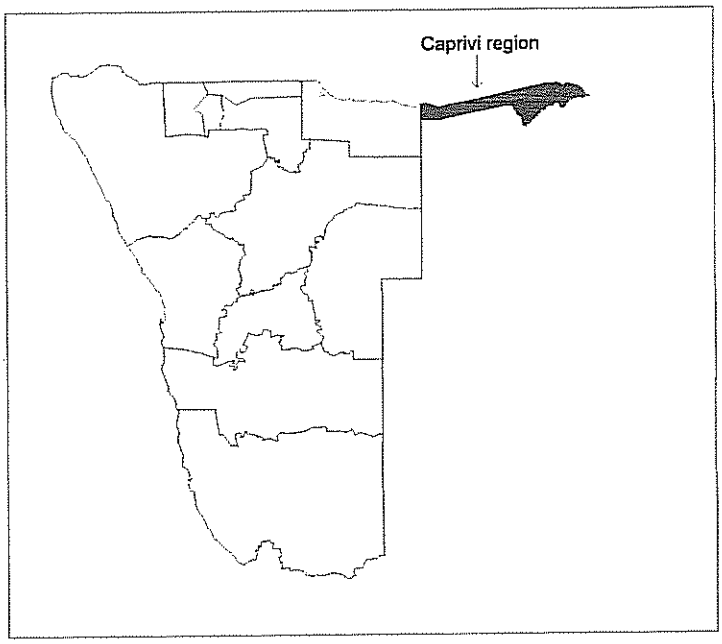
Ministry of **Environment** and Tourism

Directorate of Forestry

FOREST INVENTORY REPORT OF CAPRIVI REGION



Namibia Forestry

Finland Programme

National Forest Inventory Sub-component

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1. INTRODUCTION

Forest research carried out in the 1960s and 1970s in East Caprivi, Kavango, Owambo and Bushmanland gave a rough idea of forest areas and the volumes of sawlogs (Erkkilä and Siiskonene 1992). In the 1980s rough forest inventories were carried out in Bushmanland, Hereroland and in parts of Kavango to give estimates of the volume of *Pterocarpus angolensis*. These inventories were more localised and focussed on *P. Angolensis* and *B. Plurijuga*.

In 1995 the Directorate of Forestry in cooperation with FINNIDA started a National Forest Inventory Project aimed at producing forest data and information on the woodlands in Northern Namibia. And, in 1997 the Directorate began a comprehensive implementation of the Forest Strategic Plan of 1996 by launching the new Namibia-Finland Forestry Programme in April of 1997. The overall programme objective is to ensure an increased role of forestry in the socio-economic development of Namibia through continuous implementation and development of sustainable forest management practices. The National Forest Inventory Project was incorporated, as a sub-component, into the Namibia-Finland Forestry Programme.

A forest inventory was carried out in Caprivi Region between 7 June - 26 November 1997. The inventory covered all tree species. In this Report, Caprivi Region means Katima Mulilo and Mukwe magisterial districts. Mukwe covers West Caprivi Game Park.

The Caprivi database created from the collected field data provides possibilities for further studies on the Caprivi woodland ecosystems. Information on the species composition on different sites as well as on the species diversity may be obtained by further analysis of the data. The database can be accessed at the Directorate of Forestry, Ministry of Environment and Tourism.

This report is related to a series of inventories carried out in various other parts of Namibia. The previous reports are "Woody Resources of Western Tsumkwe", "Woody Resources of East and South Tsumkwe, Otjinene and Okakarara Districts" and "Forest Inventory Report of Ongadjera Community Forest" available at the Directorate of Forestry.

The presentation of results in this report is one out of the many possibilities in which the data can be analysed to provide different overviews of the status of the forest resources in Caprivi Region.

The personnel that directly participated in the forest inventory exercise are listed in Appendix 5.

2. GENERAL DESCRIPTION OF THE AREA

The area belongs to the Tree Savanna and Woodland vegetation zone in the classification of Giess (National Atlas of South West Africa)covering 20% of Namibia's land area. The soil is derived from Kalahari sand. The following land forms are present: dunes, dune valleys and sandy substrates. Average annual rainfall is 700 mm. The average elevation is about 930 m above sea level.

Typical for Caprivi area is dune formations in the Caprivi strip and river over-flow areas. Dunes are clearly narrower than in e.g. Tsumkwe region. Both the dunes and rivers cause that the vegetation units are smaller than in most other parts of the country.

Between 1993-95 the Vegetation Mapping Project (Directorate of Forestry) produced vegetation maps for the whole Caprivi Region. Based on these maps the total land area of Caprivi Region is about 2 007 764 ha. The wooded area is 1 647 959 ha. The wooded area is classified into 1 617 155 ha of forest (trees higher than 5 m), 15 218 ha as savannah (trees less than 5 m), 100 240 ha as grassland and pans, and 258 844 ha as other land (intensive cultivation, marshlands, water, town area). About 82 284 ha or 5% of the forest category is extensively cultivated particularly in East Caprivi, while 2 764 ha or 18% of the savanna is extensively cultivated.

3. SAMPLING METHOD

3.1 Stratified systematic sampling

The forest resources were estimated using stratified systematic plot sampling. Vegetation Maps at the Directorate of Forestry were used to stratify the area into 12 sampling strata, see Appendix 1. For each sampling stratum it was defined before hand how many field clusters should be measured (Appendix 1, Table 1). Ten (10) clusters was regarded as a minimum for the smallest strata and as a maximum 40 clusters for the largest strata. Sampling intensity was higher for dense forests than for open forests in order to collect more data from such areas.

Caprivi Region is covered by 40 Namibian Series 1:50 000 scale map sheets. The following 15 map sheets covering evenly the whole Caprivi Region were systematically selected and sampled: 1722DC, 1723CC, 1723CD, 1723DB, 1723DC, 1723DD, 1724CB, 1724CC, 1724DA, 1724DC, 1725CC, 1821AA, 1821BA, 1822AA, 1823BA. A systematic grid of sample clusters was drawn on each selected mapsheet. Each mapsheet had 20 plots located in two parallel lines running from South to North. The distance between these lines was 5 km in East-West direction. The distance between plots in a line was 1 km.

