



REPÚBLICA DE MOÇAMBIQUE

**PLANT COMMUNITIES AND LANDSCAPES  
OF THE  
'PARQUE NACIONAL DO LIMPOPO'  
MOÇAMBIQUE**



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# PLANT COMMUNITIES AND LANDSCAPES OF THE 'PARQUE NACIONAL DO LIMPOPO' MOÇAMBIQUE

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## EXECUTIVE SUMMARY

A description of the vegetation of the Limpopo National park (henceforth LNP) is required as one of the essential building blocks for the Management Plan. The major objectives of the study were therefore firstly to understand the environmental determinants of the vegetation, secondly to identify and describe individual plant communities and thirdly to delineate landscapes in terms of their plant community make-up, environmental determinants and distribution.

The survey was limited in terms of available time and resources. The sampling data and subsequent interpretation resulted from only 15 days in the field. This must be compared to the 50 years of studies in the adjoining Kruger National Park (henceforth KNP) that resulted in progressively more detailed and accurate mapping and understanding of its landscapes.

A combination of fieldwork and analysis of LANDSAT satellite imagery was used. Field data, consisting of 175 sample plots located so as to cover different habitats, were analysed by means of a TWINSPAN classification and DECORANA ordination. The IDRISI Geographical Information System was used to classify the satellite imagery. More limited information available from another 220 points that were assessed during aerial and ground surveys was used to further define the extent of plant communities and landscapes.

The ordination results clearly indicate the overriding importance of moisture availability in determining vegetation composition in the LNP. Firstly, the obvious differences in moisture availability by virtue of sample positions along quasi-perennial or seasonal waterbodies came out of the first ordination. Thereafter, the gradient in soil clay content (as a result of underlying geological substrate and landscape position) and landscape position *per se* (in determining water flow) largely determine soil moisture availability. In addition, geology determines intrinsic nutrient potential and landscape position influences nutrient depletion and accumulation processes.

The classification results were used in conjunction with the field assessment to recognise 15 distinct plant communities. These have been described in terms of their structure, composition and distribution across the Park. More than 180 woody species and more than 50 species of grasses were identified.

Different combinations of these plant communities can be grouped in 10 landscapes. Landscapes strongly reflect the underlying geology. The landscapes of the LNP have strong affinities to a number of landscapes found in the adjoining KNP. The main

difference is the much greater importance of sandveld landscapes in the LNP that constitute 44% of its surface area. This represents an area nearly 30 times larger than the total extent of sandveld found in the KNP. Mopane on calcitic areas is also much more widespread in the LNP than in the KNP.

This has important implications in that the LNP contributes in its own right to the conservation value of the Transfrontier Conservation Area. Individual and joint management strategies for the LNP and KNP need to take into account the different proportional make-up of both areas in terms of their landscapes. The KNP and LNP clearly complement each other.

A brief description of species of conservation importance including *Stadtmannia oppositifolia* and *Pterocarpus lucens* is provided. Current occurrence of alien plants and their potential threat are highlighted. The current land use and fire pattern and their influence on the vegetation are briefly discussed with particular reference to potential impact on biodiversity.

Shortcomings of the present study are highlighted and recommendations for future vegetation studies are made.

## 1. Background and approach

A description and map of the vegetation of the Limpopo National Park (henceforth LNP) are required for the Management Plan that is currently being drafted. Little or no botanical surveys were carried out in Mocambique between 1980 and 1994 during the long period of internal conflict that affected much of the country (Anonymous 1997). The extent of the area (1,000,000 ha), its relative inaccessibility due to poor road infrastructure, and the limited time available precluded a traditional fine-scale vegetation description and map. Such a fine-scale input is in any case likely to be too detailed for the scale of management envisaged for the LNP, certainly in the short- to medium-term.

Vegetation is often used as a surrogate or building block for the definition of habitats. The use of broad habitat units defined by a combination of environmental factors and vegetation would probably represent the most useful input for the drafting of the management plan. This is because such units have relevance to animal species, their availability of water might differ, they might require appropriate fire regimes, and they will differ in their sensitivity to utilisation and development. A 'landscape' approach is therefore proposed. A landscape is defined as 'an area with a specific geomorphology, climate, soil vegetation pattern and associated fauna' (Solomon *et al.* 1999).

The objectives of this study were to:

- Identify and describe individual plant communities in terms of species composition and structure, environmental determinants and broad occurrence,
- Identify and delineate landscapes in terms of their plant community make-up, environmental determinants and occurrence,
- Compile a landscape map,
- Determine the extent (surface area) of the different landscapes, and
- Where possible to match the LNP landscapes across the boundary with the landscapes of the Kruger National Park (henceforth KNP) either at the same scale or at higher hierarchical level.

## 2. Study area

The physical environment largely determines the vegetation composition and structure. Much detail on the environment of the LNP is available (Anonymous 2001) as well as on the neighbouring and comparable KNP, particularly on climate (Venter & Gertenbach 1986), geology (Bristow & Venter 1986) and soils (Venter 1986).

The make-up of the LNP can be summarized as follows:

- Study area is situated between latitudes 22° 30' - 23° 20' S and longitude 32° 15' - 33° 25' E in the Gaza Province of Mocambique. Total area is ca. 1,000,000 ha,

- The KNP neighbours the LNP to the west along the international border with South Africa, the Limpopo River forms the northern and eastern border to the LNP, whereas the Rio Elefantos forms the southern boundary (Fig. 1a).
- According to the Koppen classification the area has a warm arid climate with a dry winter and a mean annual temperature exceeding 18<sup>0</sup>C (van Rooyen *et al.* 1981b). Rainfall decreases from 500 mm annually near Massingir Dam to less than 450 mm at Pafuri. Considerably variations can be expected within and between seasons (Kelly & Walker 1976).
- Elevation ranges from 521 m asl in the north along the border with the KNP down to 45 m asl at the confluence of the Limpopo and Elefantos.
- The dominant geological feature of the LNP is the extensive sandy cover along the north-west/south-east spine of the Park. Where this sand mantle has been eroded closer to the main drainage lines, calcaric sedimentary rocks have been exposed. Along the main drainage lines (Limpopo, Elefantos and Shingwedzi) alluvial deposits are found. A narrow tongue of rhyolite rock which is of volcanic origin straddles the western border with the KNP (Fig. 1b).
- Soils derived from the sand mantle range from shallow to deep and are mostly infertile. Deep, structured clay soils are derived from calcaric sedimentary rocks. The alluvial soils are clayey and fertile. Soils derived from the rhyolite are shallow and clayey.
- The LNP falls within the Mopane vegetation of the Sudano-Zambezian Region as described by Werger & Coetzee (1978) and corresponds to the Acocks (1975) veld type 15, Mopani veld.
- Most of the diverse and numerous large herbivore component that would be expected to occur in this area has been lost over the last decades, probably mostly through indiscriminate and illegal hunting.
- A significant number of people presently live within the LNP's borders. They are mostly concentrated on the alluvial plains of the Limpopo and Shingwedzi where they practice subsistence cultivation. Livestock comprises cattle and goats, but numbers are generally low.

A good overview of the study area is obtained from the LANDSAT satellite image (Fig. 1c). This composite view of the Near Infrared, Middle Infrared and Red Visible bands clearly depicts the major river systems (Limpopo, Elefantos and Shingwedzi) with their alluvial floodplains, the Massingir Dam in the south-west and the rhyolites on the KNP/LNP border.

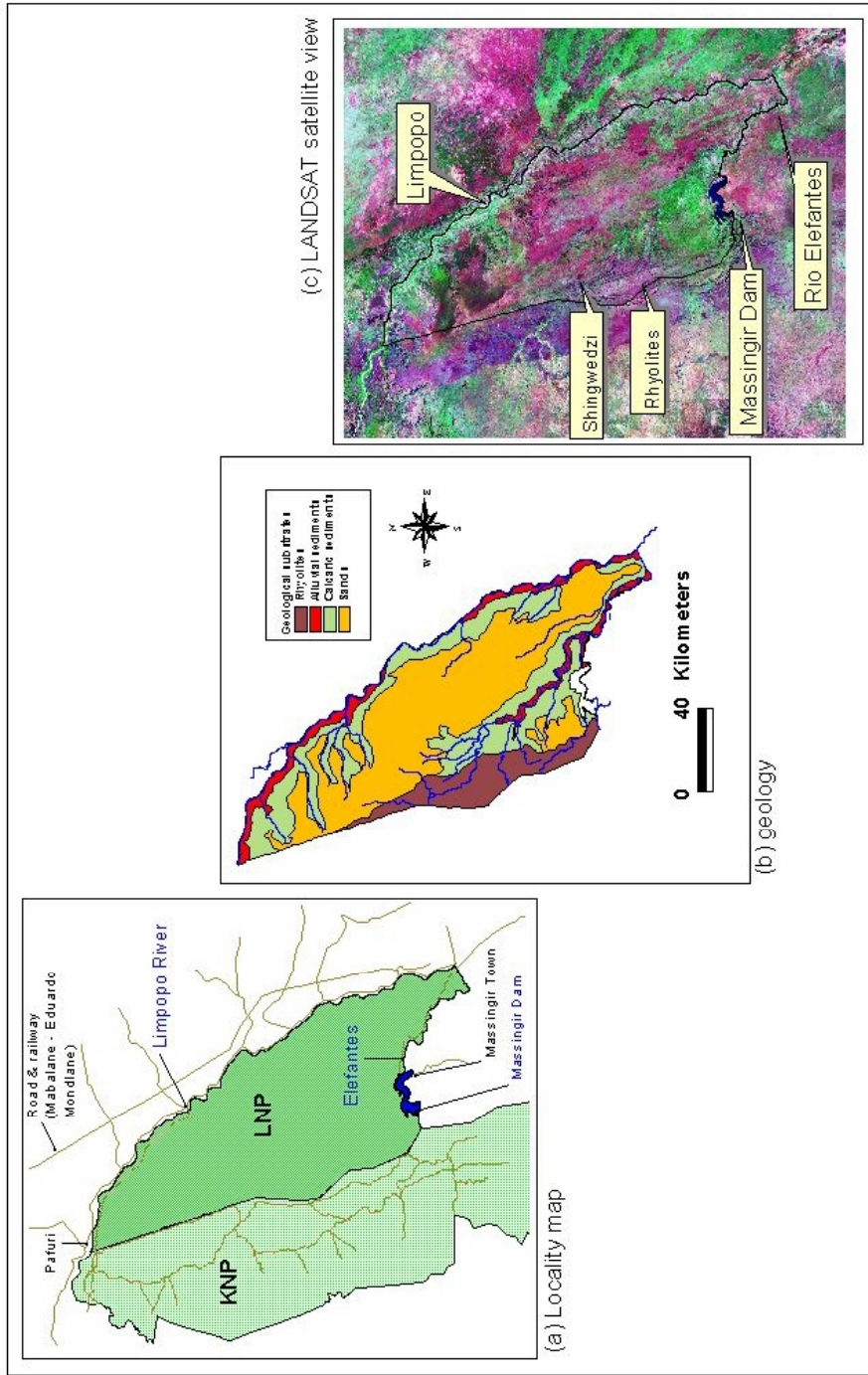


Fig. 1: Limpopo National Park

### 3. Methods

#### 3.1. Phased approach

A phased approach was followed. The first, cursory phase consisted of an evaluation of the satellite imagery, geological coverage and soils map to define broad units which needed to be covered during the field phase. Field data were gathered during the second phase. Data from vegetation plots were supplemented by informal observations. The third phase consisted of ordination and classification of the data in order to elucidate causal factors and to define individual plant communities. In the fourth phase the satellite image was classified and the results from the field survey were combined with the available GIS data into a landscape map.

#### 3.2. Field sampling

The primary aim of the vegetation survey was to produce a description and results useful for the management of the LNP. It was decided to adopt an easy, straight-forward technique in order to obtain a better coverage within the limited time available. To this end the focus was on the woody and grass component. These are also of most relevance to the herbivores. All in all, less emphasis was given on having an academically correct vegetation study, than in obtaining a user-friendly vegetation description.

Although it is useful to establish a baseline against which to monitor in future, the establishment of permanent sites is probably premature. A baseline study would require more detailed quantitative and repeatable measurements. This would have resulted in too low a coverage of the area in the time available.

A number of 40 x 40 m plots were subjectively located in representative stands of vegetation within each of the main units. Edwards' (1983) structural classes were used to describe the overall structural properties of the sampled plots. Overall cover was estimated for respectively the woody, grass, forb and geophyte component using the semi-quantitative measures of the Braun-Blanquet approach (Mueller-Dombois & Ellenberg 1974). Cover and height classes were recorded for individual woody and grass species. Records of environmental data included GPS position, geology landscape position (Land Type Survey Staff 1989), slope steepness (class estimate), soil texture (using the sausage method (National Working Group for Vegetation Ecology 1986)) and rockiness (estimated as a percentage of the ground cover). A total of 175 plots spread over the LNP were sampled between March and May 2002 (Fig. 2).

In order to further increase sampling intensity, so-called 'pseudo-plots' were also used. These consisted of a GPS point, digital photograph and subjective visual assessment relative to the formally surveyed sites. A total of 80 such pseudoplots were assessed (Fig. 2a). In addition, a total of 140 points were subjectively assessed from the air during the helicopter flights for planning purposes (Fig. 2b).

A total of 237 species were identified in the formal plots (Appendix A). Potential identification problems necessitated the lumping of *Artabotrys brachypetalus* and *A. monteiroae*, *Ochna barbosa* and another *Ochna* sp., *Aristida adscensionis* and *A. congesta* sp., all *Botriochloa* spp. as one, *Enneapogon scoparius* and *E. cenchroides*.

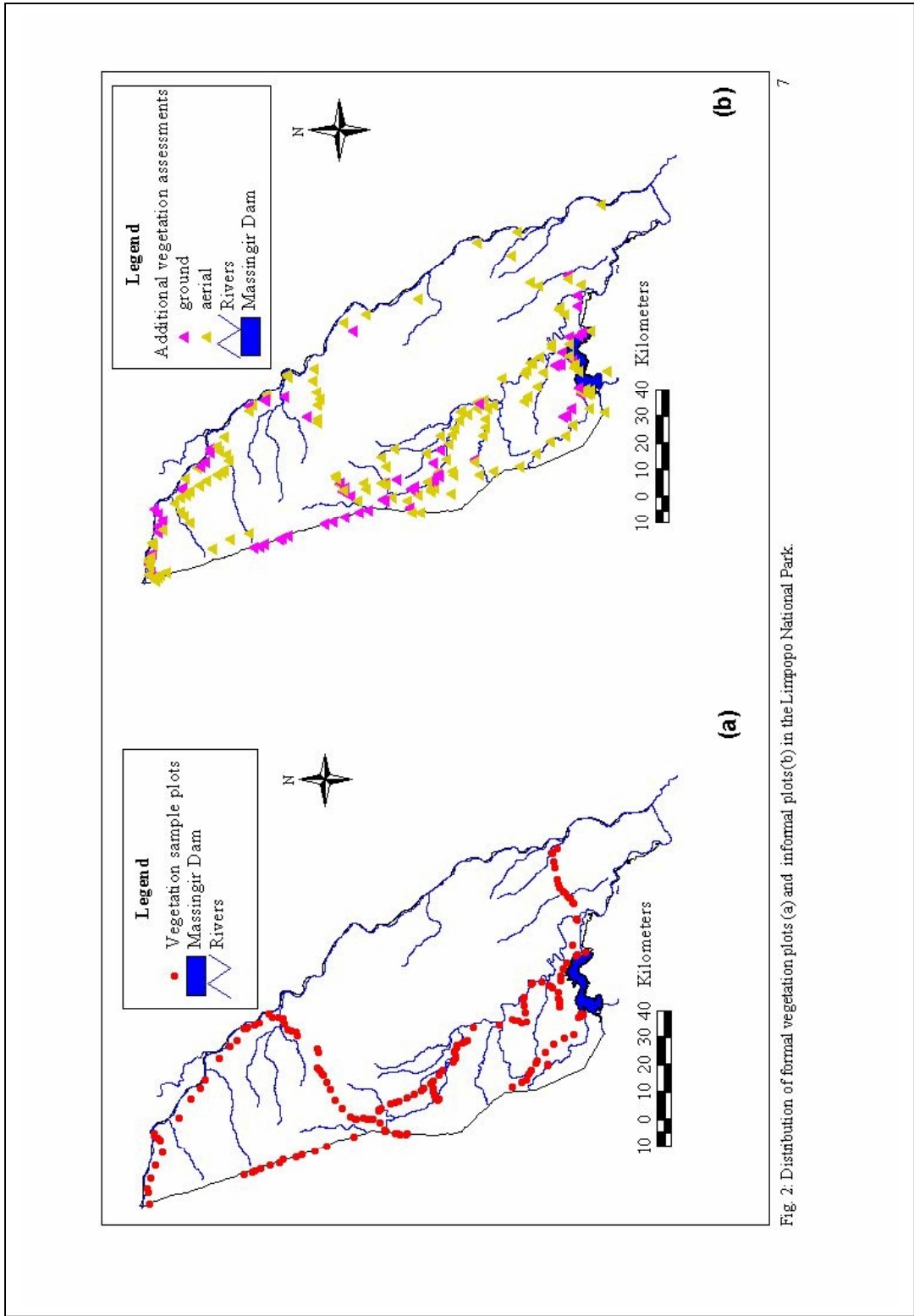


Fig. 2: Distribution of formal vegetation plots (a) and informal plots (b) in the Limpopo National Park.

### 3.3. Analysis of field data

Data were analysed through a combination of classification and ordination techniques. Classification is used to identify groups and to impose structure to raw data. Ordination aims at arranging species and samples in a low-dimensional space such that similar entities are close by and dissimilar entities far apart.

A TWINSpan classification (Hill 1979) was performed on the sample data. Two-way indicator species analysis (TWINSpan) is a polythetic divisive technique based on reciprocal averaging ordination (Gauch 1982). It is one of the preferred hierarchical techniques because of its effectiveness and robustness. It results in the definition of communities each characterised by its own distinctive species combination.

The CANOCO computer package (ter Braak 1992) was selected to analyse relationships between the data set of 175 plots by 237 species and the underlying environmental factors. CANOCO allows for canonical ordination which is an intermediate technique which combines aspects of regular ordination with aspects of regression (Jongman *et al.* 1987). The resulting ordination diagram expresses not only the pattern of variation in species composition but also the main features of species distributions along the gradient of environmental variables (ter Braak 1986).

### 3.4. Analysis of satellite imagery

Landsat Thematic Mapper quarter scene (bands 1,2,3, 4, 5 and 7) with a pixel size of 30 x 30 m, were obtained for 31/08/2000 (168/077 and 168/076 for the northern and central part of the LNP) and 22/08/2000 (169/0760 for the extreme southern part of the LNP). Bands 3, 4 and 5 were mostly used. Bands 3 (red) and band 4 (near infrared) have been shown to give a good measure of vegetation density, especially as it relates to leaf area, whereas band 5 (middle infrared) provides a good measure of canopy closure (Rey-Benayas and Pope 1995). This combination of bands has been used successfully in arid rangeland (Mackay and Zietsman 1996). All processing of the imagery was done by means of the IDRISI Geographical Information System (Eastman 1992). Visualisation of outcomes was done through ArcView (ESRI 1997).

Both supervised and unsupervised classification were used. In contrast to a supervised classification in which use is made of pre-defined training sites to assign each pixel to a certain class, the unsupervised classification allocates each pixel to a certain class based on its spectral characteristics only. The drawback to the supervised approach is that it is often difficult to locate and define homogenous training sites for all plant communities of interest. The considerable pixel to pixel variation generally results in many pixels being misclassified (Tueller 1989). Unsupervised classification approaches have worked better in rangelands. However, the drawback of the unsupervised classification is that a measure of subjectivity is unavoidable in the interpretation of the resulting clusters.



### 3.5. Delineation of landscapes

Rather than re-inventing the wheel, maximum use was made of the accumulated knowledge gained since the first vegetation maps produced in the 1950's (Codd 1951) for the adjoining and similar LNP. The Venter-based land classification system (Venter 1999) seems very appropriate to the environment of the LNP, but probably requires too much information on soil patterns to be applicable at this stage. More recently, the Gertenbach-based land classification hierarchy has been adapted and simplified to 17 landscape alliances by combining some of the 35 original landscapes (Solomon *et al.* 1999).

The relevant landscapes and landscape alliances for the LNP were identified using the knowledge gained through the ordination and classification of the LNP field data. Four approaches were used to map the landscapes of the LNP.

Firstly, given that the GIS layer of the parent material (reflecting soils) seems to provide the best available environmental information for the LNP, the actual classification the field plots (in terms of representing respectively sandveld communities, mopane communities or the alluvial community) was crosstabulated against the GIS substrate. A good match would enable one to use the substrate map as a broad landscape map.

Secondly, a 1/250 000 scale land cover map (“Carta de Uso e Cobertura da Terra”) has been derived for Mocambique a few years ago from satellite imagery. Results have been groundtruthed. The individual map units can be expected to capture meaningful units in the LNP. Units could be combined into landscapes.

