Vegetation description and mapping along a strip transect in central Namibia with the aid of satellite imagery.

by

MARIANNE MARGARETHE STROHBACH

Submitted in partial fulfilment of the requirements for the degree

MAGISTER SCIENTIAE

in the Department of Botany, Faculty of Natural & Agricultural Science

University of Pretoria

December 2002

Supervisor: Prof. Dr. G.J. Bredenkamp

ABSTRACT

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Long-term vegetation monitoring and effective land-use planning and -management in Namibia is currently hampered by a lack of ecological data available on different vegetation types. The Vegetation Survey Project of Namibia, together with BIOTA Southern Africa, aims to progressively re-classify the Namibian vegetation which has thus far only been sketchily described by the Preliminary Vegetation Map of Namibia of 1971 and the Homogenous Farming Areas Report of 1979.

Vegetation along a strip transect traversing mainly the Thornbush Savanna of Namibia was classified and characterised by subjecting 467 samples, distributed over a 30 x 320 km transect, to Braun-Blanquet and TWINSPAN procedures. Initial stratification of this transect was done by means of two LANDSAT-7-TM false-colour satellite images. Classification of floristic data resulted in the description of 14 different vegetation types. The distribution of these vegetation types was established using a supervised classification of the satellite images. Several vegetation types were combined to enable the preliminary mapping of vegetation types on a 1: 250 000 scale. This map will be used as guideline for further validating vegetation surveys to enable a future re-classification of the Thornbush Savanna described by the Preliminary Vegetation Map of Namibia.

Dedicated to two pioneers of Namibian Botany, Willy Giess (1910-2000) and Prof. O.H. Volk (1903-2000)

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1. INTRODUCTION

Biodiversity is one of the most important resources for mankind. It is the essential basis for the functioning of natural ecosystems. When considering the major advances of technologies in modern molecular biology, the potential of biodiversity for the development of especially medicines and increased food production is immense. Since the endorsement of the Convention on Biological Diversity in Rio de Janeiro in 1992, Biodiversity and related topics have become, justifiably, of crucial interest not only to science but also to politics. Yet, scientific knowledge on basic data concerning species numbers appears surprisingly low (Barthlott *et al.* 1999).

Trends in the development and expansion of the human population have led to a loss of biodiversity, which seems to be increasing at an alarming rate. Changes in biodiversity influence the composition of species, which again changes and usually limits the possibilities for land-use due to less productive ecosystems or a general degradation of abiotic resources such as soil. Because changes in biodiversity mostly occur gradually, the degradation process often progresses unnoticed for a long time. Even in Namibia, where the economy is almost entirely based on natural resources, the decline in terrestrial biodiversity has only consciously been recorded from about 1940. A gradual but steady decline of productivity of agricultural rangelands eventually forced several landowners to seek alternative means of income (Brown 1996, Volk 1966a).

The history of pastoral land use in Africa started about 8000 to 10000 years ago in the north-east, from where it gradually progressed southwards to reach southern Africa about 2000 years ago (BIOTA 2000). In Namibia, intensive grazing systems were first established during the 18th and 19th century (BIOTA 2000, Volk 1966a). Volk (1966a) attributed widespread vegetation degradation on Namibian rangelands to rangeland management. He described the main agents changing the structure and composition of vegetation in Namibia as fire and grazing. As fire was already in the 1960's seen as unfortunate and prevented as far as possible, the impact of it on Namibian Rangelands was relatively small. Grazing, on the contrary, had a much more pronounced effect, even if this only became apparent much later. Before the country was divided into farms, grazing was dependent on available surface water and rangelands were thus only subjected to short, irregular but intensive grazing, which probably did not influence the species composition over the long term. With the creation of farms, the supply of water was secured with boreholes and watering points, while the farms were fenced as single units. Nomadic grazing was replaced with permanent grazing (Standweide). Grazing intensities were relatively high (per unit area), but because farms were not subdivided, grazing was also very selective. This modus of grazing probably caused the most severe damage to rangelands in Namibia - palatable grasses were decimated, bush densities and erosion rates increased (Brown 1996, Volk 1966a, Strohbach & Austermühle in prep, Walter 1954). Only from the late 1940's on, the concept of rotational grazing was introduced to deal with the lower productivity of the veld (Volk 1966a).

In southern Africa, the opportunity thus exists to investigate relatively young states of a shift in species composition. With the expected continued population growth as well as an expansion of intensive anthropogenic land-use, it is the type of land-use itself that can be regarded, apart from climatic changes, as the main causative factor of an often-irreversible change in biodiversity.

In recent years several programs addressing global changes and their effects on natural ecosystems and -resources have been initiated based on growing concern about accelerated change and loss in global biodiversity, e.g. ILTER (International Long-Term Ecological Research Program) and UNCBD (United Nations Convention on Biological Diversity). Up to date, however, biodiversity studies only played a marginal role in these programs, as existing studies are usually isolated case studies, which are difficult to extrapolate (Jürgens & Strohbach 2000).

BIOTA (BIOdiversity monitoring Transect Analysis in Africa) was initiated in 2000/2001 to monitor changes in biodiversity, taking ecosystematic, biological and socio-economic processes into account. A thorough knowledge of the dynamics of these processes is the first aim of this multi-disciplinary endeavour, enabling the conceptualisation of practical and sustainable management guidelines for rangelands; i.e. the latter should be both socio-economically realistic, as well as scientifically validated (Jürgens & Strohbach 2000). The standardisation of methods as such is further regarded an important feature of BIOTA, as biodiversity studies in the light of global change cannot and should not be conceptualised as isolated case studies (Jürgens & Strohbach 2000, Westfall *et al.* 1996). In a first attempt to reach an ambitious goal, BIOTA started off studying biodiversity and documenting its changes in species composition on a strip transect along a climatic (rainfall) gradient throughout Africa, the basic assumption here being that overall biodiversity as well as land-use are strongly dependent on climatic- and vegetation zones. The approximate position of this strip-transect for southern Africa is shown in Figure 1.

The design of any project dealing with biodiversity and related issues is faced with the reality that only an estimated 8.5% of all species in existence is known, with even less being known about their distribution (Barthlott *et al.* 1999). Of the entire spectrum of biodiversity, vascular plants remain the most appropriate group of organism for a depiction of terrestrial diversity. There exists a relatively good knowledge base on plants, but more importantly, plants as primary producers are fundamental to all terrestrial ecosystems and their overall biodiversity (Mueller-Dombois & Ellenberg 1974). Further, through its composition, structure and functional characteristics vegetation provides a multitude of habitats for other organisms (Jürgens & Strohbach 2000). It is therefore understandable that the characterisation of vegetation types and their dynamics are a major part of the BIOTA project. The main emphasis of vegetation studies carried out by BIOTA are the documentation, classification and mapping of vegetation along the transect, in close co-operation with remote sensing techniques. Further, vegetation dynamics are monitored on permanently marked "biodiversity observatories". Research of other disciplines also focuses on the observatory area, viz.: soil analyses, characterisation of fungi, lichens and biological soil crusts, functional zoodiversity, socio-economic aspects, impact of land-use as well as the development of predictive modelling.

Vegetation can be defined as a mosaic of plant communities in the landscape. Communities again are associations of plant species that are capable of successfully competing with one another within the confines of a particular combination of environmental features (Küchler 1988). Vegetation reacts noticeably to environmental stresses, these being natural or man-induced, which can be detected in a change of known species associations (and species abundance) within a plant community. Mapping single plant communities can become rather problematic: environmental variations will lead to an infinite number of variations of plant associations. Apart from characterising communities, similar communities should, for practical purposes, be grouped into manageable units. The aim of the vegetation map of the transect is the creation of a database with relevé data which can be used for future reference (Strohbach 2001), similar to the "Veld Types of South Africa" as characterised by Acocks (1988). Acocks defines a veld type as " a unit of vegetation whose range of variation is small enough to permit the whole of it to have the same farming potentialities". Thus, mapping veld types rather than communities, while having a thorough understanding of an area's phytodiversity and its ecological requirements can be regarded as a valuable tool in the management and monitoring of natural resources (Mueller-Dombois & Ellenberg 1974, Jürgens & Strohbach 2000, Strohbach 2001).

Environmental planning can only be sustainable and adhere to sound conservation principles if it is based on a high standard of ecological data (Bredenkamp 2001). The health of an ecosystem can only be assess once the "complete picture" is known - it does not only help to look at the presence of a few dominant and desirable species while a more sensitive rare species, which may be an indicator species, disappears due to unchecked disturbances. Present vegetation maps for Namibia are at present, however, little more than just a list of dominant species (Giess 1971, Dept. Agricultural Technical Services 1979, Strohbach 2001), which does not help in assessing or managing rangelands.

