The Future Okavango Project

SP05 - Impacts of altered land use practises on the plant related ESF&S

TFO fieldwork report 2010 – 2012 for task 6 of SP05
Timber provision of Burkea woodlands

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1. Introduction

This short field work report gives an overview of the forest inventory work done during the first two years of The Future Okavango (TFO) project, a project implemented till 2015 and funded by the German Ministry of Education and Research. TFO aims to integrate ecosystem functions and services into an ecological and economic approach to sustainable land management at a regional scale.

Forest assessments are part of subproject 5 of TFO, which focuses on the vegetation in the Okavango basin of Angola, Namibia and Botswana. Objectives include : (1) qualitative and quantitative assessment and valuation of the plant based ecosystem functions and services, (2) a functional analysis of important aspects of the multiple interdependence between ecosystem compartments and drivers of change, (3) the study of the projection of current trends with regard to possible scenarios and their cumulative consequences, (4) the study of the potential for regional improvement given by the spatio-temporal composition and patterns of different land use options with the involved trade-offs and synergies.

One of the specific tasks (task 6) within this subproject is to assess the timber provision by the woodlands. Standing stock, population structure, growth, regeneration and sustainable yield of valuable timber species will be estimated for the *Brachystegia* and *Burkea* woodlands of the study area. Measurements are performed in sample plots representing varying degradation and succession stages of major tree communities, including historically deforested woodlands and forests that are evolving to their original climax state.

The field work of the first two years focused on the *Burkea* woodlands near the Mashare study site in the Kavango region of Namibia. The report gives an outline of the methods used to collect the field data as well as a general description and overview of the data collected. It does not give an in-depth analysis of the data as this will be done in journal articles. The data collected will amongst others be used for tree community analysis, tree volume calculations and the establishment of a growth model.

The data was collected in cooperation with colleagues of the Polytechnic of Namibia and the TFO project : Dr. Patrick Graz (Polytechnic of Namibia), Dr. Johannes Stoffels (University of Trier), Fransiska Kangombe (National Botanical Research Institute of Namibia), Rasmus Revermann (University of Hamburg), Selma Elago (Directorate of Forestry, Namibia) and Muwara Kamwanga (Polytechnic of Namibia). Thank you all.

2. Methodology

2.1 Sample set up

Sample plots were selected in the Mashare study area in such a way that different types of vegetation are represented and that they were easily accessible. The starting hypothesis was that vegetation is mainly influenced by :

- the depth of the groundwater table and thus by distance to rivers or dry river beds (omurambas) and by local height differences (dune/interdune),
- by the soil, and
- by anthropogenic activities.

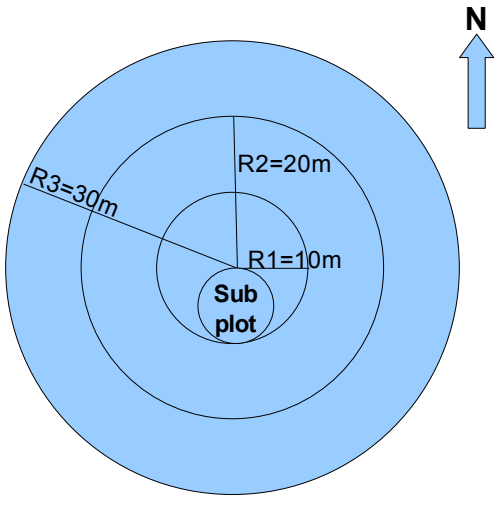
As most human activities centre along the Kavango river and soil types are running parallel with the river, transects were selected along tracks that run into the forest in a southeastern direction, almost perpendicular to the river. Potential plot sites were chosen within those transects with the assistance of aerial photographs. Plot centres are located at least 50 m, preferably more, from the track or road. The actual location of the centre plot must be chosen at random. This can in several ways, e.g. by using the coordinates of the potential plot sites or by throwing an object over the shoulder, whereby the landing point of the object is the center point.

The fact that all plots are fairly close to roads and tracks may cause a bias in the measurements, however it was considered that this outweighed the facts that otherwise significantly less data would be gathered and that this would be safer for car, equipment and researchers.