Thirdly, unsupervised classification of the satellite into broad units and crosstabulation against the available sample plots representing sandveld, mopane veld etc. could assist in delineating landscapes.

Fourthly, the landscape map of the KNP was used to define training sites for the satellite image. The image was then classified to obtain similar landscapes within the LNP based on the spectral signatures of landscapes in the KNP. The expected drawback is that landscapes represent a certain combination of plant communities. The spectral signature of landscapes can therefore not be expected to be unique and homogeneous across large areas.

The results from the 4 different approaches were evaluated and a ‘best fit’ map was subjectively drawn.

#### 4. Causal factors of vegetation pattern in the LNP

The first ordination run with the full set of 175 vegetation plots resulted in a dense bunch of plots in ordination space with 20 plots as outliers (Fig. 3). The environmental variable 'drainage channel or floodplain' had a high canonical coefficient of 0.94 with the first axis, whereas the variable 'sandy geology' had a canonical coefficient of 0.74 with the second axis. It should be noted that canonical coefficients do not have the same properties as regression coefficients. In particular they have a larger variance. The critical level for the t-values for a t-test at a 5% significance level is 2.1 if number of samples minus number of environmental variables minus one exceeds 18. The Student t-test is not appropriate for tests of significance of canonical coefficients because of their larger variation. However these t-values can be used for exploratory purposes. Where their value is below 2.1, the environmental variable does not contribute much to the fit of the species data in addition to the contribution of the other variables. In this instance 'drainage channel or floodplain' had a high t-value of 18.8 and 'sandy geology' a value of 10.4.

The 20 outlying plots represent all the pans, riverbanks and reedbeds that were sampled (Fig. 3). The amount of available moisture as determined through landscape position therefore represents a major environmental determinant of vegetation composition along the first ordination axis. The different sample scores of a specific environmental variable are represented within the ordination diagram by a single point, called the 'centroid'. Species associated with the pans and riverbeds are *Acacia xanthophloea* and grasses typically associated with damp places. These comprise *Eriochloa meyeriana*, *Sporobolus consimilis*, *Paspalidium obtusifolium* and *Eragrostis heteromera*. The group of sample plots on the riverbanks are typified more by woody species such as *Acacia xanthophloea*, *Faidherbia albida*, *Ficus sycomorus* and *Kigelia africana*.

The main group remains bunched in ordination space and no further insight on its determinants is gained in this first ordination diagram. Further analysis was thus required. The 20 outlying plots were removed from the data set and a new ordination run was done. The resulting diagram displays a major soil gradient along the first axis with sample plots in sandveld located on the left-hand side of the diagram and sample plots on heavier soils towards the right-hand side of the diagram (Fig. 4). The second axis separates brackish alluvial flats from rocky hill slopes on rhyolite. Species associated with the alluvial areas are woody species such as *Salvadora persica*, *Acacia tortilis*, *Cadaba natalitia*, *Balanites pedicellaris* and *Euphorbia ingens*. The steep rocky slopes are characterised by *Kirkia acuminata*, *Commiphora edulis*, *C. tenuipetiolata*, *Euphorbia cooperi*, *Albizia brevifolia* and *Adansonia digitata* (baobab).

Once again, the 16 sample plots thus identified were removed and the remaining data set was ordinated. The split between 'sandveld' and non-sandveld sample plots is very clear along the gradient of increasing clay content of the soil (Fig. 5). *Androstachys johnsonii* (Lebombo ironwood or Simbitsi) forests are clearly separated from the main cloud of sandveld plots. Other species typical for the sandveld plots are *Xerroderris stuhlmannii*, *Pteleopsis myrtifolia* and *Guibourtia conjugata*. The non-sandveld sample plots are characterised by mopane (*Colophospermum mopane*), *Acacia nigrescens*, *Combretum imberbe* and *Kirkia acuminata*.

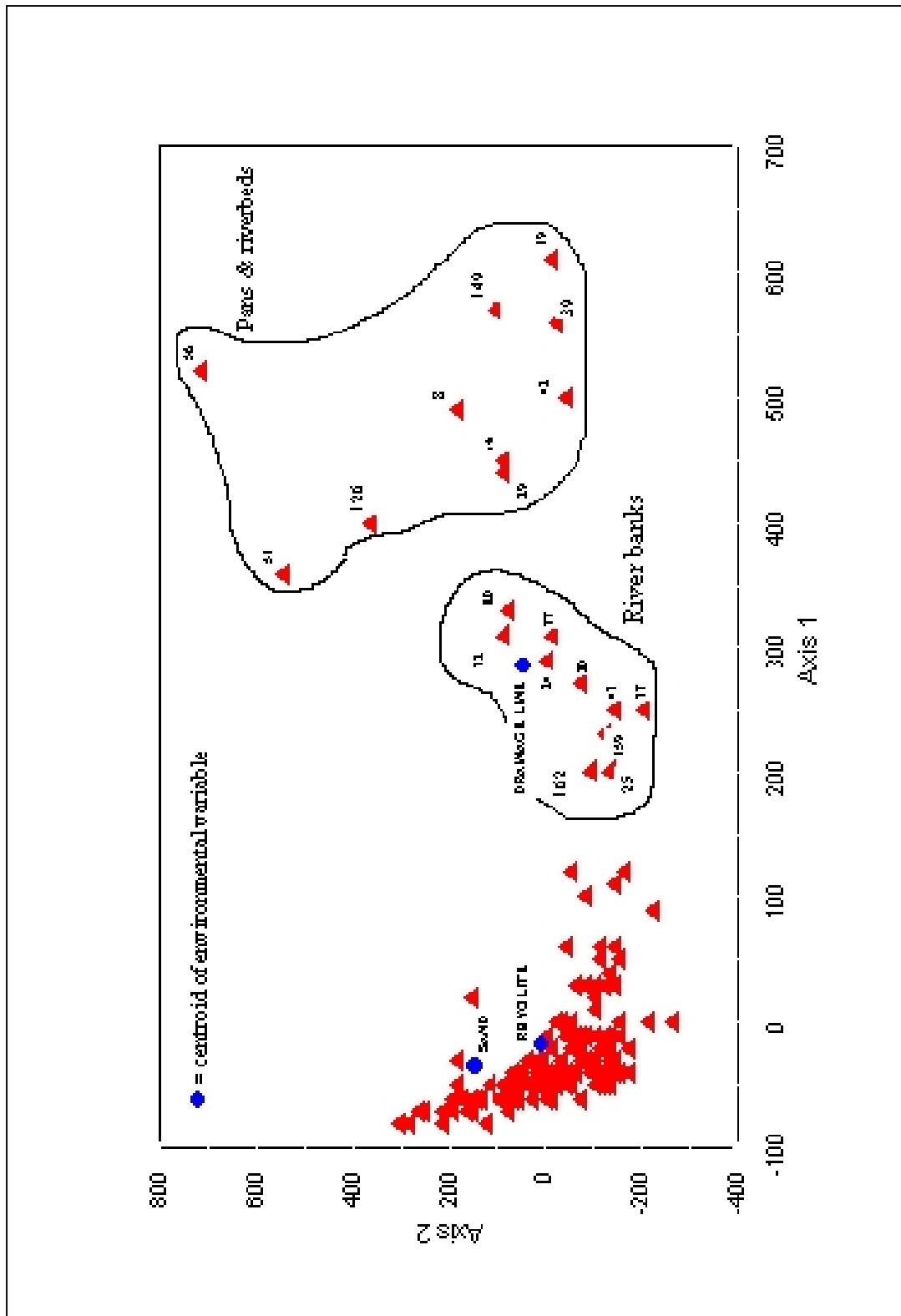


Fig. 3: DECORANA ordination of 175 vegetation sample plots in the Limpopo National Park. Note dense cloud of sample plots on left side of diagram with 20 outlying plots to the right that represent vegetation in areas with high moisture availability.

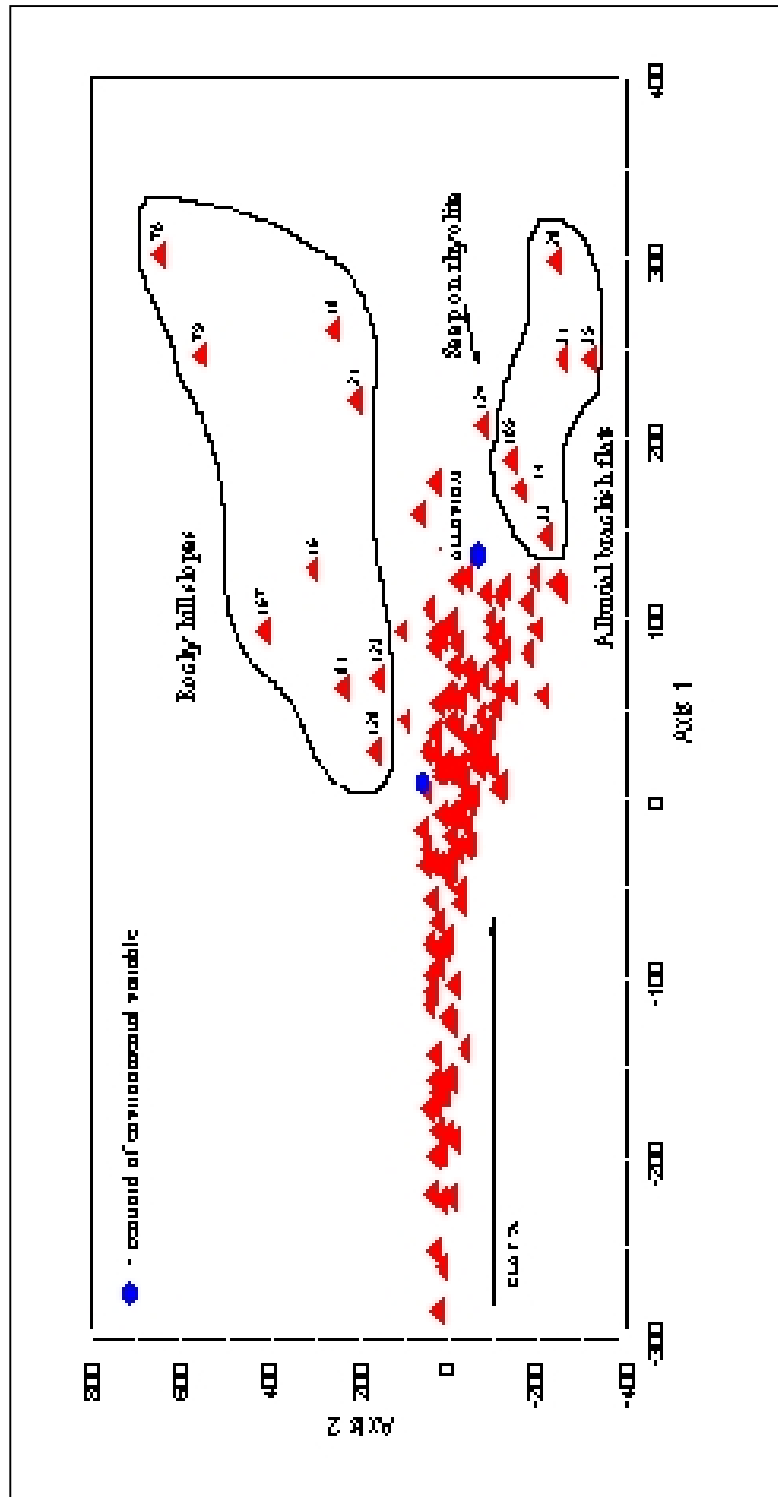


Fig. 4: DECORANA ordination of 155 vegetation sample plots in the Limpopo National Park (excluding sample plots along major drainage lines).

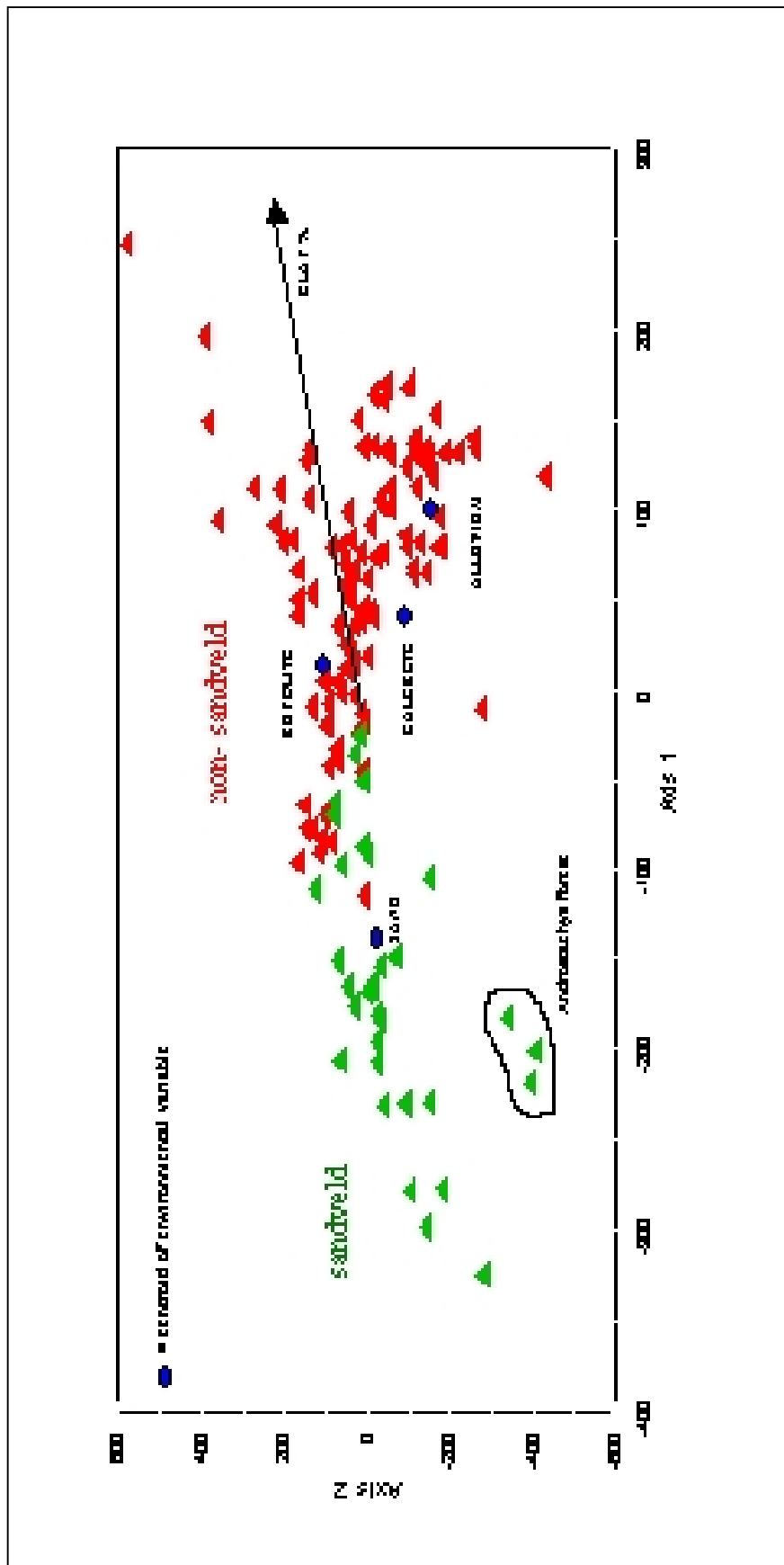


Fig. 5: DECORANA ordination of 139 vegetation sample plots in the Limpopo National Park (excluding sample plots along major drainage lines, rhyolite hills and brackish flats).

Lastly, the 34 'sandveld' plots were removed from the data set and the remaining 105 sample plots which represent 'mopane veld' were ordinated. The sample plots are scattered along the first axis according to their geological substrate, from rhyolite on the left-hand side of the diagram, calcrete in the middle to alluvium on the right-hand side (Fig. 6). The second axis arranges sample plots within those substrates in terms of their landscape position. There is no clear separation in ordination space between sample plots of different substrates which points to gradual transitions rather than sharp-edged ecotones. The gradient in clay content confirms the relevance of the two axes. One would expect clay content to increase from crest and upper slopes to the bottom of the landscape whilst at the same time clay contents increase from alluvium to rhyolite. The heavier clay soils are characterised by the grasses *Ischaemum afrum* and *Setaria incrassata*, the alluvial areas by the woody species *Salvadora persica* and *Acacia tortilis*. *Strychnos spinosa* is a typical exponent of more sandy crests and upper slopes.

The successive ordination runs clearly indicate the overriding importance of moisture availability in determining vegetation composition in the LNP. Firstly, the obvious differences in moisture availability by virtue of sample positions along quasi-perennial or seasonal waterbodies came out of the first ordination. Thereafter, the gradient in soil clay content (as a result of underlying geological substrate and landscape position) and landscape position *per se* (in determining water flow) largely determine soil moisture availability. In addition, geology determines intrinsic nutrient potential and landscape position influences nutrient depletion and accumulation processes.

The interplay of soil moisture and soil nutrient availability conforms to the current understanding of the determinants of savanna. The four-determinant model gives water availability and nutrient availability equal status in establishing the range of possible forms a savanna can assume (Scholes & Walker 1993). Fire and herbivory then determine the actual form and function within that range. Similarly, Timberlake *et al.* (1993) consider soil moisture in this environment as a major determinant in the distribution of vegetation types. Soil moisture availability results from the interaction between rainfall, topography, soil texture, soil depth, drainage and rooting habit. Du Plessis *et al.* (in prep) identified a gradient of decreasing soil moisture availability along the first axis of ordination of more than 2000 sample plots in mopane veld straddling South Africa, Namibia and Botswana. Stalmans (1994) identified water availability (as controlled by the position of the sample in the landscape and by its soil texture) as the major determinant of vegetation composition in an area adjacent to the Gonarezhou National Park in Zimbabwe that has a rainfall regime broadly similar to the LNP.

At a more localised scale, in terms of landscape position, the sandy substrates dominate the north-west to south-eastern running spine of the LNP. The vegetation of this area is typified by the sample plots found on the left-hand side of the ordination diagram of Fig. 5. Sloping towards the Shingwedzi River and Limpopo River, calcaric sedimentary rocks would be typified by the sample plots occupying the middle of the ordination diagram of Fig. 6. The vegetation of the rhyolite on the western boundary of the LNP and upper reaches of the Shingwedzi would typically be represented by the sample plots on the left of the diagram in Fig. 6, and the upper group in Fig. 4. Soils on alluvium in the Shingwedzi and Limpopo Valley are covered by vegetation typified by the sample plots on the upper-right of the ordination diagram in Fig. 6 and lower-right in Fig. 4. Along rivers and pans, the vegetation is typical of the two clusters delineated in Fig. 3.

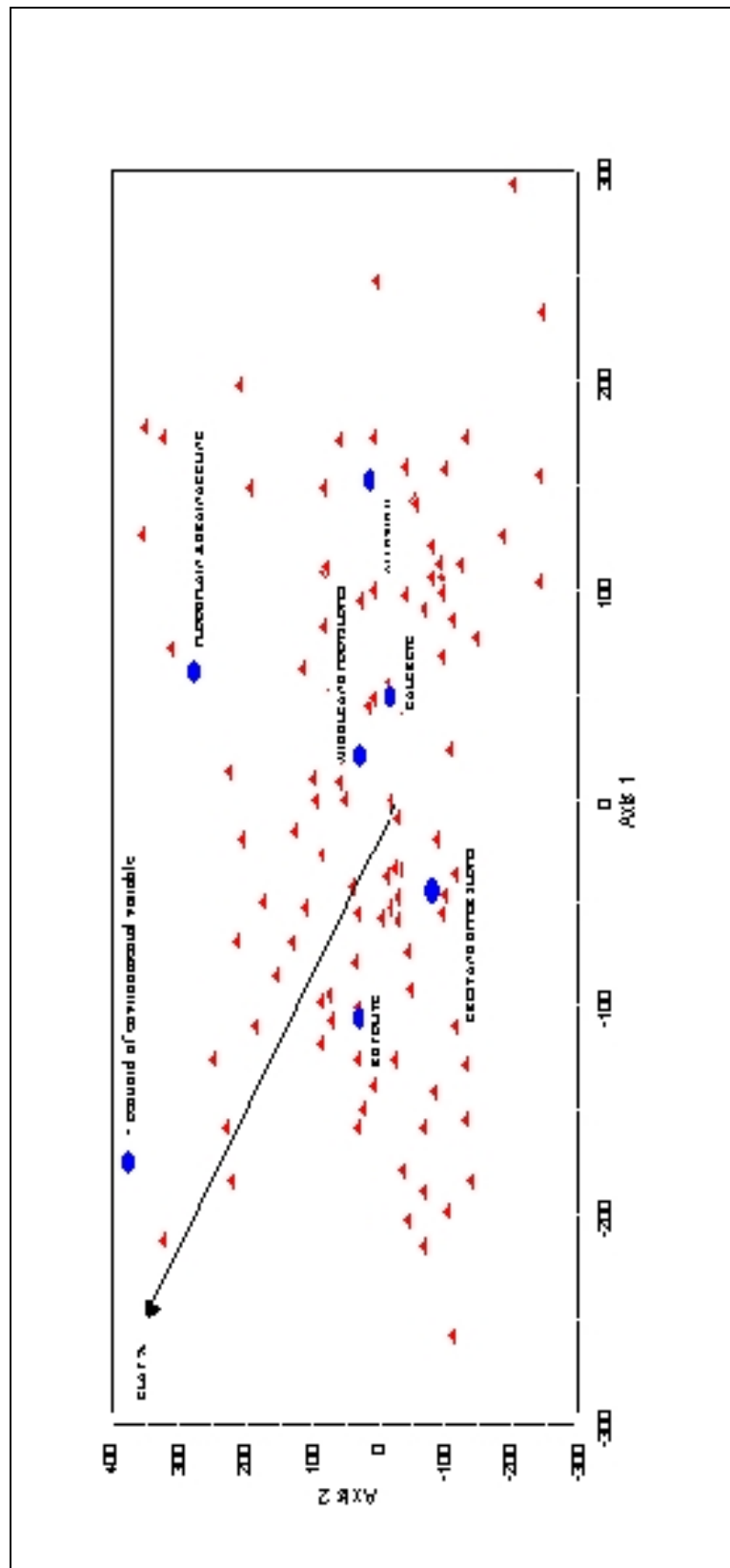


Fig. 6: DECORANA ordination of 105 vegetation sample plots in the Limpopo National Park (excluding sample plots along major drainage lines, rhyolite hills, brackish flats and sandveld).