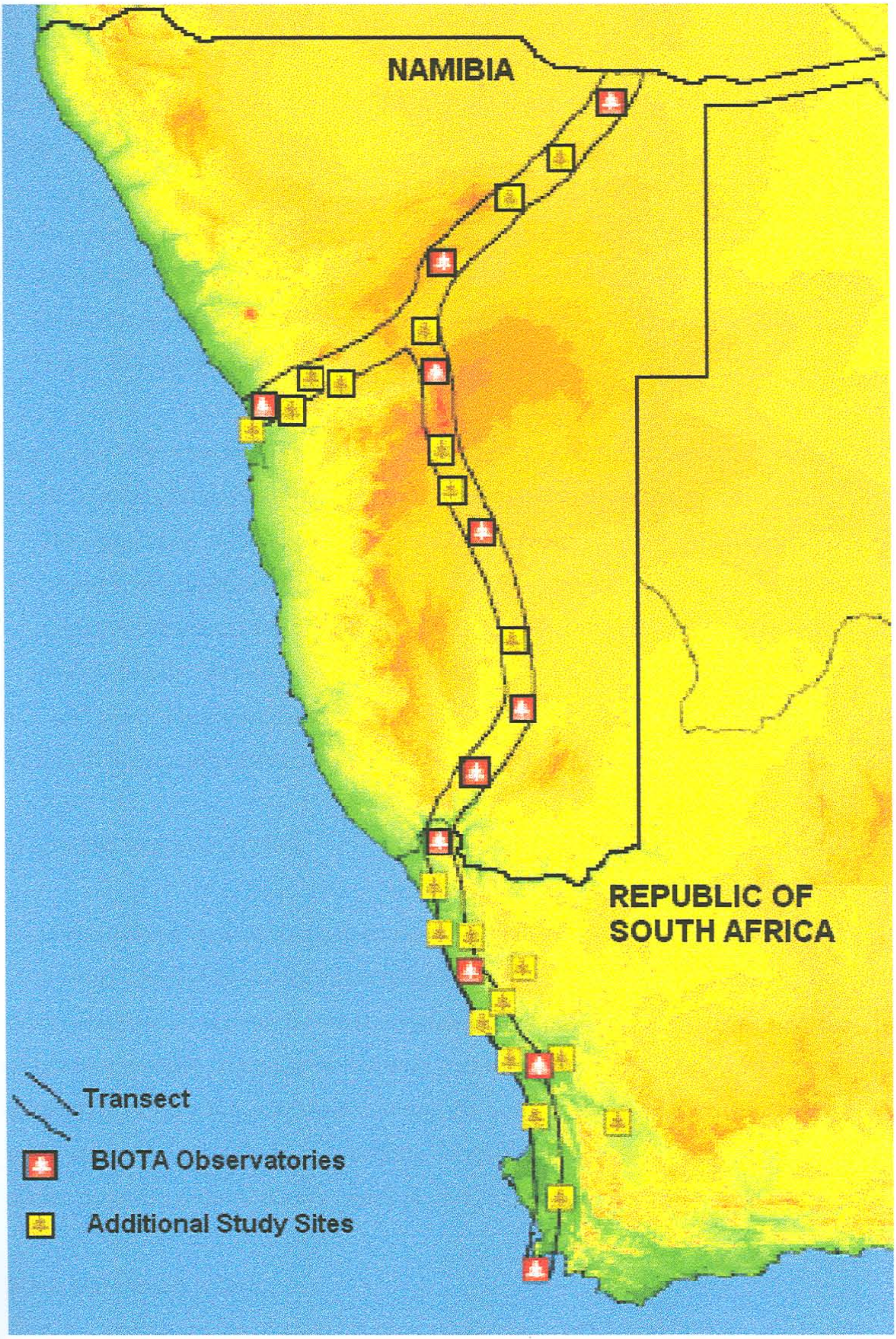


Figure 1: Position of Transects and Observatories of the overall Project BIOTA Southern Africa.

2. AIMS OF THE STUDY

As a contribution to the aims of BIOTA, the following was to be accomplished with this study:

Description and preliminary mapping of the vegetation of a section of the southern African BIOTA Transect (Figure 2), from the watershed between the Omuramba-Omatako and Swakop-river catchment areas to the dairy farm Rietfontein east of Otavi. The length of this transect section is roughly 320 km.

The aims of the transect vegetation map and its data, which is to serve as baseline data for the BIOTA project and especially its envisaged monitoring activities are:

- Documentation and description of the spatial changes in phytodiversity along the transect, paying attention to life forms (strategy-types), structure (height/layers of different life forms) and floristic components (phylogenetic diversity) as they change with changing abiotic conditions (e.g. rainfall gradient).
- Analysis of the importance of environmental features for the change in phytodiversity.
- Identification of plateau-phases and discontinuities along the transect.

3. PROBLEM ANALYSIS

Surveying a large tract of land can be incredibly time-consuming; the fieldworker is often confronted with the dilemma of surveying enough points to be representative of a vegetation type, as well as the question where to put these points to ensure that the different vegetation types can be correctly delimited. The time-frame set for the description of the plant communities along the transect is 2 years, while during those 2 years vegetation can only be successfully sampled during a 3-4 month rainy season, when plants are in full growth, flower and fruit, and thus can be positively identified.

Some key questions are:

- Can satellite imagery be used to give an adequate initial stratification of the study area, to ensure that sampling units are spread evenly over the potential plant communities?
- How well will the communities identified by classification of data correspond to plant communities identified on the satellite map?

It is hypothesised that on a smaller scale (1: 250 000 or less) phytodiversity follows a zonation roughly corresponding to the gradient of the mean annual rainfall.

- How important is this gradient compared to other environmental gradients likely to be found along the transect, e.g. soil types?

4. LOCATION OF THE STUDY AREA

The study area, forming part of the Biota Transect (Figure 1) is located in the Otjozondupa Region, Namibia, roughly following the main road between Okahandja, Otjiwarongo, Otavi and Grootfontein.

The watershed between the Swakop River and Omuramba-Omatako catchments has been taken as the southern boundary of the study area, at roughly 21°45'00" S. The decision for this southern boundary was based on the considerate differences in local topography: south of the divide the central plateau consists of strongly dissected inselberg plains with a slope range of 8-15%, while landforms of the transect area to the north of the divide consist largely of alluvial and inselberg plains, interrupted by few large inselbergs as well as the Omuramba-Omatako with its smaller tributaries. The most conspicuous inselbergs of the study area are, from south to north, Matador, Omatako Mountains, Omboroko Mountains, with the Elefantenberg on the northern boundary of the study area. Elefantenberg is situated south of Otavi, at about 19°45'00"S and forms the southern limit of the dolomite outcrops and mountain ridges of the Otavi area, which were avoided in this study. However, at this point the transect was extended east to Rietfontein, at about 17°45'00"E (Figure 2).

The average height of the study area, excluding the inselbergs, is about 1000 m to 1700 m above sea level.

The width of the transect surveyed was kept at more or less at 30 km but boundaries were not strictly fixed, as it was envisaged that with the aid of remote sensing technology the vegetation map could potentially be drawn for an area extending beyond these 30 km.

