectare), the species also represented highest volume harvested (3.25m³/ha). Other species with high volume harvested were *Markhamia zanzibarica* (2.16m³/ha), *Combretum molle* (1.43m³/ha), *Garcinia huillensis* (1m³/ha) and *Spirostachys africana* (0.85m³/ha). Figure 10, shows the percentage contribution of species with highest harvested volume to harvested volume from the

reserve. *Brachylaena huillensis* contributed 29% to harvested volume from the forest reserve, *Markhamia zanzibarica*(18%), *Combretum molle* (12%), *Garcinia huillensis* (9%) and *Spirostachys africana* (7%).

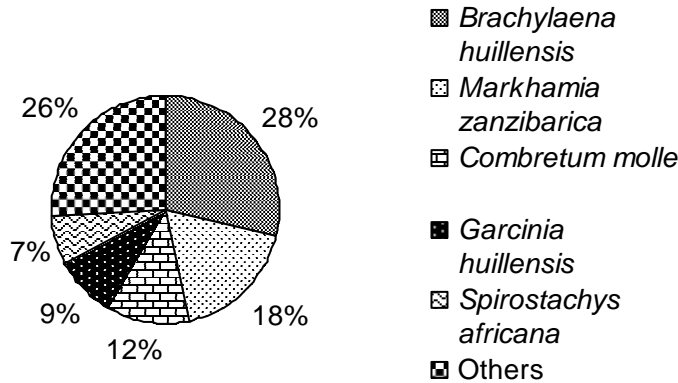


Figure 10: The percentage contribution of woody species with highest harvested volume to volume of wood harvested from the forest reserve.

The ratio of harvested volume to standing volume of forest reserve was 0.13. The removal /standing (R/S) volume ratio of *B. huillensis*, *Garcinia huillensis* and *Spirostachys africana* were 0.58, 0.08 and 1.23 respectively.

4.4 NATURAL REGENERATION

4.4.1 Coppicing Regeneration

Although some of the species were represented by only a few stumps, 50% of the 34 harvested species in the forest reserve were resprouting. Appendix 6, demonstrates coppicing potential of different species in the forest reserve. Only 6% of *B. huillensis* stumps were found resprouting in the forest reserve and its coppicing effectiveness was 0.19. *B. huillensis* was categorized as a very low resprouter since its mean combination of percentage of high coppicing effectiveness and percentage of stump coppicing (resprouting potential) is 4%. The other very low resprouter was *Spirostachys africana* with resprouting potential of 5%. *Diplorhynchus condylocarpon*, *Lecaniodiscus*

flaxinifolius and *Markhamia zanzibarica* with resprouting potential of 100%, 92% and 80% respectively, were categorized as “very high resprouters” in the forest reserve.

4.4.2 Seedling and Sapling Density

The number of seedlings per hectare for the forest reserve was 11168. *Brachylaena huillensis* had 407 seedlings per hectare. Other species with high number of seedlings per hectare were *Scorodophloeus fischeri* (3892), *Diospyros consolatae* (1086), *Teclea simplicifolia* (640), *Blighia unijugata* (567), *Zanthoxylum chalybeum* (504), *Croton pseudopulchellus* (431), *Brachylaena huillensis* (407), *Flueggea virosa* (363) and *Acacia pentagona* (175). The number of saplings per hectare for the forest reserve was found to be 5337. *Brachylaena huillensis* was found to have 68 seedlings per hectare. Other species with highest number of saplings per hectare are *Scorodophloeus fischeri* (1066), *Teclea simplicifolia* (422), *Croton pseudopulchellus* (393), *Blighia unijugata* (349), *Zanthoxylum chalybeum* (262) and *Diospyros consolatae* (228).

4.5 DISTURBANCES

4.5.1 Fire

The reserve was found to be frequently affected by fire (plate 2). Three fire occurrences were encountered in the reserve during data collection especially in open areas with dense grass layer. Additionally, 13 out of 73 plots were either partially or fully burnt plots (18% of total plots). Charcoal burners were most frequently mentioned as the cause of fire in the reserve (36% of respondents) of which 43% and 29% are males and females respectively. The second frequently mentioned reason for burning the reserve is hunting of wild animals (29%), in which hunters start fire at a certain point then wait to kill animals running from fire. The third reason for observed frequent fires in Dindili forest reserve was accidental escapes from farms, especially during preparation of farms as claimed by 20% of respondents. The farms were found to be very close to the forest and some of them encroaching the forest.



Plate 2: Fire burning in Dindili forest reserve

4.5.2 Illegal Harvesting

Although the reserve is closed from harvesting on de-jure basis, the de-facto is that illegal harvesting is continuing at a higher rate. Thirteen charcoal kilns were observed in the forest of which 4 of them were in construction with loads of wood (Plate 3). Seven pitsawing areas (Plate 4) were observed inside the forest reserve with a number of logs around them. Additionally, most of the times during data collection the sound of two-man crosscut saw and hand axe was heard up the mountain. The field guides pointed out that the sound of two-man crosscut saw or hand axe signifies that illegal harvesting of trees for timber, charcoal and poles is continuing.



Plate 3: A charcoal kiln under construction in the forest reserve



Plate 4: A pit sawing area in the forest reserve.

4.6 USE *Brachylaena huillensis* IN FULWE VILLAGE

Eighty four percent of respondents claimed to know *B. huillensis* tree, among them 89% and 80% were males and females respectively. Fishers exact test showed no significant difference in knowing *B. huillensis* between gender ($p=0.51$). 78% of respondents (82% and 74% of males and females respectively) claimed to use *B. huillensis* for various purposes. No significant difference was observed in the proportion of males and females

using it ($p=0.56$). Figure 11, shows percentage of respondents who mentioned the categories of use of *Brachylaena huillensis*. The poles category was mentioned by a comparatively large percentage of respondents (76%).

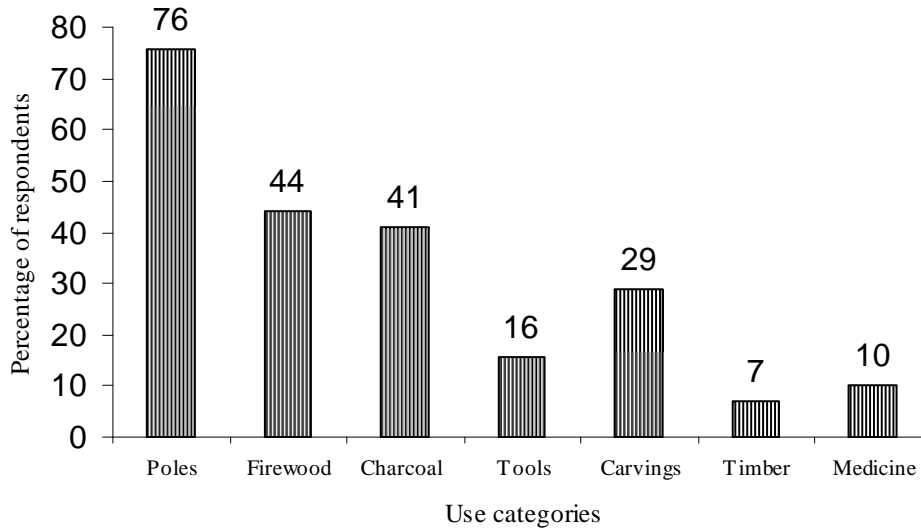


Figure 11: The mentioned use categories of *Brachylaena huillensis*.

i. Firewood

Brachylaena huillensis was mentioned by 44% of the respondents as being used for firewood, among them 40% and 48% of were males and females respectively. Fishers exact test showed no significant difference in proportion of males and females who mentioned *B. huillensis* use for firewood ($p=0.63$). Preference ranking for ten (10) highly preferred woody species for firewood in the study area is shown in Table 2, *Brachylaena huillensis* was number 8 in position. The most preferred woody species for firewood were *Garcinia huillensis*, *Acacia polyacantha* and *Combretum zeyheri*. Women in focus group discussion claimed *B. huillensis* firewood burns very well and for longtime with good scent-smell, however, it is too difficult to split and produces much ashes.

Table 2: Preference ranking for ten highly preferred woody species for firewood.

Scientific name	Newland B	Dindili	Lukole	Newland A	Total score	Mean score	Rank
<i>Garcinia huillensis</i>	18	23	20	19	80	20.00	1
<i>Acacia polyacantha</i>	22	15	23	16	76	19.00	2
<i>Combretum zeyheri</i>	18	17	17	21	73	18.25	3
<i>Combretum molle</i>	15	18	18	21	72	18.00	4
<i>Julbernardia globiflora</i>	18	17	17	16	68	17.00	5
<i>Brachystegia boehmii</i>	16	13	11	18	58	14.50	6
<i>Grewia bicolor</i>	19	15	13	10	57	14.25	7
<i>Brachylaena huillensis</i>	10	12	15	15	52	13.00	8
<i>Acacia robusta</i>	18	11	12	10	51	12.75	9
<i>Combretum schumannii</i>	13	12	11	10	46	11.50	10

ii. Charcoal

Brachylaena huillensis was mentioned by 40% of respondents as being used for charcoal. Among them 43% and 37% were males and females respectively. Fishers exact test showed no significant difference in proportion of males and females who mentioned *B. huillensis* use for charcoal ($p= 0.81$). Table 3 shows Preference ranking of 10 woody species preferred for charcoal. *Brachylaena huillensis* is in position number 9. The most preferred wood species for charcoal were *Combretum molle*, *Combretum zeyheri* and *Julbernardia globiflora*. In focus group discussion, men claimed that *B. huillensis* have dense wood which yield average quality charcoal. It is not favoured by charcoal burners as the hardwood is difficult to chop or crosscut. They also claimed that its high commercial value for poles and carvings, coupled with a few number of species which can provide quality poles and carvings, make it exempted from charcoal making.

Table 3: Preference ranking of ten woody species preferred for charcoal.

Scientific name	Newland B	Dindili	Lukole	Newland A	Total score	Mean score	Rank
<i>Combretum molle</i>	23	22	21	24	90	22.50	1
<i>Combretum zeyheri</i>	23	23	20	21	87	21.75	2
<i>Julbenardia globiflora</i>	24	21	23	19	87	21.75	2
<i>Garcinia huillensis</i>	19	20	19	22	80	20.00	4
<i>Brachystegia boehmii</i>	21	16	19	21	77	19.25	5
<i>Acacia robusta</i>	18	16	20	16	70	17.50	6
<i>Combretum schumannii</i>	18	20	13	13	64	16.00	7
<i>Acacia polyacantha</i>	16	15	17	16	64	16.00	7
<i>Brachylaena huillensis</i>	13	15	16	18	62	15.50	9
<i>Scorodophloeus fischeri</i>	14	15	13	16	58	14.50	10

iii. Poles

Brachylaena huillensis was mentioned by 76% of respondents as being used for poles. Among them 80% and 71% were males and females respectively. Fishers exact test showed no significant difference in proportion of males and females who mentioned the use of *B. huillensis* for poles ($p= 0.58$). Table 4 shows Preference ranking of 5 preferred woody species for building poles. *Brachylaena huillensis* at position 1 and *Spirostachys africana* at position 2 were found to be the most preferred wood species for poles. Both men and women in focus group discussion claimed that *B. huillensis* poles are durable and very resistant to termites. Some villagers call it “woody iron” as its service life can be more than 20 years.

Table 4: Preference ranking of five preferred woody species for building poles.