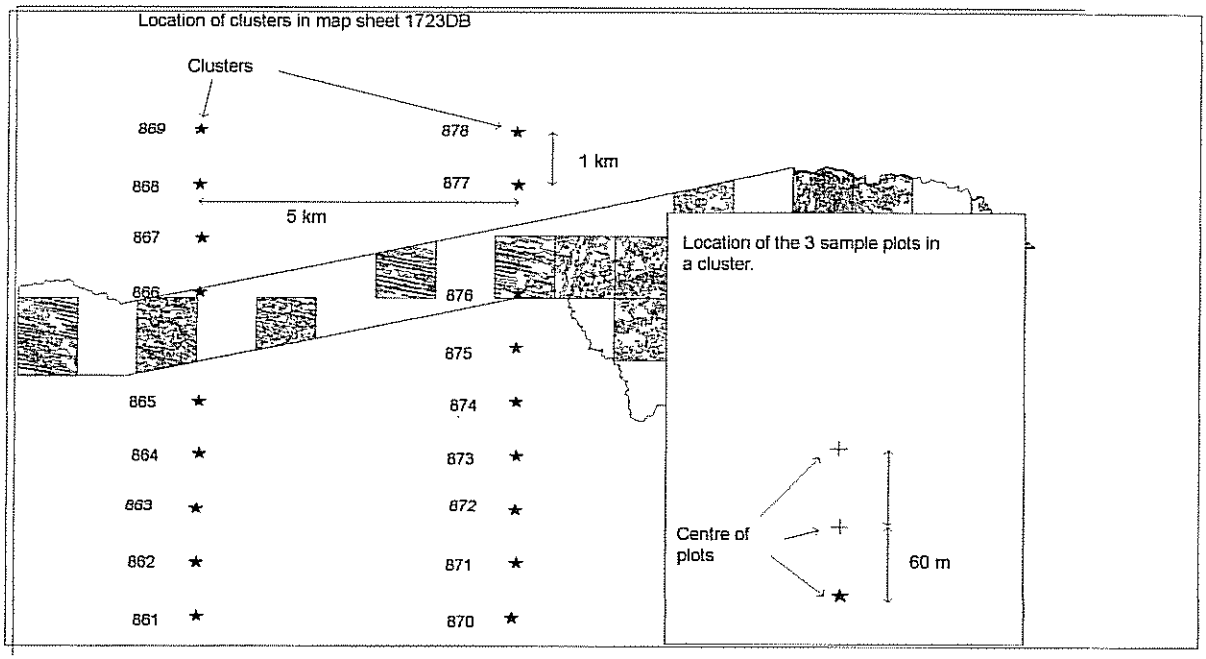


Figure 1 Sampled mapsheets in Caprivi Region inventory.

After locating all the plots in the 15 vegetation map sheets, the number of plots in each stratum was checked. If there was too many clusters in any stratum, the number was reduced by dropping out every n'th plot. If there was too few clusters in any stratum, the number was increased by selecting more sample points from the overlay grid so that they were close to the clusters to be measured. The final number of sample clusters was 300. Each cluster consisted of 3 plots at a distance of 60 m apart *in north-south direction. Hence a total of 900 sample plots were measured in Caprivi Region.*

3.2 Cluster coordinates

The clusters plotted on the Vegetation Maps were digitized using MapInfo to obtain coordinates for each cluster. *The coordinates and GPS was used for the location of the clusters in the field.* All *sample plots in each* cluster are regarded as permanent measurement plots. They can be re-located for re-measurements in future. The coordinates are shown in Appendix 2 for other users who may wish to locate the plots in the field. *The coordinates are the locations of the first plot (the plot most to the south)in the cluster. To lacate the two other plots a compass and measurement tape are needed.*

3.3 Field measurements

A plot consisted of three concentric circles with 10 m, 20 m and 30 m radii respectively. All trees with DBH equal to or larger than 5 cm inside the circular plot were measured. The size of the

plot depended on the size of the tree to be measured so that the radius of the plot was 30 m for trees with breast height diameter (DBH) more than 45 cm; 20 m for trees with 20 < DBH ≤ 45 cm; and 10 m for trees with 5 < DBH ≤ 20 cm. Diameter, location, species, crown class, quality, length and quality of possible saw log were measured and recorded for each tree (called enumeration trees). Height, diameter of canopy, crown height, damages and phenology were recorded for all the trees on the first plot of each cluster (i.e. for one third of all the trees). These trees are called sample trees.

In addition, shrubs, regeneration, coverage of grasses and herbs, were measured using two 3.99 m radii circular plots located in the first plot of each cluster. Woody plants with diameter at breast height less than 5 cm were recorded on the shrub and regeneration field form and bigger woody plants on the sample and enumeration tree field forms. Several variables describing the site, soil and tree cover were observed for each plot and recorded on the stand description field form. All the measurements are described in more detail in the field instructions (Field Instructions Western Bushmanland 1996).

3.4 Stem analysis and volume functions

Data were collected on 95 felled sample trees for constructing volume functions for *Burkea africana*, *Combretum collinum*, *Lonchocarpus nelsii*, *Pterocarpus angolensis*, *Baikiaea plurijuga*, *colophospermum mopane* and *Terminalia sericea*. All the measurements are described in the field instructions(Field Instructions for tree felling). The data on the 53 felled trees in West Tsumkwe were added to the 95 felled trees of Caprivi to derive volume functions. The estimated volume functions are in Appendix 3. For other species that were not so abundant in the data and without a volume function one of these functions was applied to estimate the volume of such species. For other users who may wish to use the models, Appendix 4 shows which models were applied to the species without volume functions.

4. INVENTORY RESULTS

4.1 Measured data

A total of 837 plots or 279 clusters were measured. And, a total of 4018 trees with diameter equal to or greater than 5 cm were measured on the plots. Out of 4018 trees, 1336 were sample trees, that is trees on which, among other variables, height was measured also. Table 1 shows the total number of measured trees by species. The total number of measured trees includes the sample trees. Fifty seven (57)species were enumerated and the most frequent trees in the data were: Colophospermum mopane 21.93%; Baikiaea plurijuga 14.83%; Burkea africana 12.69%; Terminalia sericea 11.80%; Combretum collinum 8.86%; Acacia erioloba 4.78%; Combretum zeyheri 3.09%; Guibourtia coleosperma 2.44%; and Pterocarpus angolensis 2.24%.

Table 1. Total number of measured trees and sample trees by species

Species	Total No. of measured trees	% of measured trees	Total No. of sample trees	% of sample trees
Acacia erioloba	192	4.78	63	4.72
Acacia fleckii	26	0.65	10	0.75
Acacia hebeclada (hebeclada)	10	0.25	2	0.15
Acacia hebeclada (tristis)	7	0.17	4	0.30
Acacia karroo	5	0.12	3	0.22
Acacia luederitzii	1	0.02	1	0.07
Acacia mellifera	3	0.07	2	0.15
Acacia nigrescens	31	0.77	14	1.05
Acacia reficiens	15	0.37	3	0.22
Acacia tortilis (heterecantha)	1	0.02		0.00
Afzelia quanzensis	6	0.15	5	0.37
Albizia harveyi	6	0.15	2	0.15
Amblygonocarpus andongensis	1	0.02		0.00
Baikiaea plurijuga	596	14.83	158	11.83
Baphia massaiensis	5	0.12	1	0.07
Bauhinia thonningii	2	0.05		0.00
Berchimia discolor	1	0.02		0.00
Boscia albitrunca	16	0.40	3	0.22
Burkea africana	510	12.69	162	12.13
Colophospermum mopane	881	21.93	324	24.25
Combretum apiculatum (apiculatum)	8	0.20	6	0.45
Combretum collinum	356	8.86	79	5.91
Combretum elaeagnoides	1	0.02		0.00
Combretum engleri	18	0.45	8	0.60
Combretum hereroense	8	0.20	1	0.07
Combretum imberbe	67	1.67	29	2.17
Combretum molle	5	0.12	1	0.07
Combretum zeyheri	124	3.09	51	3.82
Commiphora africana	2	0.05	2	0.15
Commiphora angolensis	14	0.35	7	0.52
Dialium engleranum	79	1.97	25	1.87
Dichrostachys cinerea	13	0.32	5	0.37
Diospyros mespiliformis	5	0.12		0.00
Erythrophleum africanum	54	1.34	19	1.42
Ficus capensis	2	0.05		0.00
Ficus natelensis	3	0.07		0.00
Guibourtia coleosperma	98	2.44	46	3.44
Kigelia africana	2	0.05	1	0.07
Kirkia acuminata	1	0.02		0.00
Lonchocarpus capassa	23	0.57	1	0.07
Lonchocarpus nelsii	73	1.82	30	2.25
Markhamia acuminata	1	0.02		0.00
Mundulea sericea	1	0.02	1	0.07
Ochna pulchra	41	1.02	14	1.05
Ozoroa longipes	21	0.52	5	0.37
Ozoroa paniculosa	3	0.07	2	0.15
Parinari curatellifolia	1	0.02	1	0.07
Peltophorum africanum	70	1.74	33	2.47
Pterocarpus angolensis	90	2.24	28	2.10
Schinziophyton rautanenii	13	0.32	3	0.22
Sclerocarya birrea	3	0.07	2	0.15
Strychnos cocculoides	2	0.05		0.00