2.2 Sample plot measurements

The method used is based on the forest inventory method of the Namibian Directorate of Forestry (Burke, Juola, Korhonen, Selaniemmi, & Chakanga, 2001) and was slightly adapted for own purposes. The plot layout is shown in figure 1.

Figure 1 – Sample plot layout



Trees are considered to be all woody vegetation with a diameter at breast height (dbh) of at least 5 cm or circumference at breast height (cbh) of 15.7 cm. They are measured in the circular sample plot according to following rules :

- **Circle 1 with radius 10 m :** measure all trees ;
- **Circle 2 with radius 20 m :** measure all trees with cbh > 62.8 cm (dbh of 20 cm) in the area outside circle 1 ;
- **Circle 3 with radius 30 m :** measure all trees with cbh > 141.4 cm (dbh of 45 cm) in the area outside circle 2.

Shrubs and regeneration are measured in a smaller subplot with a radius of 5 m (figure 1). All woody vegetation (seedlings, saplings, shrubs) with cbh < 15.7 cm is counted and crown width and height are estimated.

The actual observations and measurements in the plot consist of :

1. Measurement of GPS coordinates of the centre point ;
2. Recording general site information (field inventory sheet 1) ;
3. Individual tree and shrub measurements (field inventory sheet 2) : species, GPS coordinates of tree and/or distance from centre point, circumference of the stem at breast height (cbh) which is at 1.3 m height from the ground, assess timber quality, crown class, phenology and damage, measure or estimate the length of the timber log, measure tree height with an inclinometer (e.g. Vertex laser). The diameter and stem quality of all stems of multistemmed trees and shrubs are measured/assessed.
4. Count all woody vegetation in the subplot according to height and canopy classes and complete field inventory sheet 3.

2.3 Measurements to establish saw log volume function

In Namibia , wood volume is calculated in two ways :

- saw log volume : by using the formula of the volume of a cylinder ; clearly this leads to overestimations ;
- wood volume of the tree up to 10 cm stem/branch diameter : by using volume functions established by the Finnish for the Directorate of Forestry in frame of the Namibia-Finland Forestry Programme. Trees were felled to derive the volume functions (Chakanga, Korhonen, & Selaniemmi, 1998; Laamanen, Otsub, & Tubalele, 2002; Verlinden & Laamanen, 2006), however no trees were felled in the Kavango region.

As there is no function to estimate stem log volume from diameter for trees and as no felled tree data is available for the Kavango region, additional measurements will be made on standing trees to create volume functions for the saw logs. This will be done with a Criterion laser, acquired by the project in 2012. Several diameter measurements will be made along the saw log. The first results will be obtained in 2013. Up till now, the instrument was only tested in one field trip and it appeared that a tripod is necessary to keep the instrument stable and obtain accurate measurements.

2.4 Growth measurements

Growth will be studied through analysis of growth rings on increment borings and stem discs. The use of ten dendrometer bands to follow up diameter growth was also tested (figure 2), but they were all destroyed in a fire several months after installation.

Figure 2 – Installation of dendrometer band and removal of cambium marking (Source : V. De Cauwer, May 2012)

First, it is necessary to establish if the observed growth rings in the Namibian species are indeed annual and to check if missing or wedging rings occur at a regular basis. The technique of cambium marking or wounding (Mariaux, 1967) is being performed to support this fact by making a wound in the cambium with a sharp tool. Wood samples are collected two to four years after marking (figure 2) to study how many growth rings can be seen after the wound was made. However, removal is very difficult without felling the tree (in literature, most researchers fell the tree).

The wood cores and stem discs will be sanded and either studied under a microscope or scanned and analysed on the computer. Rings will be measured and age/diameter relations will be established.

3. Results

3.1 Location of sample plots

A total of forty sample plots were measured in 2011 and 2012. The geographic coordinates of the plot centres are listed in table 1 and illustrated in figure 2.