## 5. Plant communities of the LNP

### 5.1. TWINSpan Dendrogram

The results from the TWINSpan classification are presented by means of a dendrogram (Fig. 7). A dendrogram depicts a number of successive dichotomous splits of the vegetation samples. The dendrogram is read from top to bottom in terms of finer splits into more homogeneous units and from left to right at the same hierarchical level. Divisions stop where there is insufficient variation amongst the remaining plots to warrant a further distinction into two different groups.

Starting from the top of the dendrogram, the set of 175 sample plots was divided into two groups. The left group represents the bulk of the sample plots (n=168). The right group with as indicator species *Cynodon dactylon* and *Eriochloa meyeriana* consists of 7 samples representing vegetation found in pans and on other periodically flooded areas.

The second level split divides the group of 168 samples into one of 136 and 32 plots respectively. *Combretum apiculatum*, mopane, *Digitaria eriantha* and *Schmidtia pappaphoroides* are indicator species for the left group. *Thilachium africanum* is the indicator for the right group. The group of 7 samples resulting from the first level split is divided into two groups representing respectively open floodplain and pan vegetation.

At the third level, the group of 132 plots is divided into groups of 11 and 125 samples. The left group is characterised by *Guibourtia conjugata* and *Baphia massaiensis*. These are typical sandveld species. The right group has mopane as an indicator species.

On the fourth level the sandveld group of 11 plots is further divided into typical closed *Androstachys johnsonii* forests and open woodland. The group of 125 plots is divided into groups of 53 and 72 plots respectively on the basis of indicator species such as *Pogonarthria squarrosa*, *Lannea stuhlmannii*, *Enneapogon* sp. and *Eragrostis rigidior* for the left group. The remaining 31 *Thilachium* plots of the previous level are split into groups of 20 and 11 plots with *Acacia xanthophloea* as indicator for the right-hand split.

At the fifth level the 8 sandveld plots are split on the basis of the importance of *Combretum apiculatum*. The left hand group consists of *Baphia massaiensis* thickets. The group of 53 plots is split into a sandveld component of 26 plots with *Perotis patens*, *Pteleopsis myrtifolia*, *Terminalia sericea* and *Pogonarthria squarrosa* as indicators. The right-hand group of 27 plots has mopane (cover of at least 5 to 25%) and *Eragrostis superba* as indicator species. Five plots found on steep rhyolite slopes are being split from the previous group of 72 plots leaving 67 plots on the left. These 5 plots are characterised by an open woodland with *Kirkia acuminata* and *Adansonia digitata*. The 20 plots from the previous level are divided into thickets on calcrete and brackish alluvial flats respectively. *Boscia foetida* and mopane are indicators for the thickets and *Salvadora persica*, *Acacia tortilis* and *Urochloa mossambicensis* are indicators for the alluvial areas. The 11 plots previously indicated by *Acacia xanthophloea* at level 4, are split into a fairly open community on the left and a riverine forest community on the right with indicators *Grewia flavescens*, *Fluggea virosa* and *Lonchocarpus capassa*.

Finally at level 6 of the dendrogram, only three further splits are of importance. The group of 26 sandveld plots is divided on the basis of the indicator species *Perotis patens*



and *Combretum mossambicensis* on the left and *Combretum apiculatum* on the right. The 27 mopane plots are split with *Schmidtia pappaphoroides* as indicator for the left and *Urochloa mossambicensis* and *Botriochloa* sp. as indicators for vegetation on heavier clay soils on the right. The group of 67 plots is divided on the basis of indicator species *Setaria incrassata* and *Urochloa mossambicensis* for the right-hand group. This represents mopane, *Dalbergia melanoxylon* open woodland or shrubland on heavily-textured soils as compared to the open to closed mopane woodlands on calcareous and rhyolite substrates found in the left-hand group.

In summary, the left branches of the dendrogram represent 'sandveld', the middle divisions 'mopane veld' and the right branches vegetation associated with more mesic conditions (river banks, pans etc.).

## 5.2. Definition of plant communities

The community concept is applied in its broad sense and reflects a recurring assemblage of grass and woody species of characteristic composition and structure, growing in an area of essentially similar environmental conditions and land use history (adapted from Gabriel & Talbot (1984)).

The classification outcome was evaluated subjectively against photographs of each sample plot. The main criteria applied was the need for each community to be identifiable in the field by an observer who is not necessarily a trained botanist. Community names were chosen subjectively so as to have practical value in the field through the use of two species which are visually and/or diagnostically important. Structural information with regard to vegetation height and density follows Edwards (1983). The communities broadly conform to the lower divisions of the dendrogram and they are therefore discussed from left to right following Fig. 7.

A total of 15 communities were identified. These are:

- Community 1: *Androstachys johnsonii* – *Guibourtia conjugata* short forest,
- Community 2: *Baphia massaiensis* – *Guibourtia conjugata* low thickets,
- Community 3: *Terminalia sericea* – *Eragrostis pallens* low woodland,
- Community 4: *Combretum apiculatum* – *Pogonarthria squarrosa* low woodland,
- Community 5: *Combretum apiculatum* – *Andropogon gayanus* low woodland,
- Community 6: *Colophospermum mopane* – *Panicum maximum* short woodland,
- Community 7: *Colophospermum mopane* - *Combretum imberbe* tall shrubland,
- Community 8: *Kirkia acuminata* – *Combretum apiculatum* tall woodland,
- Community 9: *Terminalia prunioides* – *Grewia bicolor* thicket,
- Community 10: *Acacia tortilis* – *Salvadora persica* short woodland,
- Community 11: *Acacia xanthophloeia* – *Phragmites* sp. woodland,
- Community 12: *Acacia xanthophloeia* – *Faidherbia albida* tall forest,
- Community 13: *Plugia dioscurus* – *Setaria incrassata* short grassland,
- Community 14: *Sporobolus consimilis* – *Setaria incrassata* tall grassland, and
- Community 15: *Paspalidium obtusifolium* – *Cynodon dactylon* short grassland.

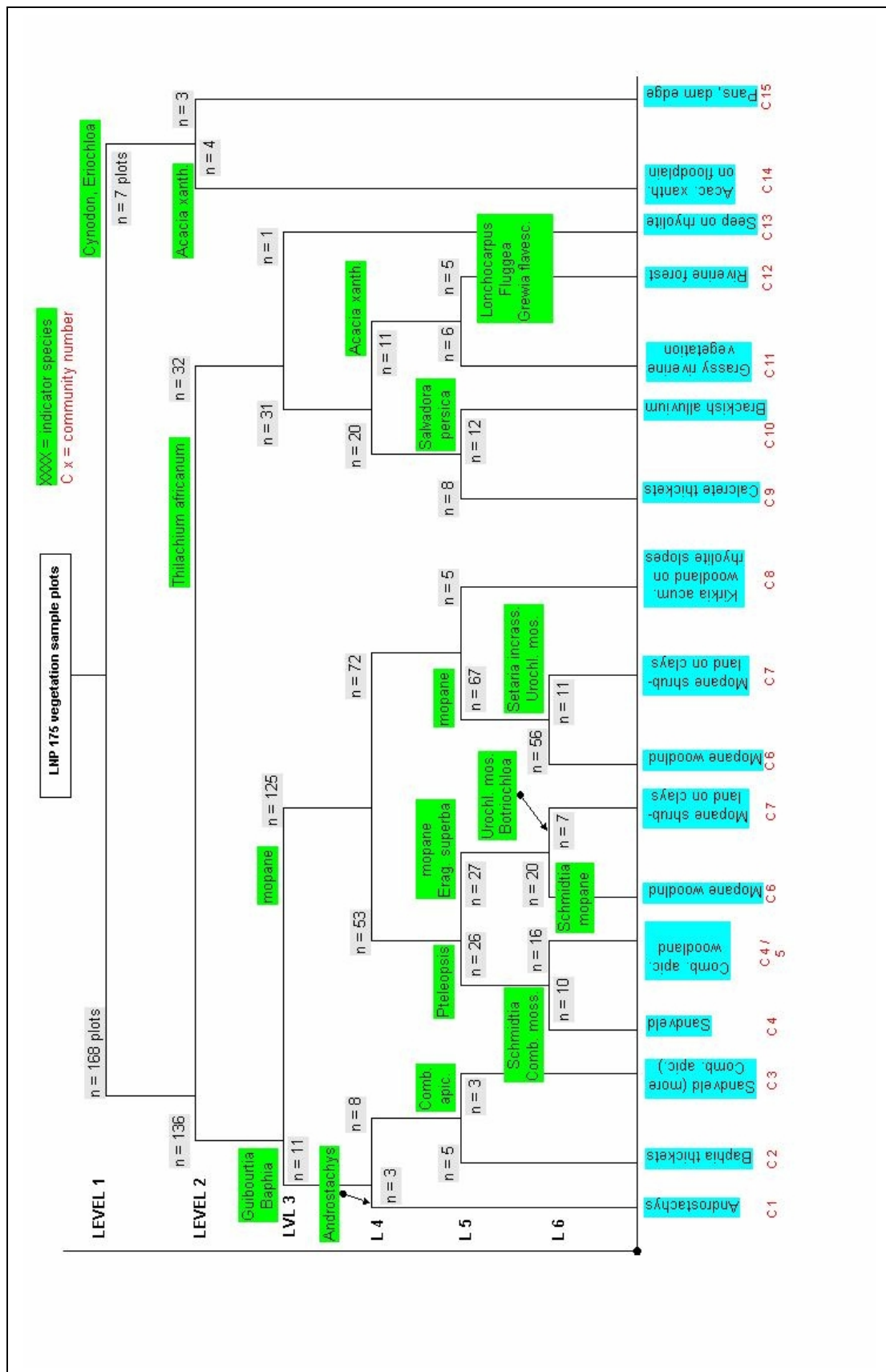


Fig. 7: TWINSpan dendrogram for 175 vegetation sample plots in the LNP.

### 5.3. Description of plant communities

#### 5.3.1. *Androstachys johnsonii* – *Guibourtia conjugata* short forest

This community is probably the most distinctive of all the plant communities found in the LNP. It consists of an extremely dense, short (5 – 10 m) forest (Box 1). Only 3 plots were formally sampled on account of the homogeneous nature of this community. *Androstachys johnsonii* forms a closed canopy. The only other woody species present in each of the three sample plots was *Guibourtia conjugata*. Only two other woody species were noted, namely *Croton pseudopulchellus* and a *Vitex* sp. Grass cover was limited (generally <1% canopy cover). Grass species diversity was low with only *Panicum maximum* having a 100% frequency. The only other species encountered were *Brachiaria deflexa*, *Perotis patens* and *Aristida* sp. This is thus a species-poor community with a total of only 4 woody and 4 grasses recorded in the 3 sample plots. Of interest is the occurrence of *Usnea* lichens which are draped in the crowns of the trees. Under normal circumstances this climate would be too dry for this lichen and it can therefore be speculated that moisture, other than that coming from rain, plays a role in its occurrence (Gertenbach 1983). Regular mist might play that role (Coetzee 1983).

This community is generally sharply demarcated from other communities. It occurs in patches ranging from a few dozen meters diameters to huge areas covering many hectares (Box 1). These patches are generally found in sandveld areas. However, significant stands of *Androstachys* have been observed on steep calcrete slopes and steps leading down to Massingir Dam and the Limpopo River as well as in the Pafuri Hills (see also K. Tinley, unpublished data).

This community corresponds to the *Androstachys johnsonii*-*Croton pseudopulchellus* dry forest described by van Rooyen *et al.* (1981) in the northern part of the Kruger National Park.

#### 5.3.2. *Baphia massaiensis* – *Guibourtia conjugata* low thicket

This community occurs on deep red sandy soils. It consists of a dense shrubby community, mostly with a canopy of 2 to 5 m height (Box 2). The main shrub is *Baphia massaiensis* whereas *Guibourtia* generally takes a tree form. Both these species occurred with a 100% frequency in the 5 sample plots belonging to this community. *Pteleopsis myrtifolia*, *Combretum celastroides* and *Stychnos madagascariensis* similarly had a 100% frequency of occurrence. Important grass species were *Eragrostis pallens* (100% frequency), *Digitaria eriantha* (80%), *Stipagrostis uniplumis* and *Panicum maximum* (both 60% frequency). Other typical sandveld elements are the trees *Xerroderris stuhlmannii* and *Hymenocardia ulmoides*. A total of 25 woody and 8 grass species were recorded.

This community was only encountered along the Mapai-Macandezulo track, both east and west of Buarinhama Pan (Box 2). It is very likely that this community links up along a south-west/north-east to the Nwambiya Sandveld in the Kruger National P where the very similar *Baphia massaiensis* – *Guibourtia conjugata* thicket was described by van Rooyen *et al.* (1981). Poor accessibility limits ground coverage of this community.



a



b



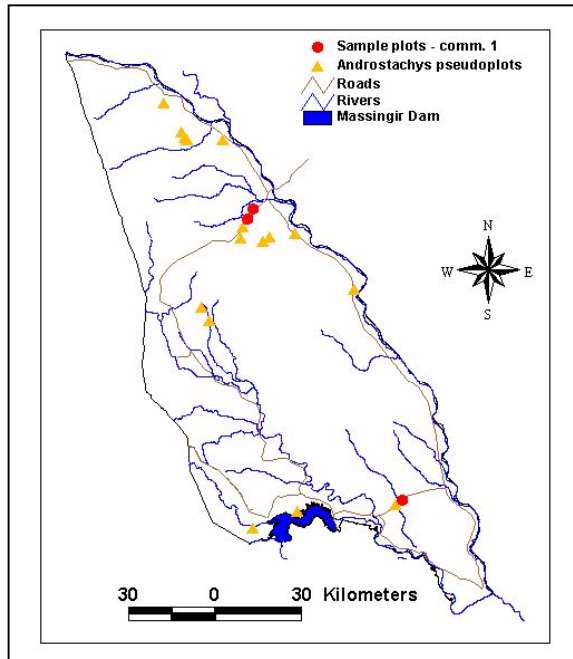
c

(a) aerial view of *Androstachys* forest in sandveld. Note sharp edge with other communities.

(b) aerial view of *Androstachys* on steep calcareous slopes above Massingir Dam. Note dark bands of *Androstachys* on hill sides with lighter green mopane and *Combretum apiculatum* on crests.

(c) Close-up of *Androstachys* forest. Note closed canopy and dense stand.

(d) Distribution of *Androstachys* forest (formal vegetation plots and pseudoplots).



d

Species	Canopy cover (%)	Frequency (%)
<i>Androstachys</i>	70.8	100.0
<i>Guibourtia</i>	5.2	100.0
<i>Panicum max.</i>	1.2	33.3
<i>Aristida sp.</i>	0.8	33.3
<i>Croton pseudop.</i>	0.8	66.7
<i>Brachiaria deflexa</i>	0.3	33.3
<i>Perotis patens</i>	0.2	33.3
<i>Vitex sp.</i>	0.2	0.0

Box 1: *Androstachys johnsonii* – *Guibourtia conjugata* short forest





a

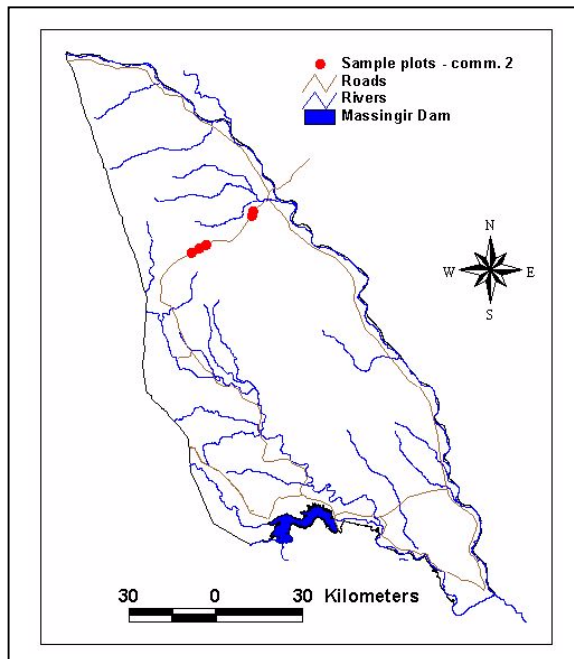


b



c

- (a) shrubby *Baphia massaiensis* in foreground at left with tree-like *Guibourtia conjugata* in background right.
- (b) Dense *Baphia* thicket with low canopy height (<5 m)
- (c) *Baphia* thicket along Macandezulo track, west of Buarinhama Pan. Note deep, red sandy soil.
- (d) Distribution of *Baphia* thickets as recorded with sample plots.



d

Species	Canopy cover (%)	Frequency (%)
<i>Digitaria eriantha</i>	17.6	80
<i>Guibourtia conjugata</i>	15.5	100
<i>Baphia massaiensis</i>	10.5	100
<i>Terminalia sericea</i>	7.5	20
<i>Eragrostis pallens</i>	6.0	80
<i>Pteleopsis myrtifolia</i>	5.7	100
<i>Stipagrostis uniplumis</i>	3.5	60
<i>Pogonarthra squarr.</i>	2.6	40
<i>Aristida</i> sp.	2.5	20
<i>Strychnos madagasc.</i>	1.3	100
<i>Panicum maximum</i>	1.1	60
<i>Xerroderris stuhlman.</i>	0.7	60

Box 2: *Baphia massaiensis* – *Guibourtia conjugata* low thickets

### 5.3.3. *Terminalia sericea* – *Eragrostis pallens* low woodland

This community typically occurs on sandy soils. It is characterised by the ubiquitous nature of *Terminalia sericea* and *Pogonarthria squarrosa*, coupled to an absence of any mopane (Box 3). The latter characteristic distinguishes this particular sandveld community from community 4 (Table 1). Other species with a 100% frequency were *Combretum apiculatum*, *Eragrostis pallens* and *Panicum maximum*. Other typical sandveld species such as *Guibourtia conjugata*, *Xerroderris stuhlmannii*, *Baphia massaiensis*, *Pteleopsis myrtifolia* and *Hugonia orientalis* occurred at lower frequencies. A total of 26 woody and 12 grass species were recorded in the 3 sample plots belonging to this community. This community is therefore more species rich than the *Baphia massaiensis* thickets.

This woodland community was found along the main sandy spine of the LNP (Box 3). It is very likely that this community is widespread along this sandy spine in between the sampled localities. Poor road access makes it difficult to map the actual extent of this community. Structurally this community is difficult to separate from community 4, thereby making an aerial assessment of its extent difficult.

This particular community very closely resembles the *Terminalia sericea* – *Pogonarthria squarrosa* tree savanna identified by van Rooyen *et al.* (1981) in the Punda Milia area of the KNP. Community 3 also encompasses the *Xerroderris stuhlmannii* – *Combretum apiculatum* tree savanna of van Rooyen *et al.* (1981).

### 5.3.4. *Combretum apiculatum* - *Pogonarthria squarrosa* low woodland

Community 4 is in some respects very similar to community 3. The major difference is a sizeable frequency of occurrence of mopane, which is absent from community 3. Nevertheless it is still a 'sandveld' community. This is evident by the presence of *Pteleopsis myrtifolia*, *Xerroderris stuhlmannii*, *Combretum celastroides* and *Eragrostis pallens*. These species are also found in sandveld communities 2 and 3, but not at all in the typical mopane woodlands of community 6. The two sandveld species *Guibourtia conjugata* and *Stipagrostis uniplumis* were only recorded once each in the 78 sample plots of community 5. A total of 65 woody and 20 grass species were recorded in the 21 sample plots belonging to this community. It is possible that this community corresponds to the patches of mopane (*Terminalia sericea* – *Colophospermum mopane* community) found by Du Plessis *et al.* (in prep) in sandveld.