Strychnos pungens	1	0.02	1	0.07
Terminalia prunioides	8	0.20	3	0.22
Terminalia sericea	474	11.80	172	12.87
Unknown1	15	0.37	2	0.15
Ziziphus mucronata	3	0.07	1	0.07
Total	4018	100.00	1336	100.00

4.2 Estimated Vegetation Structural Types

The Vegetation Structural Types were derived for each vegetation unit from the measured sample plots. The derivation of the Vegetation Structural Type is based on the measured tree height, shrub and grass cover and on measured coverage of each of these layers (Edwards 1983). The criteria used are in Appendix 4.

Table 2 shows the area of different Vegetation Structural Types in hectares and percent. Woodlands (definition: tree cover > 0.1% and shrub cover < 10% if shrub height more than 1 m) cover 75.2% of the area. The woodlands are mostly in the category Short Closed Woodland, 31.0% (definition: tree cover 11-75% and tree height 5-10 m) followed by Tall Closed Woodland, 18.3%; Short Open Woodland, 12.7%; Tall Open Woodland, 9.6%; and Low Open Woodland, 5.1%.

Vegetation Structure Type	Area In Ha	% of Total Area
Short Closed Woodland	511277.0	31.0
Tall Closed Woodland	301214.1	18.3
Short Open Woodland	208614.2	12.7
Tall Open Woodland	157430.4	9.6
Low Open Shrubland	84560.4	5.1
Short Thicket	61150.0	3.7
Bare Land	46059.8	2.8
Low Closed Shrubland	41569.7	2.5
Short Bushland	35320.4	2.1
Low Open Woodland	33265.0	2.0
Tall Closed Shrubland	26830.4	1.6
Tall Open Shrubland	26592.6	1.6
Low Sparse Shrubland	23846.6	1.4
Short Sparse Woodland	21897.9	1.3
Short Closed Grassland	14645.3	0.9
Tall Forest	13160.2	0.8
Tall Closed Grassland	12787.7	0.8
Tall Open Grassland	6258.1	0.4
Low Bushland	6246.4	0.4
Short Open Grassland	6090.7	0.4
Low Closed Woodland	4869.5	0.3
High Closed Shrubland	2148.9	0.1
Low Sparse Woodland	2123.9	0.1
Total	1647959.3	100.0

Table 2: Area by Vegetation Structural Types

Baikiaea plurijuga	375765.5	22.8
Burkea africana	245605.5	14.9
Colophospermum mopane	238719.9	14.4
Terminalia sericea	211370.1	12.8
No trees	103194.2	6.2
Combretum collinum	95377.6	5.7
Dialium engleranum	60877.3	3.6
Lonchocarpus nelsii	49070.1	2.9
Combretum imberbe	44884.4	2.7
Acacia erioloba	42276.4	2.5
Combretum zeyheri	33605.0	2.0
Erythrophleum africanum	31063.1	1.8
Acacia hebeclada (hebeclada)	22410.2	1.3
Guibourtia coleosperma	20731.7	1.2
Albizia harveyi	12981.7	0.7
Pterocarpus angolensis	8652.9	0.5
Peltophorum africanum	8382.0	0.5
Acacia karroo	6090.7	0.3
Diospyros mespiliformis	6090.7	0.3
Lonchocarpus capassa	6090.7	0.3
Acacia fleckii	4710.5	0.2
Combretum engleri	4710.5	0.2
Terminalia prunioides	4272.9	0.2
Schinziophyton rautanenii	4097.5	0.2
Ozoroa longipes	2307.7	0.1
Commiphora angolensis	2148.9	0.1
Kirkia acuminata	1033.4	0.0
Boscia albitrunca	719.0	0.0
Dichrostachys cinerea	719.0	0.0
Total	**1647959.3**	**100.00**

4.3 Crown cover and dominant species

The crown coverage of each species was calculated for each cluster. The dominant and second dominant species were derived from these crown coverage estimates. Table 3 shows the areas of dominant species in hectares and percentages. *Baikiaea plurijuga* is the most common dominant species on 375765.5 ha or 22.8% of the wooded area, followed by *Burkea africana* as the second most common dominant species, 245605.5 ha or 14.9% and then by *Colophospermum mopane* 238719.9, 14.7%; and *Terminalia sericea* 149 297 ha or 9.1%. The area with no trees comprises about 103194.2 ha or 6.26% of the wooded area.

Table 3: Area, in ha and %, by dominant species

Table 4 shows the distribution of crown cover classes by dominant species. The figures inside the table are percentages of the area of the respective species. *Pterocarpus angolensis* dominated areas are most often in the cover classes 15 - 20%. Most of the *Baikiaea plurijuga* dominated areas are in cover classes 0-5%,10-15%, 5 - 10% to and 15-20%.

Species	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	95-100	145-150
Acacia erioloba	73.30	21.25	20.39	30.71			14.41								
Acacia fleckii		100.00													
Acacia hebeclada (hebeclada)	72.82	27.18													
Acacia karroo									100.00						
Albizia harveyi		100.00													
Baikiaea plurijuga	26.92	18.02	25.25	12.51	1.62	6.85	6.33	0.19	2.30						
Boscia albitrunca	100.00														
Burkea africana	20.19	6.88	36.55	11.44	3.60		15.86	0.20	5.29						
Colophospermum mopane	18.55	15.28	16.53	5.71	10.22	2.81	26.49	0.43	2.74	0.62	0.62				
Combretum collinum	30.35	8.56	30.86	16.62	13.61										
Combretum engleri			100.00												
Combretum imberbe	40.09	41.15	2.73	13.57					2.47						
Combretum zeyheri	17.29	38.63	18.62			25.46									
Commiphora angolensis		100.00													
Dialium engleranum		26.81	3.74					26.81	21.32			21.32			
Dichrostachys cinerea	100.00														
Diospyros mespiliformis	100.00														
Erythrophleum africanum	27.86	52.54		19.61											
Guibourtia coleosperma				7.14	29.38									62.62	0.86
Kirkia acuminata	100.00														
Lonchocarpus capassa		100.00													
Lonchocarpus nelsii	31.94	34.81			33.26										
No trees	100.00														
Ozoroa longipes	100.00														
Peltophorum africanum	25.34						74.66								
Pterocarpus angolensis			100.00												
Schinziophyton rautanenii	100.00														
Terminalia prunioides	49.71			50.29											
Terminalia sericea	20.54	21.28	23.79	10.01	2.96	2.88	1.25	6.14		2.23		0.70	8.21		

