

The pool is surrounded by a relatively high lying area. So the pool can only fill up by rain or if flood exceeds 946.5 m above sea level.

The area covered by this habitat is 0.02 km² and has a perimeter of about 700 meters.

In the beginning of the dry season this area was grazed by wildebeest (*Connochaetes taurinus*), zebra (*Equus burchellii*), impala (*Aepyceros melampus*) and tsessebe (*Damaliscus lunatus*).

5.3 Vegetation

5.3.1 Classification of Vegetation Types

The description of the vegetation communities is based on the classification used by BIGGS, 1979 and has been modified for a more detailed description of the study area.

Table 7 shows the Vegetation Communities used for the present study.

table 7: classification of vegetation

	Vegetation Type (Biggs, 1979)	sub-communities
A	Aquatic vegetation types	
1	Middle channel communities	
2	Madiba communities	
B	Floodplain vegetation types	
3	Primary floodplain communities	
4	Secondary floodplain communities	
5	<i>Sporobolus spicatus</i> island communities	
C	Riverine vegetation types	
6	Closed riverine woodland	
D	Marginal vegetation types	
7	<i>Hyphaene petersiana</i> / <i>Croton megalobotrys</i> palm woodland and palm savanna woodland	
8	<i>Combretum imberbe</i> / <i>Croton megalobotrys</i> woodland and savanna woodland	
E	Dryland vegetation types	
9	Dry grassland communities	
10	<i>Acacia tortilis</i> savanna woodland	

		<i>Acacia hebeclada</i> thickets
11	<i>Acacia erioloba</i> woodland and savanna woodland	<i>Pluchea leubnitziae</i> bushland
12	Pool	

5.3.2 Analysis of the Vegetation Communities

Vegetation Type: aquatic vegetation types

Communities: middle channel communities

Middle channel communities stretch from the west to the east over a distance of approximately 3.5 km along the Boro River. The area covered by these communities is of approximately 0.6 km². In total the border to other vegetation types (both shorelines) is 8.2 km and borders nearly all vegetation types described in the study area.

Within the study area these communities can only be found in areas lower than 945.5 m. Inundation depth varies extremely and reaches from 1.5 m in the river bed to a few centimetres on the margins of these vegetation types. The water depth of the river varies, pools form extremely deep parts. Plant species of these communities depend on inundation for a long time.

In 1998 the Boro river dried out and got reflooded by the end of May. Water volume varies and depends on rainfalls falling in the Highlands of Angola in the summer. Flood arrives in the study area 5 months later between April and May.

Soils within these communities show a high content of loam compared to other vegetation communities (BIGGS, 1979).

The communities are characterised by large stands of *Phragmites australis*, *Miscanthus junceus* and *Cyperus papyrus*, which can be found on the margins. Especially in the eastern parts of the study area these plants occur in large stands. Various other submersed plant species occur in these communities. During the study no survey was done on river vegetation.

The middle channel communities are utilised by numerous animal species varying from fish to elephants. The Boro River plays an important role in keeping the water supply of the area.

Changes in the flooding pattern of the river will cause changes in vegetation because of changes in water supply of both ground and surface water.

The reeds are utilised by humans, as building material (personal observation and survey).

In 1998 this community was effected by fire. Within the study area 100 % of these communities burned down.

Communities: madiba communities

One lediba is situated in the outlet channel of the Lower Floodplain in the east of the study area. The centre of the lediba is free of vegetation. In the vicinity closed riverine woodland occurs on higher ground to the east, while floodplain vegetation types cover the area to the west. The soil in this lediba shows a high content of loam and clay. It is up to 1 m deep, comparing to the level of the channel (945.0 m above sea level). This lediba forms a permanent water body and dries out under extreme dry conditions only. During the time of the study this pool did not dry up totally. It got re-flooded by the end of May. During the time of drying up the pool formed an important water source in the study area. Water was abundant while the river already dried up. For weeks it was the only open water body in the study area.