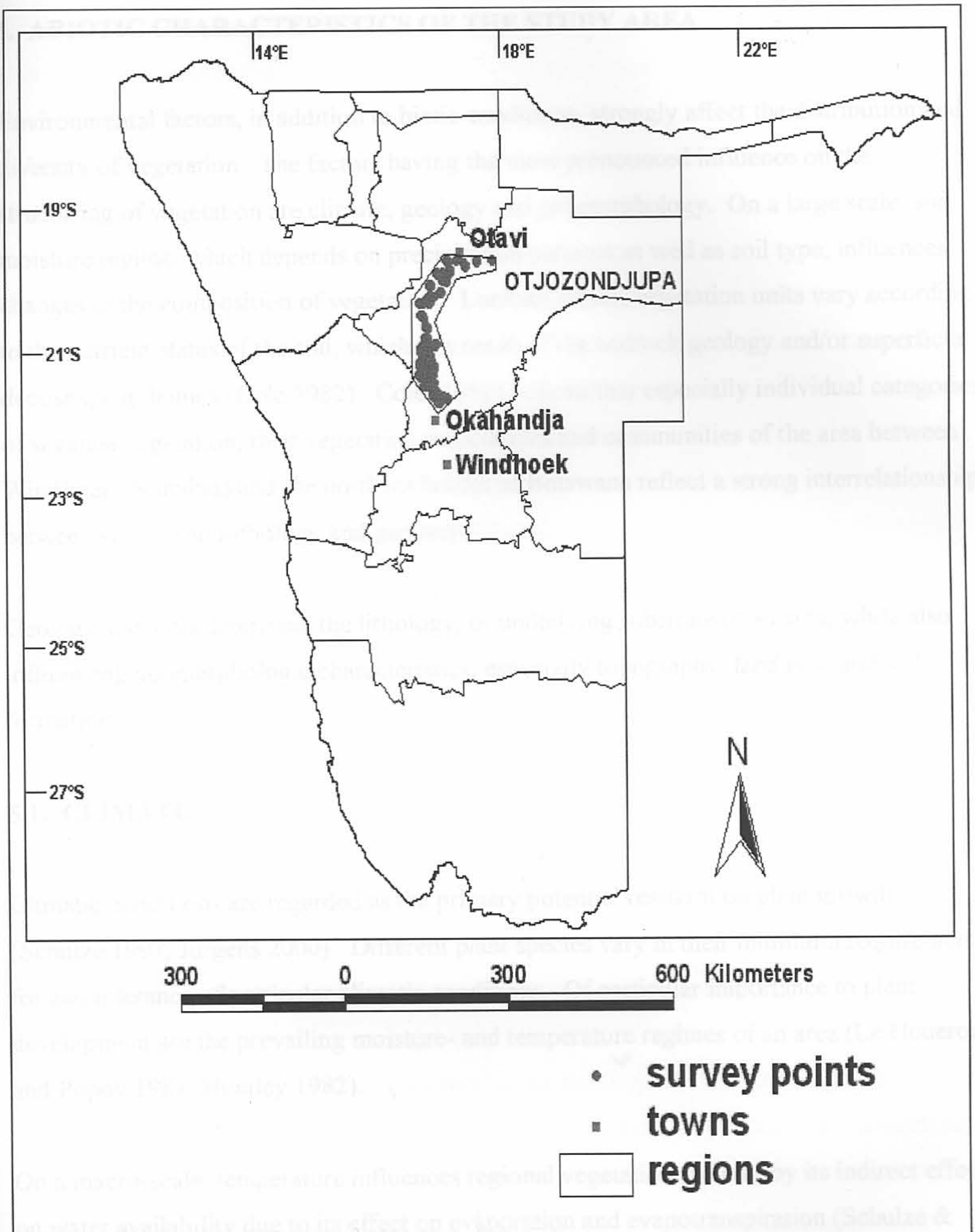


Figure 2: Location of the Study Area, which covers the part of the BIOTA Transect from 40km north of Okahandja to 20 km south of Otavi, then turning east up to the farm Rietfontein.

5. ABIOTIC CHARACTERISTICS OF THE STUDY AREA

Environmental factors, in addition to biotic conditions, strongly affect the distribution and diversity of vegetation. The factors having the most pronounced influence on the structuring of vegetation are climate, geology and geomorphology. On a large scale, soil moisture regime, which depends on precipitation patterns as well as soil type, influences changes in the composition of vegetation. Looking closer, vegetation units vary according to the nutrient status of the soil, which is a result of the bedrock geology and/or superficial deposits, e.g. humus (Cole 1982). Cole (1982) noticed that especially individual categories of savanna vegetation, their vegetation associations and communities of the area between Windhoek (Namibia) and the northern border of Botswana reflect a strong interrelationship between soil, geomorphology and geology.

Geological events determine the lithology, or underlying substrate of an area, while also influencing geomorphologic characteristics, especially topography, land type and soil formation.

5.1. CLIMATE

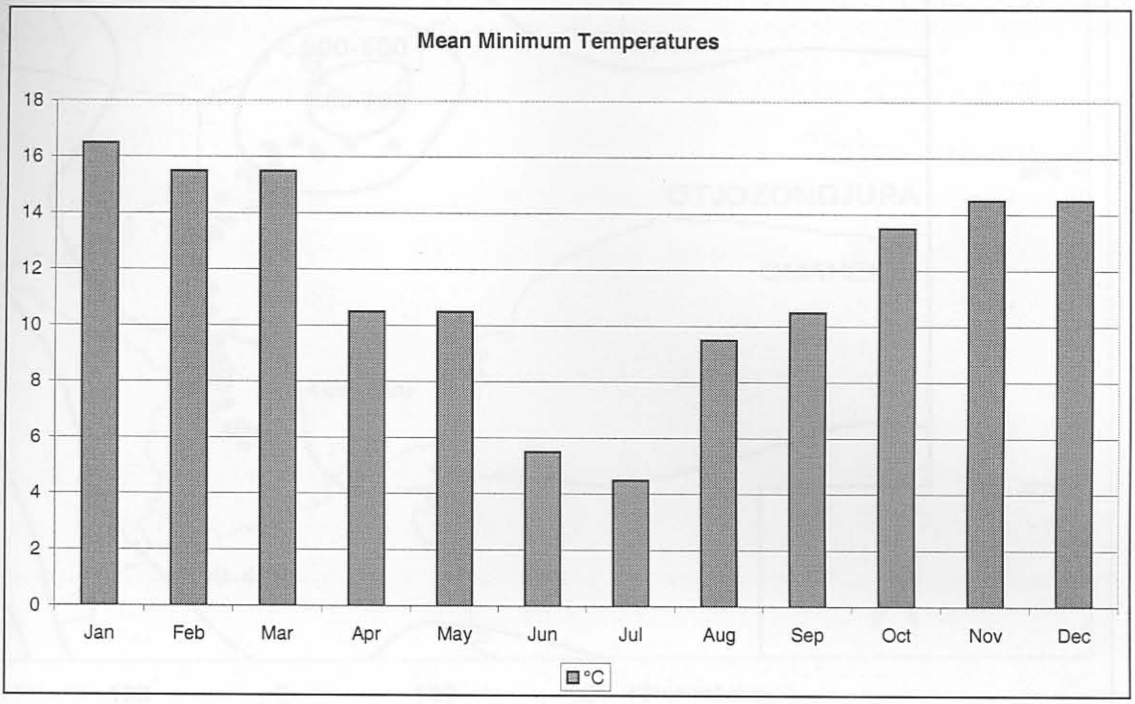
Climatic conditions are regarded as the primary potential restraint on plant growth (Schulze 1997, Jürgens 2000). Different plant species vary in their minimum requirements for and tolerance of particular climatic conditions. Of particular importance to plant development are the prevailing moisture- and temperature regimes of an area (Le Houerou and Popov 1981, Huntley 1982).

On a macro-scale, temperature influences regional vegetation patterns by its indirect effect on water availability due to its effect on evaporation and evapotranspiration (Schulze & McGee 1978). On a meso- and micro-scale, plant diversity has evolved to and is influenced by temperature effects on plant metabolism and thus temperature influences growth-, reproduction- as well as germination rates. Rutherford and Westfall (1994) and Schulze (1997) observed that savannas are in general absent from high rainfall areas (mean annual rainfall above 235 mm) with low winter temperature minima, while arid savannas are still being present in low rainfall areas with relatively severe winter frosts (Huntley 1982). The study area falls entirely within an arid eco-climatic zone with occasional frosts

(Werger & Coetzee 1978, Le Houerou and Popov 1981). Le Houerou and Popov (1981) define eco-climatic zones based on their characteristic annual distribution and amount of precipitation and temperatures, and especially take the occurrence of frost into consideration. Many plants have evolved some form of physical and biological mechanism to avoid frost-damage, but none of these will provide complete protection against below zero temperatures. An air temperature of 3-4°C is already considered low enough for light frosts to occur. Critical temperature indices such as winter minima, which also indicate the occurrence of frost, and summer maxima are thus the most useful parameters in studying plant distribution, rather than e.g. mean annual temperatures (Schulze 1997).

For southern Africa, mean daily minimum temperatures characteristic for winter are represented by July-temperatures. These temperatures range from 7-8 °C over the southern and central parts and 3-6 °C in the north-eastern part of the study area. Similarly, maximum temperatures recorded during January are taken as representative of the mean daily summer maximum temperatures, ranging from 28-30 °C for the study area (Figure 3) (Schulze & McGee 1998, AEZ 2001).

The savanna biome occurs in regions with a relatively long summer, an arid savanna experiencing about seven (or more) dry months (Huntley 1982, Rutherford & Westfall 1994, AEZ 2001). The study area receives primarily summer rainfall, with a Summer Aridity Index of 3.7 to 3.8 (Rutherford & Westfall 1994, Irish 1994). Average long-term annual rainfall gradually increases in a north-north-easterly direction over the study area (Figure 4). Local variations occur especially east of Otavi with a markedly higher rainfall than surrounding areas due to the mountain ridges found there. The bulk of the annual precipitation occurs within 4 months (Figure 5), greatly affecting annual and seasonal soil moisture balances which have a more pronounced influence on phytogeographic divisions than gross precipitation alone (Schulze 1997, AEZ 2001).