Table 4: Percentage of crown cover classes by dominant species

Table 5 shows the occurrence of a second dominant species (in the columns) for each dominant species (in the rows). The figures in the table are percentages of the area of the first dominant species. For example, if *Baikiaea plurijuga* is the first dominant species then *Combretum collinum* is the second dominant species on 37.74% of the *B. plurijuga* dominated forest/savanna area. But, when *Combretum collinum* is dominant then *Acacia fleckii* is the second dominant species on 27.22% of the *Combretum collinum* dominated area.

When *Pterocarpus angolensis* is the first dominant species then *Lonchocarpus nelsii* is the second dominant species on 100% of the *Pterocarpus angolensis* dominated area. But, when *Lonchocarpus nelsii* is the first dominant species then *Ziziphus mucronata* is the second dominant species on 33.26% of the *Lonchocarpus nelsii* dominated area.

Table 5: Occurrence, in %, of second dominant species for each first dominant species

Species	A. erioloba	A. fleckii	A. hebeclada	A. karroo	A. harveyi	B. plurijuga	B. africana	B. albitrunca	C. mopane	C. zeyheri	C. pyrotechnica	C. angolensis	C. imberbe	C. hereroense	C. zeyheri	C. mopane	C. zeyheri
Acacia erioloba								5.36		36.71	8.08	5.36					
Acacia fleckii										100.00							
Acacia hebeclada (hebeclada)	27.18						72.82										
Acacia karroo	100.00																
Albizia harveyi					100.00												
Baikiaea plurijuga	5.89	4.34						8.72	3.45			37.74					4.53
Boscia albitrunca																	
Burkea africana	5.29									6.15		9.66			2.48		0.86	5.36
Colophospermum mopane	13.37		2.55	3.71	14.33			2.96				2.27	0.46	0.62	5.86	0.43		1.44
Combretum collinum	14.38	27.22			4.94			2.23		18.09								1.39
Combretum engleri										100.00								
Combretum imberbe	2.47										4.79						16.04	
Combretum zeyheri										25.46		17.29						
Commiphora angolensis	100.00																	
Dialium engleranum								25.06		53.61								
Dichrostachys cinerea																		
Diospyros mespiliformis																		
Erythrophleum africanum								72.14										
Guibourtia coleosperma								70.62		29.38								
Kirkia acuminata																		
Lonchocarpus capassa																		
Lonchocarpus nelsii	14.30		8.35															
No trees																		
Ozoroa longipes								100.00										
Peltophorum africanum	25.34																	
Pterocarpus angolensis																		
Schinziophyton rautanenii																		
Terminalia prunioides	50.29																	
Terminalia sericea	9.44					6.14		19.02		18.14		18.57					5.51	2.57

ıble 5: continued.

Species	D. cinerea	E. erioloba	E. pilosiuscula	G. coleosperma	K. acuminata	L. capassa	L. nelsii	No trees	O. paniculosa	P. africanum	P. angolensis	P. prunioides	Unknown 1	Unknown 2
Acacia erioloba							29.60	11.14		10.11		2.02		mucronata
Acacia fleckii														
Acacia hebeclada (hebeclada)														
Acacia karroo														
Albizia harveyi														
Baikiaea plurijuga		0.57		3.24		2.30	4.02	9.25	1.62	3.45	3.45	7.31		
Boscia albitrunca												100.00		
Burkea africana		7.70	0.13	7.77				10.06		3.04	20.56	20.95		
Colophospermum mopane	5.44		0.56	2.27		1.11		18.22		1.18		22.65	0.56	
Combretum collinum							2.25	11.49				18.01		
Combretum engleri														
Combretum imberbe							0.27	62.87				13.57		
Combretum zeyheri							38.63					18.62		
Commiphora angolensis														
Dialium engleranum												21.32		
Dichrostachys cinerea												100.00		
Diospyros mespiliformis						100.00								
Erythrophleum africanum											27.66			
Guibourtia coleosperma														
Kirkia acuminata								100.00						
Lonchocarpus capassa					100.00									
Lonchocarpus nelsii				26.46							17.63			33.26
No trees								100.00						
Ozoroa longipes														
Peltophorum africanum													74.66	
Pterocarpus angolensis							100.00							
Schinziophyton rautanenii								100.00						
Terminalia prunioides								49.71						
Terminalia sericea			0.63	7.72		2.23		8.09		1.94				

4.4 Species diversity

Tables 1 and 7 show the frequency of different species in the Caprivi Region. Tables 3 and 5 described the occurrence of dominant species and also gave an idea about the mixture of species. Another measure of species diversity is the number of clusters where each species was found. Table 6 shows the number of clusters where each species was found for both trees less than 5 cm in diameter (including shrubs) and trees larger than 5 cm. A total of 57 different species were recorded on the tree field form and 57 species on the regeneration and shrub field form.

B. Plurijuga, DBH ≥ 5 cm, was found on 90 clusters while *B. Plurijuga* shrub/regeneration, DBH < 5 cm, was found on 22 clusters. *P. angolensis*, DBH ≥ 5 cm, was found on 33 clusters while *P. Angolensis* shrub/regeneration, DBH < 5 cm, was found on 2 clusters. Other species, like *Berkimia discolor*, *Ficus capensis*, *Ficus natalensis*, *Swartzia madagascariensis*, and *Parinari curatellifolia*, were found only on 1 cluster each.

Table 6: Species diversity indicated by the number of clusters where each species was found