The lediba covers an area of approximately 0.014 km² and the shape has a perimeter of about 577 m.

Lechwe (*Kobus leche leche*), elephants (*Loxodonta africana*), impala (*Aepyceros melampus*), baboons (*Papio ursinus*) and numerous other game species were observed while using this water source under dry conditions.

The lediba was influenced by the fire occurring during the study.

Vegetation Type: floodplain vegetation

Communities: primary floodplain communities

Primary floodplain communities can be found on both the Upper and the Lower Floodplain within the study area. The area covered by these communities is of approximately 0.5 km² in total. Borders to adjacent secondary floodplain communities are around 16 km long. Elevation range does not exceed 946.5 m.

The soil within these areas shows a high content of loam and clay. The nutrient status is higher than in the surrounding areas.

The communities are subject to surface inundation seasonally for a long time. Inundation can occur up to 6 month and longer. The water depth varies up to a depth of above 1 m in pools and depressions.

Usually these areas get flooded by the river in May. Flooding can also occur during good rainy seasons.

Vegetation is dominated by *Cyperus articulatus*, a sedge growing up to 1.6 m tall.

The distribution of other occurring plants depends on water depth. *Schoenoplectus corymbosus*, *Vernonia glabra*, *Ethulia conyzoides*, *Nymphaea nouchali* and *Potamogeton thunbergii* are fairly common.

On the margins *Paspalidium obtusifolium*, *Panicum repens*, *Acroceres macrum* and *Eragrostis spec.* occur with an increasing dominance.

Numerous depressions are found in these areas. These depressions play an important role during the flooding process. Especially elephants (*Loxodonta africana*) were observed while using the same depression as paths. So elephants (*Loxodonta africana*) and hippopotamuses (*Hippopotamus amphibius*) play an important role in keeping these channels open. Such regularly used paths are fairly deep (up to 0.50 m) and free of vegetation.

Grazing pressure is moderate in these communities but increases on the margins, where grazing pressure can result in bare surfaces.

These communities are utilised by numerous grazers like reedbuck (*Redunca arundinum*), impala (*Aepyceros melampus*), lechwe (*Kobus leche leche*), elephants (*Loxodonta africana*), tsessebe (*Damaliscus lunatus*) and many others.

On the Upper Floodplain these communities burned down to 100 % and large parts of the southern parts of the Lower Floodplain got effected by the fire in the end of May 1998.

Communities: secondary floodplain communities

Secondary floodplain communities cover large areas within the study area. Three different secondary floodplains can be described. The Upper Floodplain in the west, the Lower Floodplain in the central and eastern parts and a huge area in the south east connected with

the lower floodplain. The area covered by these communities is of approximately 3.9 km² in total. These communities cover about 33 % of the study area in total and form the largest vegetation type. The borderline to adjacent vegetation types is about 85 km long. These communities share boundaries with all other vegetation types of the study area. *Sporobolus spicatus* island communities and stands of *Hyphaene petersiana* can often be found within secondary floodplain communities.

The soil within these areas shows a high content of loam and clay. The nutrient status is high.

The communities are subject to surface inundation seasonally for up to 5 month depending on the micro-topography. Water depth is between 10 and 20 cm.

The elevation range of secondary floodplain communities is between 945.5 and 946.5 m above sea-level.

The vegetation structure of these communities varies. On higher ground mainly tall grass species are found. A belt of *Vetiveria nigriflora* around the floodplains is characteristic. *Imperata cylindrica* often dominates around termitaria.

Plant species found in secondary floodplain communities are *Paspalidium obtusifolium*, *Panicum repens*, *Acroceres macrum*, *Eragrostis spec.*, *Acroceres macrum*, *Chloris virgata*, *Vetiveria nigriflora*, *Setaria sphacelata* and *Imperata cylindrica*.

