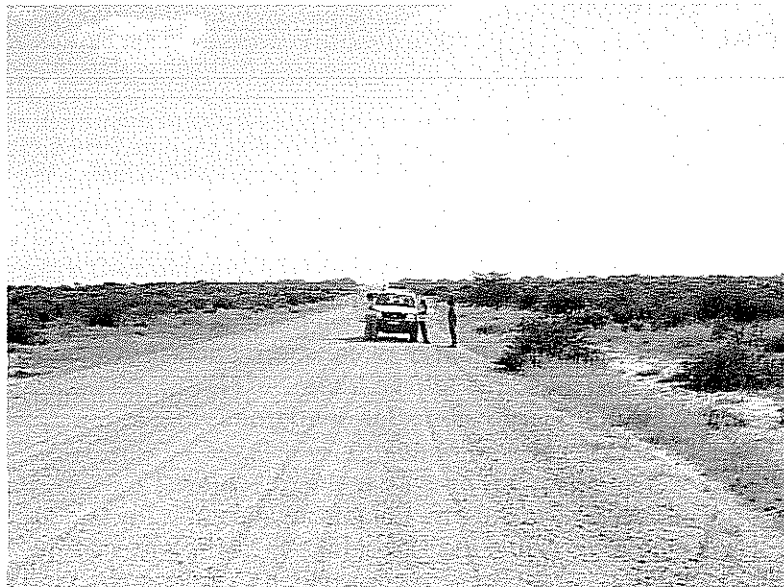


MINISTRY OF ENVIRONMENT AND TOURISM Directorate of Forestry



FOREST INVENTORY REPORT FOR UUKOLONKADHI COMMUNITY FOREST



NAMIBIA - FINLAND FORESTRY PROGRAMME

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1. INTRODUCTION

The Directorate of Forestry (DoF) under the Ministry of Environment and Tourism has a mission to carry out forest resources assessments in Namibia. In this task the Government of Finland has supported it since 1995. The aim of the support was to build up the capacity of the directorate to carry out regional forest inventories of large areas National Forest Inventory (NFI). During the years, an increasing number of local level inventories have also been carried out to fulfill specific requests by projects and forest managers. The support from the Government of Finland today through NFFP Phase II aims now more at strengthening the capacity of Directorate of Forestry to serve the needs for local level forest management planning.

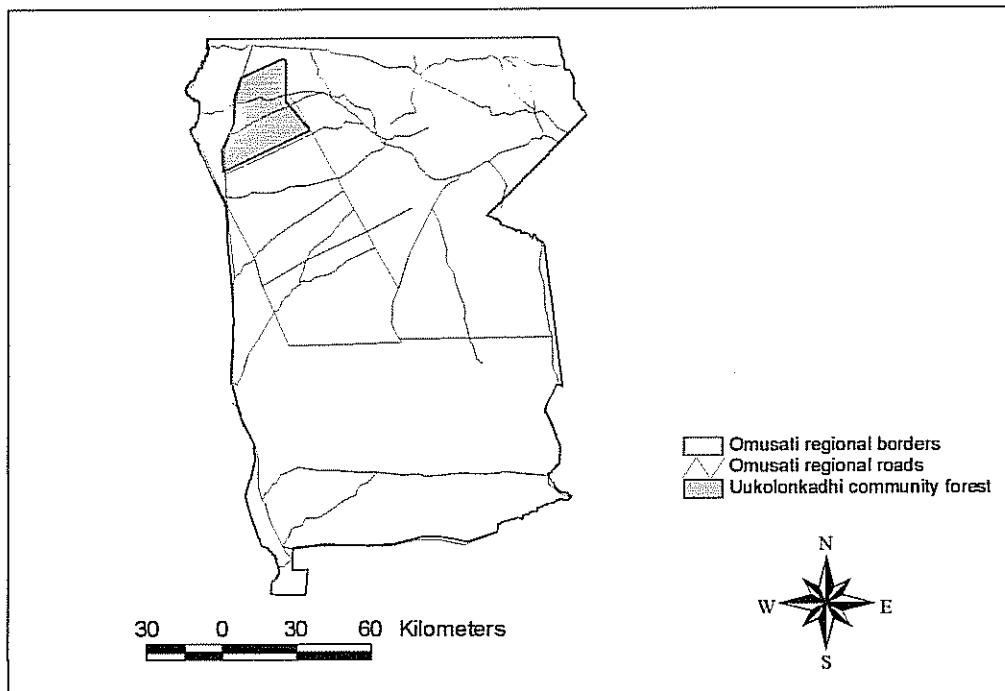
Another component of NFFP, which is the Participatory Integrated Forest Management (PIFM) in North west, is directly working with the community of Uukolonkadhi. They deemed it necessary to find out the amount of resources available in the area in order to compile a sound forest management plan. With regard to community forestry, the component is encouraging community to participate in the management of their forest and forest products. More income generating activities for sustainable development are thought of in the near future as the community will be familiarized with the concept of community forestry.

The inventory in Uukolonkadhi was carried out by the NFI team in June 2002. The inventory covered an area of 83,020 hectares, in Omusati region.

2. GENERAL DESCRIPTION OF THE AREA

The proposed Uukolonkadhi community forest is located in the Omusati region. This area is part of the Kalahari and Namib sands. Inventory area covers 83,020 hectares. The proposed community forest is a little larger than the inventory area. The area west of the Ruacana - Kamanjab road was not inventoried. Common tree species found in the area are *Baikiaea plurijuga*, *Commiphora angolensis* and *Commiphora mollis*. According to the Atlas of Namibia vegetation map, the area is classified as trees and shrub savanna vegetation and the soil is classified as sandy soil. The annual rainfall is between 300-350 mm (see Atlas of Namibia, 2002).

Map 1: Location of Uukolonkadhi inventory area



3. INDIGENOUS LAND UNITS

The indigenous land units can be referred as a collection of natural landscapes or landforms (see appendix 3). It is a land surface, which one can comprehend and detect with the eyes. Many landforms are familiar, such as plains, mountains, hills, valleys etc. Below are brief descriptions of the land units in Uukolonkadhi (see Verlinden, Nott and Nambambi, 2001).