Two variants occur. They are separated by the increased cover of *Combretum apiculatum* (see dendrogram in Fig. 7). These variants are not always easy to distinguish in the field and a single community concept was therefore preferred.

Community 4 is found along the sandy spine of the LNP and most conspicuously on the sandy substrates in the south-western part of the LNP, near Massingir Velho (Box 4).



a



b



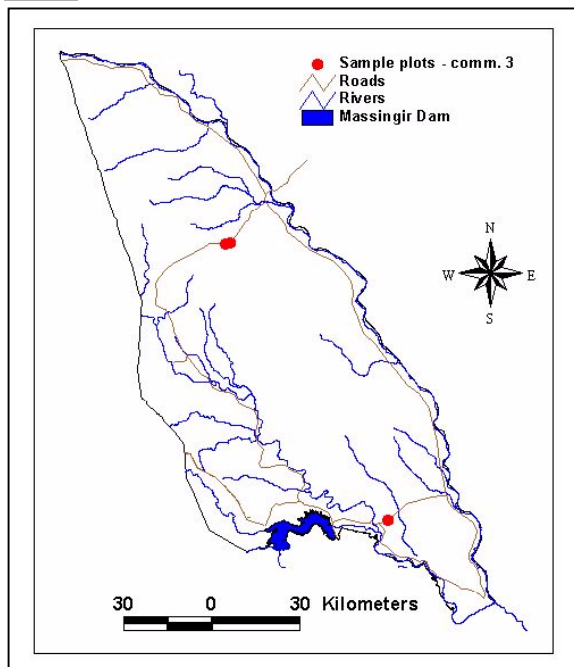
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(a) typical example of community 3 near Buarinhama Pan in the northern part of the LNP. Note prominent *Terminalia sericea* (silvery leaf) with *Pogonarthria* grass dominating the grasslayer in the foreground.

(b) *Xerroderris stuhlmannii* near Buarinhama Pan.

(c) Note prominent *Guibourtia conjugata* in the southern part of the LNP.

(d) Distribution of comm. 3 sample plots.



d

Species	Canopy cover (%)	Frequency (%)
<i>Eragrostis pallens</i>	9.2	100
<i>Pogonarthria squarrosa</i>	8.5	100
<i>Panicum maximum</i>	5.2	100
<i>Digitaria eriantha</i>	5.0	67
<i>Guibourtia conjugata</i>	5.0	67
<i>Stipagrostis uniplumis</i>	5.0	67
<i>Xerroderris stuhlmannii</i>	4.3	67
<i>Terminalia sericea</i>	1.2	100
<i>Combretum apiculatum</i>	1.2	100
<i>Tricholaena monachme</i>	1.0	67
<i>Boscia albitrunca</i>	1.0	67
<i>Perotis natens</i>	1.0	67

Box 3: *Terminalia sericea* – *Eragrostis pallens* low woodland





a

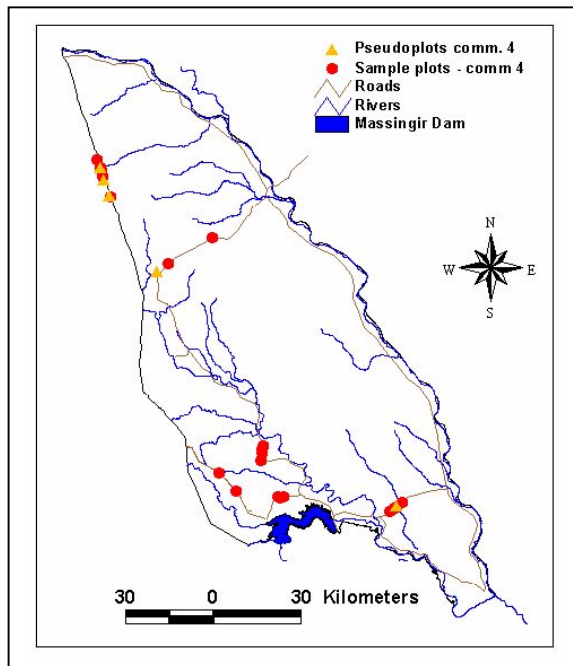


b



c

- (a) Community 4 on NE border with the KNP. Note *Combretum apiculatum*.
- (b) Although only occurring at a frequency of 24%, *Xerroderris stuhlmanii* can be a conspicuous element as evidenced by this large tree near the KNP border (see vehicle in background for scale).
- (c) *Guibourtia conjugata* in foreground with mopane in background left and right. (southern part of LNP).
- (d) Locality of sample plots of community 4.



d

Species	Canopy cover (%)	Frequency (%)
<i>Combretum apic.</i>	14.0	100
<i>Panicum maximum</i>	9.9	100
<i>Pogonarthria squarrosa</i>	5.4	88
<i>Digitaria eriantha</i>	3.8	94
<i>Urochloa mossamb.</i>	3.2	71
<i>Colophospermum mop.</i>	3.0	76
<i>Andropogon gayanus</i>	1.9	29
<i>Schmidtia pappaph.</i>	1.7	41
<i>Heteropogon contortus</i>	1.4	47
<i>Tricholaena monach.</i>	1.0	29

Box 4: *Combretum apiculatum* – *Pogonarthria squarrosa* low woodland



#### 5.3.5. *Combretum apiculatum* – *Andropogon gayanus* low woodland

This community has affinities to the previous community. It occurs however on shallow, rocky soils which are derived from rhyolites. Soils are loamy to clayey, but do not consist of the heavy, deep clayey soils found in other rhyolite areas. Typical localities are on the crest of the Lebombo Mountains near Giriwondo Gate (Box 5).

The vegetation is characterised by *Combretum apiculatum* and the grass *Andropogon gayanus*. Stunted *Albizia petersiana* represent one of the affinities with sandveld community 4. A total of 22 woody and 13 grass species were recorded in the 6 sample plots belonging to this community.

#### 5.3.6. *Colophospermum mopane* – *Panicum maximum* short woodland

This community represents the typical mopane woodlands associated with the LNP (Box 6). Much variation is encountered within these woodlands. The gradation is however often not abrupt and although four main variants may be recognised it is difficult for field work purposes to handle those separately.

The four main variants are largely based on underlying geology; calcrete, sand, rhyolite and alluvium. All variants are dominated by mopane and have as main grass species *Panicum maximum*, *Urochloa mossambicensis* and *Schmidtia pappaphoroides*. The variant on calcrete is characterised by the frequent occurrence of *Enneapogon* sp. This variant corresponds to the *Colophospermum mopane* – *Enneapogon scoparius* shrub savanna identified by van Rooyen *et al.* (1981). The variant on sandy substrates has *Combretum apiculatum* as an important component. On alluvial soils, *Acacia nigrescens* appears. On rhyolites, it is both *Acacia nigrescens* and *Heteropogon contortus* that are more obvious.

Community 6 has been recorded along all the sampled roads and tracks (Box 6). Whereas, large extended patches of mopane woodlands are found on the calcretes, the patches on sand are generally isolated. The mopane woodlands erroneously appear as the most widespread community of the LNP. This is because of the network of roads mostly being on the ecotone between the alluvial and calcrete areas thereby traversing mopane rather than sandveld that covers the greater extent of the LNP.

A total of 101 woody and 36 grass species were recorded in the 78 sample plots belonging to this community. Although this the highest number of species recorded, it is less than could be expected based on sampling intensity (see section 8).



a

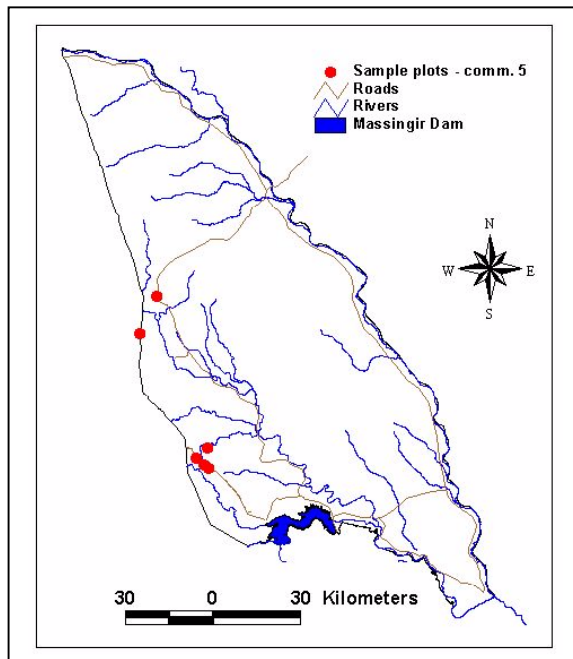


b



c

- (a) Community 5 on crest of Lebombo Mountains. Note *Combretum apiculatum*.
- (b) *Combretum apiculatum* - mopane woodland of community 5 near Giriyonde Gate.
- (c) Community 5 on rhyolite slope near Shingwedzi River.
- (d) Distribution of sample plots that belong to community 5.



d

Species	Canopy cover (%)	Frequency (%)
<i>Combretum apiculatum</i>	12.5	100
<i>Digitaria eriantha</i>	6.5	100
<i>Schmidtia pappaph.</i>	4.3	67
<i>Pogonarthria squarrosa</i>	3.8	100
<i>Andropogon gayanus</i>	3.3	67
<i>Colophospermum mop.</i>	3.1	83
<i>Heteropogon contortus</i>	3.0	67
<i>Panicum maximum</i>	2.8	100
<i>Urochloa mossamb.</i>	2.6	50
<i>Tricholaena monachme</i>	2.3	50

Box 5: *Combretum apiculatum* – *Andropogon gayanus* low woodland



Calcaric variant (West of Mapai)



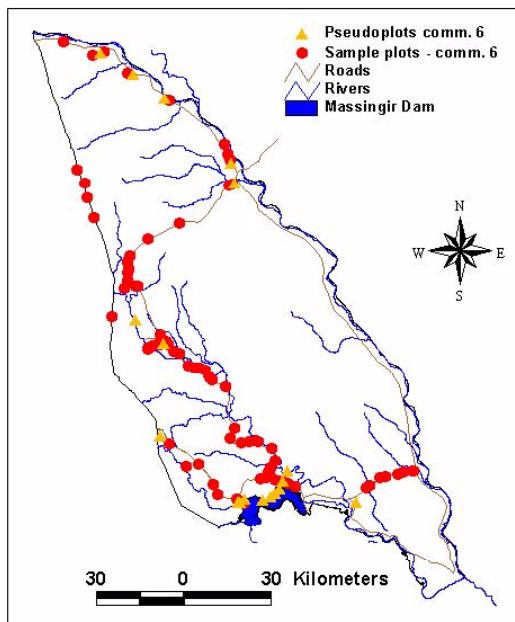
Sandy variant (NW of Massingir Velho)



Rhyolitic variant (lower Giriyondo road).



Alluvial variant (Shingwedzi Valley)



Species	Canopy cover (%)	Frequency (%)
<i>Colophospermum mop.</i>	24.1	99
<i>Panicum maximum</i>	11.0	88
<i>Urochloa mossamb.</i>	4.9	55
<i>Schmidtia pappaph.</i>	3.2	42
<i>Combretum apiculatum</i>	2.8	53
<i>Digitaria eriantha</i>	2.7	51
<i>Enneapogon scoparius</i>	1.7	49
<i>Heteropogon contortus</i>	1.1	28
<i>Grewia bicolor</i>	1.1	46
<i>Eragrostis rigidior</i>	1.0	23

Box 6: *Colophospermum mopane* – *Panicum maximum* woodland

### 5.3.7. *Colophospermum mopane* – *Combretum imberbe* tall shrubland

This community occurs on heavy clays, mostly derived from rhyolite but to a lesser extent derived from calcrete. This community consists typically of stunted mopane. These stunted specimens may occur in dense stands or as sparse individuals (Box 7). Other typical woody species are *Acacia nigrescens*, *Sclerocarya birrea* and *Combretum imberbe*. Vegetation of heavy clays has several highly exclusive species such as *Setaria incrassata* and *Ischaemum afrum* (Coetzee 1983)(Farrell 1968). This community is similar to the *Colophospermum mopane* – *Themeda triandra* shrub savanna described by van Rooyen et al (1981) on clay soils of basalts and andesites in the KNP.

A total of 21 woody and 17 grass species were recorded in the 13 sample plots belonging to this community.

### 5.3.8. *Kirkia acuminata*- *Combretum apiculatum* tall woodland

This woodland is found on moderately to very steep, rocky, rhyolite slopes as well as to a lesser degree on steep basalt hills in the vicinity of Pafuri (Box 8). The vegetation consists of a tall (often > 10 m high) woodland with *Kirkia acuminata* and *Adansonia digitata* as physiognomically the most distinct species. *Commiphora tenuipetiolata* is confined to this community. Van Rooyen *et al.* (1981) describe a similar community on basalt slopes in the northern part of the KNP as *Colophospermum mopane* – *Commiphora glandulosa* – *Seddera capensis* open tree savanna.

A total of 53 woody and 14 grass species were recorded in the 9 sample plots belonging to this community.

### 5.3.9. *Terminalia prunioides* – *Grewia bicolor* thicket

These thickets are mostly found on calcrete areas on shallow, stony soils that are probably very xeric. *Terminalia prunioides* is the most prominent woody species, second in average cover only to the shrub *Grewia bicolor* (Box 9). The succulents *Euphorbia grandidens* and *Cissus quadrangularis* are conspicuous.

A total of 41 woody and 8 grass species were recorded in the 5 sample plots belonging to this community. The number of woody species is relatively high, but the grasses are less prominent due to the closed nature of the woody canopy.





a

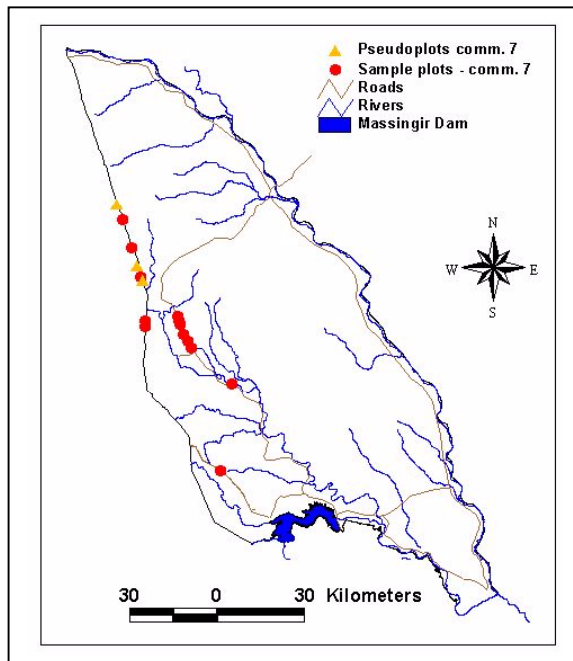


b



c

- (a) Community 7 of shrub mopane on clayey soils south of Macandezulo B.
- (b) Shrub mopane near KNP border. Note tall *Setaria incrassata* in foreground.
- (c) Mopane shrubland on heavy clays on soils derived from rhyolite near border with KNP. Note tall mopane in background on lighter soils.
- (d) Distribution of sample plots with vegetation belonging to community 7.



d

Species	Canopy cover (%)	Frequency (%)
<i>Colophospermum mop.</i>	19.3	85
<i>Setaria incrassata</i>	10.2	54
<i>Panicum maximum</i>	6.6	77
<i>Urochloa mossamb.</i>	6.1	77
<i>Ischaemum afrum</i>	4.1	38
<i>Themeda triandra</i>	3.4	54
<i>Acacia nigrescens</i>	2.2	31
<i>Sclerocarya birrea</i>	1.3	38
<i>Cenchrus ciliaris</i>	1.2	23
<i>Combretum imberbe</i>	0.4	46

Box 7: *Colophospermum mopane* – *Combretum imberbe* tall shrubland



a

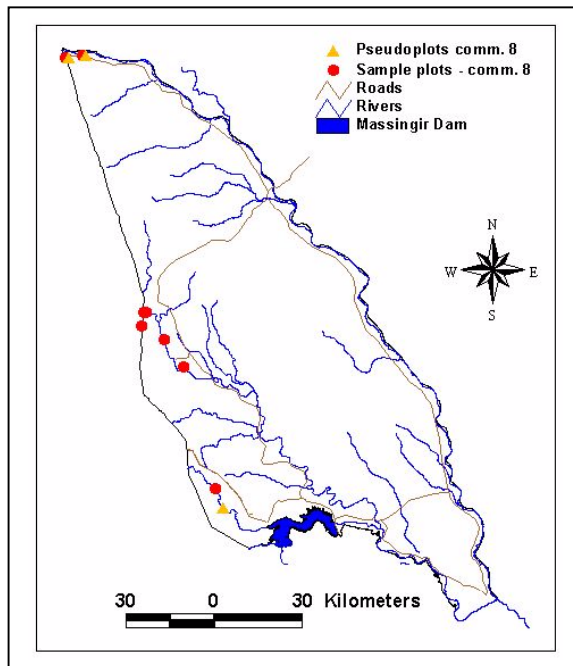


b



c

- (a) Community 8 with large *Kirkia acuminata* in background.
- (b) Community 8 along cliff edge above Shingwedzi River.
- (c) *Euphorbia tirucalli* and *Adansonia digitata* (baobab) above Shingwedzi River near KNP border.
- (d) Distribution of sample plots belonging to community 8.



d

Species	Canopy cover (%)	Frequency (%)
<i>Panicum maximum</i>	15.4	78
<i>Combretum apiculatum</i>	5.2	100
<i>Euphorbia tirucalli</i>	4.2	33
<i>Danthaniopsis parva</i>	3.1	44
<i>Kirkia acuminata</i>	2.3	67
<i>Brachiaria deflexa</i>	2.3	67
<i>Colophospermum mop.</i>	2.2	44
<i>Albizia brevifolia</i>	2.1	56
<i>Grewia bicolor</i>	1.8	44
<i>Enteropogon monost.</i>	1.7	33

Box 8: *Kirkia acuminata* – *Combretum apiculatum* tall woodland





a

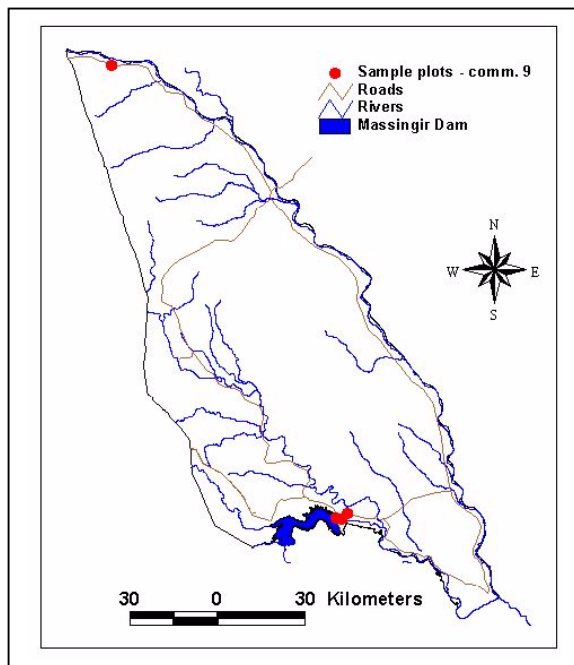


b



c

- (a) Thicket of community 9 on south-eastern side of LNP. Note *Euphorbia grandicornis* in foreground on right.
- (b) Thicket north of Massingir dam wall. Note *Pyrostria histrix* in foreground.
- (c) Thicket on calcrete north of Massingir Dam. Note *Thilachium africanum* and fruiting *Terminalia prunioides*.
- (d) Distribution of community 9.



d

Species	Canopy cover (%)	Frequency (%)
<i>Grewia bicolor</i>	15.5	100
<i>Terminalia prunioides</i>	13.1	100
<i>Panicum maximum</i>	6.0	80
<i>Colophospermum mop.</i>	5.0	40
<i>Ptaeroxylon obliquum</i>	3.1	60
<i>Euclea divinorum</i>	2.7	60
<i>Brachiaria deflexa</i>	2.5	20
<i>Grewia flavescens</i>	2.5	20
<i>Enneapogon scoparius</i>	1.6	80
<i>Dactyloctenium aeg.</i>	0.6	40

Box 9: *Terminalia prunioides* – *Grewia bicolor* thicket

#### 5.3.10. *Acacia tortilis* - *Salvadora persica* short woodland

This represents one of the most important communities from a human and animal perspective on account of its high fertility status and proximity to the water of the large rivers. It typically consists of an open woodland with *Acacia tortilis* with its characteristic umbrella-shaped canopy as the most recognizable element. *Salvadora persica* is the diagnostic species for this community (Box 10). This is still considered as one of the ‘mopane’ veld communities and was classified by van Rooyen *et al.* (1981) as the *Colophospermum mopane* – *Acacia tortilis* – *Urochloa mossambicensis* tree savanna.

This community is strictly confined to alluvial flats along the Limpopo, Elefanties and Shingwedzi Rivers (Box 10). These areas tend to be brackish in places, in particular below the Massingir Dam, where atypical, shrubby examples of this community occur.