The ground coverage depends on species composition. The low-lying parts of these communities are dominated by grass species growing usually 0.5 m high. Grazing pressure is extremely high in these plant communities and can result in bare surface.

On higher ground tall species form the dominant vegetation. For various reasons grazing pressure is low in these areas. Species occurring here seem to be independent from surface inundation.

During drier times the communities are characterised by a moderate ground water table.

These communities are utilised by numerous grazers like reedbuck (*Redunca arundinum*), impala (*Aepyceros melampus*), lechwe (*Kobus lechwe lechwe*), elephants (*Loxodonta africana*), tsessebe (*Damaliscus lunatus*) and many others.

Huge parts of this vegetation got effected by the fire occurring in the end of May, especially the low lying grounds in the Upper and southern parts of the Lower Floodplain.

Communities: *Sporobolus spicatus* island communities

Twenty *Sporobolus spicatus* island communities were found within the study area. In total these communities cover an area of approximately 0.4 km². A large area covered by these communities exists in the centre of the island where the research camp is situated.

The mainly *Sporobolus spicatus* and *Cynodon dactylon* dominated vegetation indicates a high content of salt. Soils are often characterised by a hard surface, resulting from evaporation. This effects a high surface run off of rain water.

The ground water table is moderate. Some parts of the communities occurring on termitaria in floodplains can be subject to inundation during high flood events. Elevation range of these communities is above 946.5 m.

The ground coverage varies from 25 % to 60 % and depends on the salt content of the soil. Dominant grass species are *Sporobolus spicatus* and *Cynodon dactylon*, which have a high salt tolerance. Secondary floodplain communities often border on the margins where *Eragrostis spec.*, *Setaria sphacelata* and *Imperata cylindrica* form the major vegetation. On the margins of woodlands secondary floodplain communities are often bordering *Pluchea leubnitziae* bushland.

Borders to other communities are about 12 km long.

Grazing pressure is moderate and seems to increase during dry times (pers. observation).

Vegetation type: riverine vegetation types

Communities: closed riverine woodland

In the study area closed riverine woodlands are well represented along the south-eastern edge of the Lower Floodplain. It also occurs on the western edge of the main island in the centre of the study area. Twelve different riverine woodlands were counted during the study.

These communities are characterised by tall trees. Surface inundation may occur during high flood conditions, but it does not generally occur. In the study area these communities are found in areas higher than 946.5 m above sea-level.

Soil composition differs from sandy loam along the water courses to sand in the higher parts. Salinity is increasing towards the island centre (ELLERY, 1997).

Closed riverine woodland consists of a mixture of various tree and shrub species, forming a dense woodland. Dominant woody species are *Hyphaene petersiana*, *Ficus sycomorus*, *Acacia nigrescens*, *Combretum imberbe*, *Croton megalobotrys*, *Diospyros mespiformis*, *Ficus thonningii*, *Kigelia africana* and *Lonchocarpus capassa*. Especially on the edges vegetation changes to dense stands of *Hyphaene petersiana*.

Ground coverage is high in these communities. Numerous grass species can be found e.g. *Aristida spec.*, *Eragrostis spec.* and many others.

The area covered by these communities is of approximately 0.3 km² within the study area.

The borderline to other vegetation types is about 11 km long. In the eastern parts of the study area these communities border floodplain or middle channel communities. In the central parts closed riverine woodland changes into *Hyphaene petersiana* stands and borders dryland vegetation types like *Sporobolus spicatus* communities and *Pluchea leubnitziae* bushland.

During the fire in the end of May the areas in the east got effected. Loss of vegetation was relatively low. Most damage was observed on *Hyphaene petersiana*.

Bushbuck (*Tragelaphus scriptus*), buffalo (*Syncerus caffer*), elephant (*Loxodonta africana*), baboon (*Papio ursinus*) and other game utilise these communities regularly.