Prior to the inventory, the NRSC carried out a land unit mapping with the help of the community. The map of land units can be obtained from NRSC. A small scale map of land units can be seen in appendix 3.

a) *Etapayela*

Is a landscape with omusati (*Colophospemum mopane*) trees and shrubs on a clay soil mixed with calcrete pebbles and stones. They occur in depressions throughout the area and are usually large (in comparison with the smaller Endambo).

b) *Omutunda*

Is an elevation within a landscape, either in the vicinity of a pan (Ekango) or isolated in a plain.

c) *Ehengethitu*

Is a wooded shrubland with or shrubland with *Combretum apiculatum* as a dominant shrub and with the presence of some *Terminalia sericea*.

d) *Omuthitu*

Is a wooded area with different species mainly *Baikiaea plurijuga*, *Combretum collinum*, *Terminalia sericea* and sometimes you can find *Burkea africana*. It is characterized by sandy soil mostly brown to red.

e) *Endambo*

Endambo are small depressions surrounded by larger trees scattered throughout the area. They appear as small dark patches on aerial photographs.

f) Ekango

Ekango are pans, either devoid of vegetation in the Oshana system or covered by shrubs outside the Oshana system. Ekango have light grey or white clay soils with lime that are characterized by water logging in the wet season. They are larger than Endambo and lack the calcrete outcrops of the Etapayela.

g) Oshikurundu

Oshikurundu are calcrete outcrops occurring as small ridges throughout the landscape. Is a wooded shrubland with *Terminalia sericea*, *Dicrostachys cinerea* and *Colophospermum mopane*.

h) Ondundu

It is a local name for a hill. A few stony hills occur in the area and they are covered with vegetation quite different from the plains area.

4. INVENTORY DESIGN

4.1 Sampling method

The stratification was based on the indigenous land unit map produced by the NRSC. First, the maximum number of plots possible to measure was determined using the resources available (time, staff and money) as the limiting factor. A total of three hundred plots were to be laid. Then, the total area of each land unit, the expected tree cover per cent (from the NRSC description of land units in Uukwaludhi, see Verlinden, Nott and Nambambi, 2001) and the degree of internal variation inside a land unit (from the satellite image) were used to allocate the number of plots for each land unit. No specific system was used for the allocation, the decision was based on previous experience.

Then, the individual compartments of the three main land unit types which were expected to have the majority of the tree cover (Omuthitu, Etapayela and Ehengethitu) were listed in a random order. 10 compartments were selected from each land unit type. The selection was done so that the probability of a compartment to be selected was proportional to the area of the compartment. It means that larger compartments had a higher probability to be selected. Some very small isolated compartments were dropped from the sample in order to improve efficiency of the field work. A uniform grid (plot distance according to the number of plots allocated) was then laid on the land units included in the sample. The plots were then digitized in order to obtain their coordinates.

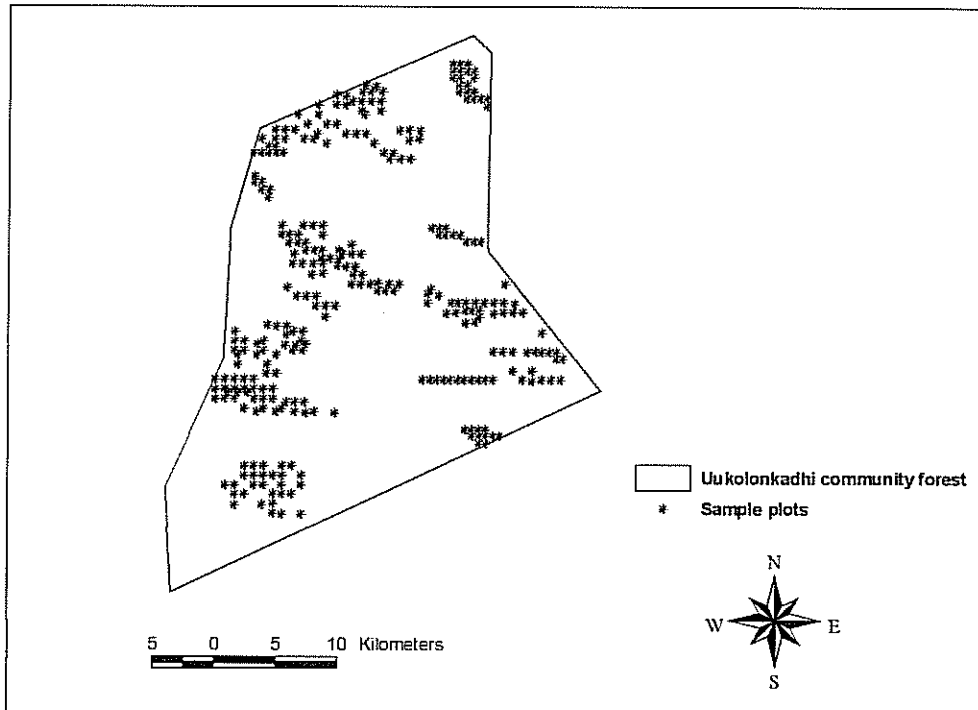
Finally, a large land unit with a very low expected tree cover (Omutunda) and one of the smaller land unit types (Oshikurundu) were sampled. These were not considered very important in respect with the tree resources. Plots for these land units were placed in vicinity of the previously selected compartments of other land units. This was done in order to reduce time spent on traveling inside the forest. The land units with a small area cover (Ondundu, Ekango, Ondombe and Endambo) were not included in the sampling (884 hectares).

The land unit map was changed to some extent after the stratification and sampling. This was because the field verification for the map could only be done after the sampling. Therefore, the allocation of plots in the land units changed as well. This caused that eventually no plots were laid in Oshikurundu either as its area became very small. Thus, the total area finally included in the inventory was 83,020 hectares.