Scientific name	Newland B	Dindili	Lukole	Newland A	Total score	Mean score	Rank
<i>Brachylaena huillensis</i>	23	24	21	24	92	23.00	1
<i>Spirostachys africana</i>	20	16	18	22	76	19.00	2
<i>Hallea rubrostipulata</i>	12	11	11	14	48	12.00	3
<i>Garcinia huillensis</i>	10	13	9	10	42	10.50	4
<i>Dalbergia melanoxylon</i>	8	14	8	10	40	10.00	5



Plate 5: A house under-construction using *Brachylaena huillensis* poles in Fulwe village.

iv. Carvings

The use of *Brachylaena huillensis* for carvings was mentioned by 19% of respondents. Among them, 29% and 9% were males and females respectively. Fishers exact test showed no significant difference in proportion of males and females who mentioned the use of *B. huillensis* for carvings ($p= 0.06$). Table 5 shows the results of preference

ranking for five highly preferred woody species for carvings. *B. huillensis* was the second most preferred species for carvings next to *Dalbergia melanoxylon*.

Table 5: Preference ranking for five highly preferred woody species for carvings.

Scientific name	Newland B	Dindili	Lukole	Newland A	Total score	Mean score	Rank
<i>Dalbergia melanoxylon</i>	23	24	22	24	93	23.25	1
<i>Brachylaena huillensis</i>	17	15	12	16	60	15.00	2
<i>Combretum schumannii</i>	10	9	11	10	40	10.00	3
<i>Markhamia zanzibarica</i>	11	10	7	8	36	9.00	4
<i>Albizia anthelmintica</i>	10	9	7	9	35	8.75	5

v. Tools

Sixteen percent of the respondents mentioned the use of *B. huillensis* for tools. Among them 20% and 11% were males and females respectively. Fishers exact test showed no significant difference in proportion of males and females who mentioned the use of *B. huillensis* for carvings ($p= 0.51$). Table 6 shows Preference ranking of 6 highly preferred woody species for tools. *B. huillensis* was ranked position four. The most preferred species for tools was *Grewia bicolor*. Villagers claimed that *B. huillensis* produces very durable mortar and pestle. The species is also used to make handles of machete, hand axe and hand hoe.

Table 6: Preference ranking of six highly preferred woody species for tools.

Scientific name	Newland B	Dindili	Lukole	Newland A	Total score	Mean score	Rank
<i>Grewia bicolor</i>	21	18	20	22	81	20.25	1
<i>Markhamia zanzibarica</i>	22	16	12	15	65	16.25	2
<i>Hagenia abyssinica</i>	15	13	9	13	50	12.5	3
<i>Brachylaena huillensis</i>	13	8	12	14	47	11.75	4
<i>Garcinia huillensis</i>	14	9	11	9	43	10.75	5
<i>Pterocarpus rotundifolius</i>	8	11	7	6	32	8.00	6

vi. Commercial wood

Sixteen percent of respondents claimed that *B. huillensis* is used as a commercial wood. Among them, 23% and 9% are males and females respectively. Fishers exact test showed no significant difference in proportion of males and females who mentioned the use of *B. huillensis* as salewood (p= 0.19). Table 7, shows the results of preference ranking of four woody species sold in the village. The results shows that *Brachylaena huillensis* is the most sold species in the area.

Table 7: Preference ranking of four most sold woody species in Fulwe village.

Scientific name	Newland B	Dindili	Lukole	Newland A	Total score	Mean score	Rank
<i>Brachylaena huillensis</i>	15	13	6	8	42	10.50	1
<i>Spirostachys africana</i>	10	11	7	9	37	9.25	2
<i>Grewia bicolor</i>	8	10	8	8	34	8.50	3
<i>Garcinia huillensis</i>	9	8	7	6	30	7.50	4

vii. Timber

Brachylaena huillensis did not qualify as one of the preferred species for timber. Also very small percentage (7%) claimed its use for timber. Two carpenters in the village claimed that its very hard wood cause difficulties in hammering nails, sawing and planing.

viii. Cultural Value

Figure 12, shows the proportion of responses to cultural value of *B. huillensis* . The large proportion of respondents (52%) claimed not to know the cultural value of *B. huillensis*. However, 37% of respondents claimed to know its cultural value in building long lasting local houses, carving traditions and its medicinal value, in which its leaves are used in treating schistosomiasis and roots in treating diabetes.

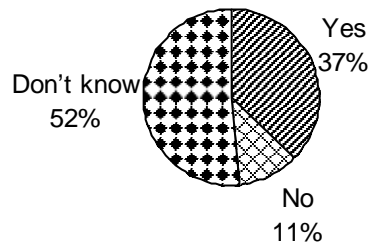


Figure 12: Cultural value of *Brachylaena huillensis* in Fulwe village.

ix. Direct Matrix Ranking of tree species in Fulwe village.

In direct matrix ranking of eight (8) preferred multipurpose woody species (table 8), *B. huillensis* was positioned second with score of 318. *Garcinia huillensis* was ranked first with score of 354.

Table 8: Direct matrix ranking of woody species in Fulwe village.

Tree species	Firewood	Charcoal	Poles	Medicine	Timber	Carvings	Tools	Fruits	Totals	Rank
<i>Garcinia huillensis</i>	83	91	53	11	12	0	31	63	344	1
<i>Brachylaena huillensis</i>	48	47	98	17	15	51	42	0	318	2
<i>Dalbergia melanoxylon</i>	34	28	48	36	11	93	28	0	278	3
<i>Azelia quanzensis</i>	20	29	19	31	95	7	41	0	242	4
<i>Pterocarpus angolensis</i>	17	25	16	31	96	22	34	0	241	5
<i>Combretum schumannii</i>	55	49	37	32	17	31	18	0	239	6
<i>Terminalia sambesiaca</i>	31	38	10	11	78	0	31	0	199	7
<i>Brachystegia microphyla</i>	29	24	21	13	89	0	15	0	191	8

x. Use Value of *Brachylaena huillensis*

Use-values multipurpose woody species in the village are shown on appendix 7. *Brachylaena huillensis* is the fourth in position in terms of highest total use-values with the use value of 2.76. The species with highest use-values were *Garcinia huillensis*(3.94), *Grewia bicolor* (3.5) and *Combretum molle*(3.31). The *B. huillensis* use-category with highest value is poles, with use value of 0.97 out of 1, followed by firewood (0.53), Charcoal (0.41) and Carvings (0.41).

4.7 MANAGEMENT OF *Brachylaena huillensis*

4.7.1 Status of *Brachylaena huillensis* from Respondents Point of View.

According to respondents point of view the status of *B. huillensis* in Dindili forest reserve is shown by figure 13, where highest percentage of respondents (51% and 40% of males and females respectively) claimed that *B. huillensis* is plenty in the forest reserve. Figure 14 demonstrates the status of *B. huillensis* in public lands, private woodlots, farms and homestead. The figure shows that 69% and 57% of males and females respectively claimed that *B. huillensis* is absent in public lands, private woodlots, farms and homestead.

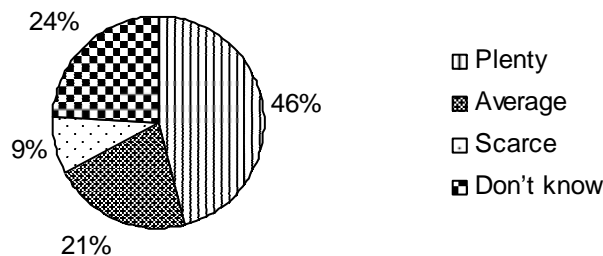


Figure 13: Status of *Brachylaena huillensis* in Dindili forest reserve from respondents point of view.

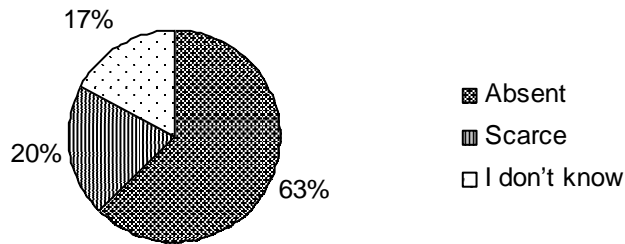


Figure 14: Status of *Brachylaena huillensis* in farms, homesteads, private woodlots and public forests from respondents point of view.

4.7.2 *Brachylaena huillensis* as an Agroforestry tree

Sixty eight percent of respondents claimed not to grow *B. huillensis* with crops. Figure 15 show the reasons for not using *B. huillensis* as an agroforestry tree, the largest percentage of respondents (60% and 48% of males and females respectively) claimed that the species is a wild tree which is not compatible with crops. Fishers exact test showed no significant difference in proportion of males and females who claimed *B. huillensis* is a wild tree which is not compatible with crops ($p= 0.47$). Others reasons for not growing it with crops were it brings shade, dries water and its role not well known.

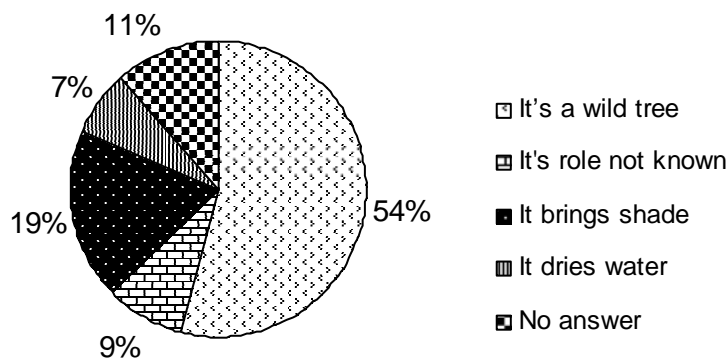


Figure 15: The reasons for not using *B. huillensis* as an agroforestry tree.

4.7.3 Planting *B. huillensis*

Hundred percent of respondents claimed not to plant *B. huillensis* in their homestead, farms and private woodlots. The most frequently mentioned reason for not planting *B. huillensis* is the species being considered as a wild tree as claimed by 60% and 57% of males and females respectively (figure 16). Fishers exact test showed no significant difference in proportion of males and females who claimed not to plant *B. huillensis* (P=1)

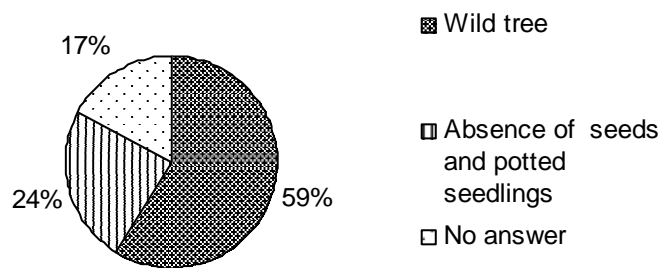


Figure 16: Reasons for not planting *B. huillensis* in homesteads, farms and private woodlots

4.7.4 Participatory Forest Management

Since October, 2004, the forest reserve is managed under Joint Forest Management (JFM) where the Government is the right holder and local people are duty bearers and have user rights. The existing village forest committee contain 16 members and villagers participated in forming by-laws concerning the management of the forest reserve. Penalties are given to those who does not follow the designated by- laws, some of the penalties are Tshs 100, 000 /= (equivalent to 100 USD) for illegal harvesting of trees for timber, Tshs 100, 000 /= (equivalent to 100 USD) for illegal charcoal burning and Tshs 20, 000 /= (equivalent to 20 USD) for harvesting of poles from the forest reserve. The forest committee claimed that the forest reserve is closed from harvesting for 10 years. However, the villagers are allowed to collect firewood (from dead trees), thatch grasses,

medicine and vegetables from the forest reserve. The forest committee reported to be constrained by lack of weapons to deal with poachers.