Species	No. of clusters Dbh < 5 cm	No. of clusters Dbh > 5 cm	Species	No. of clusters Dbh < 5 cm	No. of clusters Dbh > 5 cm
Acacia aranaria	1		Dichrostachys cinerea	53	9
Acacia ataxacantha	5		Diospyros mespiliformis	2	2
Acacia erioloba	28	77	Erythrophleum africanum	11	26
Acacia fleckii	22	12	Euclea divinorum	1	
Acacia hebeclada (hebeclada)	3	7	Euclea undulata	21	
Acacia hebeclada (tristis)		7	Ficus capensis		1
Acacia karroo	2	2	Ficus natelensis		1
Acacia luederitzii		1	Grewia bicolor	14	
Acacia mellifera	7	2	Grewia flava	6	
Acacia nigrescens	5	17	Grewia retinervis	43	
Acacia polyacantha	1		Guibourtia coleosperma	2	33
Acacia reficiens		10	Kigelia africana	1	2
Acacia tortilis (heterecantha)	1	1	Kirkia acuminata		1
Afzelia quanzensis		2	Lonchocarpus capassa		11
Albizia harveyi	2	5	Lonchocarpus nelsii	19	34
Amblygonocarpus andongensis		1	Markhamia acuminata	13	1
Baikiaea plurijuga	22	90	May se	2	
Baissea wulfhorstii	1		Mundulea sericea	7	1
Baphia massaiensis	92	3	Ochna pulchra	49	27
Bauhia petersiana	50		Ozoroa longipes	5	8
Bauhinia thonningii		2	Ozoroa paniculosa	8	2
Berchimia discolor		1	Parinari curatellifolia		1
Boscia albitrunca	2	10	Peltophorum africanum	6	20
Burkea africana	34	88	Pseudolachnostylis	2	
Colophospermum mopane	65	78	Pterocarpus angolensis	2	33
Combretum apiculatum (apiculatum)		2	Rhus marlothii	6	
Combretum collinum	59	106	Schinziophyton rautanenii		5
Combretum elaeagnoides	5	1	Sclerocarya birrea		2
Combretum engleri	4	6	Strychnos cocculoides		2
Combretum hereroense	2	6	Strychnos pungens	2	1
Combretum imberbe	7	32	Swa ma	1	
Combretum molle	4	3	Terminalia prunioides		5
Combretum zeyheri	44	52	Terminalia sericea	94	111
Commiphora africana	2	1	Unknown1	4	7
Commiphora angolensis	14	10	Ximenia americana	8	
Croton gratissimus	13		Ximenia caffra	17	
Dialium engleranum	11	20	Ziziphus mucronata	4	2

4.5 Damage to trees

Damages to trees were recorded both at cluster level (for the sampled vegetation unit) and at tree level (for the measured sample trees). Table 7 shows the area in hectares of damaging agent by severity of damage. About 88.1% of the area is affected by fire. Most of the damages were mild, 45.3%, causing only noticeable but not serious damages to the trees. But, the 8.2% fatal damage is caused by fire.

The occurrence of fire damage by severity classes for *B. plurijuga* and *Pterocarpus angolensis* is shown in Table 8. No damages were recorded for 96.6% of the *B. plurijuga* and 55.2% of the *Pterocarpus angolensis* sample trees. For *Pterocarpus angolensis*, 2.8% of the trees are dying or are already dead from fire. When some sample trees were felled for biomass data collection, it was noticed that most of the large Burkea africana trees were decayed inside even if no damages were visible outside. For Pterocarpus trees it was noticed that if the tree is damaged from the base, most of the stem is still sound and usable.

Table 7: Area in Ha of damaging agent by severity of damage

	Severity of damage						
Damaging agent	**No damage**	**Mild**	**Moderate**	**Serious**	**Fatal**	**Total**	**% of total area**
No damage observed	43779					43779	**2.7**
Forest fire	14640	687076	339517	275528	134541	1451301	**88.1**
Human		1033	12480			13513	**0.8**
Mammals, domestic			4442			4442	**0.3**
Mammals, wild		58049	60555			118605	**7.2**
Unknown	16320					16320	**1.0**
Total	74738	746159	416994	275528	134541	1647959	
% of total area	**4.5**	**45.3**	**25.3**	**16.7**	**8.2**		**100**

Table 8: Distribution by damage classes of *Baikiaea plurijuga*, *Burkea africana* and *Pterocarpus angolensis* trees

Degree of damage	**B. plurijuga % of trees**	**B. africana % of trees**	**P. angolensis % of trees**
No damage	96.6	87.34	55.2
Mild, no harm to the tree	2.5	10.28	36.2
Moderate, degrades the tree vitality	0.3	2.10	5.7
Serious, vitality seriously reduced		0.04	
Fatal, tree is dying or is lready dead	0.5	0.24	2.8
Total	100.0	100.00	100.0

4.6 Estimated tree volume and number of stems

Table 9 shows total number of stems, stems per hectare, tree volume and mean tree volume per hectare by species and for the whole area. This is for trees with DBH=5 cm and above. *Tree volume* means the volume of the entire tree comprising of the main tree trunk and branch wood. Only living trees are included in the table. The most common species is *Terminalia sericea*, on average 14.11 stems per ha, followed by *Burkea africana* 13.6 stems per ha, *C. Mopane* 12.76 stems per ha and *B. Plurijuga* 7.37 stems per ha. *P. Angolensis* has 2.24 stems per ha.

The Caprivi Region has an estimated 142 798 780 total number of trees. The average number of trees per hectare is 86.65. And, the average total tree volume per hectare is 21.37 m^3.

B. Plurijuga has the highest mean and total tree volume 6.02 m^3/ha and 9 915 120 m^3 followed by *B. africana* 2.71 m^3/ha, *C. mopane* 2.23 m^3/ha, *T. sericea* 2.03 m^3/ha. *Pterocarpus angolensis* has only 0.59 m^3/ha.

Table 9: Number of stems, stems/Ha, tree volume, volume/ha and mean volume/ha by species and for the whole area

Species	1000	Stems/Ha	m3	Mean volume,
Terminalia sericea	23244.90	14.11	3344.07	2.03
Burkea africana	22415.52	13.60	4461.13	2.71
Colophospermum mopane	21020.64	12.76	3668.66	2.23
Combretum collinum	14987.77	9.09	2531.90	1.54
Baikiaea plurijuga	12147.41	7.37	9915.12	6.02
Combretum zeyheri	9475.45	5.75	756.94	0.46
Acacia erioloba	4837.16	2.94	1725.77	1.05
Dialium engleranum	4480.20	2.72	724.56	0.44
Lonchocarpus nelsii	3882.65	2.36	577.80	0.35
Pterocarpus angolensis	3686.76	2.24	968.20	0.59
Ochna pulchra	3045.58	1.85	287.61	0.17
Acacia fleckii	2419.92	1.47	215.98	0.13
Peltophorum africanum	2187.23	1.33	212.98	0.13
Guibourtia coleosperma	1797.48	1.09	2294.62	1.39
Erythrophleum africanum	1782.91	1.08	311.53	0.19
Combretum imberbe	1608.44	0.98	653.26	0.40
Acacia nigrescens	970.01	0.59	515.89	0.31
Dichrostachys cinerea	926.54	0.56	79.70	0.05
Ozoroa longipes	860.06	0.52	46.67	0.03
Acacia reficiens	550.73	0.33	123.00	0.07
Combretum hereroense	530.19	0.32	52.18	0.03
Combretum engleri	482.34	0.29	68.69	0.04
Unknown1	430.90	0.26	63.38	0.04
Combretum apiculatum (apiculatum)	430.68	0.26	26.20	0.02
Acacia karroo	420.89	0.26	71.10	0.04
Acacia hebeclada (hebeclada)	392.97	0.24	66.23	0.04
Boscia albitrunca	390.58	0.24	152.88	0.09
Lonchocarpus capassa	388.21	0.24	243.81	0.15
Baphia massaiensis	374.49	0.23	26.05	0.02
Ziziphus mucronata	352.35	0.21	33.42	0.02
Commiphora angolensis	296.26	0.18	81.42	0.05
Commiphora africana	275.48	0.17	50.32	0.03
Albizia harveyi	224.12	0.14	78.93	0.05
Combretum molle	210.40	0.13	42.51	0.03
Ozoroa paniculosa	193.87	0.12	18.52	0.01
Afzelia quanzensis	173.74	0.11	89.25	0.05
Strychnos pungens	137.74	0.08	9.30	0.01
Schinziophyton rautanenii	92.49	0.06	238.31	0.14
Strychnos cocculoides	88.76	0.05	6.40	0.00
Diospyros mespiliformis	82.35	0.05	39.50	0.02
Acacia hebeclada (tristis)	78.54	0.05	30.80	0.02
Acacia mellifera	72.00	0.04	25.06	0.02
Kigelia africana	71.80	0.04	41.85	0.03
Ficus natelensis	65.04	0.04	67.44	0.04
Terminalia prunioides	64.27	0.04	63.66	0.04
Bauhinia thonningii	34.43	0.02	16.38	0.01
Sclerocarya birrea	29.61	0.02	33.71	0.02
Markhamia acuminata	22.54	0.01	1.54	0.00
Berchimia discolor	16.16	0.01	10.66	0.01
Combretum elaeagnoides	14.06	0.01	1.07	0.00
Acacia tortilis (heterecantha)	12.49	0.01	11.99	0.01
Mundulea sericea	12.49	0.01	0.88	0.00
Acacia luederitzii	4.83	0.00	15.52	0.01
Ficus capensis	3.12	0.00	12.08	0.01
Kirkia acuminata	1.22	0.00	5.35	0.00
Total	**142798.78**	**86.65**	**35211.80**	**21.37**