Most of the plots were measured according to the plan (see map 2). Some plots, however, fell on farming land and had to be abandoned. A few plots were left out because of lack of time to complete a certain group of plots at a distant location in a day. The number of plots measured by land unit types is given in the table below:

Indigenous land unit	Area, ha	Expected tree crown cover % (by NRSC)	Number of sampling plots measured
Omutunda	19,369	1	35
Omuthitu	32,761	15	146
Ehengehithu	23,705	3	68
Etapayela	7,184	6	44
Oshikurundu	930	5	-
Ondundu	518	-	-
Ekango	258	0	-
Ondombe	56	10	-
Endambo	52	10	-
Total	84,833		293

Map 2: Location of sample plots

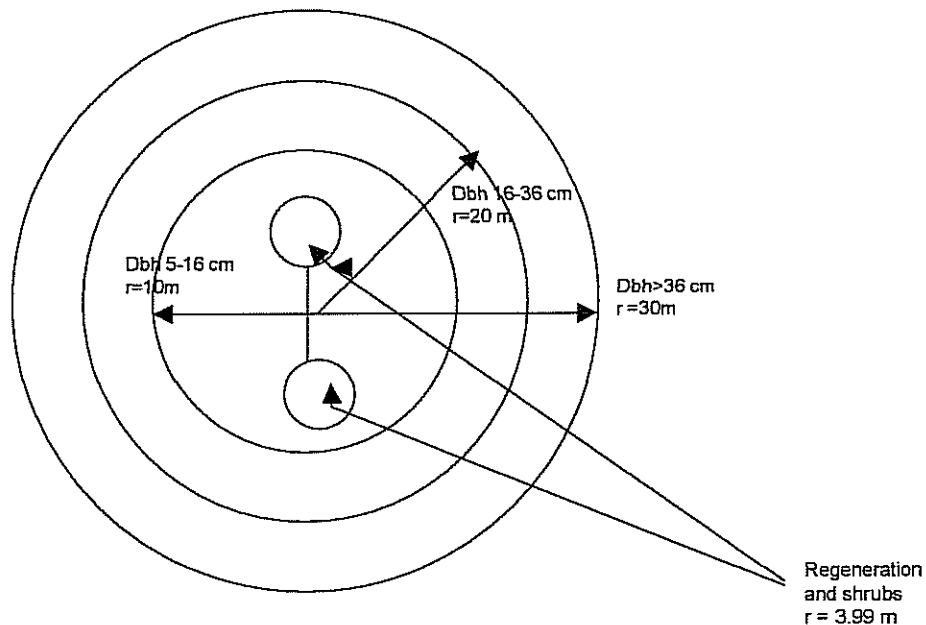


4.2 Plot design

A total of 293 sample plots were measured in Uukolonkadhi. All trees with at least 5 cm Dbh, inside a circular plot were measured. The plot consisted of three concentric circles. The size of the plot depended on the size of the tree, so that the radius of the plot is 30 m for trees with a breast height diameter (Dbh) from 36 cm upwards, 20 m for trees with $16 \leq \text{dbh} < 36$ cm and 10 m for tree with $5 \leq \text{dbh} < 16$ cm.

Dbh, location, species, crown class, height, and damage were recorded for each tree in the plot. Regeneration was recorded on two sub-plots with a 3.99 m radius. Several variables describing the site, soil and tree cover were observed for each plot. All measurements are described in more detail in the Manual for Woody Resource Inventories by the Directorate of Forestry 2001. Coordinates for the measured plots are available at the Directorate of Forestry in Windhoek.

Figure 1: Plot design



5. INVENTORY RESULTS

5.1 Measured data

A total of 293 plots were measured on an area of 83,020 hectares. A total of 3,770 trees with a diameter of at least 5 cm were measured on the plots. Table 1 shows the total number of measured trees by species.

Table 1: Number of measured trees by species

Species	Total No. of measured trees	% of measured trees
<i>Acacia erioloba</i>	10	0.3
<i>Acacia tortillis</i>	4	0.1
<i>Baikiaea plurijuga</i>	793	21.0
<i>Boscia albitrunca</i>	2	0.1
<i>Burkea africana</i>	5	0.1
<i>Colophospermum mopane</i>	365	9.7
<i>Combretum apiculatum (apiculatum)</i>	136	3.6
<i>Combretum collinum</i>	15	0.4
<i>Combretum imberbe</i>	11	0.3
<i>Combretum molle</i>	202	5.4
<i>Commiphora angolensis</i>	559	14.8
<i>Commiphora glandulosa</i>	26	0.7
<i>Commiphora mollis</i>	1205	32.0
<i>Dichrostachys cinerea (Setulosa)</i>	11	0.3
<i>Lonchocarpus nelsii</i>	14	0.4
<i>Terminalia prunioides</i>	155	4.1
<i>Terminalia sericea</i>	210	5.6
Unknown1	4	0.1
Unknown2	34	0.9
Unknown3	9	0.2
Total	3770	100.0

The four most frequent tree species in the data set were *Commiphora mollis* (32%), *Baikiaea plurijuga* (21%), *Commiphora angolensis* (14.8%) and *Colophospermum mopane* (9.7%). There were 47 observations of three unknown tree species.

5.2 Average and maximum height by species

Table 2: Average and maximum height by species found

Species	Average height (m)	maximum height (m)
<i>Acacia erioloba</i>	6.8	11.3
<i>Acacia tortillis</i>	5.1	5.1
<i>Baikiaea plurijuga</i>	7.7	19.0
<i>Boscia albitrunca</i>	4.8	4.8
<i>Burkea africana</i>	5.5	6.5
<i>Colophospermum mopane</i>	5.6	9.3
<i>Combretum apiculatum (apiculatum)</i>	4.7	8.4
<i>Combretum collinum</i>	4.5	6.7
<i>Combretum imberbe</i>	5.5	6.3
<i>Combretum molle</i>	5.1	9.3
<i>Commiphora angolensis</i>	4.6	8.4
<i>Commiphora glandulosa</i>	4.0	5.2
<i>Commiphora mollis</i>	5.5	14.3
<i>Dichrostachys cinerea</i>	4.0	5.3
<i>Lonchocarpus nelsii</i>	6.4	10.7
<i>Terminalia prunioides</i>	5.2	7.8
<i>Terminalia sericea</i>	5.0	8.5
Unknown1	5.2	7.3
Unknown2	6.2	7.7
Unknown3	5.4	6.4

The highest tree that was measured was *Baikiaea plurijuga*, a tree with 19 m. The second highest tree species is *Commiphora mollis* with a height of 14.3 m.

5.3 Species diversity

A simple measure of species diversity is to express the number of species found in the area and the number of plots where each species was found. Table 3 shows the number of plots where each species was found for both trees (≥ 5 cm) and shrubs (< 5 cm).