Figure 3 – Location of sample plots within the TFO Mashare study site near Rundu, Kavango - Namibia

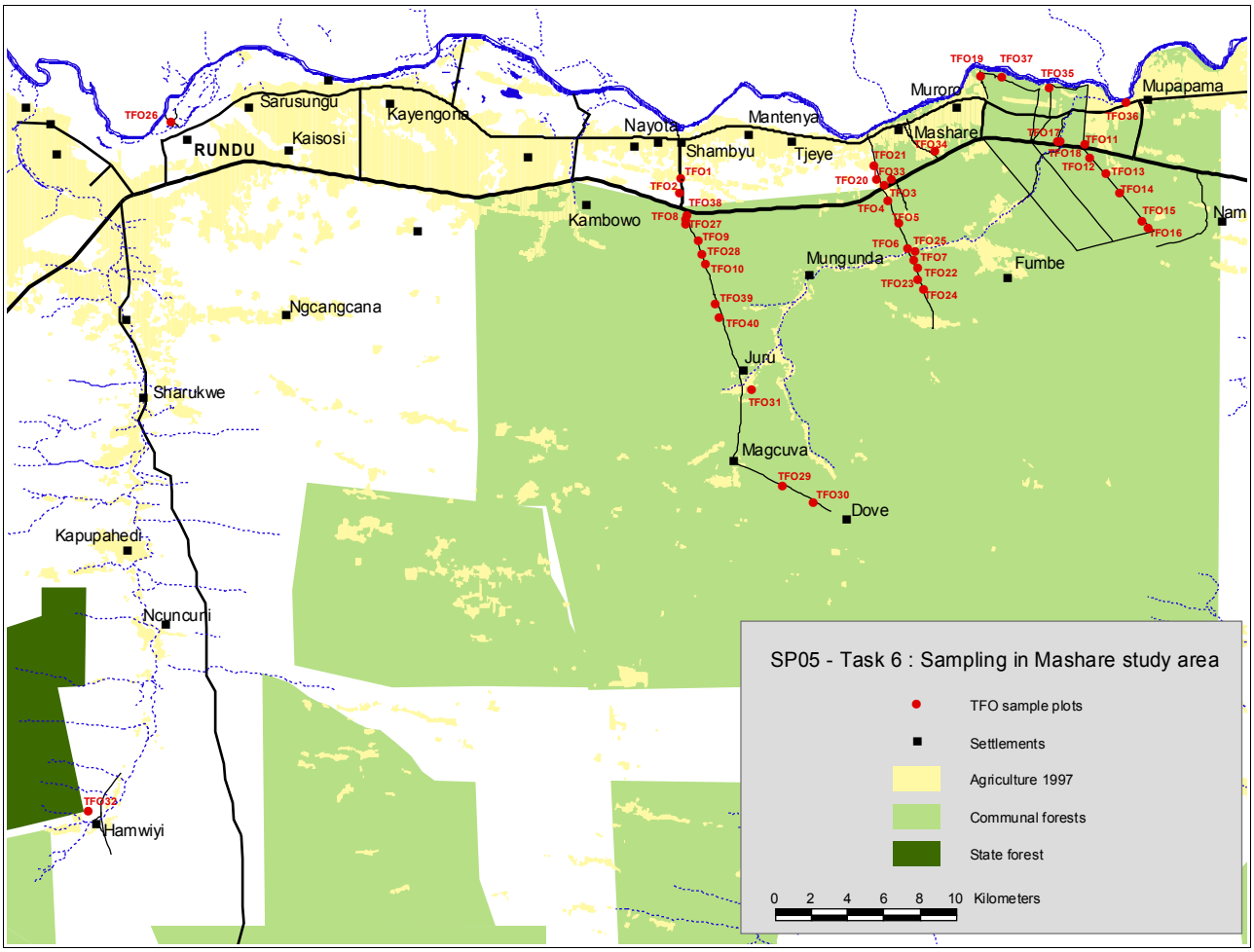


Table 1 – Geographic coordinates of sample plot centres

Name	Longitude	Latitude
TFO1	20.027200	-17.930450
TFO2	20.026410	-17.937160
TFO3	20.127940	-17.933540
TFO4	20.129810	-17.940450
TFO5	20.135060	-17.951300
TFO6	20.139360	-17.963600
TFO7	20.142890	-17.969080
TFO8	20.029150	-17.949400
TFO9	20.035250	-17.959710
TFO10	20.039170	-17.970660
TFO11	20.227394	-17.914421
TFO12	20.229948	-17.920214
TFO13	20.238049	-17.928091
TFO14	20.244880	-17.937280
TFO15	20.256070	-17.950440
TFO16	20.258740	-17.953700
TFO17	20.215118	-17.912529
TFO18	20.214078	-17.912542
TFO19	20.175889	-17.881850
TFO20	20.124432	-17.931159
TFO21	20.122831	-17.923907
TFO22	20.144443	-17.972748
TFO23	20.144725	-17.978538
TFO24	20.147738	-17.982456
TFO25	20.142924	-17.964547
TFO26	19.773673	-17.903061
TFO27	20.029410	-17.951570
TFO28	20.037665	-17.965987
TFO29	20.077419	-18.076416
TFO30	20.092519	-18.084142
TFO31	20.061895	-18.030877
TFO32	19.732510	-18.230330
TFO33	20.131380	-17.930770
TFO34	20.153010	-17.917460
TFO35	20.209700	-17.887350
TFO36	20.248070	-17.893910
TFO37	20.186390	-17.882550
TFO38	20.029900	-17.947510
TFO39	20.044120	-17.989970
TFO40	20.045870	-17.996150

3.2 Species

A total number of 579 trees were measured in the sample plots. For an analysis of the species and tree communities, only the data within the first circle with radius 10 m is used as all trees were recorded within that circle ; it concerns 387 trees. Data in the larger circles will mainly be used for calculating wood volume as the larger trees measured there will have a significant effect on total volume estimated.

The most common species was the pioneer species *Terminalia sericea* (Silver cluster-leaf) with 58 trees (figure 4). Other common species found were *Burkea africana* (35), *Baikiaea plurijuga* (Zambezi teak : 34 trees), *Combretum psidioides* (Peeling-twig combretum : 33 trees) and *Combretum collinum* (Variable combretum : 29 trees). Fourteen *Pterocarpus angolensis* (Kiaat) trees were encountered in the plots (figure 4).