For the mean tree volume of all species the standard error was 1.12 m^3/ha or 5.2% of the mean tree volume per hectare. This means that the true mean tree volume per hectare is between 20.25 and 22.49 m^3/ha with the probability of 68%. Other sampling errors are presented in Table 15.

4.7 Estimated tree volume, sawlog volume and number of stems of timber trees

For commercial forestry it is of interest to have a general idea of the saw log or merchantable volume of the commercial saw-timber tree species mainly *Pterocarpus angolensis* and *Baikiaea plurijuga*. These two species produce good quality industrial timber and are therefore important to the country's economy.

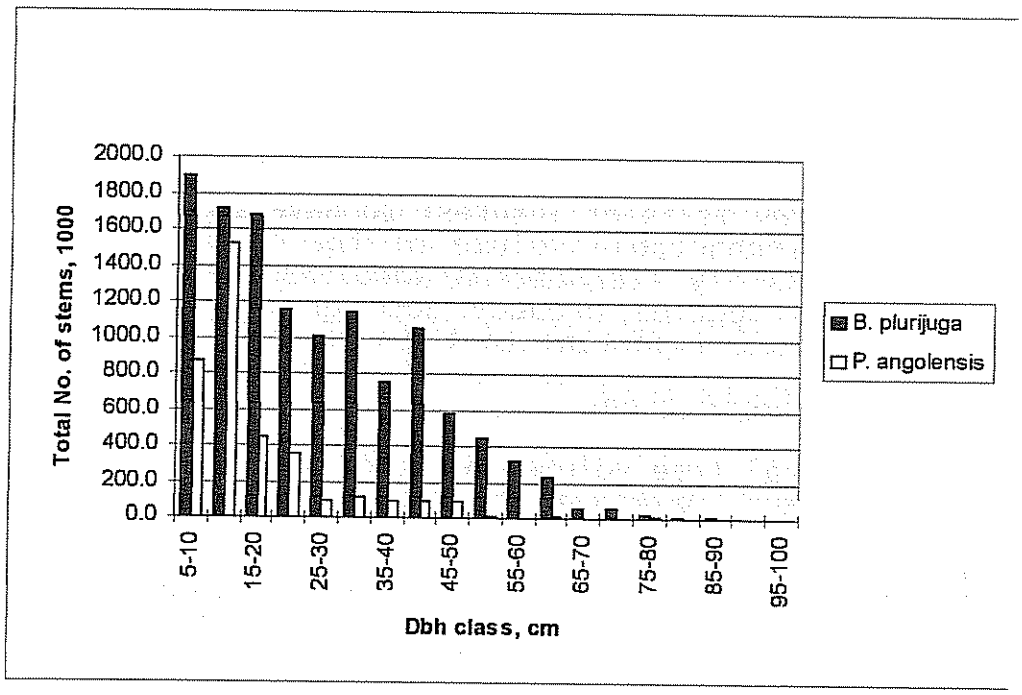
4.7.1 Volume of timber trees

Table 10 shows the total tree volume and total number of stems by diameter classes for *Baikiaea plurijuga* and *Pterocarpus angolensis* in the Caprivi Region. *Burkea africana* is included for comparison purposes. The stem size distribution for *Baikiaea plurijuga* and *Pterocarpus angolensis* is shown in graphical form in Figure 1. The small sized trees are far more frequent for *Baikiaea plurijuga* and *Burkea africana* than for *Pterocarpus angolensis*.

Table 10: Total tree volume and number of stems by diameter classes for *Baikiaea plurijuga*, *Burkea africana* and Pterocarpus angolensis

	Baikiaea plurijuga			Burkea africana			Ptrecarpus angolensis		
Dbh class, cm	Total tree volume, 1000 m3	Total No. of stems, 1000	% of total stems	Total tree volume, 1000 m3	Total No. of stems, 1000	% of total stems	Total tree volume, 1000 m3	Total No. of stems, 1000	% of total stems
5-10	67.6	1900.4	15.6	166.2	6756.1	30.14	48.4	869.8	23.59
10-15	134.6	1716.9	14.1	603.5	8199.8	36.58	127.5	1518.0	41.17
15-20	281.4	1676.6	13.8	627.5	3313.3	14.78	62.4	444.8	12.07
20-25	403.3	1150.7	9.5	524.3	1548.4	6.91	95.4	350.4	9.50
25-30	592.6	1003.3	8.3	786.7	1337.8	5.97	32.7	87.4	2.37
30-35	970.4	1139.7	9.4	489.4	567.4	2.53	83.6	114.0	3.09
35-40	918.7	754.0	6.2	410.1	327.9	1.46	94.8	93.5	2.54
40-45	1648.3	1053.1	8.7	275.3	172.7	0.77	137.4	91.4	2.48
45-50	1202.3	587.0	4.8	63.8	31.0	0.14	185.1	92.4	2.51
50-55	1143.3	449.2	3.7	239.9	90.5	0.40	21.3	7.2	0.19
55-60	989.7	323.9	2.7	64.7	20.1	0.09	1.2	0.4	0.01
60-65	823.1	228.3	1.9	83.9	24.1	0.11	40.2	10.2	0.28
65-70	233.6	57.5	0.5	28.2	7.2	0.03			
70-75	274.6	61.8	0.5						
75-80	108.8	22.5	0.2				38.2	7.4	0.20
80-85	42.0	8.1	0.1						
85-90	61.4	11.0	0.1	97.7	19.2	0.09			
90-95	4.8	0.8	0.0						
95-100	14.7	2.5	0.0						
Total	9915.1	12147.4	100.0	4461.1	22415.5	100.00	968.2	3686.8	100.00

Figure 1: Stem size distribution for *B. plurijuga* and *P. angolensis*



4.7.2 Saw log timber volume

Timber volume or saw log volume means the volume of the main tree trunk excluding branches. The saw log volume was calculated using the volume of a cylinder.