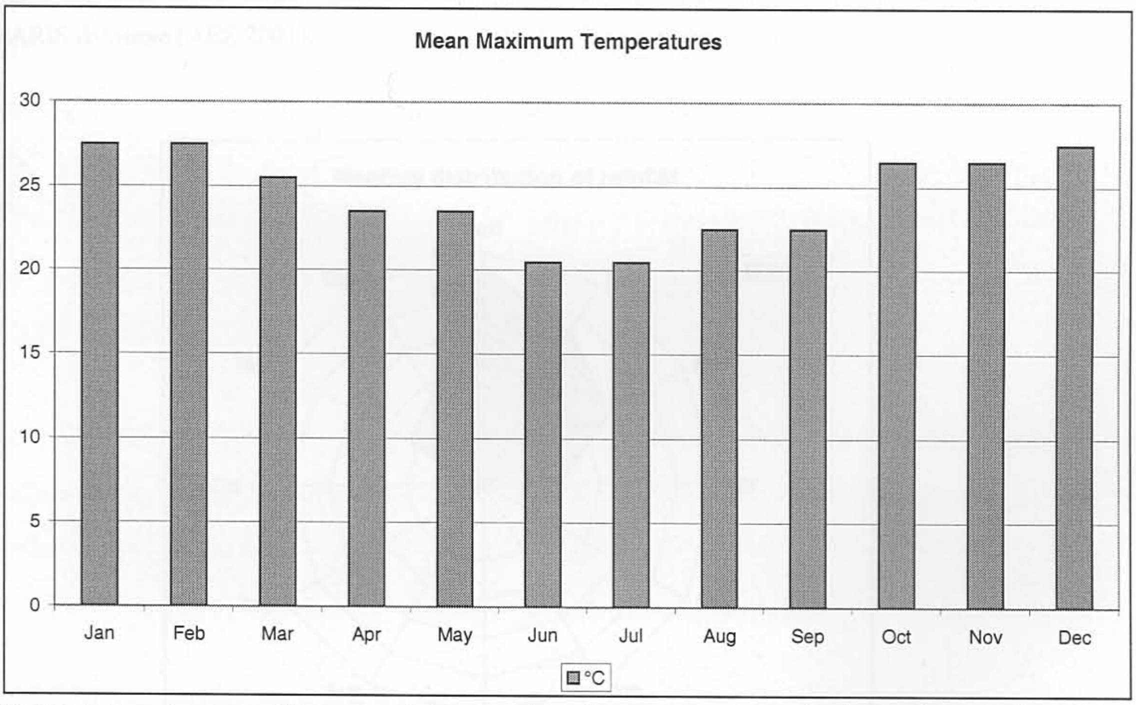


Figure 3: Long-term monthly mean minimum and maximum temperatures for the study area, adapted from the AEZ database (2001).

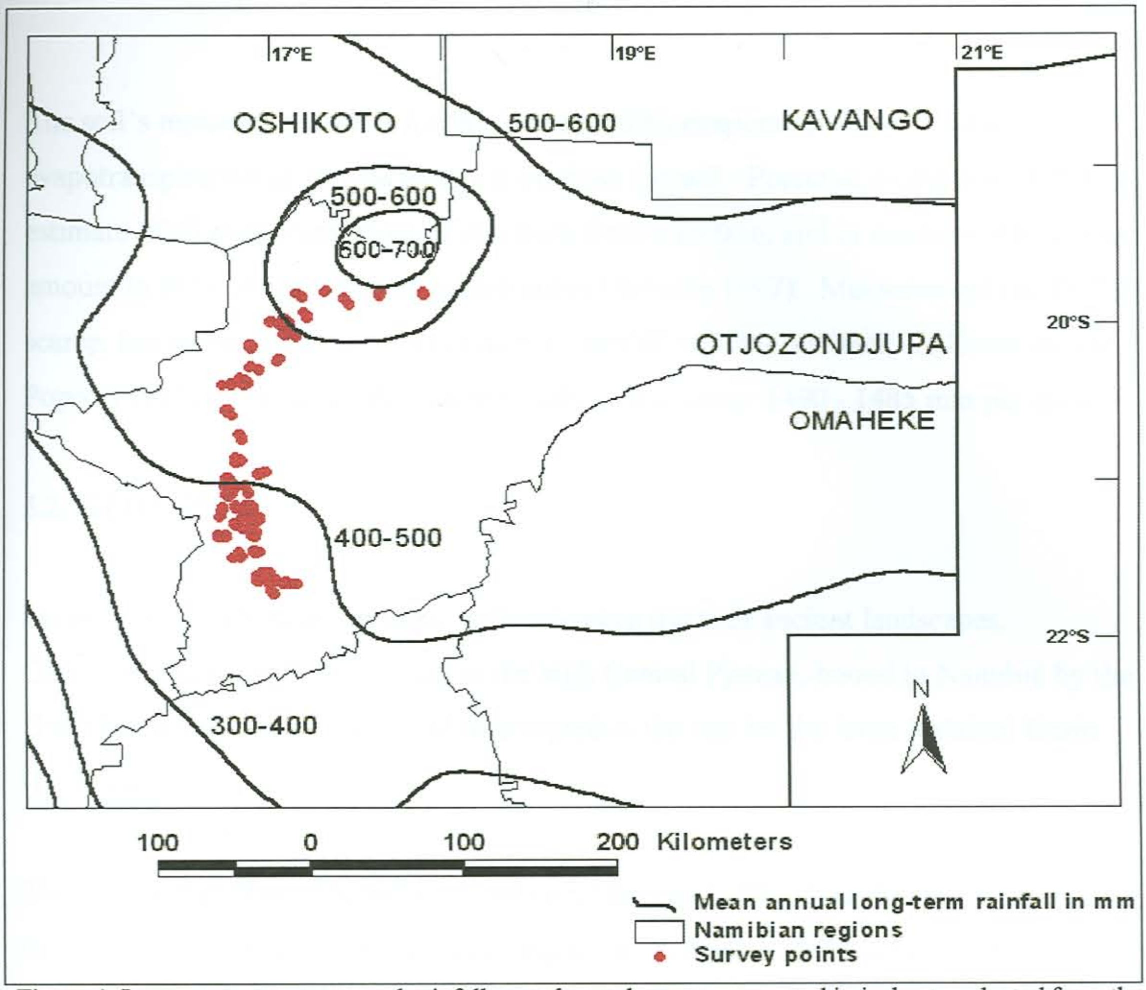


Figure 4: Long-term average annual rainfall over the study area represented in isohyets, adapted from the NARIS database (AEZ 2001).

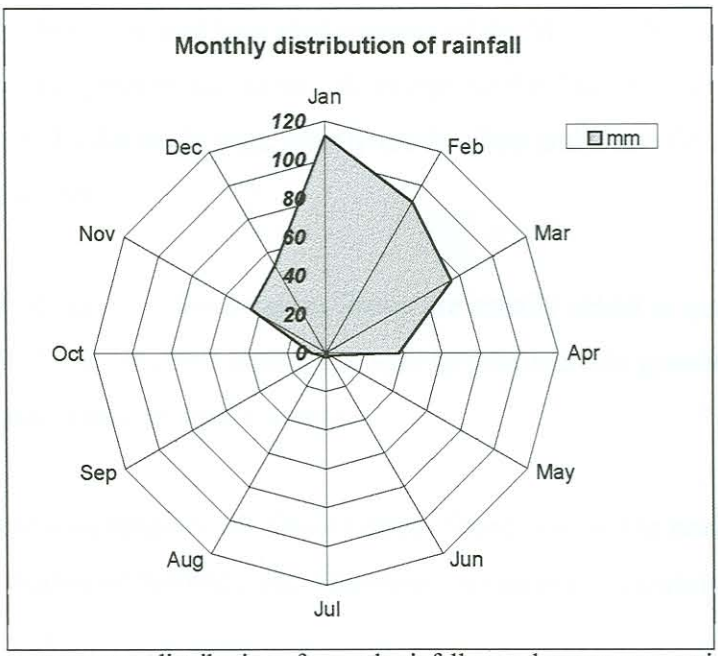


Figure 5: Long-term average distribution of annual rainfall over the year as experienced in the study area, adapted from the NARIS database (AEZ 2001).

The soil's moisture regime is further influenced by evaporation losses - both evapotranspiration as well as evaporation from the soil. Potential evaporation (PET) is an estimate of all evaporative loss of moisture from a surface, and in southern Africa may amount to 91% of mean annual precipitation (Schulze 1997). Measurements of PET are scarce, but compared to an average annual rainfall of 300 - 600 mm, Le Houerou and Popov (1981) estimate the PET of the study area at about 1490 - 1485 mm per annum.

5.2. GEOLOGY

Large parts of Africa are covered with extensive tracts of ancient landscapes. Characteristic for southern Africa is the high Central Plateau, bound in Namibia by the Great Escarpment in the west and interrupted in the east by the large Kalahari Basin (Partridge 1997).

The Geological Map of Namibia (Geological Survey 1980), describes the study area as consisting of the Karoo- and Damara Sequences as well as the Kalahari-Group (Figure 6).

The Damara Sequence, consisting of a succession of mainly sedimentary layers deposited during the late Protozoic to early Cambrian (see Table 1 below), is divided into the central and southern areas. The southern area consists of the Mulden, Swakop and Nosib Groups. The northern area is essentially identical, excepting the Otavi Group in place of the Swakop Group. In the study area, mostly the Swakop and Otavi Groups of the Damara Sequence are found.