Figure 4 - Terminalia sericea during winter and Pterocarpus angolensis with Vertex transponder (Source : V. De Cauwer, June 2011 and October 2012)

The most common shrub was *Baphia massaiensis* with a total of 275 individuals, followed by *Gymnosporia senegalensis* (161) and *Bauhinia petersiana* (104). The first two species occur in a relatively small amount of plots (14 respectively 5 plots) but did sometimes invade the shrub layer completely.

Most woody regeneration – seedlings and saplings – is from the tree species *Ochna pulchra* (101), *Terminalia sericea* (77), *Combretum collinum* (74) and *Combretum psidioides* (60). All of these species are relatively small sized in the woodlands : up to 7 m for Ochna pulchra, and 10 m for the others in the study area. They rarely form part of the top canopy layer, and if so, it is mainly *Combretum collinum*. It should be noted that some of these trees can reach considerable sizes next to the river. For example, a Silver cluster-leaf of 13.8 m high and a Variable combretum of 24 m high was measured next to the river bank near Mashare.

Of the tree species that make up most of the top canopy layer, regeneration was best for *Burkea africana* (56), *Guibourtia coleosperma* (31) and *Baikiaea plurijuga* (30). Only 6 seedlings and saplings of *Pterocarpus angolensis* were found in the subplots. However, it should be noted that some of the field trips were made during the winter or spring when shrubs and seedlings had hardly any leaves and were very difficult to find or recognise. The seedlings of some species, such as Kiaat, also tend to die back each winter.

3.3 Tree characteristics

Tree height and tree crown coverage

Tree height is an important parameter as it is affected by the site suitability for a species. The more suitable a site, the higher that species will grow. This is illustrated by the sizes of Silver cluster-leaf and Variable Combretum mentioned in the previous section.