Vegetation type: marginal vegetation types

Communities: *Hyphaene petersiana*/ *Croton megalobotrys* palm woodland and palm savanna woodland

Marginal vegetation stands of *Hyphaene petersiana* concentrate along the margins of areas on higher ground in the central parts of the study area and on termitaria in the east.

During the study 56 different stands of *Hyphaene petersiana* were counted. Most of these communities can be found on termitaria of various size in the east of the study area.

Hyphaene petersiana woodlands of large expansion exist in the centre of the study area along the shoreline of the Boro River.

The communities occur in areas above 946.5 m above sea-level and are usually not subject to surface inundation.

These communities cover an area of approximately 0.4 km² within the study area.

They mostly border secondary floodplain communities and *Pluchea leubnitziae* bushland as well as *Sporobolus spicatus* island communities. The border they are sharing with other vegetation types is about 24 km long.

The only topographical feature on higher ground within floodplain communities are termitaria. Here *Hyphaene petersiana* is often found together with *Sporobolus spicatus* island communities. *Hyphaene petersiana* occurs in the higher parts of such islands while *Sporobolus spicatus* occurs on the margins indicating a high salinity. Number and size of these small islands vary within the study area, most of them can be found on the eastern floodplains. The scattered termitaria and their vegetation give a park-like character to the floodplains. Ground coverage in communities occurring on termitaria is moderate. Dominant grass species are *Sporobolus spicatus* and *Cynodon dactylon*. *Imperata cylindrica* is often found along the margins in lower parts. *Hyphaene petersiana* is often the only woody species occurring on termitaria. Other species like *Ziziphus mucronata* and *Diospyros mespiliformis* can seldom be found. The central parts of the Upper Floodplain are nearly free of such termitaria.

Hyphaene petersiana occurs in large stands along the margins of the central island. The soil within this areas is sandy. Here *Hyphaene petersiana* is often mixed with other woody species like *Kigelia africana*, *Lonchocarpus capassa*, *Acacia nigrescens*, *Ziziphus mucronata* and *Diospyros mespiliformis*. *Pluchea leubnitziae* can be found very often. The ground coverage is low. Dominant are grasses like *Cynodon dactylon*, *Aristida sphacelata*, *Eragrostis spec.*

Stands of *Hyphaene petersiana* are often heavily browsed by elephants (*Loxodonta africana*). Numerous plants grow in a shrub like form. This seems to be a reaction to browsing. Buffaloes (*Syncerus caffer*) utilise these areas as lying-up area.

The fire effected large areas where these communities occur but the damage seems to be moderate.

Communities: *Combretum imberbe/ Croton megalobotrys* woodland and savanna woodland.

Combretum imberbe/ Croton megalobotrys woodland is concentrated along the margins of floodplains, forming a transitional stage between the *Acacia erioloba* woodlands where the ground water table is low. Ten different *Combretum imberbe/ Croton megalobotrys* woodland are found in the study area, covering an area of about 0.4 km².

The communities occur in areas between 946.0 m and 947.0 m above sea-level. The soil within this area is sandy.

These communities are normally not subject to surface inundation.

Vegetation composition within these communities is characterised by a mixture of plants found in *Acacia erioloba* woodland and riverine woodlands. Dominant woody species are *Acacia nigrescens*, *Lonchocarpus capassa*, *Kigelia africana*, *Combretum imberbe*, *Croton megalobotrys* and *Hyphaene petersiana*. Within the study area the ground coverage varies extremely. The areas on the Lower Floodplain show a high ground coverage, around 75 % while areas along the Upper Floodplain show an extremely sparse herbaceous layer, around 25 % and less.

The border to adjacent vegetation types is approximately 14 km long.

During the study period utilisation of these communities by numerous browsers like kudu (*Tragelaphus strepsiceros*), elephant (*Loxodonta africana*) and giraffe (*Giraffa camelopardalis*) was commonly observed.