Undifferentiated layers in the Swakop Group are usually schist or quartzite. However, the largest area of this group here consists of syn- to post-tectonic granites, sometimes with the inclusion of gneiss and/or quartz diorite.

The undifferentiated strata of the Otavi Group, found only in the northern part of the study area, consist mainly of dolomite and limestone, occasionally quartzites occur.

The main agent exposing the ancient Damara Sequence was erosion during the African Planation, which was a direct result of the break-up of Gondwanaland during the late Jurassic to early Cretaceous.

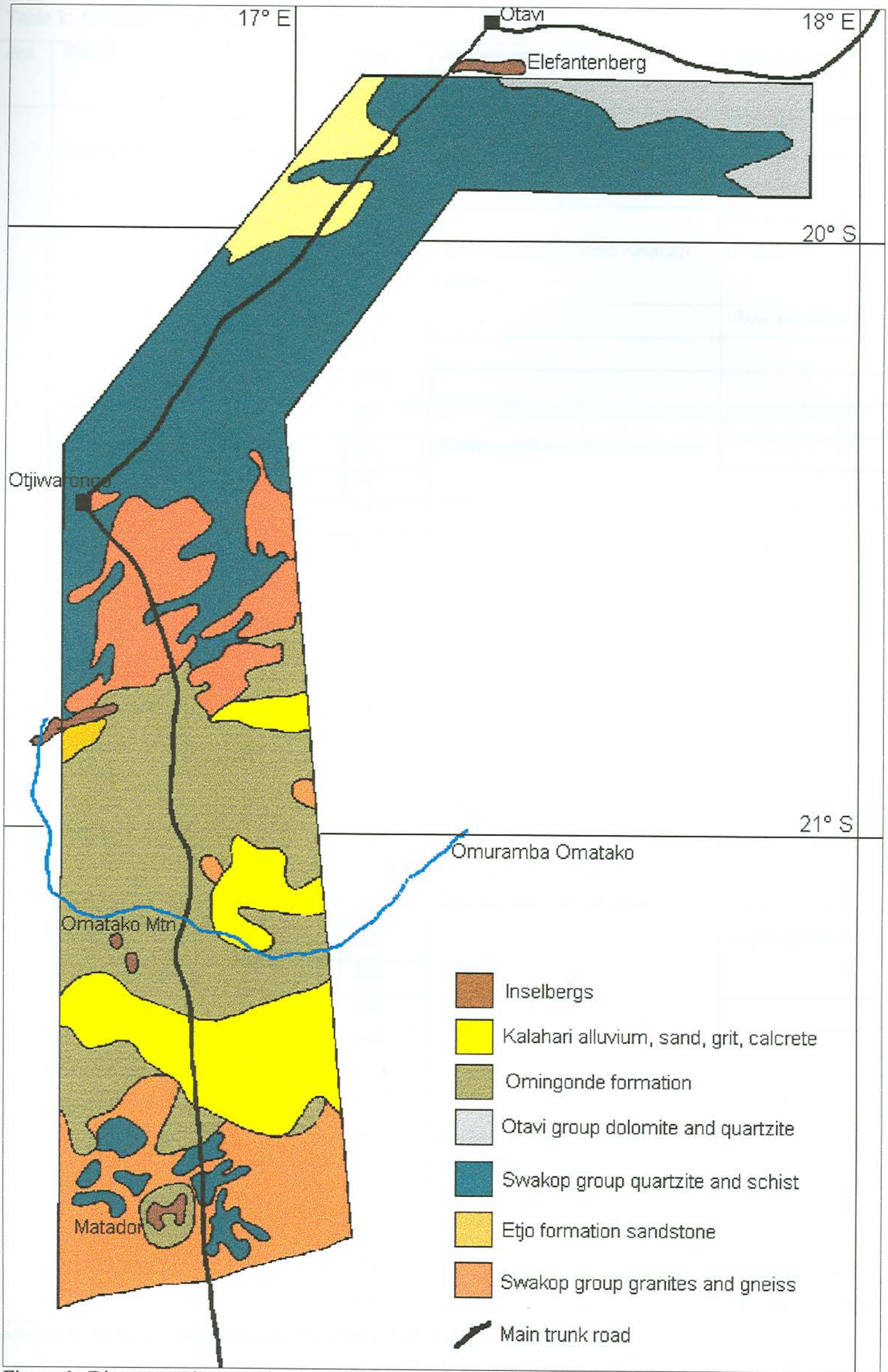


Figure 6: Diagrammatic representation of the main geological strata found in the study area, adapted from the Geological Map of Namibia (Geological Survey 1980)

Table 1: Geological Timescale

Era	*Period*	*Epoch*	*Age (M yr.)*	*Isotopic ages of geological strata*	*Major incidents*
	Quarternary	Holocene	0.01		Formation of present-day biomes, *Homo sapiens* appears
		Pleistocene			
			2		*Homo erectus* appears
	Tertiary	Pliocene	2.8	Sand-deposition onto Kalahari Basin	Pliocene cooling
		Miocene	4		*Australopithecus* appears
			5.1		
		Oligocene	24.6		
			32		
		Eocene	38	Sedimentation of Kalahari Basin	
			39		
		Palaeocene	54.9		
			65		Continents ± arrive at present-day position Dinosaurs die out
	Cretaceous		120		African Planation
			140		break-up of Gondwana-land, seed plants appear
	Jurassic		195	Formation of Karoo Sequence with	Formation of Laurasia and Gondwana
	Triassic		250	Ecca subgroup Omingonde Formation Etjo Sandstone Formation	Existence of the Pangea supercontinent
	Permian		285		
	Carboniferous		350		
	Devonian		405		
	Silurian		440		
	Ordovician		500		
	Cambrian		570		
	Pre-Cambrian (Protozoic)	Namibium	650	Swakop & Otavi Group of the Damara Sequence	
			920	Damara Sequence	
			1160		
			3500		First life-forms appear
			4500		formation of the earth

adapted from the Geological Map of Namibia (1980) and Gleich *et al.* (2000).

Also found in the study area is the Ecca Group of the Karoo Sequence. The Karoo Sequence was formed when, over 200 M yr. ago, much of southern Africa was a vast inland sea subject to sedimentation from surrounding area. The Ecca Group was formed during a period of global warming, characterized by periodic heavy rainfalls and flooding, leading to increased sedimentation of the Karoo-inland sea (King 1978). The Omingonde Formation of the Ecca Group typically consists of red mudstone, siltstone, sandstone or grit. Occasionally sills and dykes of dolerite, surrounded by aeolian sandstone of the Etjo Formation are found - the Omatako mountains are an example (Geological Survey 1980).

The Kalahari Basin has been a principal focus of continental sedimentation since the late Cretaceous, which continued into the quaternary. Accumulation of the red sands of the Kalahari probably only occurred as a result of drier climatic conditions during the Pliocene cooling (2.8 M yr.) (King 1978, Cole 1982, Geological Survey 1980, Partridge 1997). In Namibia, the Kalahari Group consists of alluvium, sand, gravel and smaller patches of surface calcrete. Typically, due to its inundation history, underneath the sandy layers is a calcareous layer, at places exceeding 10m thickness, which make it some of the thickest calcareous crusts in the world (Blümel 1982). This crust partially covers the older Omingonde Formation of the Karoo Sequence.

5.3. SOILS

Soils are the product of their environment, i.e. their formation is influenced by climate, lithology, topography as well as fauna and flora. In arid climates, more water evaporates than precipitates, leading to much reduced chemical weathering (compared e.g. to Europe) because solutes from weathering processed are accumulated rather than leached out. However, sandy soils in arid climates may undergo acidification when minerals and ions are washed out by strong, infrequent rainfall events (Scheffer & Schachtschabel 2002). Another, relatively recent factor, which cannot be ignored are land use practices which may preserve soils or lead to their degradation (Heine 1995).

The majority of Namibian soils are either Lithosols (*lithos* meaning rock or stone), weakly developed soils and further inland Arenosols (sandy soils). Calcareous sediments as well as calcrete crusts are further widely distributed in Namibia (Geological Survey 1980, Blümel & Eitel 1994, Heine 1995), forming a relatively impermeable subsurface pan horizons of cemented calcrete in the Kalahari (Tinley 1982).

Apart from the geological nature of soils, surface texture of soil is an important determinant of the soil water regime. Surface texture determines the level of water infiltration into the soil, as well as the amount of water remaining in the soil after rains and subsequent evaporation. In arid to semi-arid areas, clays or fine-textured soils are regarded as the most xeric substrates (further influenced by the presence or absence of pan horizons and their depth), while sands or coarser textured topsoils in general show a greater water retention ability (Alizai & Hulbert 1970, Tinley 1982, Scheffer & Schachtschabel 2002). In a study on soil water regimes in a shortgrass steppe, Dodd and Lauenroth (1997) established that sites with loamy sand had more a higher soil moisture content than sandy clay loams and sandy clays. In the latter, the bulk of the moisture only penetrated to the upper soil layers (about 30 cm), while water was able to infiltrate to a depth of about 100 cm on loamy sand sites. These soil moisture reserves were then much less susceptible to evaporative loss as the soil heats up during the day.