It was therefore no surprise that the plot with the tallest trees was by far TFO36, which is situated just next to the Kavango river in one of the last remnants of river vegetation in the area. The impressive Waterthorn (*Acacia nigrescens*) trees there measured up to 22.5 m. This was also the plot with the highest tree crown coverage, estimated at 85 %, and the largest number of trees measured (35).

The plots containing the next largest height measurements were TFO19 and TFO37, a bit further (at least 500 m) from the Kavango river, but still within the old river bank. They had trees with sizes up to 16.8 m (*Acacia nigrescens*), respectively 16 m (*Combretum imberbe*). Tree crown coverage here was also higher than average and estimated at 60 %, respectively 45 %.

Further away from the river, within the typical woodland vegetation, the tree canopy in the plots is dominated by *Burkea africana* (up to 15.4 m, figure 5), *Guibourtia coleosperma* (up to 15 m), *Baikiaea plurijuga* (up to 14.5 m, figure 5) and *Pterocarpus angolensis* (up to 14 m). A large *Burkea africana* next to the river at Nkwazi Lodge was 14.9 m tall, not noticeable larger than the largest individuals in the woodlands. A typical tree crown coverage of the woodland vegetation is 20 %.

Figure 5 - Baikiaea plurijuga posing with colleague Dr Patrick Graz and small group of Burkea africana trees (Source : V. De Cauwer, May respectively October 2012)

Tree diameter

The tree species with the biggest diameter found in the plots are *Schinziophyton rautanenii* (up to 113 cm) and *Acacia erioloba* (up to 97 cm). Diameter measurements allow to calculate the basal area, a typical forestry management parameter referring to the sum of the cross-sections of tree trunks (at dbh) within a certain area. It is an indication of how much wood is produced within that area.

The species with the largest basal area (3 m^2) within the first circles (radius 10 m) of the plots was *Schinziophyton rautanenii,* despite that it only concerns 8 trees. Next largest basal areas were for *Guibourtia coleosperma* (13 trees), *Burkea africana (35 trees) and Pterocarpus angolensis (14 trees)*. It indicates how certain species that are less significant in numbers still can dominate the woodland by their sizes.

3.4 Wood increment data

Up till, three of the cambium markings collected succeed in showing the puncture wound made two years ago. These markings are all for *Pterocarpus angolensis*. Figure 6 shows the puncture wound and the two growth rings formed afterwards ; so in this case the growth rings are indeed annual.

Figure 6 – Cambium marking on a Pterocarpus angolensis tree showing two growth rings – the puncture was made two years before (Source : Vera De Cauwer, July 2012)

Up till now 63 increment borings were made of which 44 are for *Pterocarpus angolensis* (Kiaat). Most often, three borings per tree were made : two at dbh and one at stump height. This is to double check for false or wedged rings. For trees in commuity forests, borings are made at stump height as not to affect the value of the wood. All but one Kiaat boring were analysed with a tree-ring measurement station (Lintab) at the Royal Museum for Central Africa in Belgium.

Four stem discs of Kiaat were obtained up till now : 3 from Hamoye and one that was illegally logged and confiscated by the Directorate of Forestry in Rundu. The last one probably comes from the Angolan side of the river, west from Rundu.

References

Burke, A., Juola, V., Korhonen, K., Selaniemmi, T., & Chakanga, M. (2001). Field instructions for the NFI.

Chakanga, M., Korhonen, K., & Selaniemmi, T. (1998). Forest inventory report of Caprivi region. National Forestry Inventory sub-component.

Laamanen, R., Otsub, M., & Tubalele, M. (2002). Inventory Report on the Woody Resources in the Salambala Conservancy Core Area.

Mariaux, A. (1967). Les cernes dans les bois tropicaux africain, nature et periodicité. *Bois et Fôrets des Tropiques*, *113*, 3–14.

Verlinden, A., & Laamanen, R. (2006). Modeling woody vegetation resources using Landsat TM imagery in northern Namibia. *Southern African Forestry Journal*, *207*(2006), 27–39.