Table 11 shows the distribution by quality classes of *Pterocarpus angolensis* and *Baikiaea plurijuga* trees with DBH>45 cm regardless of log length. The average saw log timber volume of *Baikiaea plurijuga* is 0.75 m3/ha, totalling 1 228 890 m^3 for the whole Caprivi Region. There are 1 878 390 timber quality *B. Plurijuga* trees with breast height diameter larger than 45 cm.

Table 11: Distribution by quality classes of *Pterocarpus angolensis* and *Baikiaea plurijuga* trees with DBH>45 cm regardless of log length

Baikiaea plurijuga

Quality	Stems per Ha	Total No. of logs, 1000	Total log volume, 1000 m3	Mean log volume, m3/ha
No code	0.06	92.49	25.09	0.02
Good quality	0.10	169.20	198.84	0.12
Medium quality	0.12	196.92	152.70	0.09
Poor quality	0.20	323.42	198.22	0.12
Expected good quality	0.23	386.56	262.87	0.16
Expected medium quality	0.12	198.25	122.22	0.07
Expected poor quality	0.25	410.57	228.55	0.14
Not sawable	0.06	100.98	40.40	0.02
Total	**1.14**	**1878.39**	**1228.89**	**0.75**

Pterocarpus angolensis

Quality	Stems per Ha	Total No. of logs, 1000	Total log volume, 1000 m3	Mean log volume, m3/ha
No code	0.01	10.20	0.00	0.00
Good quality	0.03	43.46	41.38	0.03
Medium quality	0.03	52.75	44.38	0.03
Poor quality	0.01	15.30	5.40	0.00
Not sawable	0.01	10.57	0.07	0.00
Total	**0.08**	**132.29**	**91.23**	**0.06**

On the other hand, the mean saw log timber volume of *Pterocarpus angolensis* trees is 0.06 m^3/ha, totalling about 91 230 m^3 for the whole Caprivi Region. There are 132 290 timber quality *Pterocarpus* trees with breast height diameter (DBH) larger than 45 cm.

A timber tree was regarded as saw able if it was possible to obtain at least a 1.2 m long timber log from the tree. Table 10 shows the distribution of sawable *B. Plurijuga* and *P. Angolensis* trees by DBH and log length classes, for logs>1.2 m and DBH>45 cm. The log lengths exclude deformed bases. Out of the 1 878 390 *B. Plurijuga* logs 1 561 100 or 83.1% are sawable. And, out of the 132 290 P. Angolensis logs 111 510 or 84.3% are sawable. Hence, most of these large trees (DBH > 45 cm) are saw able. Table 12 also shows that the saw log length of *Baikiaea plurijuga* logs ranges between 1.2 to 8 m and for *Pterocarpus angolensis* the saw log length ranges between 1.2 and 7 m.

Table 12a: Distribution of sawable *B. Plurijuga trees* by DBH and log length classes.

Baikiaea plurijuga (No. of logs, in 1000)									
	Log length class, metres								
Diam class, cm	**1-2**	**2-3**	**3-4**	**4-5**	**5-6**	**6-7**	**7-8**	**8-9**	**Total**
45-50	47.1	205.1	100.6	107.6	15.3	33.1	7.4		**516.3**
50-55	69.9	119.9	85.2	71.7	28.9	5.6		25.4	**406.5**
55-60	44.9	85.3	81.8	34.4	40.1	7.4			**293.9**
60-65	40.3	57.0	56.4	34.5	5.6		19.2		**213.0**
65-70		32.7	19.2						**51.9**
70-75	28.0	15.3				7.4			**50.7**
75-80	7.2								**7.2**
80-85		8.1							**8.1**
85-90						10.2			**10.2**
90-95			0.8						**0.8**
95-100	2.5								**2.5**
Total	**239.9**	**523.3**	**344.1**	**248.3**	**89.9**	**63.7**	**26.6**	**25.4**	**1561.1**

Table 12b: Distribution of sawable *P. angolensis trees* by DBH and log length classes

Pterocarpus angolensis (No. of logs, in 1000)								
	Log length class, metres							
Diam class, cm	**1-2**	**2-3**	**3-4**	**4-5**	**5-6**	**6-7**	**7-8**	**Total**
45-50		22.49	2.68	25.51	15.30	10.20	10.20	**86.38**
50-55	7.18							**7.18**
55-60		0.37						**0.37**
60-65			10.20					**10.20**
75-80			7.38					**7.38**
Total	**7.18**	**22.86**	**20.26**	**25.51**	**15.30**	**10.20**	**10.20**	**111.51**

4.8 Pterocarpus-Lonchocarpus and Baikiaea-Combretum woodlands

Height class, cm	P. angolensis	L. nelsii	B. plurijuga	C. collinum
0-25				
26-50	0.36	4.30	35.85	84.91
51-100	0.36	14.34	41.51	60.38
101-150		3.58	1.89	28.30
151-200		0.00	7.55	3.77
201-250		1.08		
251-300		0.72		3.77
>300				3.77
Total	**0.72**	**24.01**	**86.79**	**184.91**

Woodlands dominated by *Pterocarpus angolensis* and *Baikiaea plurijuga* are most important, from forestry point of view, for economic reasons. Table 5 showed that *P. angolensis-L. nelsii* and *B. plurijuga-C. collinum* species are found together in some cases. About 107 379.9 hectares or 6.5% of the estimated wooded area of Caprivi is dominated by *P. angolensis-L. nelsii* while 405 587.3 hectares or 24.6% of the wooded area is dominated by *B. plurijuga-C. collinum*.

Table 13 presents the number of seedlings by height classes for *P. angolensis* and *B. Plurijuga*. It should be noted that Table 13 includes only seedlings less than 5 cm in diameter - larger stems were measured as trees.

Table 13. Number of *P. angolensis, L. Nelsii, B. Plurijuga* and *C. Collinum* seedlings per hectare by height classes

There is less than one *P. Angolensis* seedlings in the *P. angolensis-L. nelsii* woodlands compared to 86.8 *B. Plurijuga* seedlings per hectare in the *B. plurijuga-C. collinum* woodlands. This may imply that *P. Angolensis* is very susceptible, among other factors, to the frequent annual forest fires in Caprivi while *B. Plurijuga* may be fire resistant.

5. RELIABILITY OF THE RESULTS

In sampling based forest inventories the following error sources are always present: sampling error, measurement error including coding error, errors in data processing and errors in models used for e.g. volume estimation.

In this work, specific attention was paid to guarantee good quality field data. Field personnel were continuously trained on-the-job in forest measurements and plant identification. The field team undertook a re-fresher course in Tree Identification at the national Botanical Research Institute. Field instructions were reviewed both in the office and in the field. Data processing programs were carefully designed and double checked. Several cross checkings were done to find out possible errors and inconsistencies in the data.