From structured interview, 74% of respondents (76% and 70% of males and females respectively) claimed that participatory forest management is the type of management which is applied in managing Dindili forest reserve. Fisher's exact test showed no significant difference in proportion of males and females who stated that participatory forest management is applied ($p=0.79$). The most frequently mentioned by-laws set for management of Dindili forest reserve were don't cut any standing tree in the forest reserve (81% of respondents) and don't burn the forest reserve (14% of respondents). 86% of villagers were found to depend on the Dindili forest reserve for forest products such as firewood, charcoal, poles, tools and carvings as shown in figure 17.

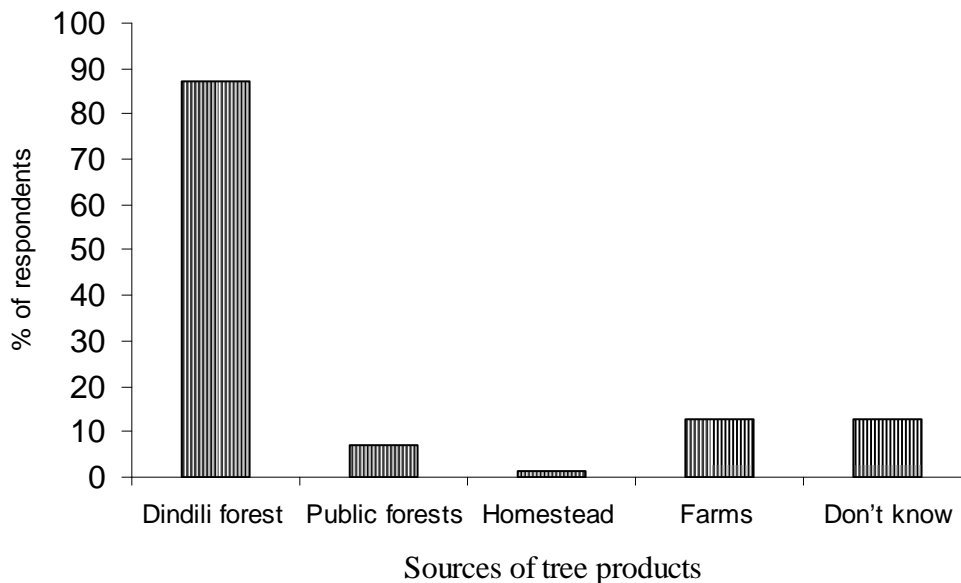


Figure 17: Sources of tree products in Fulwe village.

5.0 DISCUSSION

5.1 FLORISTIC COMPOSITION.

The results show that Dindili forest reserve is floristically diverse. The 129 woody species identified in the forest reserve are superior to some of the studies conducted in different areas of Tanzania. For example, 54 woody species were recorded by Issango (2004) at Mgori forest reserve. Eliapenda (2000) recorded 104 plant species in Mafai dry afro-montane forest, and Malimbwi *et al* (2002) recorded 80 tree species in the South Kilimanjaro montane forest reserve.

The most dominant family in the forest reserve is Fabaceae with 28% of identified woody species. The finding concurs with Burgess and Muir, (1994) report that many areas of Coastal forests on well drained sites are dominated by trees of Fabaceae family. The finding is also inline with 25-50% Fabaceae dominance in coastal forests such as Gendagenda, Kilulu and Ruvu north in Tanzania as reported by Burgess and Clarke, (2000). The observation that *Scorodophloeus fischeri* (Zanzibar inhambane endemic) is the most abundant tree species in the forest reserve (Figure 5) coincide with literature from Temu, (1990) who reported the species to be common and often a dominant canopy constituent in Coastal forests of southern Kenya, Tanzania and Northern Mozambique.

5.2 STANDING WOOD STOCKS.

Brachylaena huillensis was found to be one of the abundant woody species in the forest reserve (Figure 5) with density of 15 trees per hectare. The finding conform with CELP (2003) report that the species is dominant at many places in the forest reserve. Additionally, a good correlation of *B. huillensis* abundance between forest inventory and local people perception of abundance was observed. The higher forest inventory abundance (Figure 5) is inline with higher percentage of respondents (Figure 13) claiming that *B. huillensis* is plentiful in the forest reserve. *Brachylaena huillensis* was also found to be one of the woody species with highest basal area in the forest reserve (Figure 8) with basal area of 0.73m²/ha. CIFOR infobrief (2002) indicated *Brachylaena huillensis* standing volume of 2.7m³/ha in Arabuko-Sokoke forest reserve, Kenya. The

standing *B. huillensis* volume ($5.63\text{m}^3/\text{ha}$) in this forest reserve is relatively higher than the stated volume in Kenya forest.

IVI is an important parameter that reveals ecological significance of species in a given ecosystem (Lamprecht, 1989). The high IVI of *B. huillensis* (13.87) (Appendix 3) reveals that the species is important in characterizing the Dindili forest ecosystem as it is abundant, dominant and frequently occurring. The above finding is in line with Kigomo *et al* (1990a) who found *B. huillensis* to have high IVI (54 and 43 in Karura and Ngong forests respectively), Kenya.

A characteristic reversed J-shape observed in density distribution of woody species in the forest reserve by dbh classes (Figure 6) indicate a good recruitment and consequently a good regeneration trend of the forest reserve. However, the abnormal *B. huillensis* density distribution by dbh classes is an indication of poor regeneration trend of the species (Figure 7). The poor representation of *B. huillensis* trees of Dbh class 4-8.9 and 9-13.9 might be a result of an array of factors, including disturbances brought by tree felling for poles and fires. The villagers utilize *B. huillensis* poles of smaller size as beams in house construction. The exploitation of the species for beams might have caused the paucity of individual in Dbh class 4-8.9cm and 9-13.9cm. The irregular representation of *B.huillensis* in higher Dbh classes ($\geq 29\text{cm}$) is attributed to selective harvesting of larger *B. huillensis* trees for supports in house construction and carvings. Additionally, Whelan, (1995) argues that frequent fire outbreak can affect population structure by elimination of certain classes or a delay in the whole recruitment process. Though information on *B. huillensis* fire tolerance is inadequate, fire might have caused the poor representation of individuals from 4-13.9cm. This observation is not inline with the findings of Kigomo *et al* (1990a) in Karura and Ngong forest reserves, Kenya, in which *B. huillensis* density distribution by Dbh classes was found to follow a normal reversed J-shaped trend.

5.3 HARVESTED WOOD

The harvested wood volume from the reserve (11.63m³/ha) is higher compared to that obtained in Kitulanghalo forest (neighbouring forest) (7m³/ha) by Luoga *et al.*,(2002), indicating higher exploitation of the forest reserve by local people. The higher removal/standing (R/S) volume ratio of *B. huillensis* (0.58) indicate over one-third of the standing stock of *B. huillensis* have been harvested. The high removal of *B. huillensis* individuals (figure 10) present ecological threat to its genetic diversity. Newton (1996) argues that, the removal of large trees could have severe effect on total genetic variation of the population. He further argues that in such circumstances, it is conceivable that single harvest could cause significant genetic erosion, particularly of individuals which are genetically distinctive.

Harvesting of *B. huillensis* indicated local knowledge about its dioecy, of which wood harvesters prefer female tree which produces consistently harder wood than male tree. They claimed to identify female tree through its deeply fissured bark. Although identification of sexes through bark is unreliable taxonomically, the observation presents a serious threat to its future successful reproduction.

5.4 NATURAL REGENERATION

Management proposal of Dindili forest reserve requires coppice regeneration of *B. huillensis* maintained and selected to raise good quality timber (CELP, 2003). On contrary, the study found *B. huillensis* to be a very low resprouter as indicated in appendix 6 . The finding , however, is in congruence with Kigomo *et al* (1994) who reported that the species regenerates mainly from seeds and there is no evidence of vegetative spread. Regeneration of *B. huillensis* from seeds is reasonably high as indicated by high seedling density (407 individuals per hectare) in the forest reserve. The observed high number of seedlings of *B. huillensis* conform with findings from AgroForestryTree Database, (2003) which pointed out that the *B. huillensis* regenerates mainly from seeds. Convincingly, *B. huillensis* regenerates mainly from seeds and the study is not in agreement with the argument of promising *B. huillensis* coppice regeneration in Dindili forest reserve.

5.5 FIRE

The vegetation of coastal forest depends on absence of fire to perpetuate itself (Burgess and Clarke, 2000). However, the studied coastal forest was found to be frequently burnt. Swaine *et al* (1992) argued that repeated intensive burning leads to conversion of both forest and woodland to grassland, in which, combustion of woody vegetation enables increased light levels to reach the ground, thus allowing the development of dense grass layer (Plate 6), which in turn renders the habitat more susceptible to fire. The above phenomenon, pose a serious threat to the perpetuity of *B. huillensis* in the forest reserve, since it is a shade-tolerant species not favoured by open woodland and grassland formation. Moreover, the reduction of the forest area due to fire coupled with poor migration of *B. huillensis*, which takes around 4000 years for a population to advance 1km into a new area as reported by Kigomo (1994), present a profound effect on its perpetuity in the forest reserve.



Plate 6: The dense grass layer in the periphery of Dindili forest reserve.

5.6 USE OF *B. huillensis*

Brachylaena huillensis is popularly known (84% of respondents) and highly utilized (78% of respondents) in the studied village. The statistical tests (Fisher's exact test) did not show significant gender based knowledge on use and management of *B. huillensis*. The species came in the second position in direct matrix ranking and fourth position in total

use-values which indicate that it is one of the multipurpose tree species in the village utilized for poles, carvings, charcoal, firewood, tools, medicine and commercialized for one or more of those purposes. The results of structured interview (Figure 11), preference ranking (Table 4) and use-values(Appendix 7) reveal that *B. huillensis* is highly preferred for poles as attributed to its durable and termite resistant poles. The finding conform with literature from Bryce and Chihongo (1999), which exemplify that the service life of *B. huillensis* poles is over 10 years, the wood is exceptionally resistant to decay , termites and marine borers as confirmed by local tests, where samples in contact with ground remained free of attack after 15 years.

B. huillensis was found to be the most sold species in the village, its commercial value is attributed to its durable poles and high quality carvings. Besides, absence of the species in neighbouring villages and towns might have increased its commercial value. The findings are in congruence with literature from Kigomo (1994), who pointed out that *Brachylaena huillensis* is the main commercially important tree species in central and coastal forests of Kenya. The low percentage of respondents (7%) who mentioned the use of *B. huillensis* for timber and the carpenters' claim that the hardwood from the species is very difficult to work with hand tools are both justified by literature from Bryce and Chihongo, (1999) who argued that planing *B. huillensis* wood with standard knives is impossible owing to the interlocked grain and brittle surfaces, a cutting angle of 15° is recommended, the wood is also difficult to glue and impossible to nail. However, the wood works well with machine with moderate resistance to cutting and moderate blunting of saw teeth and cutters.