Vegetation types: dryland vegetation types

Communities: dry grassland communities

Within the study area these communities occur along the margins of floodplains in the central parts of the research area. Three different dry grasslands were mapped during the study. The ground coverage varies within these communities from medium (50 %) to sparse (10 %). Dominant grass species are *Sporobolus spicatus*, *Eragrostis spec.* and *Aristida spec.*. Other grass species occurring in these areas are *Cynodon dactylon*, *Panicum spec.* and *Cymbopogon excavatus*. The forb *Pluchea leubnitziae* and some *Acacia hebeciada* can be found especially along the margins.

The area covered by dry grasslands is 0.24 km². The borderline to adjacent communities is 5.9 km.

These areas are not subject to surface inundation. The communities occur in areas between 947.0 m above sea level except north of the lower floodplain where the elevation is around 646.5 m above sea level. Parts of this area could be subject to surface inundation during high flood events.

Some parts of the low lying dry grassland got effected by the fire occurring in May 1998.

Communities: *Acacia tortilis* woodland and savanna woodland

Sub Communities: *Acacia hebeclada* thicket

In the study area this community forms a successional stage between secondary floodplain communities and *Acacia erioloba* or *Acacia tortilis* woodland.

Large stands of *Acacia hebeclada* thicket can be found in the north-western parts of the study area, only north of the Upper Floodplain. But here they are fairly large in expansion. In total these communities cover an area of about 1.4 km². The community occurs on higher ground (above 947.5 m) only and is not subject to surface inundation. In the study area the soil within this area is sandy. But in some parts it shows a hard surface, which results in a high surface run off of rain water.

Acacia hebeclada thicket borders mainly *Acacia erioloba* woodlands. In the southern parts of the community it borders dry grassland communities, *Pluchea leubnitziae* bushland, and secondary floodplain communities. The length where these communities join up with others is about 16.7 km long.

Acacia hebeclada is the dominant woody species in these communities, growing up to 5 m tall. Other woody species found in this area are *Acacia erioloba* mostly growing in a shrub-like form, *Ziziphus mucronata* and others. *Pluchea leubnitziae* often occurs along the margins. The herbaceous layer is sparse. Dominant grass species are *Vetiveria nigritiana*, *Cynodon dactylon* and others.

Thickets are an important food source for browsers, like giraffe (*Giraffa camelopardalis*), kudu (*Tragelaphus strepsiceros*), impala (*Aepyceros melampus*) and elephants (*Loxodonta africana*). Carnivores use these thickets as lying-up area.

Sub-communities: *Pluchea leubnitziae* bushland

Within the study area the *Pluchea leubnitziae* bushland occurs on the margins of floodplains forming a transitional stage between the low lying, temporary inundated secondary floodplain communities and woodlands or *Acacia hebeclada* thicket on higher ground. *Pluchea leubnitziae* bushland was found 6 times within the study area and covers an area of about 0.5 km². The boundaries to other communities are approximately 10.6 km long.

Within the study area the communities do not occur below 946.5 m above sea level.

Especially in the western and central parts of the study area *Pluchea leubnitziae* bushland is characteristic.

They occur on sandy soils in open woodland and grasslands where ground water is saline (K. and W. ELLERY 1997). *Pluchea leubnitziae* prefers alkaline soils and is an indicator plant for disturbed areas. It does not tolerate inundation.

The ground cover in these areas is very sparse and consists mainly of tall grass species as *Vetiveria nigritiana*, *Cymbopogon excavatus*, *Aristida spec.*, *Eragrostis spec.*. Other woody species like *Acacia spec.* growing in shrub or tree like forms can be found in higher parts.

Surface inundation can occur under certain circumstances in these areas. This may result in the death of the communities because of low flooding tolerance of *Pluchea leubnitziae*.

The fire did not influence any of these communities.

Communities: *Acacia erioloba* woodland and savanna woodland

Acacia erioloba woodland covers 3.5 km² in the north of the study area and does not occur in areas below 947.0 m above sea level. The soil in these areas is sandy with a low content of loam. The ground water table is low.