A total of 44 woody and 16 grass species were recorded in the 13 sample plots belonging to this community.

#### 5.3.11. *Acacia xanthophloea* – *Phragmites* sp. woodland

This community typically fringes the smaller rivers. It generally consists of a fringe of *Acacia xanthophloea* dominated woodland on the banks with an inner section dominated by grasses (including reeds) and sedges on the lower banks and in the river (Box 11). A sharp contrast can sometimes be observed between the occurrence within a few meters of each other of *Eriochloa meyeriana* in very damp conditions and *Danthaniopsis parva* in very dry conditions on exposed rocks.

A total of 20 woody and 14 grass species were recorded in the 6 sample plots belonging to this community.

#### 5.3.12. *Acacia xanthophloea* – *Faidherbia albida* tall forest

In contrast to the previous community this community is more commonly found along the larger rivers. It is particularly prominent above Mapai along the Limpopo River. It consists of a tall forest with large trees (Box 12). This community seems to occur in areas that are less prone to flooding than communities 11, 14 and 15 (see also K. Tinley, unpublished data). This forest corresponds to the *Acacia albida* – *Ficus sycomorus* riverine forest described by van Rooyen *et al.* (1981) along the Limpopo and Levubu Rivers in the KNP.

A total of 36 woody and 10 grass species were recorded in the 5 sample plots belonging to this community.





a

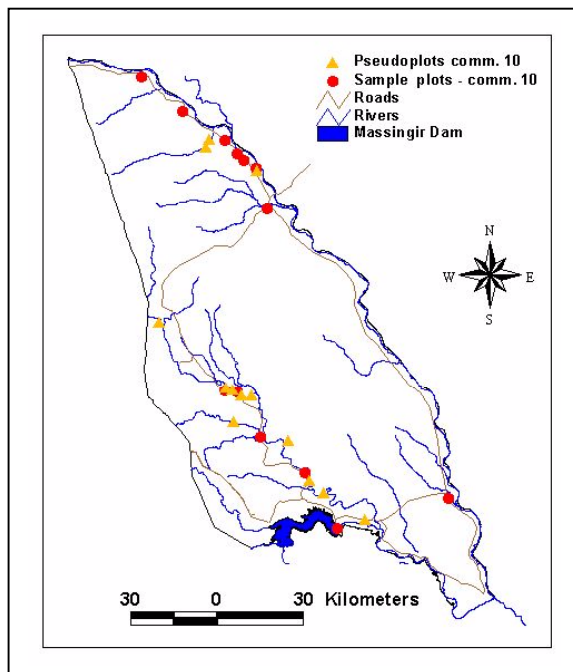


b



c

- (a) *Acacia tortilis* is the most conspicuous and typical element of community 10 (Shingwedzi Valley).
- (b) *Acacia tortilis* woodland (lower Limpopo Valley)
- (c) *Salvadora persica* and *Euphorbia cooperi* (Limpopo Valley)
- (d) Distribution of community 10 (only on alluvium of major rivers).



d

Species	Canopy cover (%)	Frequency (%)
<i>Panicum maximum</i>	23.3	92
<i>Urochloa mossamb.</i>	10.1	69
<i>Eragrostis cylindriflora</i>	8.7	31
<i>Acacia tortilis</i>	8.0	69
<i>Grewia bicolor</i>	6.9	46
<i>Salvadora persica</i>	3.7	62
<i>Acacia burkei</i>	3.1	15
<i>Enneapogon scoparius</i>	2.0	23
<i>Acacia nigrescens</i>	1.9	15
<i>Eragrostis lehmann.</i>	1.0	15

Box 10: *Acacia tortilis* – *Salvadora persica* short woodland



a

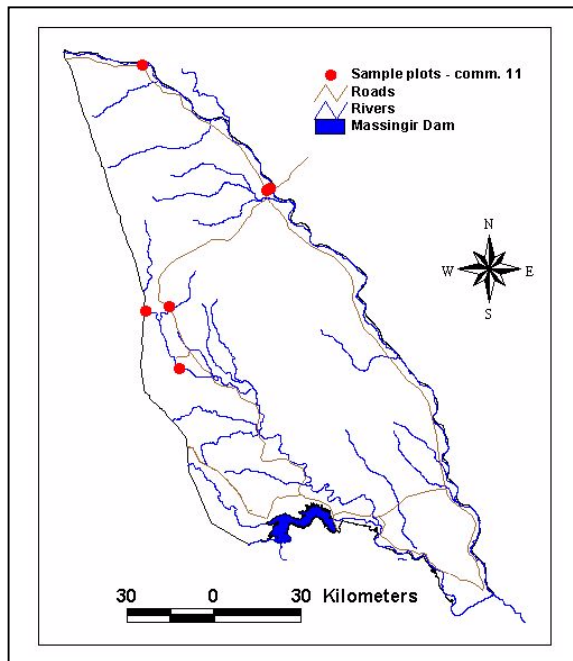


b



c

- (a) Community 11: *Acacia xanthophloea* and sedges.
- (b) Aerial view of community 11. Note open grassy nature and fringe of *Acacia xanthophloea*.
- (c) Reeds (*Phragmites* sp.) in upper Shingwedzi River.
- (d) Distribution of community 11.



d

Species	Canopy cover (%)	Frequency (%)
<i>Acacia xanthophloea</i>	12.8	100
<i>Phragmites</i> sp.	6.9	83
<i>Danthaniopsis parva</i>	2.5	33
<i>Panicum maximum</i>	2.4	83
<i>Eragrostis cylindriflora</i>	2.2	33
<i>Sporobolus consimilis</i>	2.1	17
<i>Sorghum</i> sp.	2.1	17
<i>Hyphaene natalensis</i>	2.1	17
<i>Cynodon dactylon</i>	0.5	33
<i>Phyllanthus reticulatus</i>	0.5	33

Box 11: *Acacia xanthophloea* – *Phragmites* sp. woodland.





a

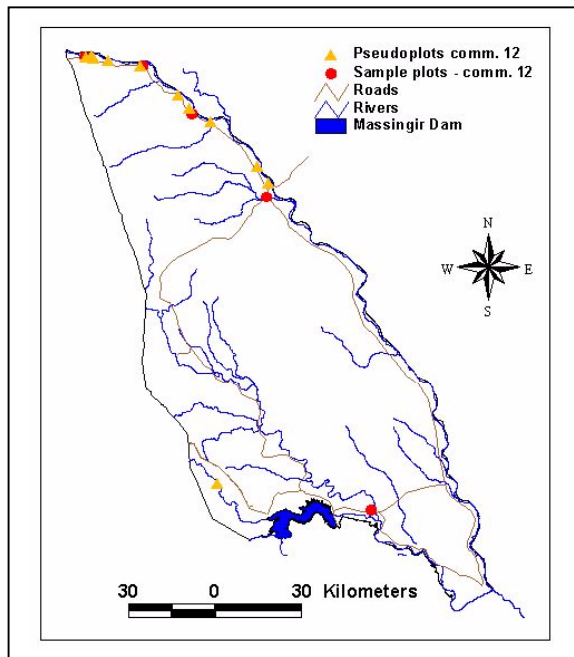


b



c

- (a) Riverine forest near Mapai with *Diospyros mespiliformis* and *Combretum imberbe*.
- (b) Aerial view of riverine forest (Machampane River).
- (c) Riverine forest (lower Shingwedzi River) with *Acacia xanthophloea*.
- (d) Distribution of community 12. Note occurrence in particular along Upper Limpopo River.



d

Species	Canopy cover (%)	Frequency (%)
<i>Acacia xanthophloea</i>	13.5	100
<i>Panicum maximum</i>	13.1	100
<i>Faidherbia albida</i>	8.0	40
<i>Xanthocercis zamb.</i>	5.0	40
<i>Combretum imberbe</i>	5.0	40
<i>Acacia schweinfurtii</i>	3.5	60
<i>Grewia flavescens</i>	3.1	60
<i>Ziziphus mucronata</i>	3.0	40
<i>Diospyros mesp.</i>	2.8	80
<i>Brachiaria deflexa</i>	2.6	40

Box 12: *Acacia xanthophloea* – *Faidherbia albida* tall forest

#### 5.3.13. *Plugia dioscurus* – *Setaria incrassata* short grassland

This represents probably the smallest community in the LNP in terms of its total extent. It is however one of the physiognomically most distinct communities found (Box 13). It is a very open community on account of being waterlogged through seepage from surrounding rhyolite slopes. This prevents invasion by most woody species. Only the woody forb *Plugia dioscurus* was recorded. The grass species are similar to those found on other heavy soils.

Only 1 woody and 2 grass species were recorded in the single sample plot belonging to this community.

#### 5.3.14. *Sporobolus consimilis* – *Setaria incrassata* tall grassland

This community is found in seasonally water-logged areas. These might be as a result of flooding (for example along the Limpopo River near Pafuri) or from the filling of pans from rain. These areas do however become dry again, in contrast to community 15.

As a result of the waterlogged soils, the woody component is limited (Box 14). The grasslayer is very dense and tall (> 1m). Dominant species are *Sporobolus consimilis* (sometimes in almost monospecific stands) and *Setaria incrassata*. Van Rooyen *et al.* (1981) similarly described *Sporobolus consimilis* grassland for the Limpopo floodplain in the KNP.

A total of 4 woody and 6 grass species were recorded in the 4 sample plots belonging to this community.

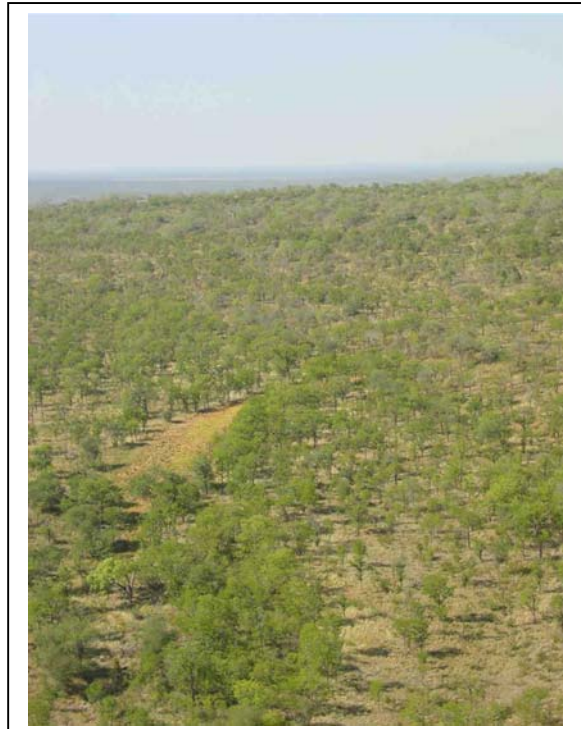
#### 5.3.15. *Paspalidium obtusifolium* – *Cynodon dactylon* grassland

This community is found in areas that are more permanently wet than the previous community. The sample sites that were surveyed were at some of the larger pans and in one of the inlets of the Massingir Dam. The waterlogged nature of the soils impedes tree growth as in the previous community. Typically the vegetation will consist of a floating mat of *Paspalidium* when flooded with a fringe of *Cynodon dactylon* and *Eragrostis heteromera* (Box 15).

A total of 3 woody and 8 grass species were recorded in the 3 sample plots belonging to this community.



a



b



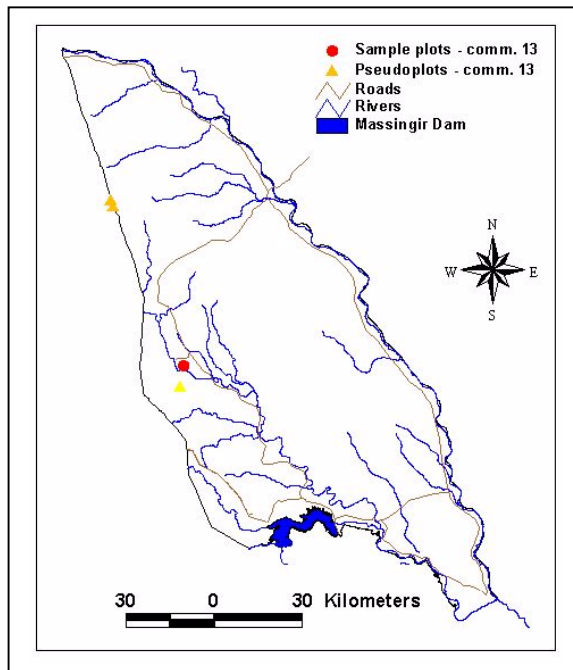
c

(a) Seepage on rhyolite slope in Shingwedzi Valley. Note abrupt change from mopane woodland into grassy community 13.

(b) Aerial view of seepage on Lebombo Mountains.

(c) Seepage near KNP border in north-western sector of the LNP.

(d) Locality of seepage areas recorded during 2002.



d

Species	Canopy cover (%)	Frequency (%)
<i>Setaria incrassata</i>	37.5	100
<i>Plugia dioscurus</i>	37.5	100
<i>Eragrostis cf. trich.</i>	0.5	100

Box 13: *Plugia dioscurus* – *Setaria incrassata* short grassland





a

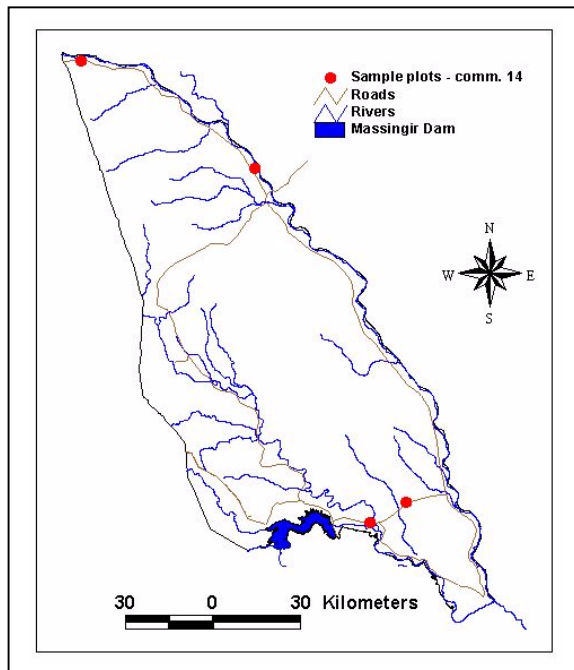


b



c

- (a) Floodplain (lower Shingwedzi) with tall *Setaria incrassata* and *Sporobolus consimilis*.
- (b) *Sporobolus consimilis* grassland in Limpopo Valley. Note *Acacia xanthophloeia* forest (community 12) in background.
- (c) Dryish pan in mopane veld (southern section).
- (d) Distribution of comm. 14.



d

Species	Canopy cover (%)	Frequency (%)
<i>Sporobolus consimilis</i>	47.0	100
<i>Setaria incrassata</i>	22.0	50
NO WOODY		25
<i>Eriochloa meyeriana</i>	6.3	50
<i>Acacia xanthophloeia</i>	0.9	75
<i>Eragrostis heteromera</i>	0.6	25
<i>Setaria sagittifolia</i>	0.1	25
<i>Parkinsonia aculeata</i>	0.1	25
<i>Ischaemum afrum</i>	0.1	25
<i>Hvphaene natalensis</i>	0.1	25

Box 14: *Sporobolus consimilis* – *Setaria incrassata* tall grassland



a

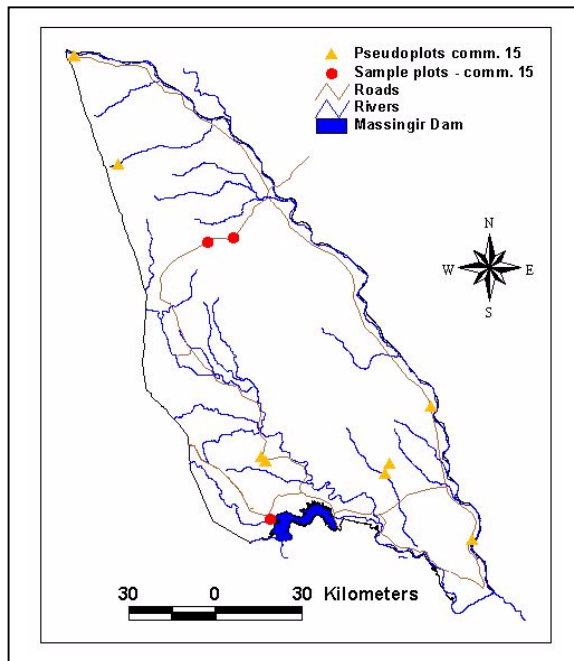


b



c

- (a) Pan with *Paspalidium obtusifolium* grass, west of Buarinhama.
- (b) Aerial view of pan with comm. 15 vegetation in northern part of LNP close to KNP border.
- (c) Inlet of Machampane River at Massingir Dam.
- (d) Locality of sample plots and pseudoplots that belong to community 15.



d

Species	Canopy cover (%)	Frequency (%)
NO WOODY		67
<i>Paspalidium obtusif.</i>	41.7	67
<i>Cynodon dactylon</i>	25.8	100
<i>Eragrostis heteromera</i>	5.0	67
<i>Echinochloa colona</i>	1.0	67
<i>Sorghum sp.</i>	0.8	33
<i>Sesbania sp.</i>	0.8	33
<i>Ricinus communis</i>	0.8	33
<i>Paspalum sp.</i>	0.8	33
<i>Faidherbia albida</i>	0.8	33

Box 15: *Paspalidium obtusifolium* – *Cynodon dactylon* short grassland

## 6. Landscapes of the LNP

### 6.1. Results from classification and mapping attempts

The crosstabulation between the actual vegetation type and the geological substrate on which the sample plots were located, generally yielded the expected results for sandveld (Table 1). Lower matching figures are obtained for the alluvial and mopane communities. The reason for the partial mismatch might be that either communities are not strictly defined by the underlying geological substrate or that the available GIS coverage of the geological substrate is imperfect. Both reasons apply. The sandveld communities are exclusively limited to sandy substrates. However, the sandy substrates do not exclusively carry sandveld communities but also patches of mopane. Most of the sample plots showing a mismatch with the substrate are actually closely located to their 'expected' substrate according to the GIS data. This particularly applies to the alluvial vegetation supposedly occurring on calcrete. The alluvium is defined as a small narrow strip along the main rivers. Small mapping errors would explain the mismatch. A sample plot of alluvial vegetation in the upper reaches of the Shingwedzi River was supposedly found on rhyolite. It was however located on alluvium whereas the geological map does not indicate the presence of alluvium.

Table 1: Crosstabulation between plant communities (from sample plots) and geological substrate (% indicate the match between observed and expected occurrence).

	Sandy geology	Alluvium	Calcrete	Rhyolite
Sandveld communities	72%	0%	22%	6%
Mopane communities	9.7%	19.4%	48.4%	2.2%
Alluvial community	0%	50%	46.6%	0.4%

The underlying geological substrate thus serves an important predictive role in terms of expected broad communities occurring. It is however not sufficiently accurate nor can it be used as the sole determinant for larger-scale landscapes.

The unsupervised as well as the supervised classifications yielded mixed results. Clusters that represent landscapes clearly identifiable in the field are extracted for certain areas (Fig. 8). The interpretation of these clusters however proved problematic. As an example, two areas along the north-western border with the KNP are lumped with areas of mopane veld. The available landcover data (Carta de Uso e Cobertura da Terra) also describe these areas as mopane veld (Fig. 9). However, from field sampling and aerial surveys it is clear that these particular areas are covered by sandveld (Fig. 9). The similarity in spectral signature might be due to this specific sandveld being denser than most of the other sandveld and thus being more similar in structure to the usually fairly closed canopy of mopane woodlands. This example demonstrates that great care should be used in applying the available landcover data to map landscapes. The units identified in the landcover undoubtedly make sense, but their interpretation is unreliable, probably because of insufficient groundtruthing being possible at local scale for a project undertaken at the national scale.



The use of KNP landscapes as training sites for the supervised classification of the LNP did not yield satisfactory results. This was despite attempts of classifying different geological substrates separately and despite using more advanced techniques such as 'fuzzy' logic to address the mix of spectral signatures in a single landscape.