5.7 IN-SITU VERSUS EX-SITU CONSERVATION OF *Brachylaena huillensis*

In this study, the species was found not to be ex-situ conserved, as indicated by 100% of respondents claiming not to plant *B. huillensis* in homesteads, farms, and private woodlots. Additionally, 68% of respondents indicated not to use *B. huillensis* as an agroforestry tree. The claim that it is a wild tree species was the frequently mentioned reason for not planting (Figure 16) or using it as an agroforestry tree (Figure 15). The above phenomenon, in addition to below listed grounds, present difficulty in ex-situ

conservation of the species; Firstly, its slow growth rate of 100 years to reach 40cm, 130 years to reach 45cm dbh and reach 60cm in approximately 175 years at its best rate of growth as reported by Kigomo (1994) appear to be a disincentive to plant it. Secondly, its poorly formed tree in open areas as reported by Bryce and Chihongo (1999) create a challenge to its management for merchantable wood. Finally, *B. huillensis* is a shade tolerant species (Kigomo *et al*, 1990b), therefore its success in management as a plantation tree may present some problems. From the above impediments, its in-situ conservation is the immediate way-forward. The above arguments conform with FAO (1986a) report that the species is a priority for insitu conservation.

5.8 PARTICIPATORY FOREST MANAGEMENT (PFM)

Following recent countrywide policy initiatives to involve local people in managing natural resources (URT, 1998), by the year, 2004 village forest committee had been established in Fulwe village. This committee has the mandate to liaise with the Morogoro regional catchment forest office in all issues pertaining to protection of the forest through JFM. However, considering the number of observed illegal activities in the forest reserve, the policy has apparently not yet produced expected results in Dindili forest reserve. Among others, factors which might have led to lack of positive impact of JFM are as follows: Firstly, the “Closure” of the forest reserve for 10 years does not seem to be a viable solution, since the impoverished villagers depend on the forest for their livelihood (Figure 17) especially through extraction of poles, charcoal and timber. JFM could have allowed controlled harvesting for old trees. Secondly, the unmotivated forest committee and forest guards are unlikely to raid the well equipped groups poachers, more so, they are reported to be bribed by poachers. The forest guards should be trustful people who are well equipped.

Thirdly, there is a paradox between conservation of the forest reserve and agricultural activities, caused by a good number of monkeys from the forest reserve eating crops of subsistence farmers. These poor farmers are not allowed to kill them but chase them to the forest reserve, the unpopularity of JFM to some villagers (especially farmers) have been caused by these monkeys. The farmers should be shifted to other areas far away

from these monkeys. Fourthly, the foresters from Regional catchment forest office have failed to help villagers formulate reasonable regulations and produce workable management plans, their lack of expertise is evidenced on the relatively small fine villagers pay for illegal harvesting of trees for poles (Tshs 20,000 equivalent to 20 USD), which does not seem to be a substantial disincentive to harvest trees preferred for poles such as *Brachylaena huillensis* from the reserve and more importantly, no forest management plan prepared on basis of forest inventory and social-economic considerations was found to be in place .

In addition to lack of expertise on JFM package among foresters, there is poor understanding of whether and when a community has any incentive to take on responsibilities for JFM (Ald and Dewees, 2001). In most cases, local communities are not sure of what kind of additional benefit, they are going to obtain from jointly managed forest beyond what they used to enjoy. In fact, the entitlements granted to local people in the study area such as collecting dead firewood, thatch grasses and vegetable for domestic use, are too trivial to act as incentives to conserve the Dindili forest reserve. Dubois (1999) argues that to function as incentives the access and use rights must provide more tangible benefits to people. Hence, more alternative income-generating activities to degrading the forest reserve are needed to attract full commitment of forest dwellers to protect rather than destroying the forest.

5.9 FLAGSHIP SPECIES POTENTIAL OF *Brachylaena huillensis*

B. huillensis met the criteria for flagship species in the study area (Table 9). The concept of flagship species capitalizes on the fact that such species have the ability to capture the imagination of the public and induce people to support conservation action and/or to donate funds. The public in developed countries identifies with high profile, charismatic species, examples of which include tigers, dolphins, rhinos, elephants and gorillas. Such a focus on charismatic megafauna has been criticized for its narrow mammal-centric approach (Entwistle 2000). Whilst more effort could be made to enhance the public profile of other types of organism such as trees for potential use as flagships.

Flagships such as tigers and pandas have traditionally been used by international conservation organizations as a means to raise public awareness and to fundraise in developed countries for conservation projects in developing countries (Leader- Williams and Dublin 2000). The key to a good flagship is raising support or funds that are used more widely than for the preservation of the flagship alone. This may be as simple as providing revenues for wider biodiversity conservation in protected areas where flagships reside. It is necessary to ensure that the flagship species concept is also locally, rather than simply internationally, attractive. Many of the flagship species favoured by the western public and promoted by international conservation organizations are not viewed by local people with the same equanimity, particularly where a tiger is eating their livestock or an elephant is trampling their crops. The following are factors which can make *B. huillensis* a brilliant flagship species for conservation of some coastal forests elsewhere:-

1. Its high subsistence and commercial value in forest patches it exists, can raise popular conservation interest locally, nationally, and internationally.
2. Its restricted distribution in some dry coastal forests and dry upland semi-deciduous forests make its conservation cost-effective.
3. Its ecological value as the main nesting site for Sokoke Scops owl -*Otus ireneae* which is categorized as endangered in 2006 IUCN red list (Birdlife International, 2006) can raise concern among conservation organizations.
4. Its use as a substitute for sandal wood (*Santalum album*) (categorized as vulnerable in the 2006 IUCN red list) in cremation (AgroForestryTree Database, 2003), can draw attention of conservation organisations.
5. Its successful growth is with associated species, therefore the viable option is insitu conservation.
6. Its occurrence mainly in dry coastal forests make it the conservation ambassador of these forests which epitomize difficulties in biodiversity conservation caused by high fragmentation, high dependence for forest products by surrounding impoverished communities and relatively little protected by Government agencies.

Table 9: The evaluation of the flagship species potential of *Brachylaena huillensis* in Fulwe village.

Criteria developed by Bowen-Jones and Entwistle (2002).	<i>Brachylaena huillensis</i> evaluation in Fulwe village
Geographical status	Typical of Dindili forest reserve (abundant, dominant and frequently occurring)
Conservation status	Threatened in the forest reserve (over one- third of standing wood stocks harvested)
Ecological role	Insufficient data to establish its ecological role
Recognition	Large percentage of local people know it (The tree is distinctive and easily recognized by local people)
Existing usage	Mostly for poles and carvings. It is also used for firewood, charcoal, tools and medicine
Charisma	Its durable poles and carvings give a considerable charisma to local people
Cultural significance	Building long-lasting local houses and medicinal purposes.
Positive association	Used for variety of purposes, plus income assisting villagers.
Traditional knowledge	High local knowledge of the species and its uses.
Common names	Indigenous names such as “muhugwe” from its durable poles have no negative connotations, and emphasize its usefulness.

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

From the findings of this study, the following conclusions are drawn:

- *Brachylaena huillensis* standing wood stocks in Dindili forest reserve are substantial as revealed by relatively high density, basal area, volume and Importance Value Index (IVI).
- *B. huillensis* is highly harvested in the forest reserve, as confirmed by over one-third of standing *B. huillensis* already harvested.
- *B. huillensis* does not show good recruitment and regeneration trend in the forest reserve, as indicated by abnormal density distribution by dbh-classes.
- Selective harvesting of female *B. huillensis* poses a serious threat to future successful reproduction of this dioecious species.
- The study categorized *B.huillensis* as a very poor resprouter contrary to CELP (2003) report which proposed coppice regeneration of *B. huillensis* to be maintained and selected to raise good quality timber.
- *B. huillensis* is a multipurpose tree species highly utilized for poles which are durable and termite resistant, its other uses are carvings, firewood, charcoal, tools, medicine and commercial purposes.
- Frequent fires create a serious threat to the perpetuity of the Dindili forest reserve.
- The ongoing Joint Forest Management (JFM) have so far failed to yield positive results mainly due to lack of important socio-economic considerations during its inception.
- *B. huillensis* is an excellent flagship species in conservation of its habitat. By focusing on and achieving its conservation the status of many other species which share its habitat may also be improved.

6.2 RECOMMENDATIONS

- Due to the fact that villagers prefer to harvest female *B. huillensis* tree which produce consistently harder wood than male tree, then research should be done on correlation of deeply fissured bark (local people identify) and flowers (taxonomic identity) of the female tree. Additionally, future management of the species must take into account its dioecy and be organized so that favourable sex ratio is maintained.
- Deliberate human intervention through further research is needed to restore normal recruitment and regeneration trend of *B. huillensis* in the forest reserve.
- The study recommends a flagship species project which use *B. huillensis* as the conservation ambassador of this poorly protected coastal forest.
- The study proposes further research regarding *B. huillensis* conservation status and flagship species potential elsewhere in Tanzania.
- The study recommends conservation education to villagers and encouraging villagers to establish woodlots to provide for fuel wood, building poles and wood for charcoal production. This will minimize the daily walking routine of villagers into the reserve in search of those materials.
- Education on the adverse impact of fire should be done to villagers and the firebreaks (fire lines) constructed around the forest reserve to protect the reserve from accidental fires from the farmlands and surrounding grasslands.
- The ongoing Joint Forest Management (JFM) of the forest reserve should be reviewed and important ecological and socio-economic considerations incorporated. The review should take into account villagers dependence on forest reserve, human-monkeys conflicts and tangible incentives in order to pave way for JFM by consent through popular participation.
- Alternative income-generating activities to degrading the forest reserve are needed to attract full commitment of local people in conserving the forest reserve. The non-destructive income generating activities for this forest may include controlled harvesting of dead logs (old age and wind falls), beekeeping, mushroom and vegetable cultivation, ecotourism and marketing of available non-

wood forest products (NWFP'S). Revenues from these activities should be distributed equally among stakeholders.

- Improvement of social facilities in the village by JFM project is recommended in order to build rapport with villagers. JFM can be enhanced by solving persistent problems in the village such as scarcity of water and lack of dispensary.

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8. 0 APPENDICES

Appendix 1: Questions Administered to Households, Regional Catchment Forest Officer and the District Forest Officer

a) QUESTIONNAIRE TO HOUSEHEAD /HOUSEWIVE

1. For how long have you lived in the area?

- 1) Since birth 2) Last 20 years 3) The last 5 years 4)Others (specify)

2. Education status of respondent:

- 1) Can not read and write 2) Can read and write
3) Primary education 4) Secondary education
5) Higher education

3. What is your occupation?

- 1) Handcraft (specify) 6) Casual worker
2) Carver 7) Selling wood
3) Trading (specify) 8) Apiculture
4) Crop production 9) Salaried work
5) Vegetable Production 10) Others

4. Gender of respondent:

- 1) Male 2) Female

5. Age of respondent:

- 1) <18 2) 18-40 3) 41-60 4) ≥ 60

6. Religion of respondent:

- 1) Traditionalist 2) Christian 3) Muslim 4) Others (specify)

7. Martial status of respondent:

- 1) Single 2) Married 3) Widowed 4) Divorced

Forest resources Utilization (General)

8. What trees species do you use for various purposes and where do you get them from?

No	Types of uses	Species name	Source
1	Fuelwood		
2	Construction		
3	Timber		
4	Farm implements		
5	Medicine		
6	Fence		
7	Carving wood		
8	Sale		
9	Others (specify)		

Sources

- 1) Dindili forest reserve. 2) Public forests 3) Private woodlots 4) Homestead
- 5) Farms

9. How do you get access to forest reserve?

- 1) free 2) permission 3) fee

10. Which tree species are you not allowed to harvest from the reserve unless licence given?

11. Which five tree species (in order of priority) are most preferable for the following uses?

No	Products	Rank				
		1	2	3	4	5
1	Fuel wood					
2	Charcoal					
3	Construction wood					
4	Timber					
5	Carving wood					
6	Medicine					
7	Farm implements					
8	Sale wood					

Management of forest resources

12. Do you know how DFR is managed?

- 1) Yes 2) No 3) I don't know

13. If the answer is yes, what type of management is applied?

- 1) Community participation 2) Government only
3) I don't know

14. How is local community involved in management of Dindili forest reserve? (roles)

15. Are there any rules set for management of the DFR in this area?

- 1) Yes 2) No

If yes, what are they?