Table 3: Species diversity by the number of plots where each species was found

Species	No. of plots dbh < 5 cm	No. of plots dbh ≥ 5 cm
<i>Acacia ataxacantha</i>	13	
<i>Acacia erioloba</i>	4	5
<i>Acacia fleckii</i>	18	
<i>Acacia nebrownii</i>	1	
<i>Acacia tortillis</i>	1	1
<i>Baikiaea plurijuga</i>	30	80
<i>Baphia massaiensis</i>	141	
<i>Bauhinia petersiana</i>	108	
<i>Boscia albitrunca</i>	5	1
<i>Burkea africana</i>	1	2
<i>Colophospermum mopane</i>	76	57
<i>Combretum apiculatum (apiculatum)</i>	101	36
<i>Combretum apiculatum (leutweinii)</i>	2	
<i>Combretum collinum</i>	53	8
<i>Combretum engleri</i>	18	
<i>Combretum hereroense</i>	1	
<i>Combretum imberbe</i>	4	4
<i>Combretum molle</i>	9	22
<i>Combretum zeyheri</i>	2	
<i>Commiphora angolensis</i>	93	144
<i>Commiphora mollis</i>	27	88
<i>Croton gratissimus</i>	75	
<i>Dichrostachys cinerea</i>	65	5
<i>Grewia bicolor</i>	14	
<i>Grewia flava</i>	10	
<i>Grewia retinervis</i>	32	
<i>Lonchocarpus nelsii</i>	3	10
<i>Mundulea sericea</i>	52	
<i>Ochna pulchra</i>	3	
<i>Ozoroa paniculosa</i>	53	
<i>Peltoporum africanum</i>	3	
<i>Pterocarpus angolensis</i>	1	
<i>Rhigoszum brevispinosum</i>	62	
<i>Rhus tenuinervis</i>	2	
<i>Terminalia prunioides</i>	23	26
<i>Terminalia sericea</i>	86	47
<i>Vangueria infausta</i>	3	
<i>Commiphora glandulosa</i>		8
Unknown1	1	3
Unknown2		3
Unknown3		2

A total of 41 woody species were recorded in Uukolonkadhi. 20 species are occurring as trees while 38 species are found in the shrub layer. 17 species occurred both as trees and in the shrubs layer.

5.4 Tree volumes and number of stems

Live trees

Table 4: Volume and number of stems for live trees

Species	Total No. of stems	Stems per ha	Total tree volume, m ³	Mean volume m ³ /ha
<i>Acacia erioloba</i>	31,728	0.4	2,199	0.0
<i>Acacia tortillis</i>	28,571	0.3	509	0.0
<i>Baikiaea plurijuga</i>	4,513,809	54.4	306,286	3.7
<i>Boscia albitrunca</i>	8,928	0.1	1,035	0.0
<i>Burkea africana</i>	45,624	0.5	3,031	0.0
<i>Colophospermum mopane</i>	2,344,409	28.2	69,648	0.8
<i>Combretum apiculatum (apiculatum)</i>	944,146	11.4	15,824	0.2
<i>Commiphora angolensis</i>	3,646,851	43.9	241,759	2.9
<i>Combretum collinum</i>	155,183	1.9	3,538	0.0
<i>Commiphora glandulosa</i>	136,093	1.6	11,872	0.1
<i>Combretum imberbe</i>	12,993	0.2	1,516	0.0
<i>Commiphora mollis</i>	8,265,830	99.6	333,962	4.0
<i>Combretum molle</i>	1,343,407	16.2	93,816	1.1
<i>Dichrostachys cinerea (Setulosa)</i>	84,745	1.0	890	0.0
<i>Lonchocarpus nelsii</i>	74,935	0.9	9,343	0.1
<i>Terminalia prunioides</i>	799,188	9.6	19,673	0.2
<i>Terminalia sericea</i>	1,776,985	21.4	47,635	0.6
<i>Unknown1</i>	12,993	0.2	1,632	0.0
<i>Unknown2</i>	143,647	1.7	16,323	0.2
<i>Unknown3</i>	90,074	1.1	2,734	0.0
Total	24,460,140	294.6	1,183,226	14.3

Table 4 above shows that there are 24,460,140 stems in total, which is 294 stems per ha. The biggest share of stems is of *Baikiaea plurijuga*, *Commiphora angolensis* and *Commiphora mollis*. The mean volume of all species is 14.3 m³/ha.

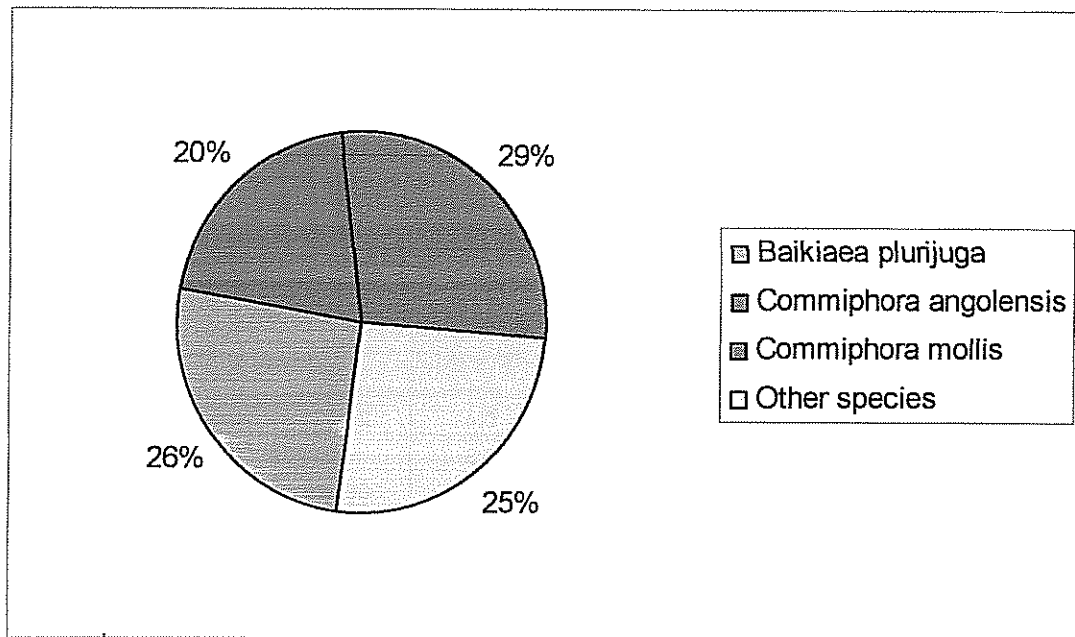


Figure 2: The volume of the most common live tree species expressed in % of the total volume of all species (1,183,226m³)

The total volume of all live trees is 1,183,226 m³. The total volume of *Baikiaaea plurijuga* is 306,286 m³, for *Commiphora angolensis* it is 241,759 m³ and the total volume for *Commiphora mollis* is 333,962 m³.