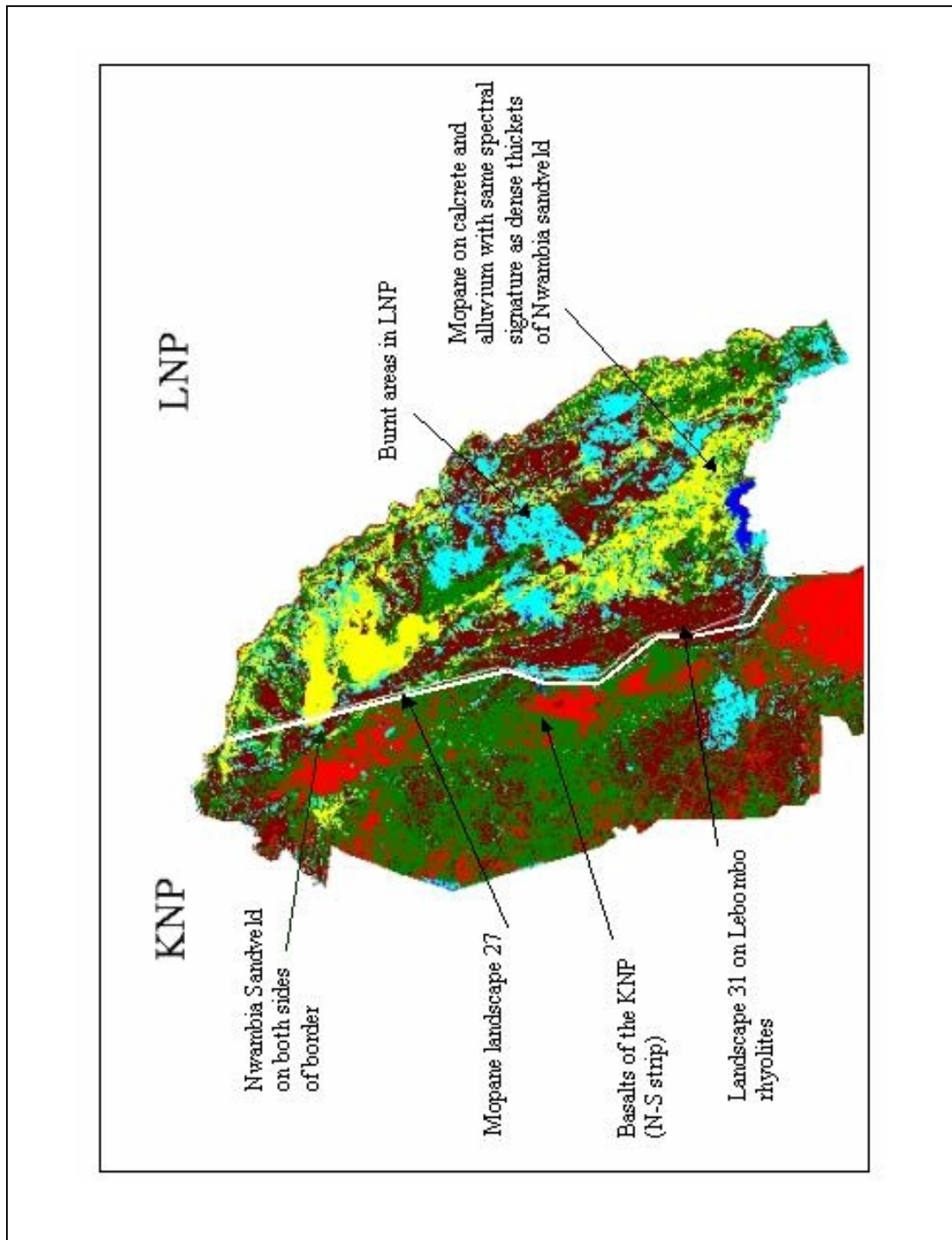
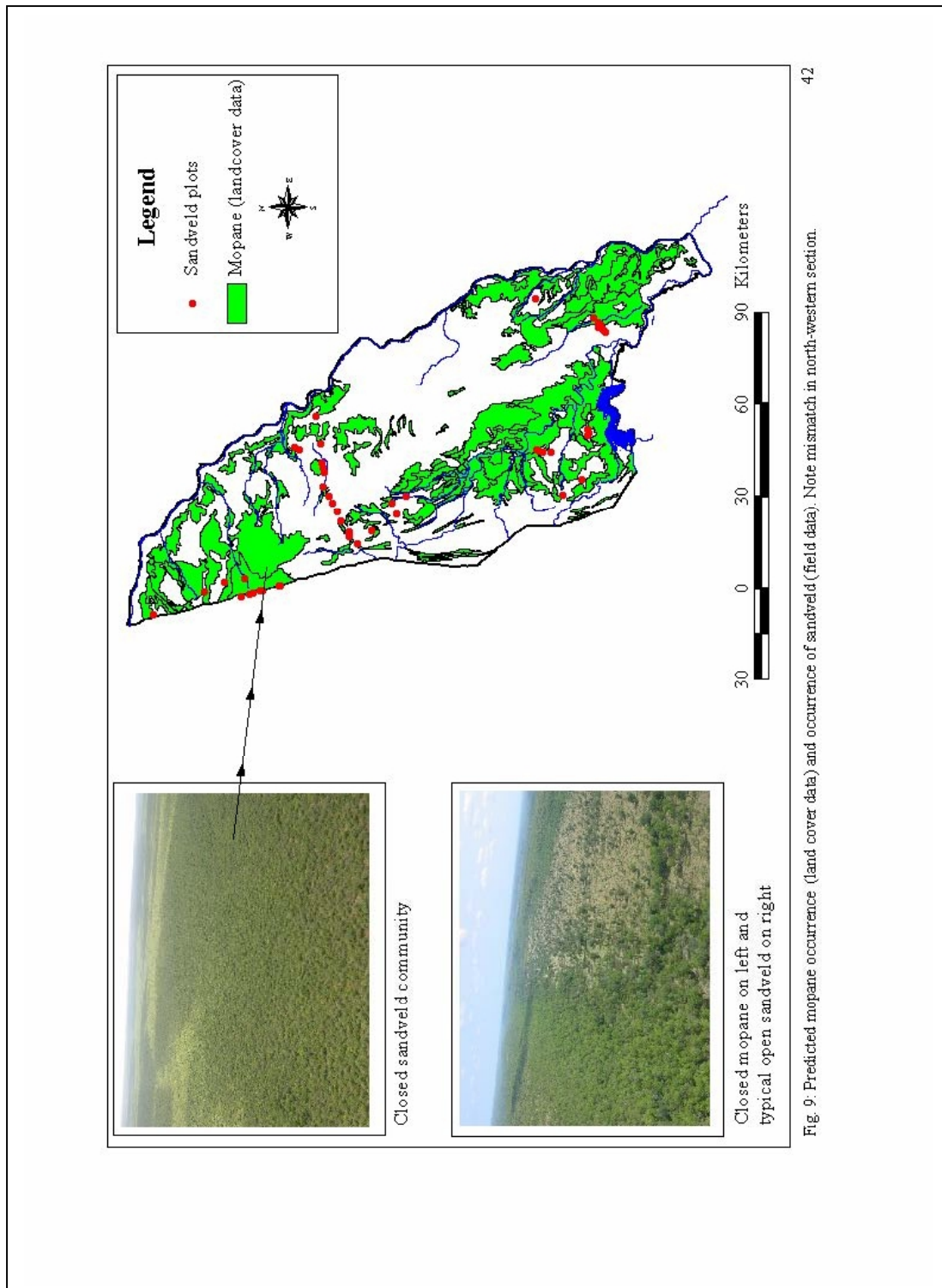


Fig. 8: Supervised classification of LNP and KNP. Note cross-border differences due to dividing Lebombo Mountains. Note presence of sand on LNP side and presence of basalts and granites on KNP side.



## 6.2. Delineation of landscapes

The less than perfect results obtained through the different classification and mapping techniques therefore necessitated a different approach for the delineation of landscapes. The existing classification of the KNP into landscapes was assessed to determine which of those are likely to occur in the LNP based on the understanding gained into the LNP from the ordination and from the classification into communities.

Based on this assessment, the LNP is likely made up of the following 10 landscapes that can be combined in a number of landscape alliances (as defined by Solomon *et al.* 1999):

- Recent sand plains (Landscape alliance no. 17)
  - Nwambia Sandveld (Landscape no. 32)
  - Pumbe Sandveld (Landscape no. 30)
- Calcitic plains with *C. mopane* shrub savanna (Landscape alliance no. 15)
  - *Adansonia digitata* / *Colophospermum mopane* Rugged veld (Landscape no. 25)
  - *Colophospermum mopane* shrubveld on calcrete (Landscape no. 26)
- Basaltic or gabbroic plains with *C. mopane* bush or shrub savanna (Landscape alliance no. 13)
  - *Combretum* spp. / *Colophospermum mopane* Rugged Veld (Landscape no. 22)
  - *Colophospermum mopane* shrubveld on basalt (Landscape no. 23)
- Basaltic plains or rhyolitic mountains with *C. apiculatum* or *C. mopane* bush savanna plains (Landscape alliance 14)
  - Mixed *Combretum* spp. / *Colophospermum mopane* Woodland (Landscape no. 27)
  - Lebombo North (Landscape no. 31)
- Alluvial plains with *Faidherbia albida* or *Salvadora angustifolia* tree savanna (Landscape alliance no. 16)
  - Limpopo Levubu Floodplains (Landscape no. 28)
  - *Salvadora angustifolia* Floodplains (Landscape no. 35)

These likely landscapes were mapped using a ‘best fit’ approach by combining the results of the supervised and unsupervised classification, the available underlying substrate map and the available land cover map. The units resulting from those approaches were used as guidelines to manually delineate landscapes on the original satellite image.

Because of the fact that there is seldom a definite and visible border between landscapes, but rather a gradient, the map boundaries are drawn subjectively out of necessity (see also Solomon *et al.* 1999 for a similar sentiment). A small extent of landscape 15 *Colophospermum mopane* Forest is found on the north-western border with the KNP. Its occurrence within the LNP could not be confirmed due to the difficult accessibility of this area. This landscape was ignored because of its very small extent if occurring in the LNP.

The outcome of the mapping is depicted in Fig. 10 and 11. It is clear that the KNP and LNP might harbour the same landscapes, but their relative cover is very different. In particular, the sandveld landscapes and the mopane on calcrete are much more widespread in the LNP (Table 2). These landscapes cover 10 to 30 times larger areas in the LNP. This has important implications in that the LNP contributes in its own right to the conservation value of the Transfrontier Conservation Area. Management strategies for the LNP and KNP individually and jointly need to take into account the different proportional make-up of both areas in terms of their landscapes. Neither one of the areas is an ‘extension’ of the other. The KNP and LNP clearly complement each other.

Table 2: Surface area of the common landscapes of the KNP and LNP.

Landscapes	KNP (ha)	LNP (ha)	LNP as % of KNP
22	80,736	69,911	86.6
23	199,918	271	0.1
25	32,304	1,219	3.8
<b>26</b>	10,716	415,890	3881
27	33,131	10,576	31.9
28	9,571	17,292	180.7
<b>30</b>	2,548	25,608	1004.9
31	55,470	39,878	71.9
<b>32</b>	15,789	458,642	2904
35	16,656	76,692	460.4

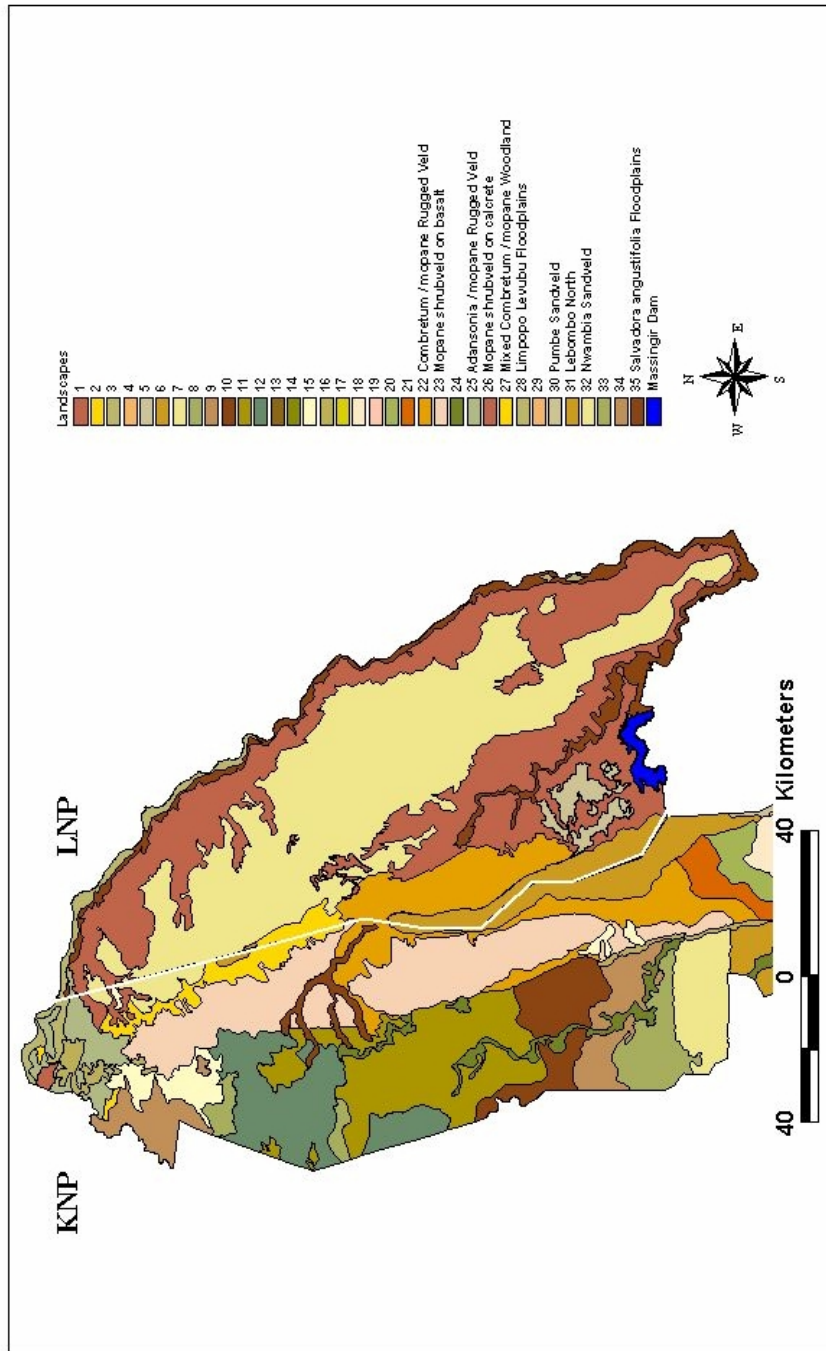


Fig. 10. Landscapes of the LNP and KNP. Note dominance of Nwambila Sandveld (landscape 32) and Mopane on calcrete (landscape 26) in the LNP (only landscapes common to both the KNP and LNP are named in the legend).

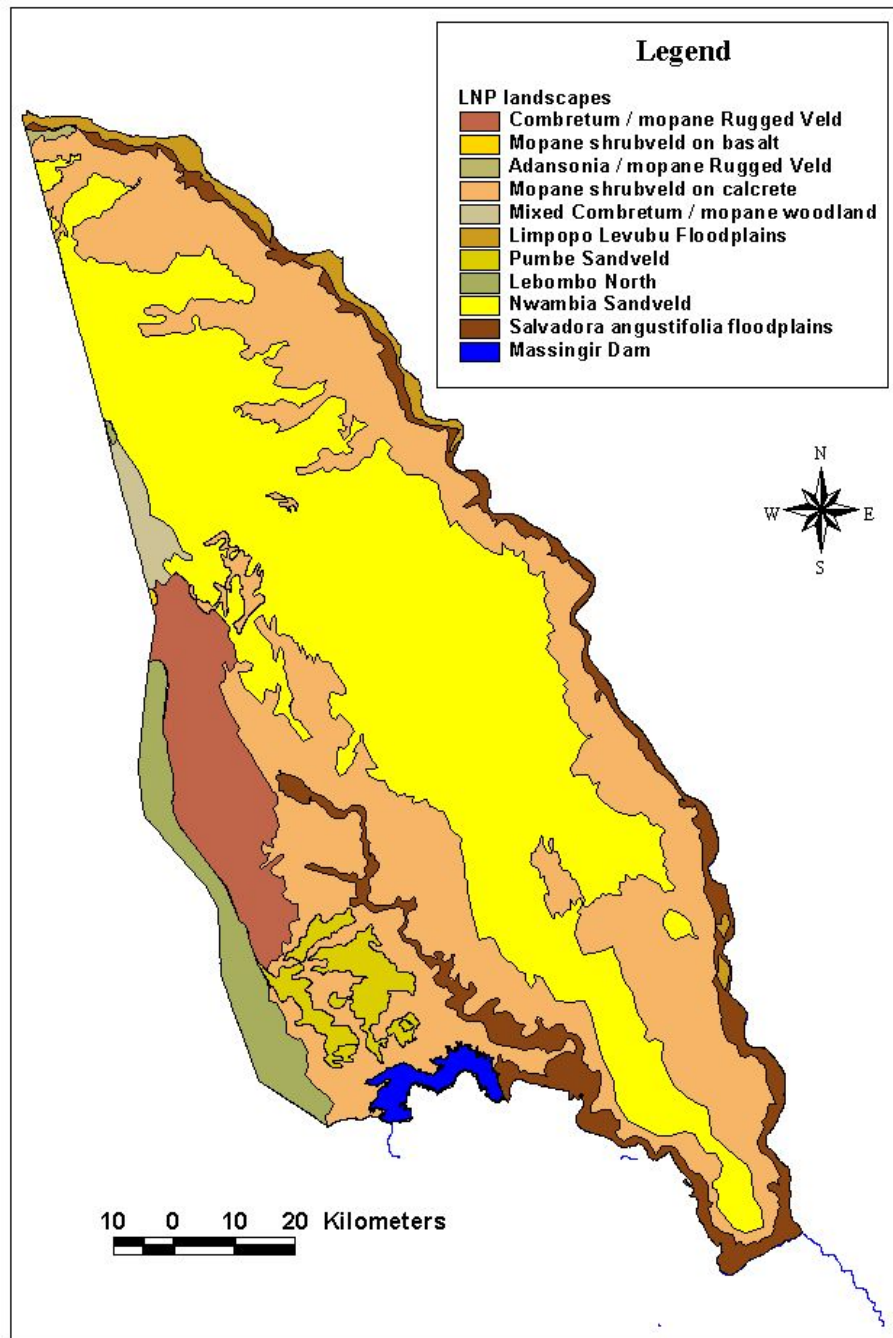


Fig. 11: Landscapes of the LNP.

As the sandveld landscapes clearly constitute the most important feature of the LNP, it is important to know what value can be attached to the landscape map. A probability rating (0-1 = low, 2-3 = medium high, 4 = very high likelihood of correct classification) was derived by scoring all polygons from the land cover map that fell within landscapes 30 and 32 (see Fig. 11) as follows:

- Sandy substrate and 'no mopane' vegetation in land cover map = +2
- Sandy substrate and 'mopane' vegetation in land cover map = +1
- No sandy substrate and 'no mopane' vegetation = +1
- No sandy substrate and 'mopane' vegetation = 0

To the above scores a value of +2 was added if a sandveld sample plot was located within the map polygon and a value of +1 was subtracted if a mopane sample plot was located in the polygon. Scores therefore ranged from 0 to 4. A large area in the centre of the LNP has a 'Medium High' rating due to the poor access that prevented sampling in this area (Fig. 12). Further field work will very likely confirm that most of this area indeed consists of sandveld.



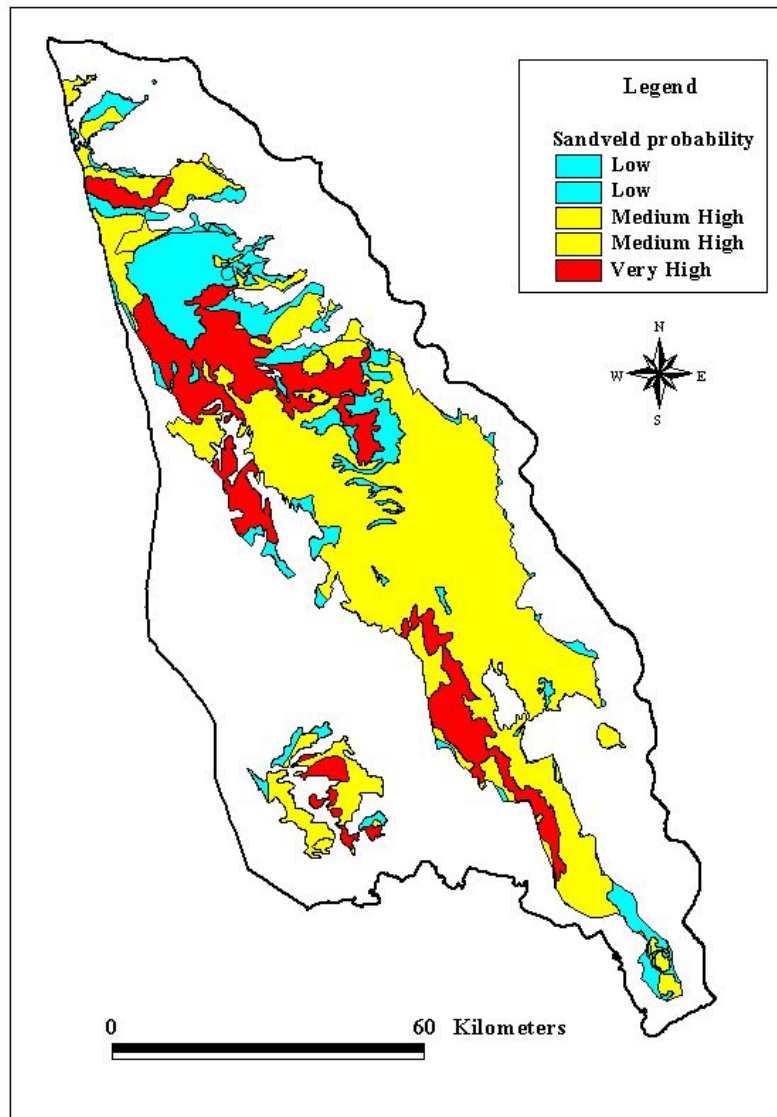


Fig. 12: Likelihood of correct classification of sandveld landscape.