The communities show moderately developed layers. Other woody plant species found in *Acacia erioloba* Woodland within the study area are *Acacia hebeclada*, *A. tortilis*, *A. fleckii*, *A.*

nigrescens, *A. sieberana*, *Combretum imberbe*, *Croton megalobotrys*, *Lonchocarpus nelsii*, *Terminalia sericea*, *Grewia schinzii*, *G. flavescens* and *Ziziphus mucronata*.

On margins to the floodplains *Hyphaene petersiana* sometimes can be found. The height of the canopy varies, on the margins of the communities it does not exceed 10 m, in the centres it can be up to 16 m high.

Dominant species of the herbaceous layer are *Tricholaena monachne*, *Eragrostis spec.*, *Digitaria eriantha*, *Cynodon dactylon*, *Aristida stipitata*, *Stipagrostis spec.*

The communities are not subject to surface inundation.

Acacia erioloba woodland borders mainly secondary floodplain communities, especially along the Lower Floodplain. In the western parts it borders *Pluchea leubnitziae* bushland and *Acacia hebeclada* thicket. An increasing number of *Acacia tortilis* is found within this area.

The length of the border where *Acacia erioloba* woodland joins up with other vegetation communities is approximately 32.8 km.

Acacia erioloba woodland is an important food source for browsers like kudu (*Tragelaphus strepsiceros*), giraffe (*Giraffa camelopardalis*) and elephants (*Loxodonta africana*) even impala (*Aepyceros melampus*), zebra (*Equus burchellii*), wildebeest (*Connochaetes taurinus*), tsessebe (*Damaliscus lunatus*), bushbuck (*Tragelaphus scriptus*), buffalo (*Syncerus caffer*), baboon (*Papio ursinus*) and lions (*Panthera leo*) were observed while utilising these communities regularly.

5.4 Mapping of the burned area

5.4.1 Introduction

Fire is a natural part of Southern Africa's ecosystems. Natural burns occur usually during rainy season, from October to December, when lightning may cause fire.

The vegetation of the Okavango Delta as we know it today has certainly been modified by man-made fires for at least 10,000 years (KNAPP, 1973). Fires have always been an important process. What has changed during the last years is the frequency of man-made fires. In the Delta these fires are most frequent west of the Moremi Game Reserve where human settlements exist. The fires within the Delta are made to improve hunting, viewing and the conditions for poling the mekoros. The floodplains on the western edge of the Moremi Game Reserve near the safari lodges are frequently burnt (Management Plan of the Moremi Game Reserve, 1991).

Burning the plant cover removes the soil's protection from sun, wind and rain. This can markedly reduce fertility levels and organic matter content leading to soil deficiencies of various kind. It also makes the soil surface hard, water can not seep through.

The extension and the speed of extension mainly depend on topography, wind directions and vegetation coverage.

The net of channels in the wetland areas keep those fires mostly small in extension.

5.4.2 Description

In 1998 the Boro River dried out completely so there was no barrier for the burns anymore. Three fires (pers. survey), lit outside the reserve boundary, occurred within the area and its surroundings between the 14th of May and the 23rd of May. The study area got effected by two of these fires. On the 21st of May the fire crossed the dry river bed and the Upper Floodplain burned down within one night (personal observation). The same day a 2nd fire moved in from the south-east. The southern part of the Lower Floodplain burned down on the 22nd of May. Both fires head up near the camp (see map) on the 23rd of May.

The woodland seems to have been a fire barrier. Woodland got only effected in parts where *Hyphaene petersiana* dominates in a shrub-like form.

The impact of these fires was different depending on the vegetation composition of the different habitats.

Between the 14th of May and the 23rd of May an area of approximately 2.92 km² got effected by man-made fires in the study area. For extension of the fire see map - Burned area 1998.

The length of the fire line within the study area was 8.63 km.