The applied volume functions are propably the main source of errors. The size of the material collected for constructing the functions was moderate. In Caprivi only 95 trees were felled, mainly from East Caprivi, for stem analysis. However, the 53 trees from West Tsumkwe were combined with the 95 trees from Caprivi and the pooled data was then used to derive the volume functions. The saw log timber volumes were estimated simply by multiplying the timber log height with the timber log basal area at breast height because it was felt that the cylindrical volume more or less estimated the log volume. These error sources have an effect on the volume estimates but not, for example, on the estimates of stem or tree numbers and size class distributions.

The magnitude of sampling error, Table 14, was estimated with the formula of stratified random sampling using clusters, not sample plots, as sampling units. The applied sampling method was systematic, not random, but the formula is more or less valid. However, the formula may over estimate the sampling error.

5.1 Sampling error and confidence limits

For the estimate of mean tree volume per hectare of all species the sampling error was 1.12 m^3/ha (i.e. 5.2% of the mean). For the mean tree volume per hectare of *Baikiaea plurijuga* the sampling error was 0.77 m^3/ha (12.8%). This means that the true mean tree volume is between 20.25 and 22.49 m^3/ha with the probability of 68%. And, the mean tree volume of *B. plurijuga* is between 5.23 and 6.77 m^3/ha with the probability of 68%. Since no sampling error is related to the area estimates of the sampling strata, the total volume estimates for the whole area have the relative sampling errors of 5.2% and 12.8% for the total volume of all species and *P. angolensis*, respectively. Table 14 shows the sampling error.

Table 14a: Sampling error for tree volume for the whole area

Item	Sampling variance	Standard error, m3/ha	Average volume, m3/ha	Sampling error, %	Lower confidence limit, m3/ha	Upper confidence limit, m3/ha	Confidence level, %
All species	1.26	1.12	21.37	5.2	20.25	22.49	68
B. Plurijuga	0.59	0.77	6.00	12.8	5.23	6.77	68
B. *africana*	0.17	0.42	2.71	15.4	2.29	3.12	68
P. angolensis	0.02	0.15	0.59	25.9	0.44	0.74	68

Table 14b: Sampling error for saw log timber volume for the whole area

Species	Sampling variance	Standard error, m3/ha	Average volume, m3/ha	Sampling error, %	Lower confidence limit, m3/ha	Upper confidence lim m3/ha	Confidence level, %
B. Plurijuga	0.01327	0.12	0.736	15.6	0.62	0.85	68
B. africana	0.00023	0.02	0.047	32.4	0.03	0.06	68
P. angolensis	0.00037	0.02	0.055	34.9	0.04	0.07	68

6. SUMMARY AND CONCLUSIONS

This inventory provides quantitative estimates of the present state of the forests in Caprivi. The results can be used in future as a basis for planning inventories,for example, determination of sample size to achieve a desired allowable error. The inventory data indicate that the forest resources in Caprivi Region are still remarkable. The Region has a higher tree species diversity, 57 species, compared to West Tsumkwe where 29 species were recorded. In "East and South Tsumkwe, Otjinene and Okakarara" area 24 species were recorded.

The average tree volume per hectare is 21.37 m^3 compared to 17.81 m^3/ha in West Tsumkwe and 4.22 m^3/ha for "East and South Tsumkwe, Otjinene and Okakarara" area.

The woodlands of Caprivi are mostly sparse, open to closed woodlands. However, the total area of woodlands is noticeable, about 82% of the land area is wooded. The total number of trees, e.g, of valuable commercial species, *B. plurijuga* and *P. angolensis*, is relatively high, of which there is about 1 878 390 and 132 290 trees respectively larger than 45 cm DBH for the whole Caprivi Region. On the other hand there were 310 090 *P.*

angolensis trees larger than 45 cm DBH in West Tsumkwe area.

There is very little regeneration particularly of *P. angolensis*. There is less than 1 seedling per hectare compared to about 53 seedlings per hectare of *B. plurijuga*. Comparatively, there were about 18 *P. angolensis* seedlings per hectare in West Tsumkwe.

The incredibly low number of *Pterocarpus angolensis* seedlings is alarming. Further information need to be collected on the regeneration of these trees. The causes of the poor regeneration, most likely frequent fires among other factors, need to be found out and if possible, corrective measures taken. Excessive removal of large trees in the past for commercial purposes might be one of the reasons for the poor regeneration and low number of small trees at present. It might be possible that the removal of big trees disturbs the ecosystem so that *Pterocarpus angolensis* trees have no possibility to regenerate. Or, it is possible that conditions favourable to the regeneration of *P. angolensis* occur only seldom in Caprivi.

The cutting practices in the area must also be looked into. For example, removal of all utilisable sized trees should be carefully controlled. Also, changing of species composition radically by removing only one species from the upper layer should be avoided. Where ever concessions are given it should be ensured that a reasonable amount of utilisable sized healthy *P. angolensis* and *B. Plurijuga* trees, or any other species, are left standing to provide genetic material.

The forest resources are threatened mainly by fire which is the most prevalent cause of damage to the forests in Caprivi. About 88.1% of the wooded area is affected by fire. Fire caused fatal damage to trees on 8.2% of the wooded area. There is therefore need for concerted effort to protect the forest resources from uncontrolled wild fires. Concerted planning and action in fire control and management to save the woodlands from further degradation are therefore required. The endeavour should involve local communities to ensure long term success.

At present it is not possible to estimate the amount of sustainable harvesting because there is no information on the growth rate of the species in the area. Sample discs obtained from felled trees have been sent to University of Gottingen, Germany to study the age of seven species. The possibilities for sustainable management of the woodlands needs to be pursued and implemented. Thus requires further research to produce information on sustainable management regimes for the woodlands in Caprivi.

Caprivi Region had about 107 900 people according to estimates of the 1996 Demographic Survey. The majority of the people depend on the forest resources for fuelwood and poles for house construction and grass for thatching. 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 maintain the forest bio-diversity of the area.

In 1997 the Directorate of Forestry began a comprehensive implementation of the Namibia Forest Strategic Plan (NFSP) of 1996 through the new Namibia-Finland Forestry Programme which started in April 1997. The Strategic Plan (NFSP) identified the main challenges to sustainable forestry management as: forest *production* (production forestry, environmental forestry, and processing of forest products); *protection* of forest resources; and people's *participation* in forestry development.

The Directorate is at present revising the National Forest Policy of Namibia. The first stated aim of the forest policy is: *"Reconcile rural development with biodiversity conservation by empowering farmers and local communities to mange forest resources on a sustainable basis"*. The imense potential of the Caprivi forest resources, which are mainly on communal lands, can, in the long run, only be effectively conserved through the active participation of the local communities in forest resource management and conservation. Furthermore the completion of the new Forest Bill to replace the Preservation of Trees and Forests Ordinance of 1952 and the Forest Act of 1968, will facilitate people's participation in forestry development.

There is need to work closely with the local communities in Caprivi in the difficult task of conserving the forest resources. In addition to the already on-going pilot Integrated Forest Fire Control exercise which is working with the communities to control forest fires there is need to work with existing conservancies such as Salambala to empower the communities to manage and conserve forest resources. This way the survival of the forest resources will be ensured. Otherwise the forest resource of Caprivi will continue dwindling uncontrollably due to fires, clear cuts for agricultural expansions and other factors.

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