### 6.3. Description of landscapes

- Nwambia Sandveld (Landscape no. 32)
  - Approximately 458,641 ha (41.1% of LNP),
  - Stretches from the north-western border with the KNP in a south-easterly direction down towards the confluence of the Limpopo and Elefantas,
  - On sandy substrate, including deep red soils of the red sandy mantle dunes of the interior. A characteristic of the geomorphology is an absence of well defined drainage channels and the presence of a variety of pans (Gertenbach 1983).
  - Plant community make-up (in descending order of importance);
    - Community 3: *Terminalia sericea* – *Eragrostis pallens* low woodland
    - Community 4: *Combretum apiculatum* – *Pogonarthria squarrosa* low woodland
    - Community 2: *Baphia massaiensis* – *Guibourtia conjugata* low thickets
    - Small and large patches of Community 1: *Androstachys johnsonii* – *Guibourtia conjugata* short forest, embedded in the previous communities,
    - Community 6: *Colophospermum mopane* – *Panicum maximum* short woodland (sandy variant)
    - Community 15: *Paspalidium obtusifolium* – *Cynodon dactylon* grassland in and around pans.
  
- Pumbe Sandveld (Landscape no. 30)
  - Approximately 25,608 ha (2.3% of LNP),
  - In south-western section of the LNP, to the north-west of Massingir Velho,
  - On sandy substrate,
  - Plant community make-up;
    - Community 3: *Terminalia sericea* – *Eragrostis pallens* low woodland
    - Community 4: *Combretum apiculatum* – *Pogonarthria squarrosa* low woodland
    - Community 6: *Colophospermum mopane* – *Panicum maximum* short woodland (sandy variant)
  - Very similar to Nwambia Sandveld but closer proximity to Pumbe, contact with rhyolites, and likely slightly higher rainfall suggest a closer affinity with the Pumbe Sandveld than with Nwambia. Recommended local name for LNP might be ‘Massingir Velho Sandveld’.

- *Adansonia digitata* / *Colophospermum mopane* Rugged Veld (Landscape no. 25)
  - Approximately 1,219 ha (0.1% of LNP),
  - In extreme north-western part of LNP at Pafuri (Fig. 13),
  - On rocky hill slopes (basalts and calcrete). Low annual rainfall (<450 mm). Shallow, calcareous soils with a reasonable amount of clay.
  - Plant community make-up;
    - Community 8: *Kirkia acuminata* – *Combretum apiculatum* tall woodland
    - Community 9: *Terminalia prunioides* – *Grewia bicolor* thicket
    - Community 6: *Colophospermum mopane* – *Panicum maximum* short woodland (calcrete variant)



Fig. 13: Hills of the Pafuri area (Landscape no. 25) with mixture of communities 8 and 6.

- *Colophospermum mopane* shrubveld on calcrete (Landscape no. 26)
  - Approximately 415,890 ha (38.8% of LNP),
  - Distributed along north-south lines above Limpopo Valley, and on both sides of Shingwedzi Valley.
  - On sedimentary footslopes and ravines with calcareous pebblebeds. Shallow and calcareous soils.
  - Plant community make-up;
    - Community 6: *Colophospermum mopane* – *Panicum maximum* short woodland (calcrete variant),
    - Community 7: *Colophospermum mopane* - *Combretum imberbe* tall shrubland

- Community 9: *Terminalia prunioides* – *Grewia bicolor* thicket
  - Community 14: *Sporobolus consimilis* – *Setaria incrassata* tall grassland on the pans found in the mopane.
  - patches of Community 1: *Androstachys johnsonii* – *Guibourtia conjugata* short forest, mainly on steep slopes falling towards Massingir Dam,
  
- *Combretum* spp. / *Colophospermum mopane* Rugged Veld (Landscape no. 22)
  - Approximately 69,911 ha (6.21% of LNP),
  - Distributed north and south of the Shingwedzi as it enters the LNP from the KNP.
  - Relatively shallow soils, with skeletal soils on the Lebombo rhyolites of the koppies and slopes with deeper, clayey soils in the low-lying areas.
  - Plant community make-up;
    - Community 8: *Kirkia acuminata* – *Combretum apiculatum* tall woodland
    - Community 7: *Colophospermum mopane* - *Combretum imberbe* tall shrubland
    - Community 6: *Colophospermum mopane* – *Panicum maximum* short woodland (rhyolite variant)
    - Typically, the upper rhyolite slopes would carry community 8 (*Kirkia acuminata*-*Combretum apiculatum* tall woodland) whereas the footslope with the vertic clays would consist of community 7 (Fig. 14). An abrupt and drastic increase in both clay and adsorbed cations occurs at the contact between mid- and footslopes in B horizons which is caused by the abrupt transition between sand and clay in this position. The exchangeable cations show a further increase as one proceeds down along some of the longer footslopes (Venter 1990).



Fig. 14: Catenal sequence in Landscape no. 22 with community 8 on upperslope of rhyolite hills and community 7 on footslopes characterised by vertic clays.

- *Colophospermum mopane* shrubveld on basalt (Landscape no. 23)
  - Approximately 271 ha (0.02% of LNP),
  - Extends marginally from the KNP into the LNP north of the Shingwedzi River (see Fig. 10).
  - On basalts that have developed dark colored soils with vertic characteristics.
  - Plant community make-up;
    - Community 7: *Colophospermum mopane* - *Combretum imberbe* tall shrubland
  
- Mixed *Combretum* spp. / *Colophospermum mopane* Woodland (Landscape no. 27)
  - Approximately 10,576ha (0.94% of LNP),
  - Occurs north of the Shingwedzi River between the border with the KNP and the large sandveld expanse to the east.
  - On soils of mixed origin that consists of weathered products of basalt, Quaternary sand and gravel.
  - Plant community make-up;
    - Community 6: *Colophospermum mopane* – *Panicum maximum* short woodland (sand variant)

- Lebombo North (Landscape no. 31)
  - Approximately 39,878 ha (3.5% of LNP),
  - Along the western boundary with the KNP, south of the Shingwedzi River, with a few isolated outcrops north of the river.
  - On shallow soils derived from rhyolite with rocky outcrops. Extremely stony. The erosion pattern leading to right-angled drainage lines is extremely characteristic (Fig. 15).
  - Plant community make-up;
    - Community 5: *Combretum apiculatum* – *Andropogon gayanus* low woodland
    - Community 6: *Colophospermum mopane* – *Panicum maximum* short woodland (rhyolite variant)
    - Community 13: *Plugia dioscurus* – *Setaria incrassata* short grassland as small seepages.
    - Community 8: *Kirkia acuminata* – *Combretum apiculatum* tall woodland



Fig. 15: Typical right-angled drainage pattern of Landscape 31 Lebombo North.

- Limpopo Levubu Floodplains (Landscape no. 28)
  - Approximately 17,292 ha (1.5% of LNP),
  - Upper Limpopo from Pafuri to Mapai.
  - Underlying material is alluvium. Subject to flooding.
  - Plant community make-up (Fig. 16);
    - Community 12: *Acacia xanthophloeia* – *Faidherbia albida* tall forest,
    - Community 14: *Sporobolus consimilis* – *Setaria incrassata* tall grassland in areas that are regularly flooded.
    - Community 15: *Paspalidium obtusifolium* – *Cynodon dactylon* grassland in and around pans.
    - Community 11: *Acacia xanthophloeia* – *Phragmites* sp. woodland in river beds.
    - Community 10: *Acacia tortilis* – *Salvadora persica* short woodland



Fig. 16: Aerial view of Limpopo Levubu Floodplains landscape with riverine forest of community 12 along an oxbow of the Limpopo River and community 14 on the periodically flooded areas.

- *Salvadora angustifolia* Floodplains (Landscape no. 35)
  - Approximately 76,692 ha (6.81% of LNP),
  - Distributed along Shingwedzi River, Limpopo south of Mapai and Elefantes.
  - On alluvium. As a result of the accumulation of salts in the alluvium, the soils of this landscape are usually brackish (Gertenbach 1983). White salt deposits are sometimes detectable on the surface of the soil (Fig. 17).
  - Plant community make-up;
    - Community 10: *Acacia tortilis* – *Salvadora persica* short woodland
    - Community 14: *Sporobolus consimilis* – *Setaria incrassata* tall grassland
    - Community 6: *Colophospermum mopane* – *Panicum maximum* short woodland (alluvium variant)
    - Community 11: *Acacia xanthophloeia* – *Phragmites* sp. woodland in river beds.
    - Community 12: *Acacia xanthophloeia* – *Faidherbia albida* tall forest in isolated pockets (eg along lower Shingwedzi).





Fig. 17: White salt deposits on alluvial flats of the Elefantes, below Massingir Dam. Note circular patches of *Acacia tortilis* – *Salvadora persica* short woodland.

## 7. Plant species of conservation importance

The methodology followed and the scale and intensity of the survey undertaken, precluded a detailed assessment of rare species. Nevertheless the following observations are of interest.

The Red-listed tree *Stadmannia oppositifolia* ssp. *rhodesiaca* was observed on cliffs overlooking the Shingwedzi River in community 8 (*Kirkia acuminata* – *Combretum apiculatum* tall woodland). Nowhere common, this subspecies is found relatively widely on hills in the Zimbabwe lowveld, in adjacent parts of Mozambique, Canicadoa and Rio dos Elefantes, and into Northern Province, South Africa. Records from KwaZulu-Natal need confirmation. (Hilton-Taylor 2000). It is listed as LR/nt which means Lower Risk/near threatened.

The tree *Pterocarpus lucens* ssp. *antunesii* was found in sandveld community 4 (*Combretum apiculatum* – *Pogonarthria squarrosa* low woodland) in the south-eastern section of the LNP. This is considered a very rare tree in the KNP (van Wyk 1973). It is however much more widespread outside South Africa and occurs further north into Africa in the Soudanian savannas of Senegal and Cameroun (Geerling 1982). This species is browsed by game and its status might be affected by increasing numbers of game in the LNP

A host of other species are considered as rare or as typical sandveld species with associated conservation value because of their restricted KNP distribution. It is important to note that the current understanding and value judgement on so-called 'rare sandveld endemics' is largely based on this South African perspective. These species occur in the limited extent of Nwambia Sandveld found in the KNP. Rather than regarding the LNP sandveld as an extension of the Nwambia Sandveld, the appropriate view would be to see the Nwambia Sandveld in the KNP as a small extension of the LNP sandveld across the border. The Nwambia landscape constitutes the single largest landscape of the LNP. Within a true TFCA context, species such as *Hugonia orientalis* and *Pterocarpus lucens* might therefore acquire a very different status compared to their position in the KNP only.

## 8. Plant community and landscape diversity

The available time frame and limited ground coverage did not allow for a detailed inventory of plant diversity. During the survey, more than 240 species were recorded (Appendix A).

A relative measure of plant community diversity can be derived by comparing the total species count to the sampling intensity for each respective community. The species count per community in relation to the expected species number (based on the average accumulated number of species per sample plot) is depicted in Table 3. Sandveld communities 2 (*Baphia massaiensis* – *Guibourtia conjugata* low thickets) and 3 (*Terminalia sericea* – *Eragrostis pallens* low woodland), the rhyolite community 8 (*Kirkia acuminata* – *Combretum apiculatum* tall woodland) as well as the closed formations of community 9 (*Terminalia prunioides* – *Grewia bicolor* thicket) and community 12 (*Acacia xanthophloeia* – *Faidherbia albida* tall forest) are relatively more species-rich than the other communities.

Based on the composition of the landscapes in terms of plant communities it can be expected that Landscape no. 32 (Nwambia Sandveld), Landscape no. 25 (*Adansonia digitata* / *Colophospermum mopane* Rugged Veld) and Landscape no. 31 (Lebombo North) are relatively richer than other landscapes.

These are only preliminary findings and more detailed assessments are required.

Table 3: Relative species richness of plant communities in the LNP.

Community	No. of sample plots	Total species	Expected no. of species	Actual no. as % of expected	Relative diversity
1	3	8	16	48.6	Low
<b>2</b>	5	33	27	120.2	<b>High</b>
<b>3</b>	3	38	16	230.6	<b>High</b>
4	21	85	115	73.7	Low
5	6	35	33	106.2	Medium
6	78	137	428	32.0	Low
7	13	38	71	53.2	Low
<b>8</b>	9	67	49	135.5	<b>High</b>
<b>9</b>	5	49	27	178.4	<b>High</b>
10	13	60	71	84.0	Low
11	6	34	33	103.2	Medium
<b>12</b>	5	46	27	167.5	<b>High</b>
13	1	3	5	54.6	Low
14	4	10	22	45.5	Low
15	3	11	16	66.8	Low

## 9. Land use patterns and their influence on the vegetation of the LNP

### 9.1. Settlements and cultivation

The available landcover data and field surveys confirm that the highest density of people and agricultural activity is found along the Limpopo, Elefantas and Shingwedzi River (Fig. 18). Subsistence cultivation is practiced.

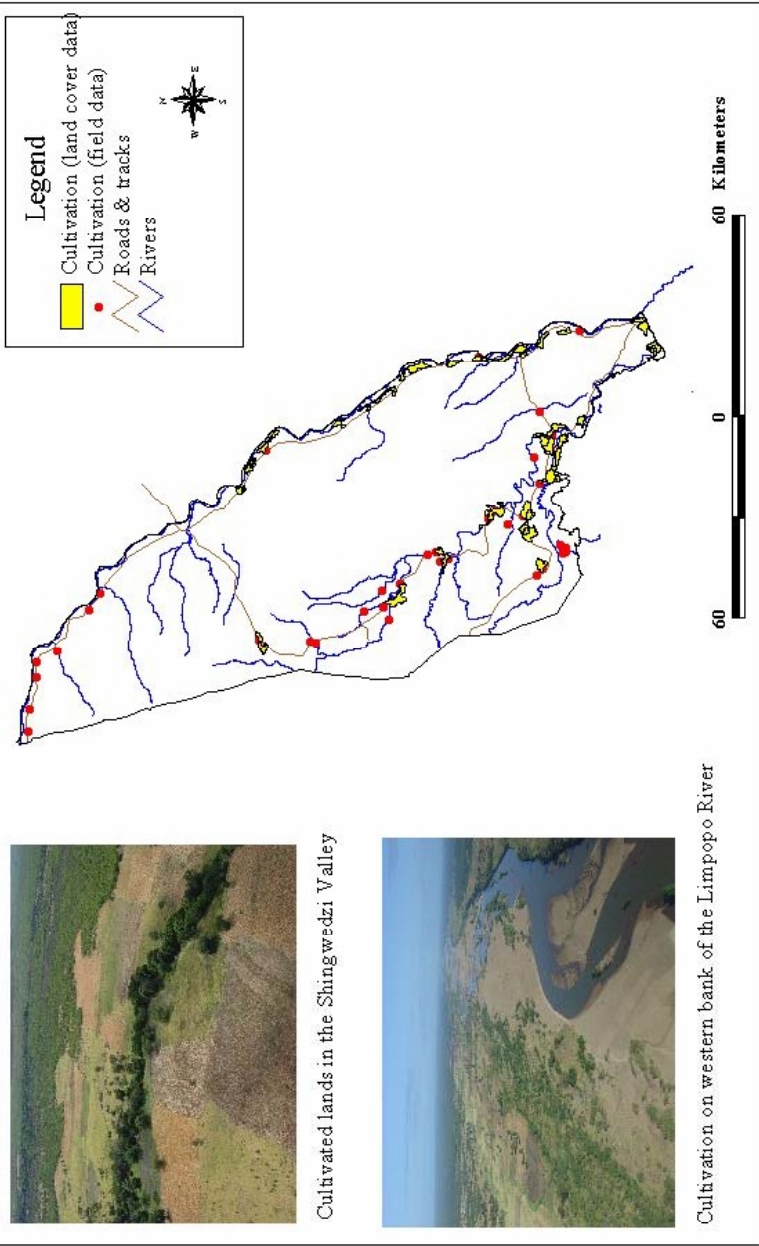
The impact on the vegetation is fairly substantial. According to the land cover data a total of 26,330 ha of land cover units are partly cultivated and/or settled. Using the average percentage transformation within those units an effective 6,795 ha is cultivated. This is likely an underestimate. The more fertile areas on alluvium seem to remain almost permanently under cultivation with only short fallow cycles. Agriculture in less fertile parts of the landscape seems to be more of a shifting nature. Lands are cleared, cultivated for a few years and then abandoned for a long time period.

The abandonment of lands and the fallow cycle result in a number of regeneration states being found throughout the LNP. The most distinct are mopane shrubland following regeneration on cleared mopane woodlands of community 6 (*Colophospermum mopane* – *Panicum maximum* short woodland) and an open woodland with large *Sclerocarya birrea*, *Berchemia discolor*, *Cassia abbreviata*, *Acacia tortilis*, mopane trees and an understorey of *Urochloa mossambicensis* and *Panicum maximum* grass that are the sites of abandoned settlements (Fig. 19). *Dichrostachys cinerea* and *Dalbergia melanoxylon* in association with mopane might also represent regeneration on formerly cultivated areas (Farrell 1968).

Clearing is presently still actively taking place, even in sensitive and species-rich areas such as the riverine forest of community 12 (*Acacia xanthophloeia* – *Faidherbia albida* tall forest) and the sandveld of community 4 (*Combretum apiculatum* – *Pogonarthria squarrosa* low woodland) (Fig. 20).

### 9.2. Herbivory

Levels of herbivory (both grazing and browsing) seem presently very limited in the LNP. Present numbers of game are certainly very low. During nearly 15 hours of low-level flying with a helicopter only some 60 animals were observed. A similar time flying across the KNP would have yielded a total of a several thousand animals. Livestock numbers are also relatively limited. Both cattle and goats were observed. The subjective scoring of the sample plots yielded the following results: subjected to only light grazing pressure 75.4%, medium grazing 16.6%, heavily grazed 8%. The heavily grazed areas are presently located close to the villages (Fig. 21).



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Fig. 18: cultivated and settlement areas in the LNP (land cover data and field data).



Mopane shrubland developing on fallow field originally cleared in mopane woodland of community 6. Note old barrier of cut branches in foreground to prevent access by livestock to the crops.



Large *Sclerocarya birrea* with understorey of *Urochloa mossambicensis* on abandoned settlement site in Shingwedzi Valley. Notice surrounding mopane woodland of community 6.

Fig. 19: Regeneration states following abandonment of cultivated fields and settlement areas in the LNP.





Clearing of fields in the *Acacia xanthophloeia* forest of community 12 near Pafuri.



Clearing of sandveld in south-eastern section of the LNP. Note typical red colour of sandveld soils.



Active clearing of mopane woodland (community 6) in Shingwedzi Valley. Note existing maize field on left of picture.

Fig. 20: Clearing of lands taking place in the LNP (2002).



Heavy grazing of sandveld community 4 in sandveld near Massingir Velho village.



Heavy grazing on abandoned settlement site near Mavodse (mopane woodlands of community 6 – calcrete variant).



Heavily hedged shrub through browsing by livestock in the Shingwedzi Valley. Note *Panicum maximum* that escapes grazing within the canopy of the shrub compared to the stems grazed down to groundlevel outside the shrub canopy.

Fig. 21: Herbivory in the LNP.

### 9.3. Alien plants

In 1997 during a management review on biodiversity conservation in KNP, alien plants were officially recognised as the greatest threat to the biodiversity of the KNP ([http://www.parks-sa.co.za/frames.asp?mainurl=parks/national\\_parks.html](http://www.parks-sa.co.za/frames.asp?mainurl=parks/national_parks.html)). Invasions have occurred as a result of the spread of plants from gardens and restcamps within the KNP, and also due to dispersal along the major river systems entering the park, all of which arise outside the KNP.

The LNP, being situated downstream from the KNP, is therefore much at risk from alien plants. The most serious invaders in the KNP include *Chromolaena odorata*, (so far not found north of the Sabie River, but could become a threat in the Lebombo Mountains), *Lantana camara*, *Opuntia stricta*, *Ricinus communis* and *Senna* spp.

During the present vegetation survey the following invasive alien species were observed: *Nicotiana glauca* (on banks of Massingir Dam), *Parkinsonia aculeata* (in Limpopo floodplain near Pafuri), *Ricinus communis* (along Limpopo River near Mapai), *Agave* sp. (proposed Ngwenya development site on upper Shingwedzi), and *Xanthium strumarium* (riverine areas). The Limpopo River near Pafuri more than likely is infested by the following waterweeds; *Pistia stratiotes*, *Salvinia molesta* and *Azolla filiculoides* which are all found in the Limpopo River within the KNP (David Zeller, pers. comm. 2002).

The history of invasion in the KNP originating from restcamps provides a clear warning that existing settlement areas should be scouted for potentially dangerous invasive species, before they escape from these areas and become difficult and expensive to control.