Dead trees

The majority of dead trees in Uukolonkadhi are *Baikiaea plurijuga*, *Commiphora angolensis* and *Commiphora mollis* trees. The total volume for *Baikiaea plurijuga* is the highest (see table 5). The 3 most common species represent 58 % of the total volume as indicated in figure 3.

Table 5: Volume and total number of stems for dead trees

Species	Total No. of stems	Stems per ha	Total tree volume, m ³	Mean volume m ³ /ha
<i>Acacia erioloba</i>	16,744	0.2	2,379	0.0
<i>Baikiaea plurijuga</i>	341,601	4.1	25,834	0.3
<i>Burkea africana</i>	5,197	0.1	166	0.0
<i>Colophospermum mopane</i>	200,537	2.4	5,272	0.1
<i>Combretum apiculatum (apiculatum)</i>	145,649	1.8	3,115	0.0
<i>Commiphora angolensis</i>	323,237	3.9	17,040	0.2
<i>Combretum imberbe</i>	36,380	0.4	808	0.0
<i>Commiphora mollis</i>	212,239	2.6	5,896	0.1
<i>Combretum molle</i>	119,730	1.4	8,970	0.1
<i>Dichrostachys cinerea (Setulosa)</i>	35,713	0.4	614	0.0
<i>Terminalia prunioides</i>	84,287	1.0	3,200	0.0
<i>Terminalia sericea</i>	187,411	2.3	9,906	0.1
Unknown2	7,143	0.1	340	0.0
Total	1,715,870	20.7	83,542	1.0

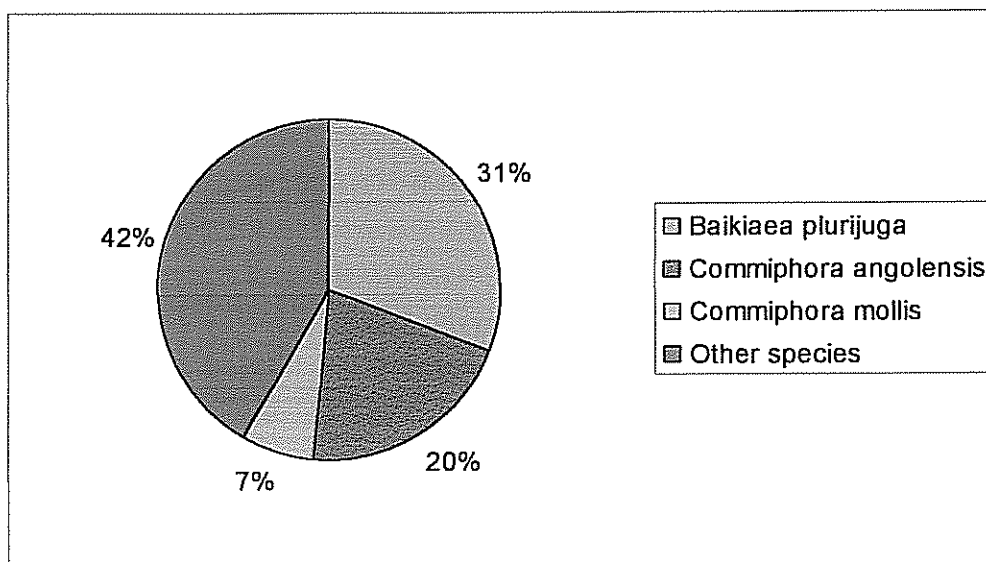


Figure 3: The volumes of the most common dead trees expressed in % of the total volume of all species (83,542 m³)

5.5 Diameter distribution

Live trees

Appendix 1 shows the diameter distribution of live trees. The bulk of the trees in Uukolonkadhi are in the small and medium sized diameter classes. The distribution also gives indications on which tree species have a potential to grow into big size trees in the area. The biggest live trees in Uukolonkadhi are *Commiphora mollis*, *Baikiaea plurijuga* and *Commiphora angolensis* trees. Their diameter distribution is also good in the sense that the majority of the stems are in lower diameter classes. The number of small size of *Commiphora mollis* is very high compared to the other species

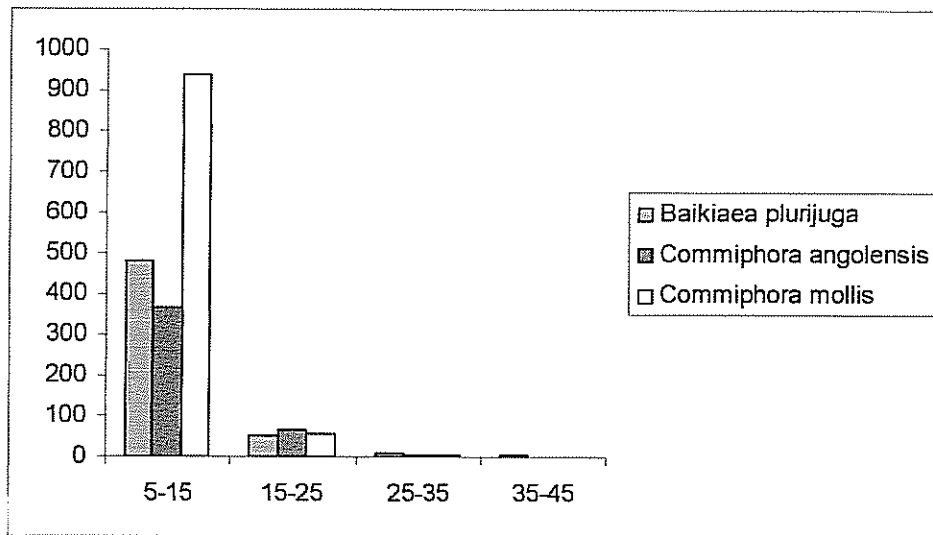


Figure 4: Live wood diameter distribution for the 3 most common species

Dead trees

Figure 5 and appendix 2 show that most of dead stems are *Baikiaea plurijuga* and *Commiphora angolensis*. They are mainly with small size, diameter less than 25 cm at breast height.