16. What happens to a person, if he/she breaks the rules?

17. Which species of trees do you grow?

Species	Number	Where grown	Management	Desirable traits	Use
1					
2					
3					
4					
5					

Code for where grown

FB=Farm Boundary

OF=On-farm

WH= Woodlot

HS= Homestead

OT= Others

Code for desirable trait

FG= Fast growth

NC=Not compete with crops

RL= Resistant to livestock

SF= To improve soil fertility

Code for management

CP=Coppicing

NM=No management

Code for use

FW= Fuel wood

TM= Timber

MD=Medicinal value

FD= Fodder

CW=Carving wood

PL= Pole

18. Do you practice modern agroforestry such as multi-storey mixing of trees/shrubs with crops? 1) Yes 2) No

If yes, what species are used?

Utilization and Management of *B. huillensis*

19. Do you know *B.huillensis* tree?

1) Yes 2) No

If yes

20. Do you use *B.huillensis* tree?

- 1) Yes
- 2) No

If Yes, What do you use it for?

If No, Why you don't use *B.huillensis*?

21. Where do you get *B.huillensis* products?

- 1) Dindili forest reserve
- 2) Private woodlots
- 3) Homestead
- 4) Farmland
- 5) Public lands
- 6) others (specify)

22. What is the status of *B.huillensis* in the following sources? Is it increasing or decreasing?

Status	DFR	Private woodlots	Farm lands	Homestead	Forests in public lands
Plenty					
Moderately Scarce					
Scarce					
Very scarce					

I= increasing

D= Decreasing

23. What is the commonest use of *B.huillensis*

Rank in order of priority three commonest uses

- 1) _____
- 2) _____
- 3) _____

24. Do you grow *B.huillensis* trees?

- 1) Yes
- 2) No

If yes

Where do you grow	Desirable trait	Management	Use
Farm boundary			
On farm			
Wood lat			
Home stead			
Others (specify)			

Code for management

PL=Pollarding

CP= Coppicing.

NM=No management

Code for desirable trait

FG=Fast growth

NC=Not compete with crop

RL=Resistance to livestock

SF=Soil fertility

Code for use

FW=Fuelwood

PL=Pole

TM=Timber

MD=Medicinal value

FD=Fodder

CW=Carving wood.

25. Do you grow *B.huillensis* with your crops in the farm?

1) Yes 2) No

If yes, what benefits do you get?

If No, Why you don't grow *B.huillensis* with your crops?

26. Do you consider *B.huillensis* as one of the important tree species around DFR?

1) Yes 2) No

If Yes, Why? Explain

If No, Why? Explain

27. Is *B.huillensis* having any cultural significance in the area?

b) QUESTIONS TO THE REGIONAL FOREST CATCHMENTS OFFICER (RFCO).

1. How do you manage Dindili forest reserve?
2. Are people allowed to utilize Dindili forest reserve resources?
If yes, what resources and species are they allowed to utilize and to what extent?
3. What are the economically important tree species in the reserve?
4. Which economically important tree species are depleted in the reserve?
5. What is the extent of utilization and management of *B.huillensis* in the reserve?
6. What are government initiatives to manage *B.huillensis*?
7. Is *B.huillensis* a charismatic tree species in the area? If Yes, how?
8. What is the ecological role of *B.huillensis* in the forest?
9. Is *B.huillensis* having any cultural significance in the area?
10. What are your own views on management of *B.huillensis*
11. Do people grow *B.huillensis* in farms, woodlots and homestead. If not why don't they grow? If Yes, for what purpose?

c) QUESTIONS TO THE DISTRICT FOREST OFFICER (DFO).

(Responsible for management of public lands)

1. How do you manage public lands surrounding the Dindili forest reserve?
2. Are the public lands sufficient to supply the villagers with forest products? If not, where do they get forest products?
3. Which important tree species are depleted in the public lands?
4. What is the extent of utilization and management of *B. huillensis* in the public lands?
5. Do people grow *B.huillensis* in farmlands, woodlots and homestead? If not, why they don't they grow? If yes, for what purpose?
6. What are government initiatives to manage *B.huillensis* in the public lands?
7. Is *B.huillensis* important tree species in the area?
8. What is the ecological role of *B.huillensis* in the forest?
9. Is *B.huillensis* having any cultural significance?
10. What are your own views on management of *B. huillensis*?

Appendix 2: A Checklist of woody species encountered Dindili forest reserve.

Se. No.	Vo. No	Scientific name	LOCAL NAME (Kami and Luguru tribes)	Family	Habit
1	JPM 20	<i>Acacia goetzei</i> Harms	Kisasa	Fabaceae	Tree
2	JPM 111	<i>Acacia hockii</i> De Wild.	Mkandekande	Fabaceae	Shrub
3	JPM 43	<i>Acacia nigrescens</i> Oliver	Mkambala	Fabaceae	Tree
4	JPM 27	<i>Acacia nilotica</i> (L.)Willd.ex Del	Kifunganyumbu	Fabaceae	Tree
5	JPM 101	<i>Acacia pentagona</i> (Schumach.)Hook.F.	Lusewa	Fabaceae	Shrub
6	JPM 5	<i>Acacia polyacantha</i> (Hochst.ex A.Rich.) Brenan	Muwindi	Fabaceae	Tree
7	JPM 63	<i>Acacia robusta</i> Burch	Mkongowe	Fabaceae	Tree
8	JPM 94	<i>Acacia senegal</i> (L.) Willd	Mgunga	Fabaceae	Tree
9	JPM 24	<i>Acalpha fruticosa</i> Forsk.		Euphorbiaceae	Shrub
10	JPM 95	<i>Adansonia digitata</i> L.	Mbuyu	Bombacaceae	Tree
11	JPM 62	<i>Azelia quanzensis</i> Welw	Mkongo	Fabaceae	Tree
12	JPM 137	<i>Albizia adianthifolia</i> W.F.Wight	Mkengemaji	Fabaceae	Tree
13	JPM 21	<i>Albizia anthelmintica</i> Brongn	Mfuleta	Fabaceae	Tree
14	JPM 92	<i>Albizia gummifera</i> (J.F.Gmel) A.R.Sm	Mkenge	Fabaceae	Tree
15	JPM 91	<i>Albizia harveyi</i> Fourn		Fabaceae	Tree
16	JPM 32	<i>Albizia petersiana</i> Oliver	Mkengepori	Fabaceae	Tree
17	JPM 113	<i>Allophylus africanus</i> P.Beauv	Msemelele	Sapindaceae	Shrub
18	JPM 44	<i>Allophylus rubifolius</i> (A..Rich.) Engl	Msemelele	Sapindaceae	Shrub
19	JPM 46	<i>Anthocleista grandiflora</i> Gilq.	Embembala Mbala	Loganiaceae	Tree
20	JPM 18	<i>Apholia theiformis</i> (Vahl) Benn		Apholiaceae	Tree
21	JPM 109	<i>Asparagus africanus</i> Lam.		Asparagaceae	Shrub
22	JPM 135	<i>Beilchmiedia kweo</i> (Mildbr.)Robyns and Wilczek	Mfimbo	Lauraceae	Tree
23	JPM 45	<i>Blighia unijugata</i> Baker	Mzindanguruwe	Sapindaceae	Tree
24	JPM 96	<i>Bombax rhodognaphalon</i> K.Schum.exEngl.	Msufipori	Bombacaceae	Tree
25	JPM 28	<i>Boscia salicifolia</i> Oliver	Mlawilila(mguluka)	Capparaceae	Tree
26	JPM 1	<i>Brachylaena huillensis</i> O. Hoffm	Muhugwe	Asteraceae	Tree
27	JPM 42	<i>Brachystegia boehmii</i> Taub	Muyombo	Fabaceae	Tree
28	JPM 92	<i>Brachystegia microphyla</i> Harms	Mseni	Fabaceae	Tree
29	JPM 132	<i>Brachystegia spiciformis</i> Benth	Mbonha	Fabaceae	Tree
30	JPM 6	<i>Bridelia cathartica</i> Bertol.F.	Msisimisi	Euphorbiaceae	Shrub
31	JPM 100	<i>Carissa edulis</i> Vahl		Apocynaceae	Shrub
32	JPM 71	<i>Carpolobia goetzei</i> Gurke		Polygalaceae	Shrub
33	JPM 99	<i>Catunaregum spinosa</i> (Thunb) Tirvengadam	Mtutuma	Rubiaceae	Tree
35	JPM 61	<i>Clausena anisata</i> Hook.f.	Kisekilasengo	Rutaceae	Tree
36	JPM 105	<i>Combretum molle</i> R..Br.ex G.Don	Mlama mweusi	Combretaceae	Tree
37	JPM 29	<i>Combretum padoides</i> Engl. & Diels	Mkungalungo	Combretaceae	Shrub
38	JPM 3	<i>Combretum schumannii</i> Engl.	Mkatakolongo(mperamwitu)	Combretaceae	Tree
39	JPM 64	<i>Combretum zeyheri</i> Sond	Mlama mwekundu	Combretaceae	Tree
40	JPM 47	<i>Commiphora Africana</i> (A.Rich.) Eng.	Mtwinhi	Burseraceae	Shrub
41	JPM 133	<i>Cordyla africana</i> Lour.		Fabaceae	Tree