### 9.4. Use of other plant resources

No formal assessment was made, but much use is clearly made of trees for the building of dwellings, livestock pens, fuel wood and carving of various items. The impact of these activities is selective. Whereas this use does not seem to impact significantly on the overall woody resource, no data are available on the impact on specific species. Grass is cut and used for thatching (mostly *Themeda triandra*). Much use is made of medicinal plants and wild fruits. No data are available regarding the impact thereof on specific species.

### 9.5. Fire pattern

Fires are very prominent within the LNP with signs of old and recent fire events visible throughout the landscape. Although a number of fires must originate through lightning, the most probable cause of fire is through the activities of the inhabitants of the LNP (clearing of lands, producing a green flush for livestock grazing, smoking out of beehives etc.) (Fig. 22).





Recently burnt mopane woodlands (Shingwedzi Valley)(April 2002).



Pacha burn on the rhyolite communities of the Lebombo Mountains. Note strong pattern induced by underlying drainage pattern (see Fig. 13).



Burnt *Androstachys* thicket in sandveld near Buarinhama Pan. The trees probably died as a result of drought, resulting in an invasion by graminoids that provided the fuel for the subsequent fire.

Fig. 22: Fire pattern in the LNP.

Within the constraints of the present study it was not possible to assess the fire return period and its appropriateness. Of interest is the relatively small-scale pattern that can be observed in the field. This is confirmed by satellite imagery (Fig. 23). This small-scale pattern as opposed to a larger scale pattern often found in formally managed Protected Areas is typical of communal areas. This pattern is likely beneficial for the maintenance of diversity (Stalmans *et al.* in prep.).

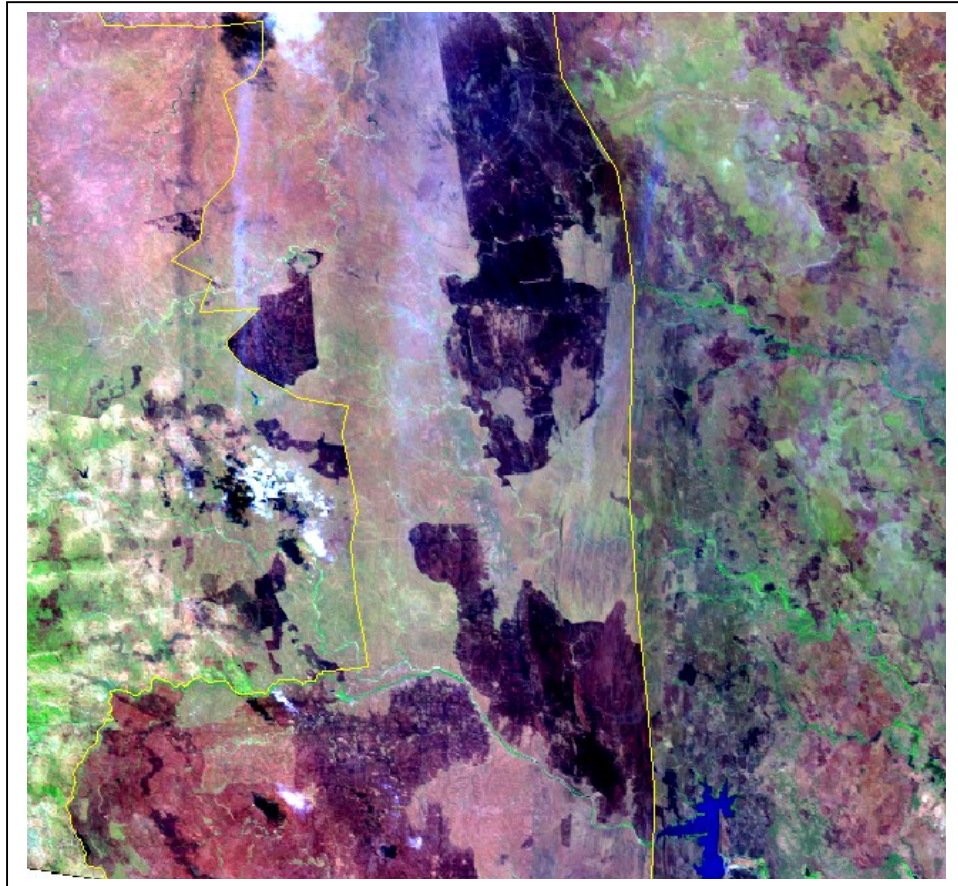


Fig. 23: Difference in fire pattern between the KNP and the Mocambican woodlands. Note small-scale pattern on right hand side of image within Mocambique, whereas a much larger scale pattern can be observed within the KNP (JPEG image derived from Landsat satellite image – courtesy of Dr H Biggs, SanParks).

## 10. Limitations and recommendations

The superficial nature of this study and the resulting lack of groundtruthing as to actual plant community and landscape extent must be put in perspective when compared with the KNP where the first vegetation descriptions and map were already generated during the 1950's. The survey was limited in terms of available time and resources. The sampling data and subsequent interpretation resulted from only 15 days in the field. Experience in the southwest United States indicates that cover-type maps over wide areas (> 100,000 ha) at reasonable scales (1:100,000 or finer) can take anywhere from 3 to 5 years to complete with a modicum of accuracy. They can quickly become expensive (US \$ 0.40 - \$ 2.00 per ha) (Muldavin *et al.* 2001).

Poor accessibility to in particular the main sandveld landscape resulted in an uneven coverage of the study area. Although it is believed that the main pattern of vegetation has been adequately captured, the landscape map needs to be refined. Recommendations for further vegetation work include:

- a similar ground assessment of the NW-SE sandveld spine of the LNP. This could take the form of a traverse on foot along the diagonal from Pafuri to the confluence of the Limpopo and the Elefantas. This traverse could be broken down in sections and should be undertaken by a small, fit team that includes a trained botanist/ecologist.
- Use aerial and/or ground assessment of so-called mopane units (according to the 1/250,000 land cover map) and other polygons that received a low probability score in the Nwambia Sandveld to establish their true character
- Establish true position of interface between landscapes 31 and 22 on the rhyolites,
- Initiate studies on fence-line contrasts on the western border of the LNP with the KNP as early as possible to capture the effects of differential fire management and stocking rates. Such fence-line contrasts potentially have great information value but might disappear within the TFCA context,
- Long-term monitoring programmes on vegetation structure, composition and condition should be initiated to assess the effects of changes in management regime, land use pattern and increase in game numbers..



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## APPENDIX A: PRELIMINARY CHECK-LIST OF THE FLORA OF THE LIMPOPO NATIONAL PARK.

### 1. Introduction

The preliminary check-list holds names of the more than 240 species recorded during the 2002 survey within the Limpopo National Park. Identifications were obtained through field knowledge and use of existing literature. In addition, a number of specimens were identified by Mervyn Lotter, Ernst Schmidt, Warren McClelland, Gwin Zambatis and Nick Zambatis. Plant names follow Arnold & de Wet (1993). More recent name changes follow Retief & Herman (1997). An asterisk (\*) denotes an alien invasive species.

### 2. Check-list

#### Arecaceae

*Hyphaene natalensis* Kunze  
*Phoenix reclinata* Jacq.

#### Asphodelaceae

*Aloe marlothii* Berger

#### Dracaenaceae

*Sansevieria pearsonii* N.E. Br.

#### Amaryllidaceae

\* *Agave* sp.

#### Moraceae

*Ficus abutilifolia* (Miq.) Miq.  
*F. sycomorus* L. ssp. *sycomorus*  
*Maclura africana* (Bur.) Corner

#### Urticaceae

*Pouzolzia mixta* Solms

#### Olacaceae

*Olax dissitiflora* Oliv.  
*Ximenia americana* L.  
*X. caffra* Sond. var. *caffra*

## Annonaceae

*Artabotrys* sp. cf. *A. brachypetalus* Benth.  
*Cleistochlamys kirkii* (Benth.) Oliv.  
*Monodora junodii* Engl. & Diels  
*Uvaria gracilipes* N. Robson

## Capparaceae

*Boscia foetida* Schinz.  
*B. mossambicensis* Klotzsch  
*Cadaba natalensis* Sond.  
*Capparis tomentosa* Lam.  
*Maerua angolensis* DC.  
*M. edulis* (Gil. & Ben.) Dewolf  
*M. juncea* Pax. ssp. *crustata* (Wild) Wild  
*Thilachium africanum* Lour.

## Fabaceae

*Acacia burkei* Benth.  
*A. erubescens* Welw. ex Oliv.  
*A. exuvialis* Verdoorn  
*A. gerrardii* Benth. var. *gerrardii*  
*A. grandicornuta* Gerstn.  
*A. karroo* Hayne  
*A. nigrescens* Oliv.  
*A. nilotica* (L.) Willd. ex Del. ssp. *kraussiana* (Benth.) Brenan  
*A. robusta* Burch. ssp. *robusta*  
*A. schweinfurthii* Brenan & Exell var. *schweinfurthii* River  
*A. senegal* (L.) Willd.  
*A. tortilis* (Forssk.) Hayne subsp. *heteracantha* (Burch.) Brenan  
*A. welwitschii* Oliv. ssp. *delagoensis* (Harms) Ross & Brenan  
*A. xanthophloea* Benth.  
*Afzelia quanzensis* Welw.  
*Albizia anthelmintica* (A. Rich.) Brongn.  
*A. brevifolia* Schinz  
*A. forbesii* Benth.  
*A. petersiana* (Bolle) Oliv. ssp. *evansii* (Burt Davy) Brenan  
*Baphia massaiensis* Taub. ssp. *obovata* (Schinz) Brummitt var. *obovata*  
*Cassia abbreviata* Oliv.  
*Colophospermum mopane* (Kirk ex Benth.) Kirk ex J. Leonard  
*Dalbergia melanoxydon* Guill. & Perr.  
*Dichrostachys cinerea* (L.) Wight & Arn. ssp. *nyassana* (Taub.) Brenan  
*Elephantorrhiza goetzei* (Harms) Harms ssp. *goetzei*  
*Faidherbia albida* (Delile) A. Chev.  
*Guibourtia conjugata* (Bolle) J. Leonard  
*Lonchocarpus capassa* Rolfe  
*Mundulea sericea* (Willd.) A. Chev.

*Newtonia hildebrandtii* (Vatke) Torre var. *hildebrandtii*  
*Ormocarpum kirkii* S. Moore  
*O. trichocarpum* (Taub.) Engl.  
\* *Parkinsonia aculeata* L.  
*Peltophorum africanum* Sond.  
*Pterocarpus lucens* Guill. & Perr. ssp. *antunesii* (Taub.) Rojo  
*P. rotundifolius* (Sond.) Druce  
*Schotia capitata* Bolle  
*Senna persiana* (Bolle) Lock  
*Sesbania* sp.  
*Xanthocercis zambesiaca* (Bak.) Dumaz-le-Grand  
*Xerroderris stuhlmannii* (Taub.) Mendonca & E.P. Sousa

#### Linaceae

*Hugonia orientalis* Engl.

#### Balanitaceae

*Balanites maughamii* Sprague  
*B. pedicellaris* Mildbr. & Schltr.

#### Rutaceae

*Teclea pilosa* (Engl.) Verdoorn  
*Toddaliopsis bremekampii* Verdoorn  
*Zanthoxylum capense* (Thunb.) Harv.

#### Simaroubaceae

*Kirkia acuminata* Oliv.

#### Burseraceae

*Commiphora edulis* (Klotzsch) Engl.  
*C. glandulosa* Schinz  
*C. mollis* (Oliv.) Engl.  
*C. schimperi* (O. Berg.) Engl.  
*C. tenuipetiolata* Engl.

#### Ptaeroxylaceae

*Ptaeroxylon obliquum* (Thunb.) Radlk.

#### Meliaceae

*Trichilia emetica* Vahl

#### Euphorbiaceae



*Acalypha pubiflora* Baill.  
*Androstachys johnsonii* Prain  
*Bridelia mollis* Hutch.  
*Cleistanthus schlechteri* (Pax) Hutch. var. *schlechteri*  
*Croton gratissimus* Burch. var. *gratissimus*  
*C. madandensis* S. Moore  
*C. megalobotrys* Mull. Arg.  
*C. pseudopulchellus* Pax  
*Drypetes mossambicensis* Hutch.  
*Euphorbia cooperi* N.E. Br. ex Berger var. *cooperi*  
*E. grandicornis* Goebel ex N.E. Br. ssp. *grandicornis*  
*E. ingens* E. Mey. ex Boiss.  
*E. tirucalli* L.  
*Hymenocardia ulmoides* Oliv.  
*Phyllanthus reticulatus* Poir.  
*Pseudolachnostylis maprouneifolia* Pax  
 \* *Ricinus communis* L.  
*Flueggea virosa* (Roxb. ex Willd.) Pax & K. Hoffm.  
*Spirostachys africana* Sond.

#### Anacardiaceae

*Lanea schweinfurtii* (Engl.) Engl. var. *stuhlmannii* (Engl.) Kokwaro  
*Ozoroa engleri* R. & A. Fernandes  
*Rhus* sp. cf. *R. pyroides* Burch.  
*R.* sp. cf. *R. tenuinervis* Engl.  
*Sclerocarya birrea* (A. Rich.) Hochst. ssp. *caffra* (Sond.) Kokwaro

#### Celastraceae

*Cassine aethiopica* Thunb.  
*C. transvaalensis* (Burt Davy) Codd  
*Gymnosporia pubescens* (Robson) M. Jordaan  
*G. oxycarpa* (N. Robson) M. Jordaan  
*G. senegalensis* (Lam.) Exell  
*Hippocratea crenata* (Klotzsch) K. Schum. & Loes.  
*H. indica* Willd.  
*Maytenus putterlickioides* (Loess.) Exell & Mendonça

#### Sapindaceae

*Lecaniodiscus fraxinifolius* Baker  
*Pappea capensis* Eckl. & Zeyh.  
*Stadmannia oppositifolia* (Lam.) Poir. ssp. *rhodesica* Exell

#### Rhamnaceae

*Berchemia discolor* (Klotzsch) Hemsl.  
*Ziziphus mucronata* Willd. ssp. *mucronata* Buffalo-thorn

## Vitaceae

*Cissus cornifolia* (Bak.) Planch.  
*C. quadrangularis* L.  
*Rhoicissus digitata* (L.f.) Gil & Brandt

## Tiliaceae

*Gossypium herbaceum* L. ssp. *africanum* (Watt) Vollesen  
*Grewia bicolor* Juss.  
*G. flavescens* Juss.  
*G. hexamita* Burret  
*G. monticola* Sond.  
*G. sulcata* Mast.  
*G. villosa* Willd.

## Bombacaceae

*Adansonia digitata* L.

## Sterculiaceae

*Sterculia rogersii* N.E. Br.

## Ochnaceae

*Ochna barbosa* N.K.B. Robson  
*Ochna* sp.

## Clusiaceae

*Garcinia livingstonei* T. Anders.

## Passifloraceae

*Adenia spinosa* Burt Davy

## Combretaceae

*Combretum apiculatum* Sond. ssp. *apiculatum*  
*C. celastroides* Welw. Ex. Laws.  
*C. collinum* Fresen.  
*C. erythrophyllum* (Burch.) Sond.  
*C. hereroense* Schinz  
*C. imberbe* Wawra  
*C. mkuzense* Carr & Retief  
*C. microphyllum* Klotzsch  
*C. mossambicense* (Klotzsch) Engl.  
*C. zeyheri* Sond.  
*Pteleopsis myrtifolia* (Laws.) Engl. & Diels

*Terminalia phanerophlebia* Engl. & Diels  
*T. prunioides* Laws.  
*T. sericea* Burch. ex DC.

Sapotaceae

*Manilkara mochisia* (Bak.) Dubard

Ebenaceae

*Diospyros lycioides* Desf.  
*D. mespiliformis* Hochst. ex A. DC.  
*Euclea divinorum* Hiern  
*E. schimperi* (A. DC.) Dandy

Salvadoraceae

*Azima tetracantha* Lam.  
*Salvadora australis* Schweick.  
*S. persica* L.

Loganiaceae

*Nuxia oppositifolia* (Hochst.) Benth.  
*Strychnos decussata* (Pappe) Gilg  
*S. henningsii* Gilg.  
*S. madagascariensis* Poir.  
*S. potatorum* L.f.  
*S. spinosa* Lam.

Apocynaceae

*Carissa bispinosa* (L.) Desf. Ex Brenan  
\* *Catharanthus roseus* (L.) G. Don.  
*Tabernaemontana elegans* Stapf

Boraginaceae

*Cordia grandicalyx* Oberm.  
*Ehretia amoena* Klotsch

Verbenaceae

*Vitex* sp.

Solanaceae

\* *Nicotiana glauca* R.C. Grah.

Bignoniaceae

*Kigelia africana* (Lam.) Benth.  
*Markhamia acuminata* (Klotzsch) K. Schum.  
*Rhigozum zambesiicum* Bak.

#### Acanthaceae

*Anisotes rogersii* S. Moore

#### Rubiaceae

*Canthium frangula* S. Moore  
*Gardenia resiniflua* Hiern ssp. *resiniflua*  
*G. volkensii* K. Schum.  
*Heinsia crinita* (Afzel.) G. Tayl. ssp. *parviflora* (K. Schumach. & Krause) Verdc.  
*Hymenodictyon parvifolium* Oliv. ssp. *parvifolium*  
*Lagynias* sp.  
*Psydrax locuples* (K. Schumach) Bridson  
*Pyrostria hystrix* (Brem.) Bridson  
*Tricalysia junodii* (Schinz) Brenan  
*Vangueria infausta* Burch. ssp. *infausta*

#### Asteraceae

*Brachylaena huillensis* O. Hoffm.  
*Pluchea dioscoridis* (L.) DC.  
\* *Xanthium strumarium* L.

#### Poaceae

*Acroceras macrum* Stapf  
*Andropogon gayanus* Kunth var. *polycladus* (Hack.) Clayton  
*Antephora pubescens* Nees  
*Aristida adscensionis* L.  
*A. congesta* Roem. & Schult.  
*A. stipitata* Hack.  
*Bothriochloa radicans* (Lehm.) A. Camus  
*B. sp. cf. B. insculpta* (A. Rich.) A. Camus  
*Brachiaria deflexa* (Schumach.) C.E. Hubb. ex Robyns  
*B. nigropedata* (Fical. & Hiern) Stapf  
*Cenchrus ciliaris* L.  
*Chloris gayana* Kunth  
*C. roxburghiana* Schult.  
*Cymbopogon excavatus* (Hochst.) Stapf ex Burt Davy  
*Cynodon dactylon* (L.) Pers.  
*Dactyloctenium aegyptium* (L.) Willd.  
*D. giganteum* Fisher & Schweick.  
*Danthaniopsis sp. cf. pruinosa* C.E. Hubb.  
*Digitaria eriantha* Steud.  
*Echinochloa colona* (L.) Link

*Enneapogon cenchroides* (Roem. & Schult.) C.E. Hubb.  
*E. scoparius* Stapf.  
*Enteropogon monostachyos* (Vahl) K. Schum. ssp. *africanus* Clayton  
*Eragrostis cylindriflora* Hochst.  
*E. gummiflua* Nees  
*E. heteromera* Stapf  
*E. lehmanniana* Nees var. *lehmanniana*  
*E. pallens* Hack.  
*E. rigidior* Pilg.  
*E. superba* Peyr.  
*E. sp. cf. E. trichophora* Coss. & Dur.  
*Eriochloa meyeriana* (Nees) Pilg. ssp. *meyeriana*  
*Fingerhuthia africana* Lehm.  
*Heteropogon contortus* (L.) Roem. & Schult.  
*H. melanocarpus* (Ell.) Benth.  
*Ischaemum afrum* (J.F. Gmel.) Dandy  
*Leptocarydion vulpiastrum* (De Not.) Stapf  
*Melinis repens* (Willd.) Zizka ssp. *repens*  
*Microchloa caffra* Nees  
*Panicum deustum* Thunb.  
*P. maximum* Jacq.  
*Paspalum* sp.  
*Perotis patens* Gand.  
*Phragmites* sp.  
*Pogonarthria squarrosa* (Roem. & Schult.) Pilg.  
*Schmidtia pappophoroides* Steud.  
*Setaria incrassata* (Hochst.) Hack.  
*S. sagittifolia* (A. Rich.) Walp.  
*Sorghum* sp.  
*Sporobolus consimilis* Fresen  
*S. ioclados* (Trin.) Nees  
*S. nitens* Stent.  
*S. panicoides* A. Rich.  
*S. pyramidalis* Beauv.  
*Paspalidium obtusifolium* (Walt.) Kuntze  
*Stipagrostis uniplumis* (Licht.) De Winter  
*Themeda triandra* Forssk. Redgrass  
*Tragus berteronianus* Schult.  
*Tricholaena monachne* (Trin.) Stapf & C.E. Hubb.  
*Urochloa mosambicensis* (Hack.) Dandy

### 3. References

- Arnold T.H. & de Wet B.C. 1993. Plants of southern Africa: names and distribution. National Botanical Institute, Pretoria.
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