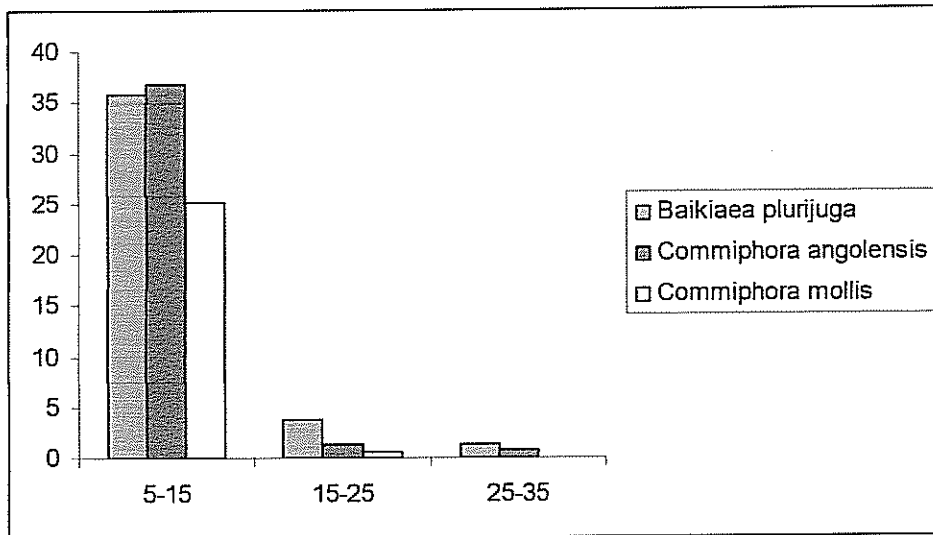


Figure 5: Dead wood diameter distribution for the 3 most common species

5.6 Number of stems by quality classes

A specific tree quality classification designed for Uukolonkadhi was used as follows:

- ⇒ 1 = Timber (old quality classes 1-3): tree with dbh >35 cm and quality good enough for timber.
- ⇒ 2 = Pole for house: trees from 25 cm to 35 cm with good enough quality.
- ⇒ 3 = Pole for fence or kraal: trees from 5 to 25 cm with good enough qualities.

From the table below, it can be seen that there are 9,000 trees with a quality good enough for timber. The timber trees are of *Baikiaea plurijuga* and of *Lonchocarpus nelsii*. There are about 36,000 trees suitable for house construction, mainly of *Baikiaea plurijuga*. There are about 4 million trees suitable for fence or kraal poles.

Table 6: Utilizable tree species according to quality classes

species	Quality	No. of stems per ha	Total No. of stems	% of utilizable stems
<i>Baikiaea plurijuga</i>	1	0.1	6,547	0.2
<i>Lonchocarpus nelsii</i>	1	0.0	2,774	0.1
<i>Baikiaea plurijuga</i>	2	0.4	34,714	0.9
<i>Terminalia serices</i>	2	0.0	1,299	0.0
<i>Acacia erioloba</i>	3	0.1	11,703	0.3
<i>Baikiaea plurijuga</i>	3	19.8	1,643,102	42.1
<i>Burkea africana</i>	3	0.3	28,009	0.7
<i>Colophospemum mopane</i>	3	14.3	1,183,426	30.3
<i>Combretum apiculatum (apiculatum)</i>	3	2.0	163,483	4.2
<i>Combretum collinum</i>	3	0.1	11,703	0.3
<i>Combretum imberbe</i>	3	0.0	1,299	0.0
<i>Combretum molle</i>	3	1.8	147,351	3.8
<i>Lonchocarpus nelsii</i>	3	0.0	3,571	0.1
<i>Terminalia prunioides</i>	3	2.3	194,403	5.0
<i>Terminalia serices</i>	3	5.6	468,497	12.0
Total		47.0	3,901,882	100

5.7 Damage to the woody vegetation

No fire damage was observed in the area. Very little human activities in form of cutting were observed in the community forest.

5.8 Regeneration of the trees and shrub layer

The regeneration potential of *Colophospermum mopane* is good with 384 seedlings per hectare. Other tree species have much less regeneration. The number of seedlings of all species is 802 per hectare. The number of saplings per hectare of all tree species is expressed in the table 7 below.

Table 8 shows the number of seedlings for shrub species. There is an average 1400 shrubs per hectare in the shrub layer. *Baphia massaiensis* is dominating in the shrub layer with 438 shrubs per hectare.

Table 7: Number of tree seedling per hectare by height classes

Species	0-25	26-50	51-100	101-150	151-200	201-250	251-300	300+	Total	% of total
<i>Acacia ataxacantha</i>	0	1	3	2	4	2	0	1	13	1.7
<i>Acacia erioloba</i>	0	1	0	0	0	0	0	0	2	0.2
<i>Acacia fleckii</i>	0	3	4	4	1	1	0	0	14	1.8
<i>Baikiaea plurijuga</i>	0	3	2	4	3	6	2	9	28	3.5
<i>Boscia albitrunca</i>	0	0	2	1	1	0	0	0	4	0.5
<i>Burkea africana</i>	0	0	0	0	0	0	0	0	0	0.0
<i>Colophospermum mopane</i>	4	32	86	98	90	32	3	39	384	47.9
<i>Combretum collinum</i>	1	12	28	22	9	5	0	2	78	9.8
<i>Combretum engleri</i>	0	0	1	4	3	2	0	1	11	1.4
<i>Combretum zeyheri</i>	0	0	0	0	0	2	0	1	2	0.3
<i>Commiphora angolensis</i>	1	8	42	26	10	3	1	1	92	11.5
<i>Dichrostachys cinerea (Setulosa)</i>	0	3	4	10	17	11	1	4	51	6.4
<i>Lonchocarpus nelsii</i>	0	0	0	0	0	1	0	0	2	0.2
<i>Ochna pulchra</i>	1	0	0	1	0	0	0	0	2	0.2
<i>Peltophorum africanum</i>	0	0	0	1	0	0	0	0	2	0.3
<i>Terminalia prunioides</i>	0	1	1	1	3	7	2	7	22	2.7
<i>Terminalia sericea</i>	3	3	8	11	17	16	11	25	94	11.7
Total	11	67	182	185	159	89	21	89	802	100.0