Based on Scheffer & Schachtschabel 2002, FAO Guidelines for Soil Description (FAO 1990) and the Soil Map of Namibia (AEZ 2001) the soils of the study area can be described as follows (note that soil colour descriptions are the colours of soils when wet):

Leptic Regosols are found mainly on the footslopes of hills and ridges on hard Damara limestone. These coarse to moderately coarse soils are shallow to moderately deep and in general well drained. The surface layer consists of loamy sand to loam of a dark grey to dark red colour. The limited depth of these soils limits plant rooting depth, while further constraining plant growth due to its low water-holding capacity.

Haplic Regosols are very deep with common to many coarse fragments and in general good drainage. The surface layer consists of loamy sand to sandy loam with quartz fragments, while the colour ranges from brown to yellowish red.

Chromic Cambisols are relatively old soils, having formed when the loamy soluble remains of limestone or dolomite have aggregated to a thickness exceeding 10 - 30 cm. Iron oxides are often present, leading to the reddish to brownish colours of these soils. The genesis of these soils is often associated with warmer, moister climates during the tertiary. These soils are thus comparatively very deep and well drained. The surface layer consists of coarse to moderately coarse loamy sand to sandy clay loam with a very dark greyish brown to dusky red colour. These soils have a moderate to high water holding capacity. When dry, the topsoil may become very hard, making it a generally difficult soil to work with.

Leptic-Chromic Cambisols are moderately deep to deep and well drained. The surface layer consists of loamy sand to sandy clay loam with a very dark greyish brown to dusky red colour. Texture varies from moderately coarse to moderately fine with occasionally few rock fragments. Water holding capacity of these soils is moderate.

Petric Calcisols are often found on hard Damara limestone, and are consequently very shallow and well drained. The surface layer consists of loamy sand to loam and is very dark grey to brown. The soils texture is moderately coarse to medium without rock fragments. Water holding capacity of these soils is very low.

Haplic Calcisols are very deep and well drained. The surface layer consists of coarse to moderately fine-textured sandy loam to silty loam with a very dark grey to dark yellowish brown colour. The underlying material often has accumulations of hard and soft nodules, resulting in a calcic horizon. Water holding capacity is moderate.

Lithic Leptosols are weakly developed soils, derived from and found on top of bedrock, here hard limestone outcrops, ridges or hills of the Damara sequence. These soils are very shallow (2-20 cm) and well drained, drying out relatively quickly. The surface layer consists of loamy sand to sandy clay loam and is dark greyish brown to dark reddish brown. Some humus may have accumulated, but is not significantly decomposed. Often these soils are relatively steep, which adds to their poor water holding capacity and makes them prone to erosion.

Mollic Leptosols are somewhat more developed than lithic Leptosols, with usually a richer component of humus and thus also nutrients. They are found on a bedrock of Damara limestone, are very shallow and well drained. The surface layer consists of coarse to moderately coarse loamy sand to sandy loam and are black to very dark brown. Water holding capacity is low.

Ferralic Arenosols are sands derived from aeolian deposits. They are very deep and somewhat excessively drained, with a typically poorly developed profile. The surface layer consist of coarse sand with a dark grey to reddish brown colour. Water holding capacity of these soils is low.

Arenic Fluvisols are typical for the omurambas (shallow, slow flowing water channels which are only seasonally filled) and river depressions of the Kalahari Region. These soils are weakly developed, derived from alluvial deposits, very deep and moderately to well drained. The soil surface consists of sand to loamy sand with a very dark grey to brown colour. Water holding capacity of these soils is low to moderate.

Specific soil types are hardly continuous over a large area, and may change within relative short distances. It can thus be anticipated that it is unrealistic to map singular soil types, rather, the Soil Map of Namibia has attempted to map the characteristic combinations of soils for a given map unit. These units for the study area (Figure 7) are:

CKf2: leptic Regosols with leptic-skeletic Regosols and leptic-chromic Cambisols as minor inclusions
CKg1: chromic Cambisols with leptic Regosols and petric Calcisols
CKh1: rock outcrops with lithic Leptosols
CKl1: mollic Leptosols with petric Calcisols
CLg1: leptic Regosols with haplic Regosols and petric Calcisols
CLh1: rock outcrops & lithic Leptosols Complex
CLl1: chromic Cambisols with leptic-chromic Cambisols and petric Calcisols as minor inclusions
CLl2: chromic Cambisols with leptic-chromic Cambisols
CLl3: petric Calcisols & leptic-chromic Cambisols Complex
KDf1: ferralic Arenosols & arenic Fluvisols & haplic Calcisols Association
KFv1: arenic Fluvisols and haplic Calcisols
KFv5: fluvic Cambisols & haplic Fluvisols & ferralic Arenosols Complex

KSd1: ferralic Arenosols

The occurrence of arid savannas in southern Africa is closely related to the distribution of calcareous soils (Huntley 1982), thus these soils deserve further mention. As mentioned earlier, they are widely distributed in Namibia and typical for arid climates. As calcareous soils, all soils containing free calcium carbonate ($CaCO_3$) or calcium-magnesium carbonate are referred to. They are not restricted to any particular type of substratum, but are rather the result of aeolian material (loess), which was generated and transported during various climatic phases (Scheffer & Schachtschabel 2002). To generate calcrete itself, any loose sufficiently permeable material will suffice should it be capable of absorbing $CaCO_3$ from descending infiltration facilitated by e.g. rainfall events (Blümel 1982). The actual formation of calcrete is a rather complex process (described by Blümel 1982). However, the final stages of calcrete formation may have an enormous impact on the vegetation. Erosion of the topsoil exposes the calcic horizon, which had formed during past decades, which then enables the re-solution and surface-cementation of Ca. Runoff water may further aid the deposition of the very fine Ca grains into voids or pores on the soil surface, so creating a lamellar soil surface. This surface becomes relatively impermeable to water-infiltration (Blümel 1982), which creates a rather arid soil environment for vegetation. These soils may be responsible for the occurrence of "marginal savannas" as described by Irish (1994) within the savanna biome, whose distribution cannot be ascribed to climatic conditions alone.