42	JPM 138	<i>Croton macrostachyus</i> Hochst.ex A.Rich	kikwati	Euphorbiaceae	Tree
43	JPM 31	<i>Croton megalocarpus</i> Hutch	Kiweluko	Euphorbiaceae	Tree
44	JPM 16	<i>Croton pseudopulchellus</i> Pax	Mkambaku	Euphorbiaceae	Tree
45	JPM 60	<i>Dalbergia boehmii</i> Taub	Mzeza	Fabaceae	Tree
46	JPM 48	<i>Dalbergia melanoxydon</i> Guill. & Perr	Mpingo	Fabaceae	Tree
47	JPM 114	<i>Dalbergia nitidula</i> Baker	Mzezegele	Fabaceae	Tree
48	JPM 41	<i>Dalbergia obovata</i> E.Mey	Mgoweko	Fabaceae	Tree
49	JPM 129	<i>Deinbollia borbonica</i> Scheff.	Mmoyomoyo	Sapindaceae	Shrub
50	JPM 65	<i>Dichrostachys cinerea</i> (L.) Wight & Arn	Kikulagembe	Fabaceae	Shrub
51	JPM 106	<i>Diospyros abyssinica</i> (Hiern) White	Mlenga	Ebenaceae	Tree
52	JPM 2	<i>Diospyros consolatae</i> Chiov.	Msungura	Ebenaceae	Shrub
53	JPM 33	<i>Diospyros kirkii</i> Hiern	Mmoyomoyo	Ebenaceae	Tree
54	JPM 89	<i>Diospyros mespiliformis</i> Hochst.ex A.DC		Ebenaceae	Tree
55	JPM 139	<i>Diospyros zombensis</i> B.L.Burt) F.White	Msofu simba	Ebenaceae	Shrub
56	JPM 90	<i>Diplorhynchus condylocarpon</i> (Muell-Arg.)Pichon	Mtogo	Apocynaceae	Tree
57	JPM 66	<i>Dobera loranthifolia</i> Warb.ex Harms	Msiga	Salvadoraceae	Tree
58	JPM 13	<i>Dombeya cincinnata</i> K.Schum.ex Engl.	Mkalerengala(Mkwerengala)	Sterculiaceae	Tree
59	JPM 85	<i>Dombeya rotundifolia</i> (Hochst.)Planch	Msooana(Mlwati)	Sterculiaceae	Tree
60	JPM 14	<i>Drypetes gerrardii</i> Hutch		Fabaceae	Shrub
61	JPM 119	<i>Ehretia amoena</i> Clotzsch	Mkilika (kiluko)	Boraginaceae	Tree
62	JPM 59	<i>Erythrina abyssinica</i> Lam.ex DC.	Mjafari	Fabaceae	Tree
63	JPM 118	<i>Erythroxylum emarginatum</i> Thonn.		Erythroxylaceae	Shrub
64	JPM 77	<i>Euclea divinorum</i> Hiern	Mdaa	Ebenaceae	Tree
65	JPM 126	<i>Euphorbia candelabrum</i> Tremaut ex Kotschy	Bamba langali	Euphorbiaceae	Tree
66	JPM 15	<i>Euphorbia nyikae</i> Pax ex Engl	Bamba chihililo	Euphorbiaceae	Tree
67	JPM 49	<i>Flueggea virosa</i> (Willd.)Voigt	Mkwambe	Euphorbiaceae	Shrub
68	JPM 8	<i>Garcinia huillensis</i> Welw ex Oliv.	Msezi	Clusiaceae	Tree
69	JPM 116	<i>Grewia bicolor</i> Juss.	Mkole	Tiliaceae	Tree
71	JPM 117	<i>Hallea rubrostipulata</i> (K.Schum)Leroy	Msunguti(Mgunguti)	Rubiaceae	Tree
72	JPM 34	<i>Halleria lucida</i> L	Mkungalungo(mkulubuko)	Scrophulariaceae	Shrub
73	JPM 115	<i>Haplocoelum inopleum</i> Radlk	Kihale (mhale)	Sapindaceae	Tree
74	JPM 4	<i>Harissonia abyssinica</i> Oliv.	Mkunzu	Simaroubaceae	Shrub
75	JPM 40	<i>Julbernardia globiflora</i> (Benth.) Troupin	Mnondolo	Fabaceae	Tree
76	JPM 67	<i>Julbernardia magnistipulata</i> (Harms) Troupin	Mhangala	Fabaceae	Tree
77	JPM 58	<i>Landolphia parvifolia</i> K.Schum	Mbungo	Apocynaceae	Shrub
78	JPM 78	<i>Lannea schimperi</i> (A .Rich.)Engl.	Mnindi	Anacardiaceae	Tree
79	JPM 62	<i>Lannea welwitschii</i> (Hiern)Engl.	Mumbu luzigwe	Anacardiaceae	Tree
80	JPM 79	<i>Lecaniodiscus flaxinifolius</i> Bak.	Mbwewe	Sapindaceae	Tree
81	JPM 50	<i>Lepidotrichilia volkensii</i> (Gurke) Leroy		Meliaceae	Tree
82	JPM 30	<i>Leptonychia usambarensis</i> K. Schum	Mkole mnangu/ wa nguu	Rubiaceae	Tree
83	JPM 130	<i>Maerua triphyla</i> A.Rich	Mdudu	Capparaceae	Shrub
84	JPM 68	<i>Margaritaria discoidea</i> (Baill.) Webster	Msakulang'wale(kisakulankwale)	Euphorbiaceae	Tree
85	JPM 75	<i>Markhamia zanzibarica</i> K. Schum	Mtalawanda	Bignoniaceae	Tree

86	JPM 39	<i>Maytenus senegalensis</i> (Lam.) Excell	Mwambangoma	Celastraceae	Tree
87	JPM 51	<i>Millettia usaramensis</i> Taub	Mhanvi	Fabaceae	Tree
88	JPM 57	<i>Myrianthus holstii</i> Engl.	Mlowelowe	Cecropiaceae	Tree
89	JPM 17	<i>Newtonia buchananii</i> (Baker) Gilbert & Boutique	Mnyasa	Fabaceae	Tree
90	JPM 74	<i>Ochna leptoclada</i> Oliver	Mhungilo	Ochnaceae	Tree
91	JPM 11	<i>Ormocarpum kirkii</i> S.Moore	Kilumbulumbu	Fabaceae	Shrub
92	JPM 104	<i>Ozoroa insignis</i> Del	Mkomachuma	Anacardiaceae	Shrub
93	JPM 108	<i>Polyscias fulva</i> (Hiern) Harms	Mkong'onolo	Araliaceae	Tree
94	JPM 80	<i>Psorospermum febrifugum</i> Spach		Clusiaceae	Tree
95	JPM 73	<i>Pteleopsis myrtifolia</i> Engl. & Diels	Mgovu(Mngoji)	Combretaceae	Tree
96	JPM 128	<i>Pterocarpus angolensis</i> DC.	Mninga	Fabaceae	Tree
97	JPM 12	<i>Pterocarpus rotundifolius</i> (Sond.)Druce	Mhambalasha	Fabaceae	Tree
98	JPM 72	<i>Pterocarpus tinctorius</i> Welw	Mkula	Fabaceae	Tree
99	JPM 84	<i>Rhoicissus revoilii</i> Planch.	Mtongotongo(kifugang'ombe)	Vitaceae	Shrub
100	JPM 69	<i>Rhothmannia fischeri</i> (K.Schum.) Bullock	Msesewe (Msewempuuzi)	Rubiaceae	Tree
101	JPM 81	<i>Rytigynia celastroides</i> (Baill.)Verdc	Mlavilavi	Rubiaceae	Shrub
102	JPM 52	<i>Sclerocarya birrea</i> (A..Rich.) Hochst.	Mng'ong'o	Anacardiaceae	Tree
103	JPM 25	<i>Scorodophloeus fischeri</i> (Taub.) J. Leon	Mhande	Fabaceae	Tree
104	JPM 123	<i>Sorindeia madagascariensis</i> Baill	Mpilipili	Anacardiaceae	Tree
105	JPM 56	<i>Spirostachys africana</i> Sond	Msaraka	Euphorbiaceae	Tree
106	JPM 121	<i>Steganotaenia oraliacea</i> Hochst.	Mhogola	Apiaceae	Shrub
107	JPM 102	<i>Sterculia africana</i> (Lour.) Fiori.	Mmoza	Sterculiaceae	Tree
108	JPM 35	<i>Sterculia appendiculata</i> K.Schum.ex Engl	Mdandalanyani	Sterculiaceae	Tree
109	JPM 9	<i>Sterculia quinqueloba</i> (Garcke)K.Schum	Mhembeti	Sterculiaceae	Tree
110	JPM 124	<i>Stereospermum kunthianum</i> Cham	Mkomanguku	Bignoniaceae	Shrub
111	JPM 70	<i>Strychnos spinosa</i> Lam.	Mtonga	Loganiaceae	Tree
112	JPM 53	<i>Suregada procera</i> (Prain) Croizat	Mdimumbago	Euphorbiaceae	
113	JPM 122	<i>Suregada zanzibariensis</i> Baill.	Mdimumbago	Euphorbiaceae	Tree
114	JPM 127	<i>Symphonia globulifera</i> L.f.	Mmelemele(mlemele)	Thymelaeaceae	
115	JPM 37	<i>Syzygium guineense</i> (Willd.)DC	Mzamarau pori	Myrtaceae	Tree
116	JPM 83	<i>Tamarindus indica</i> Linn.	Mkwaju	Fabaceae	Tree
117	JPM 120	<i>Teclea nobilis</i> Delile	Mndizi	Rutaceae	Tree
118	JPM 10	<i>Teclea simplicifolia</i> Verdoorn	Mndizi	Rutaceae	Tree
119	JPM 54	<i>Terminalia sambesiaca</i> Engl. & Diels	Mpululu	Combretaceae	Tree
120	JPM 7	<i>Terminalia sericea</i> Burch.ex.DC	Mkulungo	Combretaceae	Tree
121	JPM 36	<i>Thylachium africanum</i> Lour.	Mdudu	Capparaceae	Shrub
122	JPM 103	<i>Turraea nilotica</i> Gurke	Mjapofu	Meliaceae	Tree
123	JPM 121	<i>Vernonia wakefieldii</i> Oliv.	Mtugutu	Asteraceae	Shrub
124	JPM 26	<i>Vitex mombassae</i> Vatke	Mfululu	Verbenaceae	Tree
125	JPM 55	<i>Xeroderris stuhlmanii</i> (Taub.) Mendonca & Sousa	Mnyenye	Fabaceae	Tree
126	JPM 82	<i>Ximenia caffra</i> Sond.	Mhingi	Olaceae	Tree
127	JPM 141	<i>Xylopia aethiopica</i> A.Rich	Mlawilila	Annonaceae	Tree
128	JPM 22	<i>Zanthoxylum chalybeum</i> Engl.	Mhunungu(Mkunungu)	Rutaceae	Shrub
129	JPM 38	<i>Ziziphus mucronata</i> Willd		Rhamnaceae	Tree

Appendix 3: Importance Value Index (IVI) of woody species in Dindili forest reserve.

No	Name of tree species	Relative frequency	Relative density	Relative Basalarea	Importance Value Index (IVI)
1	<i>Garcinia huillensis</i>	4.88	6.6	14.3	25.78
2	<i>Scorodophloeus fischeri</i>	3.96	12.08	6.98	23.02
3	<i>Brachylaena huillensis</i>	3.56	4.01	6.3	13.87
4	<i>Combretum schumannii</i>	3.17	5.74	4.88	13.79
5	<i>Commiphora africana</i>	3.43	3.2	3.55	10.18
6	<i>Croton pseudopulchellus</i>	3.56	5.03	1.54	10.13
7	<i>Sterculia quinqueloba</i>	1.32	0.76	7.27	9.35
8	<i>Terminalia sambesiaca</i>	3.03	1.78	3.79	8.6
9	<i>Clausena anisata</i>	3.56	2.89	1.2	7.65
10	<i>Teclea simplicifolia</i>	2.9	2.49	0.35	5.74
11	<i>Pteleopsis myritifolia</i>	1.58	1.02	3.01	5.61
12	<i>Albizia gummifera</i>	1.98	1.37	2.21	5.56
13	<i>Millettia usaramensis</i>	1.85	3.6	0.04	5.49
14	<i>Brachystegia microphyla</i>	0.66	1.07	2.97	4.7
15	<i>Erythroxylum emarginatum</i>	2.24	1.93	0.49	4.66
16	<i>Lecaniodiscus flaxinifolius</i>	1.37	1.78	1.2	4.15
17	<i>Dalbergia melanoxyton</i>	1.58	1.37	1.1	4.06
18	<i>Sterculia africana</i>	1.45	0.61	1.96	4.02
19	<i>Dombeya rotundifolia</i>	1.32	2.13	0.56	4.02
20	<i>Diplorhynchus condylocarpon</i>	0.79	2.18	0.89	3.87
21	<i>Tamarindus indica</i>	1.19	0.81	1.87	3.87
22	<i>Zanthoxylum chalybeum</i>	1.72	1.02	1.12	3.85
23	<i>Blighia unijugata</i>	1.85	1.47	0.12	3.44
24	<i>Diospyros consolatae</i>	1.72	1.02	0.68	3.41
25	<i>Haplocoelum inopleum</i>	1.45	1.83	0.01	3.29
26	<i>Grewia bicolor</i>	1.45	1.42	0.39	3.26
27	<i>Hagenia abyssinica</i>	1.19	1.37	0.54	3.09
28	<i>Sterculia appendiculata</i>	0.53	0.25	2.24	3.02
29	<i>Pterocarpus rotundifolius</i>	1.45	1.02	0.34	2.8
30	<i>Markhamia zanzibarica</i>	0.92	1.68	0.19	2.79
31	<i>Lannea schimperi</i>	1.72	0.81	0.13	2.66
32	<i>Spirostachys africana</i>	0.79	0.86	0.92	2.58
33	<i>Euphorbia nyikae</i>	1.06	0.76	0.59	2.41
34	<i>Erythrina abyssinica</i>	0.4	0.15	1.7	2.25
35	<i>Sclerocarya birrea</i>	0.79	0.3	1.14	2.24
36	<i>Polyscias fulva</i>	0.92	0.36	0.94	2.22
37	<i>Halleria lucida</i>	0.79	0.51	0.87	2.17