Table 8: Number of shrubs per hectare by height classes

Species	0-25	26-50	51-100	101-150	151-200	201-250	251-300	300+	Total	% of total
<i>Combretum apiculatum</i> (<i>apiculatum</i>)	1	2	19	12	30	24	6	23	116	8.3
<i>Combretum apiculatum</i> (<i>leutweinii</i>)	0	0	0	0	1	0	0	0	1	0.1
<i>Grewia bicolor</i>	0	0	1	3	3	0	1	1	9	0.7
<i>Grewia flava</i>	0	1	1	1	2	0	0	0	5	0.4
<i>Grewia retinervis</i>	0	1	2	8	5	3	0	0	19	1.3
<i>Mundulea sericea</i>	2	7	16	25	25	10	2	1	88	6.3
<i>Ozoroa paniculosa</i>	0	5	11	17	4	0	0	0	37	2.6
<i>Rhigoszum brevispinosum</i>	13	12	28	40	47	14	2	1	157	11.2
<i>Rhus tenuinervis</i>	0	0	0	0	1	0	0	0	1	0.1
<i>Vangueria infausta</i>	0	0	0	0	0	0	0	0	1	0.1
<i>Baphia massaiensis</i>	37	69	134	120	61	14	2	1	438	31.3
<i>Bauhinia petersiana</i>	71	52	159	76	43	14	0	0	415	29.6
<i>Croton gratissimus</i>	2	9	35	40	20	3	2	1	112	8.0
Total	126	157	408	342	243	82	15	28	1400	100.0

5.9 Results by indigenous land units

In this chapter, the area of each indigenous land unit which was sampled (table 9) and the number of stems by species for each unit (table 10) is presented. The results for a certain land unit have been calculated using the data of the plots that fell in the specific land unit. More detailed results can be easily derived from the inventory database.

When analyzing these results, it must be kept in mind that the land unit structure is based on visual interpretation of a satellite image. No land unit classification was done in the measurement of the inventory field plots. Therefore, possible errors in interpretation of the image affect also the results for the land units.

Table 9: Indigenous land units within the Uukolonkadhi inventory area

Indigenous land units	Area, hectares	Area, % of total	Count of plots
Ehengethithu	23,706	28.6	68
Etapayela	7,184	8.7	44
Omuthithu	32,761	39.5	146
Omutunda	19,369	23.3	35
Total	83,020	100.0	293

Omuthithu is the dominant indigenous land unit with about 40% of the hectares in the inventory area. Etapayela has got only a minor share, 9% of the area. The most wooded land unit seems to be Omuthithu with 444 stems per hectare (see table 10). Ehengethithu is the least wooded with 172 trees per hectare. Omuthithu is the most species rich land unit. 15 out of the 20 tree species found in the whole inventory were found in Omuthithu. In other land units, the diversity is much less. *Commiphora angolensis* dominates in Ehengethithu and Omutunda. In Etapayela *Terminalia prunioides* and *Colophospermum mopane* are dominating. In Omuthithu, the dominant species are *Commiphora mollis* and *Baikiaea plurijuga*.

Table 10: Number of stems per hectare by species in the indigenous land units

Species	Ehengethitu	Etapayela	Omuthitu	Omutunda
<i>Acacia erioloba</i>	0.6		0.5	
<i>Acacia tortillis</i>			0.9	
<i>Baikiaea plurijuga</i>	18.4		119.0	9.3
<i>Boscia albitrunca</i>			0.3	
<i>Burkea africana</i>		1.4		1.8
<i>Colophospemum mopane</i>	26.4	75.9	18.5	29.3
<i>Combretum apiculatum (apiculatum)</i>	8.4	45.0	3.7	15.5
<i>Commiphora angolensis</i>	58.6	25.3	29.9	56.6
<i>Combretum collinum</i>	2.5	1.4	0.5	3.6
<i>Commiphora glandulosa</i>	0.5		3.8	
<i>Combretum imberbe</i>		1.8		
<i>Commiphora mollis</i>	27.7	2.2	212.8	32.1
<i>Combretum molle</i>	7.0	0.7	27.7	13.7
<i>Dichrostachys cinerea (Setulosa)</i>			0.4	3.6
<i>Lonchocarpus nelsii</i>	2.1		0.8	
<i>Terminalia prunioides</i>	4.2	87.5		3.6
<i>Terminalia sericea</i>	12.3	7.6	21.6	37.3
Unknown1	3.7	1.8		
Unknown2			4.4	
Unknown3	3.7	0.2		
Total	172.4	251.0	444.7	206.5

Table 11: Total number of stems by species for live trees in the land indigenous land units

Species	Ehengehithu	Etapayela	Omutithu	Omutunda
<i>Acacia erioloba</i>	13,871		17,857	
<i>Acacia tortillis</i>			28,571	
<i>Baikiaea plurijuga</i>	435,549		3,897,707	180,554
<i>Boscia albitrunca</i>			8,928	
<i>Burkea africana</i>		10,394		35,230
<i>Colophospermum mopane</i>	625,427	545,558	605,340	568,084
<i>Combretum apiculatum (apiculatum)</i>	199,742	323,524	121,425	299,455
<i>Commiphora angolensis</i>	1,389,872	181,901	978,544	1,096,535
<i>Combretum collinum</i>	58,258	10,394	16,071	70,460
<i>Commiphora glandulosa</i>	11,097		124,996	
<i>Combretum imberbe</i>		12,993		
<i>Commiphora mollis</i>	657,484	15,592	6,971,825	620,929
<i>Combretum molle</i>	164,910	5,197	907,117	266,182
<i>Dichrostachys cinerea (Setulosa)</i>			14,285	70,460
<i>Lonchocarpus nelsii</i>	49,936		24,999	
<i>Terminalia prunioides</i>	99,871	628,857		70,460
<i>Terminalia sericea</i>	291,290	54,570	708,908	722,216
Unknown1		12,993		
Unknown2			143,647	
Unknown3	88,774	1,299		
Total	4,086,081	1,803,273	14,570,220	4,000,566

Table 12: Total number of stems by species for dead trees in the land indigenous land units

Species	Ehengehithu	Etapayela	Omutithu	Omutunda
<i>Acacia erioloba</i>			7,936	8,808
<i>Baikiaea plurijuga</i>	44,387		297,214	
<i>Burkea africana</i>		5,197		
<i>Colophospermum mopane</i>	47,161	82,433	35,713	35,230
<i>Combretum apiculatum (apiculatum)</i>		67,563	42,856	35,230
<i>Commiphora angolensis</i>	5,548	5,197	312,491	
<i>Combretum imberbe</i>		36,380		
<i>Commiphora mollis</i>	44,387		167,852	
<i>Combretum molle</i>	16,645		67,855	35,230
<i>Dichrostachys cinerea (Setulosa)</i>			35,713	
<i>Terminalia prunioides</i>		75,359	8,928	
<i>Terminalia sericea</i>	33,290	12,704	101,783	39,634
Unknown2			7,143	
Total	191,419	284,834	1,085,485	154,131

Because of the large area of Omuthitu (about 32,000 hectares), this land unit has got the biggest total number of stems (see table 11). Omuthitu has 14,5 million live trees of which about 4 million trees area of *Baikiaea plurijuga* species. In addition to live trees, there are about 1 million dead trees in Omuthitu (see table 12). The dead trees are mainly of *Baikiaea plurijuga* and *Commiphora* species.