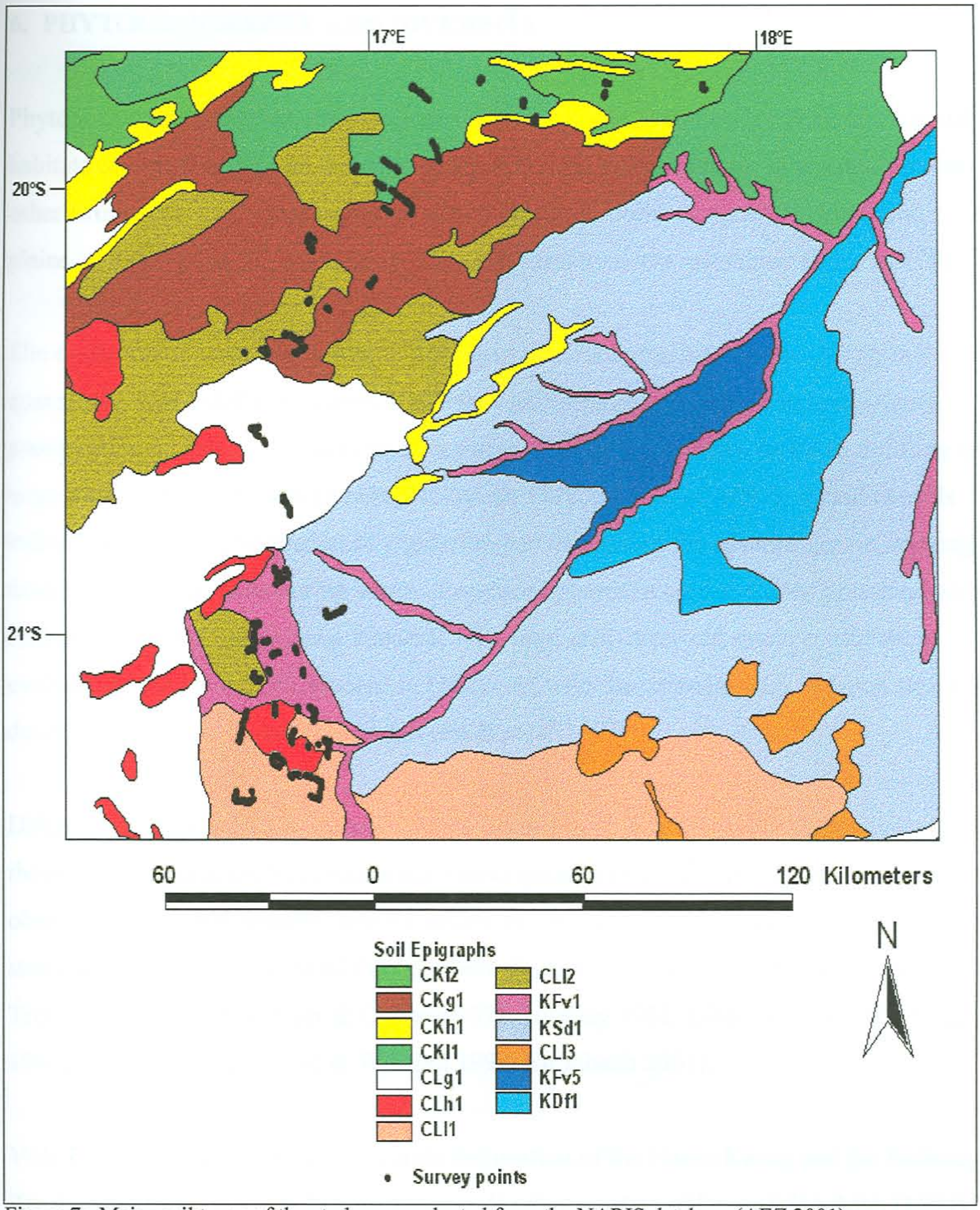


Figure 7: Major soil types of the study area, adapted from the NARIS database (AEZ 2001).

6. PHYTOGEOGRAPHY AND DIVERSITY

Phytogeographical or phytochorological units are usually based on the flora of the zonal habitats of a region. Unless the entire region consists predominantly of mountainous or other extreme features of topography or soil, the floral units characterised are found on the plains, reflecting the full effect of the regional climate on the vegetation (Jürgens 1991).

The evolution of present-day southern African plant communities started during the quaternary, when shifts in biomes were the result of large fluctuations in temperature, precipitation and seasonal distribution patterns of moisture, brought on by an uplifting of large tracts of the continent (Axelrod & Raven 1978, Scott *et al.* 1997). Fossil records indicate a strong cyclic change of vegetation patterns within the savanna biome, ranging from woodland savanna during warm interglacial phases to cool and open grassland with fynbos elements during glacial maxima. The semi-arid thornveld savanna probably evolved during the late Pleistocene to Holocene, with the contemporary savanna structure developing as recently as 1000 yr. BP (Scott *et al.* 1997).

Different authors provided a general characterisation or description for the study area, even though the information from which such description was derived is only based on observations or photographs; actual baseline surveys with quantitative information for the study area is extremely limited (Volk 1966b, Giess 1971, Werger 1978 quoting White, Troupin and Monod, Werger & Coetzee 1978, Huntley 1982, Gibbs Russel 1987, Jürgens 1991, Irish 1994, Rutherford & Westfall 1994, Strohbach 2001).

Volk (1966b) proposed a more accurate delineation of the Nama-Karoo and the Sudano-Zambezian floral region in Namibia, using distribution data of key species. Irish (1994), following the approach of Rutherford and Westfall (1994), subdivided the Namibian Flora into major biomes. According to his classification the study area falls entirely within the savanna biome, with phanerophytes and hemicryptophytes the dominant life form, corresponding with other general vegetation descriptions (see Huntley 1982, Rutherford and Westfall 1994, Rutherford 1997 and Scholes 1997). A typical diagnostic characteristic of the savanna biome is that hemicryptophytes within the biome are mostly comprised of the C_4 type of graminoids (Huntley 1982, Rutherford and Westfall 1994). Following Huntley (1982) and Scholes (1997), the savanna of the study area can be further described as an arid, fine-leafed savanna, with most of the dominant trees having leaves of less than 1 cm^2 in surface area and also tending to be predominantly spinescent. Cowling and Hilton-Taylor (1997) have a somewhat different approach in dividing the savanna into the Zambezian Regions, which covers northern and north-eastern Namibia, while the remainder of the savanna is classified as the Kalahari-Highveld Transition Zone. They characterise this zone as consisting of residual Zambezian tree flora (mainly *Acacia* spp.), with an overall relatively low species diversity and few endemics. However, as Scholes (1997) rightly points out, any definition and delineation of savanna is to a large degree arbitrary, as savannas are a continuum of arid shrublands, lightly wooded grasslands, deciduous woodlands and dry forests.

The nature of the African savanna has been defined as being a seasonal ecosystem with a continuous herbaceous, usually graminaceous layer and a discontinuous layer of trees and/or shrubs, varying from sparse to 75% canopy cover (Edwards 1983, Frost *et al.* 1986, Rutherford & Westfall 1994, Scholes 1997). It is believed that local savannas owe their existence to the impact of fire and large herbivores rather than climate alone. Fires in this system are the result of seasonal water availability, which leads to an accumulation of dry, easily ignited fuels, which may potentially lead to annual (in moist savannas) or one in 10 years or more (in arid savannas) major fire events (Scholes 1997). Savanna plants in general are well adapted to withstanding fire, which is demonstrated by a mortality rate of often less than 10% after an "average" surface fire. Phanerophytes may experience top-kill during such a fire event, but will resprout from the base. Dominant life forms of savannas are equally well adapted to drought, although woody plants usually have a higher resistance than graminoids. High grazing pressure exerted on graminoids during drought usually leads to the weakening of this layer, creating favourable conditions for seedling emergence of the woody layer (Knoop and Walker 1985, Rutherford & Westfall 1994), but also leading to erosion which will affect the soil moisture balance (Walter & Volk 1954). Savannas thus overall are highly dynamic event-driven systems, in which temporal as well as spatial changes are caused in the short- and long term by changes in climate, e.g. poor vs. good rainy seasons, adding to the effects of soil nutrient content, fire regime and herbivory (Walker 1987, Skarpe 1992).

Westoby et al. (1989) described the state-and-transition model, which is highly applicable to savanna ecosystems: Transitions of a stable vegetation state occur as *a result of often long-term climatic conditions and accompanying management practices. Climatic circumstances can be either opportunistic or hazardous. Management practices should therefore adapt to a continuous state of non-equilibrium, taking advantage of opportunities and avoiding hazards (e.g. by timely de-stocking).*

Giess (1971) in his "Preliminary Vegetation Map" of Namibia presented the most comprehensive vegetation classification for Namibia available up to date. According to his map (Figure 8), the study area stretches over the following vegetation types: Mountain Savanna and Karstveld, Thornbush Savanna (also referred to as Tree and Shrub Savanna) as well as bordering on Tree Savanna and Woodland (also referred to as Northern Kalahari). The majority of the study area falls within the Thornbush Savanna. Giess (1971) characterises this vegetation type as being dominated by *Acacia* species, of which *Acacia mellifera* ssp. *detinens* is the most prominent, leading to various degrees of bush encroachment. Further typical *Acacia* species here are *A. reficiens*, *A. hebeclada*, *A. erubescens*, *A. fleckii* and occasionally *A. tortilis* ssp. *heteracantha* and *A. erioloba*. *Boscia albitrunca* and *Ziziphus mucronata* are found throughout the vegetation type, although in relatively low densities. *Lonchocarpus nelsii* is common on the more sandy areas, while *Combretum apiculatum* may predominate on rocky outcrops or limestone.

The report on "Relatively Homogenous Farming Areas" (Dept. Agricultural Technical Services 1979) further divides the Thornbush Savanna from south to north into Okahandja Thornbush Savanna, Osire Sandveld, Etjo-Catchment Area, Otjiwarongo Thornbush Savanna, Otjenga Plains and the Namibian Maize Triangle. A vegetation description *per se* is not provided, rather a limited list of common shrubs and trees, or a list of edible/browsable shrubs and trees. More important, although not standardised, is a brief description of valuable grasses present in "original" veld, somewhat degraded "succession-state" veld as well as degraded veld. The report also occasionally indicates which areas are prone to degradation, and which are already extensively degraded - be it affected by bush encroachment or poor grazing remaining - all as observed in the 1970's. This report, despite being very basic, does enable some comparison between "what was" and "what is". Specific studies on such long-term dynamics are sparse, but show for example that in some areas valuable grasses such as *Brachiaria nigropedata* have entirely disappeared (Strohbach & Austermühle, in prep).

The Mountain Savanna and Karstveld, which occurs mostly in the northern regions of the study area, is relatively diverse, covering a largely mountainous region. The plains between the mountains are typically covered with shrubs and small trees such as *Combretum apiculatum*, *Dichrostachys cinerea* - which is the major bush encroacher in this area - as well as species of *Croton* and *Acacia*. The tree stratum of the plains and low rocky ridges consists of *Kirkia acuminata*, *Olea europaea* ssp. *africana*, *Sclerocarya birrea* ssp. *caffra* and *Peltophorum africanum*. *Combretum imberbe* is found on outcrops of recent surface limestone, in the study area usually in the form of dolomite. Sandveld patches support trees such as *Lonchocarpus nelsii*, *Terminalia sericea* and *Acacia* species. A species common throughout this vegetation type and also leading to bush encroachment is *Terminalia prunioides*. According to the Giess (1971) map, this vegetation borders on the northern fringes of the study area. As some of the defined Homogenous Farming Areas in the Otavi-Region overlap both Thornbush Savanna and Karstveld, it has been expected from the onset that a transition zone of Karstveld into Thornbush Savanna may occur throughout the northern half of the study area, roughly from around Otjiwarongo.