38	<i>Ochna leptoclada</i>	0.79	0.36	1	2.14
39	<i>Maytenus senegalensis</i>	0.66	0.51	0.94	2.11
40	<i>Julbernardia globiflora</i>	1.06	1.02	0.02	2.09
41	<i>Combretum molle</i>	1.06	0.76	0.22	2.03
42	<i>Dalbergia obovata</i>	0.92	0.86	0.15	1.94
43	<i>Dombeya cincinnata</i>	0.66	0.91	0.36	1.93
44	<i>Acacia robusta</i>	0.66	0.71	0.41	1.78
45	<i>Albizia petersiana</i>	0.53	0.61	0.61	1.75
46	<i>Symphonia globulifera</i>	1.06	0.56	0.11	1.72
47	<i>Ehretia amoena</i>	0.92	0.66	0.09	1.68
48	<i>Combretum zeyheri</i>	0.66	0.86	0.13	1.65
49	<i>Turraea nilotica</i>	0.53	0.25	0.85	1.64
50	<i>Acacia polyacantha</i>	0.13	0.05	1.39	1.57
51	<i>Allophylus africanus</i>	0.66	0.71	0.15	1.52
52	<i>Ximenia caffra</i>	0.53	0.36	0.55	1.43
53	<i>Myrianthus holstii</i>	0.66	0.51	0.24	1.41
54	<i>Dalbergia boehmii</i>	0.4	0.41	0.59	1.39
55	<i>Rothmannia fischeri</i>	0.66	0.61	0.12	1.39
56	<i>Julbernardia magnistipulata</i>	0.26	0.1	0.91	1.28
57	<i>Strychnos spinosa</i>	0.66	0.3	0.27	1.23
58	<i>Dichrostachys cinerea</i>	0.53	0.51	0.1	1.14
59	<i>Margaritaria discoidea</i>	0.53	0.25	0.33	1.11
60	<i>Acacia senegal</i>	0.53	0.41	0.16	1.09
61	<i>Euphorbia candelabrum</i>	0.4	0.36	0.33	1.08
62	<i>Lannea welwitschii</i>	0.26	0.2	0.5	0.96
63	<i>Acacia pentagona</i>	0.53	0.36	0.08	0.96
64	<i>Combretum padoides</i>	0.26	0.61	0.07	0.94
65	<i>Diospyros mespiliformis</i>	0.13	0.1	0.7	0.94
66	<i>Hallea rubrostipulata</i>	0.4	0.25	0.22	0.86
67	<i>Croton megalocarpus</i>	0.53	0.3	0.03	0.86
68	<i>Brachystegia boehmii</i>	0.26	0.3	0.27	0.84
69	<i>Xeroderris stuhlmanii</i>	0.26	0.15	0.4	0.82
70	<i>Newtonia buchananii</i>	0.53	0.2	0.07	0.8
71	<i>Rytigynia celastroides</i>	0.53	0.2	0.02	0.75
72	<i>Apholia theiformis</i>	0.26	0.41	0.07	0.74
73	<i>Thylachium africanum</i>	0.13	0.51	0.05	0.69
74	<i>Vitex mombassae</i>	0.26	0.3	0.12	0.68
75	<i>Albizia anthelmintica</i>	0.26	0.1	0.3	0.66
76	<i>Bombax rhodognaphalon</i>	0.26	0.15	0.22	0.64
77	<i>Rhoicissus revoilii</i>	0.4	0.2	0.02	0.62
78	<i>Cordyla africana</i>	0.4	0.15	0.04	0.59

79	<i>Dobera loranthifolia</i>	0.4	0.15	0.03	0.58
80	<i>Euclea divinorum</i>	0.26	0.1	0.17	0.53
81	<i>Afzelia quanzensis</i>	0.26	0.1	0.13	0.5
82	<i>Adansonia digitata</i>	0.13	0.15	0.21	0.5
83	<i>Xylopia aethiopica</i>	0.26	0.2	0.02	0.49
84	<i>Pterocarpus angolensis</i>	0.26	0.1	0.09	0.45
85	<i>Albizia adianthifolia</i>	0.13	0.1	0.21	0.44
86	<i>Dalbergia nitidula</i>	0.26	0.15	0.01	0.43
87	<i>Leptonychia usambarensis</i>	0.26	0.1	0.06	0.42
88	<i>Acacia hockii</i>	0.26	0.1	0.04	0.41
89	<i>Ceiba pentandra</i>	0.26	0.1	0.04	0.4
90	<i>Anthocleista grandiflora</i>	0.26	0.1	0.01	0.38
91	<i>Teclea nobilis</i>	0.26	0.1	0.01	0.38
92	<i>Ozoroa insignis</i>	0.26	0.1	0.01	0.38
93	<i>Diospyros zombensis</i>	0.26	0.1	0.01	0.37
94	<i>Beilschmiedia kweo</i>	0.13	0.05	0.18	0.36
95	<i>Albizia harveyi</i>	0.13	0.1	0.09	0.32
96	<i>Catunaregum spinosa</i>	0.13	0.15	0.02	0.3
97	<i>Boscia salicifolia</i>	0.13	0.15	0.01	0.29
98	<i>Steganotaenia oraliacea</i>	0.13	0.1	0.05	0.28
99	<i>Sorindeia madagascariensis</i>	0.13	0.05	0.08	0.26
100	<i>Pterocarpus tinctorius</i>	0.13	0.05	0.07	0.25
101	<i>Diospyros kirkii</i>	0.13	0.1	0.01	0.25
102	<i>Brachystegia speciformis</i>	0.13	0.1	0.01	0.25
103	<i>Croton macrostachyus</i>	0.13	0.1	0.01	0.24
104	<i>Stereospermum kunthianum</i>	0.13	0.1	0.01	0.24
105	<i>Acacia nigrescens</i>	0.13	0.05	0.04	0.22
106	<i>Acacia nilotica</i>	0.13	0.05	0.02	0.2
107	<i>Carissa edulis</i>	0.13	0.05	0.02	0.2
108	<i>Syzygium guineense</i>	0.13	0.05	0.01	0.2
109	<i>Lepidotrichilia volkensii</i>	0.13	0.05	0.01	0.19
110	<i>Psorospermum febrifugum</i>	0.13	0.05	0.01	0.19
111	<i>Suregada procera</i>	0.13	0.05	0.01	0.19
112	<i>Terminalia sericea</i>	0.13	0.05	0.01	0.19
113	<i>Flueggea virosa</i>	0.13	0.05	0	0.19
		100	100	100	300

Appendix 4: Standing volume of Woody species in Dindili forest reserve.

No	Species name	Volume m3/ha
1	<i>Sterculia quinqueloba</i>	12.9102
2	<i>Garcinia huillensis</i>	12.8037
3	<i>Brachylaena huillensis</i>	5.6279
4	<i>Scorodophloeus fischeri</i>	4.1943
5	<i>Terminalia sambesiaca</i>	3.5750
6	<i>Erythrina abyssinica</i>	3.3972
7	<i>Combretum schumannii</i>	3.3593
8	<i>Pteleopsis myritifolia</i>	3.3476
9	<i>Brachystegia microphyla</i>	3.1237
10	<i>Commiphora africana</i>	2.5796
11	<i>Lannea schimperi</i>	2.1300
12	<i>Sterculia africana</i>	1.9467
13	<i>Albizia gummifera</i>	1.8001
14	<i>Croton pseudopulchellus</i>	1.7991
15	<i>Tamarindus indica</i>	1.5976
16	<i>Sclerocarya birrea</i>	1.3107
17	<i>Zanthoxylum chalybeum</i>	1.1334
18	<i>Turraea nilotica</i>	1.0358
19	<i>Dalbergia boehmii</i>	0.8502
20	<i>Acacia polyacantha</i>	0.8176
21	<i>Julbernardia globiflora</i>	0.7857
22	<i>Dalbergia melanoxylon</i>	0.7472
23	<i>Polyscias fulva</i>	0.7082
24	<i>Ochna leptoclada</i>	0.7000
25	<i>Spirostachys africana</i>	0.6915
26	<i>Albizia petersiana</i>	0.6562
27	<i>Clausena anisata</i>	0.6448
28	<i>Sterculia appendiculata</i>	0.5400
29	<i>Diplorhynchus condylocarpon</i>	0.5062
30	<i>Haplocoelum inopleum</i>	0.4542
31	<i>Millettia usaramensis</i>	0.4337
32	<i>Diospyros consolatae</i>	0.3928
33	<i>Ximenia caffra</i>	0.3926
34	<i>Euphorbia nyikae</i>	0.3863
35	<i>Xeroderris stuhlmanii</i>	0.3463
36	<i>Dombeya cincinnata</i>	0.2971
37	<i>Dombeya rotundifolia</i>	0.2634
38	<i>Lecaniodiscus flaxinifolia</i>	0.2292