5.10 Reliability of the results

The following error sources are always present in sampling based forest inventories: sampling error, measurement error including coding error, errors in data processing and errors in models for volume estimation. In this work, specific attention was paid to guarantee good quality of the field data. Several cross checking's done to find out possible errors and inconsistencies in the data. The applied volume functions are probably the main source of errors.

The sampling error was estimated using the formula for stratified random sampling. The standard error for the mean volume was 1.01 m³/ha (7% of the mean) which is 14.3 m³/ha. The true average tree volume for all species with 95% probability is between 12.3 m³/ha and 16.3 m³/ha.

6. Inventory costs

All inventories require financial inputs which are either direct or indirect costs. The design of the inventory determines the financial implications that will be incurred during the inventory activities on the ground. The inventory in Uukolonkadhi was carried out by National Forest Inventory team (NFI) in June 2002. 1 field trip was undertaken for 25 days. 6 people did the actual fieldwork. In the calculation, a cost for a man-day includes the salary plus the daily subsistence costs. 3 cars (1100 km one way, from Windhoek to Uukolonkadhi) were used to reach the area from Windhoek. 4 ATVs were used for moving from one plot to another. The costs for fuel are more or less real, but the cost for vehicle maintenance is an estimate which has been derived from annual maintenance costs. This calculation only includes immediate costs of the inventory. It does not include fixed costs and overhead costs like office facilities, computers, supervision, etc. the total cost of the inventory is about N\$ 164,760 which is N\$ 1.98 per hectare.

Table 13: Inventory costs

Cost item	Units	Cost/unit, N\$	Total cost, N\$
Inventory planning	1 week	1,000	1,000
Inventory equipment			5,000
Inventory fieldwork	150 man days	828	124,200
Fuel	2000 litres	4.03	8,060
Vehicle maintenance			15,000
Data entry	2 weeks	1,000	2,000
Data analysis	3 weeks	1,000	3,000
Report writing	4 weeks	1,000	4,000
Report printing			2,500
Total			164,760

7. Conclusion

The majority of people depend on the forest resources for fuel wood and poles for homestead construction. Other plants are also used for nutrition and medicinal purposes. Domestic animals and game also depend on the forest resources for fodder and shelter. Hence, there is need to manage and maintain the forest bio-diversity of the area. The most common tree species found in Uukolonkadhi community were *Commiphora mollis*, *Baikiaea plurijuga* and *Commiphora angolensis*. Both commiphoras are used mainly for carvings. *Colophospermum mopane* and *Baikiaea plurijuga* are used for household construction, fuelwood and poles for fencing. Both acacias and *Lonchocarpus* species are used for fodder. *Boscia albitrunca* roots are mainly used to make fresh milk thick.

The average tree volume per hectare is 14.3 m³ compared to Uukwaluudhi which is 6.3 m³. Uukolonkadhi has a higher tree species diversity with 20 species compared to Uukwaluudhi where 16 species were enumerated.

The area inventoried has very good potential for management by the local community. The information in this report and the map of indigenous land units creates now a sound basis for forest management planning.

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Appendix 1

Diameter distribution of the total number of stems per hectare by species for live trees (1000s)

Species	5-15	15-25	25-35	35-45	45-55	55-65	65-75	Total	%of total
<i>Acacia erioloba</i>	25	5	2					32	0.1
<i>Acacia tortillas</i>	29							29	0.1
<i>Baikiaea plurijuga</i>	3990	437	63	21	2	1		4514	18.5
<i>Boscia albitrunca</i>	7	2						9	0.0
<i>Burkea africana</i>	28	18						46	0.2
<i>Colophospermum mopane</i>	2202	125	14	2	2			2344	9.6
<i>Combretum apiculatum (apiculatum)</i>	943	1						944	3.9
<i>Combretum collinum</i>	151	5						155	0.6
<i>Combretum imberbe</i>		13						13	0.1
<i>Combretum molle</i>	1167	166	7		1		2	1343	5.5
<i>Commiphora angolensis</i>	3047	564	36					3647	14.9
<i>Commiphora glandulosa</i>	111	21	4					136	0.6
<i>Commiphora mollis</i>	7773	457	30	5		1		8266	33.8
<i>Dichrostachys cinerea (Setulosa)</i>	85							85	0.3
<i>Lonchocarpus nelsii</i>	52	21		3				75	0.3
<i>Terminalia prunioides</i>	767	32						799	3.3
<i>Terminalia sericea</i>	1709	67	2					1777	7.3
Unknown1	5	5	3					13	0.1
Unknown2	107	32	4	1				144	0.6
Unknown3	89		1					90	0.4
Total	22286	1969	165	32	5	2	2	24460	100.0

Appendix 2

Diameter distribution of the total number of stems per hectare by species for dead trees (1000s)

Species	5-15	15-25	25-35	35-45	45-55	55-65	Total	% of total
<i>Acacia erioloba</i>	7	9		1			17	1.0
<i>Baikiaea plurijuga</i>	298	32	11			1	342	19.9
<i>Burkea africana</i>	5						5	0.3
<i>Colophospermum mopane</i>	193	7		1			201	11.7
<i>Combretum apiculatum (apiculatum)</i>	146						146	8.5
<i>Combretum imberbe</i>	36						36	2.1
<i>Combretum molle</i>	100	16	5				120	7.0
<i>Commiphora angolensis</i>	305	11	7				323	18.8
<i>Commiphora mollis</i>	209	4					212	12.4
<i>Dichrostachys cinerea (Setulosa)</i>	36						36	2.1
<i>Terminalia prunioides</i>	73	12					84	4.9
<i>Terminalia sericea</i>	179	6		1	1		187	10.9
<i>Unknown2</i>	7						7	0.4
Total	1593	95	23	3	1	1	1716	100.0

Appendix 3