39	<i>Strychnos spinosa</i>	0.2284
40	<i>Acacia robusta</i>	0.2273
41	<i>Erythroxylum emarginatum</i>	0.2073
42	<i>Euphorbia candelabrum</i>	0.1886
43	<i>Grewia bicolor</i>	0.1815
44	<i>Pterocarpus rotundifolius</i>	0.1692
45	<i>Beilschmiedia kweo</i>	0.1687
46	<i>Brachystegia boehmii</i>	0.1587
47	<i>Albizia adianthifolia</i>	0.1562
48	<i>Bombax rhodognaphalon</i>	0.1528
49	<i>Euclea divinorum</i>	0.1469
50	<i>Adansonia digitata</i>	0.1459
51	<i>Diospyros mespiliformis</i>	0.1424
52	<i>Myrianthus holstii</i>	0.1397
53	<i>Albizia anthelmintica</i>	0.1324
54	<i>Teclea simplicifolia</i>	0.1287
55	<i>Halleria lucida</i>	0.1251
56	<i>Markhamia zanzibarica</i>	0.1220
57	<i>Combretum molle</i>	0.0947
58	<i>Lannea welwitschii</i>	0.0917
59	<i>Maytenus senegalensis</i>	0.0876
60	<i>Azelia quanzensis</i>	0.0845
61	<i>Acacia senegal</i>	0.0810
62	<i>Allophylus africanus</i>	0.0643
63	<i>Pterocarpus angolensis</i>	0.0578
64	<i>Sorindeia madagascariensis</i>	0.0558
65	<i>Dalbergia obovata</i>	0.0539
66	<i>Albizia harveyi</i>	0.0494
67	<i>Vitex mombassae</i>	0.0492
68	<i>Combretum zeyheri</i>	0.0440
69	<i>Pterocarpus tinctorius</i>	0.0435
70	<i>Rothmannia fischeri</i>	0.0412
71	<i>Symphonia globulifera</i>	0.0407
72	<i>Dichrostachys cinerea</i>	0.0398
73	<i>Blighia unijugata</i>	0.0356
74	<i>Ehretia amoena</i>	0.0320
75	<i>Steganotaenia oraliacea</i>	0.0311
76	<i>Newtonia buchananii</i>	0.0303
77	<i>Acacia pentagona</i>	0.0298
78	<i>Hallea rubrostipulata</i>	0.0267
79	<i>Margaritaria discoidea</i>	0.0242

80	<i>Apholia theiformis</i>	0.0235
81	<i>Combretum padoides</i>	0.0229
82	<i>Acacia nigrescens</i>	0.0198
83	<i>Acacia hockii</i>	0.0171
84	<i>Cordyla africana</i>	0.0164
85	<i>Thylachium africanum</i>	0.0160
86	<i>Ceiba pentandra</i>	0.0158
87	<i>Dobera loranthifolia</i>	0.0119
88	<i>Teclea nobilis</i>	0.0113
89	<i>Croton megalocarpus</i>	0.0097
90	<i>Combretum padoides</i>	0.0076
91	<i>Xylopia aethiopica</i>	0.0073
92	<i>Rhoicissus revoilii</i>	0.0069
93	<i>Acacia nilotica</i>	0.0063
94	<i>Carissa edulis</i>	0.0063
95	<i>Rytigynia celastroides</i>	0.0061
96	<i>Catunaregum spinosa</i>	0.0059
97	<i>Diospyros zombensis</i>	0.0049
98	<i>Syzygium guineense</i>	0.0048
99	<i>Dalbergia nitidula</i>	0.0043
100	<i>Brachystegia specifformis</i>	0.0042
101	<i>Anthocleista grandiflora</i>	0.0034
102	<i>Boscia salicifolia</i>	0.0029
103	<i>Ozoroa insignis</i>	0.0029
104	<i>Croton macrostachyus</i>	0.0025
105	<i>Julbenardia magnistipulata</i>	0.0020
106	<i>Psorospermum febrifugum</i>	0.0020
107	<i>Suregada procera</i>	0.0020
108	<i>Terminalia sericea</i>	0.0020
119	<i>Leptonychia usambarensis</i>	0.0019
110	<i>Stereospermum kunthianum</i>	0.0018
111	<i>Diospyros kirkii</i>	0.0014
112	<i>Flueggea virosa</i>	0.0014
113	<i>Lepidotrichilia volkensii</i>	0.0009
Total Standing Volume		83.6244

Appendix 5: Harvested volume of woody species from Dindili forest reserve.

No	Species name	Volume (m ³ /ha)
1	<i>Brachylaena huillensis</i>	3.2511
2	<i>Markhamia zanzibarica</i>	2.1596
3	<i>Combretum molle</i>	1.4294
4	<i>Garcinia huillensis</i>	0.9952
5	<i>Spirostachys africana</i>	0.8547
6	<i>Dalbergia boehmii</i>	0.3764
7	<i>Albizia gummifera</i>	0.3603
8	<i>Combretum schumannii</i>	0.3559
9	<i>Terminalia sambesiaca</i>	0.3042
10	<i>Acacia senegal</i>	0.2919
11	<i>Pterocarpus angolensis</i>	0.2230
12	<i>Afzelia quanzensis</i>	0.2084
13	<i>Scorodophloeus fischeri</i>	0.1468
14	<i>Pteleopsis myrtifolia</i>	0.1295
15	<i>Sterculia appendiculata</i>	0.0791
16	<i>Diplorhynchus condylocarpon</i>	0.0780
17	<i>Tamarindus indica</i>	0.0574
18	<i>Acacia robusta</i>	0.0515
19	<i>Haplocoelum inopleum</i>	0.0479
20	<i>Dalbergia melanoxyton</i>	0.0456
21	<i>Pterocarpus rotundifolius</i>	0.0456
22	<i>Diospyros consolatae</i>	0.0453
23	<i>Brachystegia boehmii</i>	0.0429
24	<i>Milletia usaramensis</i>	0.0171
25	<i>Acacia goetzei</i>	0.0142
26	<i>Lecaniodiscus flaxinifolia</i>	0.0105
27	<i>Commiphora africana</i>	0.0079
28	<i>Dalbergia nitidula</i>	0.0075
29	<i>Combretum zeyheri</i>	0.0062
30	<i>Ormocarpum kirkii</i>	0.0026
31	<i>Dombeya rotundifolia</i>	0.0024
32	<i>Margaritaria discoidea</i>	0.0022
33	<i>Teclea simplifolia</i>	0.0019
34	<i>Flueggea virosa</i>	0.0019
Total harvested volume		11.6540

Appendix 6: Coppicing potential of woody species in Dindili forest reserve.

STUMPS	Number of stumps	Coppicing effectiveness	% of high coppicing effectiveness	% of stump coppicing	Resprouting Potential	Resprouting category
<i>Diplorhynchus condylocarpon</i>	7	10.86	100	100	100	Very high resprouter
<i>Lecaniodiscus flaxinifolia</i>	1	9	83	100	91.5	Very high resprouter
<i>Markhamia zanzibarica</i>	2	6..5	60	100	80	Very high resprouter
<i>Acacia goetzei</i>	1	6	55	100	77.5	High resprouter
<i>Sterculia appendiculata</i>	4	6	55	100	77.5	High resprouter
<i>Margaritaria discoidea</i>	1	5	46	100	73	High resprouter
<i>Brachystegia boehmii</i>	2	4	37	100	68.5	High resprouter
<i>Dalbergia boehmii</i>	2	4	37	100	68.5	High resprouter
<i>Combretum zeyheri</i>	1	3	28	100	64	High resprouter
<i>Ormocarpum kirkii</i>	1	2	18	100	59	Average resprouter
<i>Commiphora africana</i>	1	5	46	50	49	Average resprouter
<i>Dalbergia nitidula</i>	1	4	37	50	43.5	Average resprouter
<i>Albizia gummifera</i>	4	3.75	35	50	42.5	Average resprouter
<i>Combretum schumannii</i>	9	4..33	40	33	36.5	Low resprouter
<i>Combretum molle</i>	2	2..5	23	50	36.5	Low resprouter
<i>Spirostachys africana</i>	13	0. 23	2	8	5	Very low resprouter
<i>Brachylaena huillensis</i>	27	0.19	2	6	4	Very low resprouter
<i>Acacia robusta</i>	1	0	0	0	0	Non resprouter
<i>Acacia senegal</i>	7	0	0	0	0	Non resprouter
<i>Azelia quanzensis</i>	2	0	0	0	0	Non resprouter
<i>Dalbergia melanoxylon</i>	1	0	0	0	0	Non resprouter
<i>Diospyros consolatae</i>	2	0	0	0	0	Non resprouter
<i>Dombeya rotundifolia</i>	1	0	0	0	0	Non resprouter
<i>Flueggea virosa</i>	1	0	0	0	0	Non resprouter
<i>Garcinia huillensis</i>	10	0	0	0	0	Non resprouter
<i>Haplocoelum inopleum</i>	2	0	0	0	0	Non resprouter
<i>Milletia usaramensis</i>	4	0	0	0	0	Non resprouter
<i>Pteleopsis myrtifolia</i>	1	0	0	0	0	Non resprouter
<i>Pterocarpus angolensis</i>	1	0	0	0	0	Non resprouter
<i>Pterocarpus rotundifolius</i>	1	0	0	0	0	Non resprouter
<i>Scorodophloeus fischeri</i>	7	0	0	0	0	Non resprouter
<i>Tamarindus indica</i>	1	0	0	0	0	Non resprouter
<i>Teclea simplifolia</i>	1	0	0	0	0	Non resprouter
<i>Terminalia sambesiaca</i>	3	0	0	0	0	Non resprouter

Appendix 7: Use Values of multipurpose woody species in Fulwe village.

	SCIENTIFIC NAME	FIREWOOD	CHARCOAL	POLES	TIMBER	CARVINGS	MEDICINE	TOOLS	FRUITS	TOTAL
1	<i>Garcinia huillensis</i>	0.93	0.87	0.37	0.18		0.31	0.31	0.61	3.58
2	<i>Grewia bicolor</i>	0.88	0.68	0.13			0.37	0.94	0.5	3.5
3	<i>Combretum molle</i>	0.94	1	0.37	0.13		0.37	0.25		3.06
4	<i>Brachylaena huillensis</i>	0.53	0.41	0.97	0.06	0.41	0.16	0.22		2.76
5	<i>Pterocarpus angolensis</i>	0.25	0.38	0.13	1	0.31	0.37	0.25		2.69
6	<i>Combretum zeyheri</i>	0.88	1	0.25	0.19		0.25			2.57
7	<i>Azelia quanzensis</i>	0.18	0.31	0.06	1	0.13	0.43	0.44		2.55
8	<i>Combretum schumannii</i>	0.63	0.68	0.31	0.19	0.19	0.25	0.13		2.38
9	<i>Dalbergia melanoxydon</i>	0.19	0.25	0.06	0.19	1	0.43	0.25		2.37
10	<i>Acacia senegal</i>	0.75	0.81	0.19			0.25	0.13	0.19	2.32
11	<i>Tamarindus indica</i>	0.37	0.31	0.06	0.13		0.19	0.31	0.94	2.31
12	<i>Acacia polyacantha</i>	0.81	0.87	0.18	0.13		0.19	0.06		2.24
13	<i>Julbernardia globiflora</i>	1	0.97	0.06			0.13			2.16
14	<i>Spirostachys africana</i>	0.19	0.19	0.87			0.5	0.31		2.06
15	<i>Syzygium guineense</i>	0.25	0.38	0.19	0.5		0.13	0.06	0.53	2.04
16	<i>Milicia excelsa</i>	0.31	0.25	0.19	0.94		0.13	0.13		1.95
17	<i>Markhamia zanzibarica</i>	0.37	0.31	0.19		0.19	0.25	0.56		1.87
18	<i>Terminalia sambesiaca</i>	0.19	0.31	0.19	0.94		0.13			1.76
19	<i>Clausena anisata</i>	0.56	0.5	0.25			0.19	0.25		1.75
20	<i>Brachystegia spiciformis</i>	0.5	0.68	0.06	0.37		0.13			1.74

DECLARATION

I, Joseph Perfect Mrema, certify that although I may have drawn upon a range of sources cited in this work, the contents of this thesis is solely my original work and has not been submitted any where else for the same purpose.

Joseph Perfect Mrema

Name

Signature

Date

This thesis has been submitted for examination with my approval as supervisor:

Prof. Zerihun Woldu

Name

Signature

Date

Dr. Zemedede Asfaw

Name

Signature

Date