The Thornbush Savanna of northeastern regions of the study area merges into the Northern Kalahari, which in itself is a very complex vegetation type. According to Giess (1971) the southern parts of this vegetation type are characterised as open savanna with *Combretum imberbe*, *Acacia mellifera* ssp. *detinens*, *Peltophorum africanum*, *Lonchocarpus nelsii*, *Acacia reficiens*, *Combretum apiculatum*, *Tarchonanthus camphoratus*, *Ziziphus mucronata*, *Catophractes alexandri* and *Combretum hereroense*.

An interesting observation made by Irish (1994) is that small outliers of Nama-Karoo are found within the Savanna Biome. He defines these outliers as being dominated by *Catophractes alexandri*, and regards such areas as “marginal savanna”. Although Irish (1994) did not list such outliers within the study area, on a first glance such patches of *Catophractes*-dominated vegetation occasionally do occur.

A factor limiting the characterisation and description of the majority of vegetation types of and their delineation within Namibia is that they have been derived from isolated case studies, very basic field observations and photographs only (Burke and Strohbach 2000). The larger part of this categorisation, including the study area, remains to be substantiated with more quantitative field data.

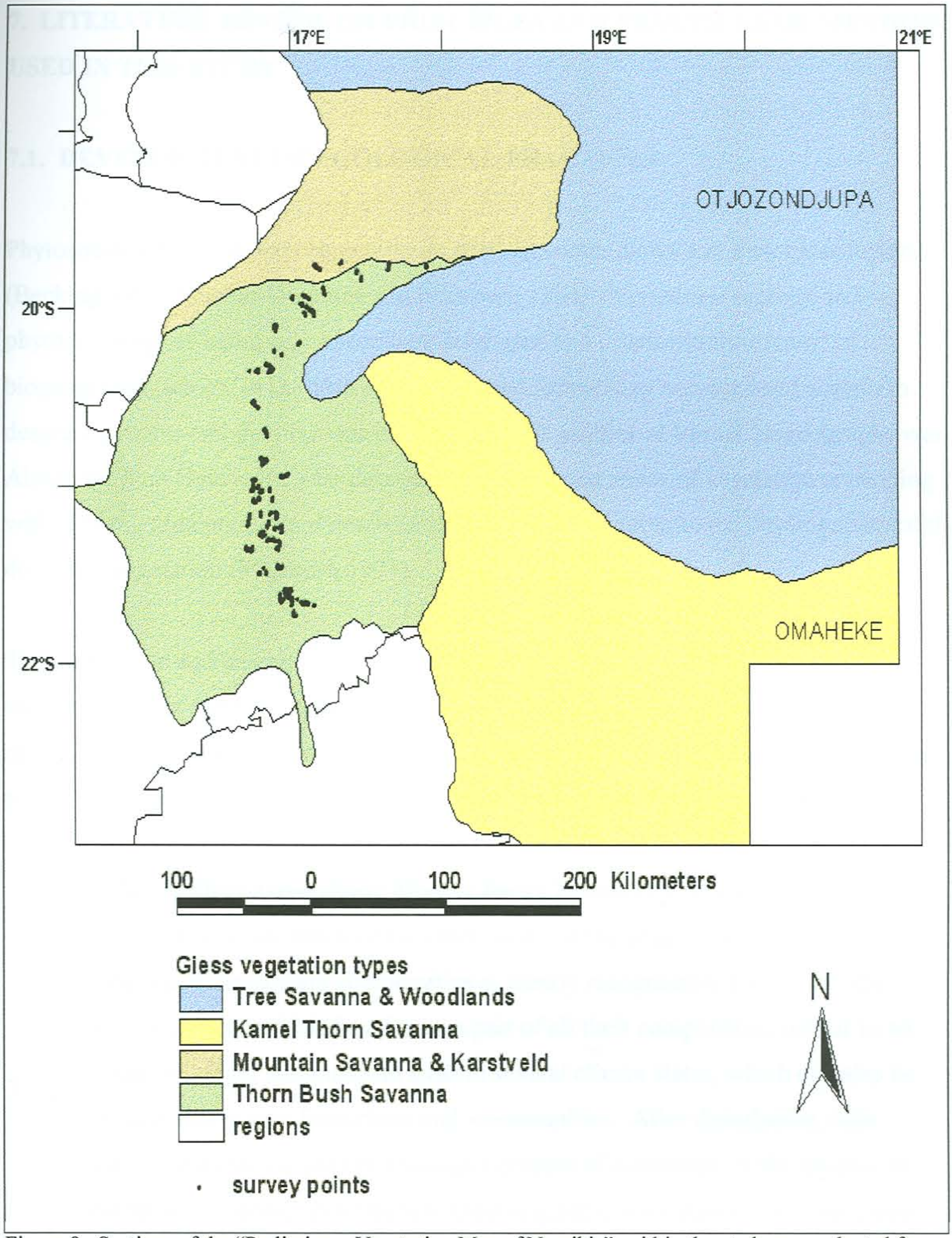


Figure 8: Sections of the "Preliminary Vegetation Map of Namibia" within the study area, adapted from Giess (1971).

7. LITERATURE REVIEW ON PRINCIPLES AND PRACTICES OF METHODS USED IN THIS STUDY

7.1. DEVELOPMENT OF ECOLOGICAL PRACTICES

Phytosociology studies the characteristics of plant communities and their classification (Becking 1957, Mueller-Dombois and Ellenberg 1974). Vegetation ecology and phytosociology as being part of ecology developed as a science in the context of biogeography, which, in the 19th century, started formalising concepts and criteria to describe patterns and distributions of organisms. A pioneer of formal biogeography was Alexander Von Humboldt, who described and measured zones of vegetation coinciding with climatic gradients. He characterised vegetation according to the physiognomy of the dominant vegetation (McIntosh 1991).

The delineation and description of a plant community has led to the development of various concepts and hence also schools of thought (with a large difference in opinion and non-acceptance between European and American and British scientists) in plant ecology, which all in the end differently contribute to vegetation description and -mapping.

i. The Holistic-Organismic Mono-Climax Theory of Clements

Clements, who did much of his initial work on the grassy plains of northern America, defined plant communities as clearly recognisable and repeatedly occurring units, which function as a part of all their components, similar to an organism. Plant communities exist in several climax states, which can also be divided into climax formations and -communities. After disturbance, such communities would always, through a process of succession in the absence of further disturbance, revert back to their original climax states (Kent and Coker 1992, McCook 1994). As this approach is practical to investigate, this approach, although recently criticised, is still widely used, e.g. as part of the "Range Succession Model" (Werger 1974, Westoby *et al.* 1989).

Clements further suggested a basic method for vegetation mapping, which consisted of a survey of the abundance of all species in a pre-defined quadratic area of vegetation (Joyce 1993).

ii. The Individualistic Species and Continuum-Concept of Gleason

Gleason stated that it is virtually impossible to describe a static plant community, as individual plant species are distributed over a continuum of environmental gradients. Successional patterns observed are thus rather the sum of individual species response to a perturbation than the response of an entire community. The co-existence of several plant species at any point in space is regarded as more coincidental, depending on the ecological adaptations of such species, and a group of species could not as such be found repeatedly in a region (Kent and Coker 1992, McCook 1994). Understandably, it is difficult to describe vegetation units especially of larger areas following this approach. Nevertheless, Gleason's concept is highly useful when studying plant species strategies and responses or plant population dynamics, see Grime 2001, Harper 1977 (quoted by Kent and Ballard 1988).

iii. The Zurich-Montpellier (Z-M) School of Phytosociology

Braun-Blanquet, as some of the most famous authors of this group, regards all plants growing in the same habitat as forming a phytocoenose. The different characteristics of phytocoenoses can be used to systematically classify the vegetation of a larger area. Any change in habitat will in due time be reflected by the characteristics of the phytocoenose. Another term for phytocoenose was "association", which is basically as "abstract" plant community, being characterised and defined according to the taxonomic species concept (Becking 1957, Mueller-Dombois and Ellenberg 1974).

This plant community as a basis of a phytosociological classification was first defined in 1910 by Schröter and Flahault (quoted by Werger 1974) as: an association, which has a definite floristic composition, a uniform physiognomy and is bound to uniform habitat conditions. Associations are defined according to their total floristic composition.

Associations may be subdivided into sub-associations and variants, which are characterised by their respective differential species. Associations may also be combined into alliances and the latter into orders, based on characters and differential species. Orders again can be combined into vegetation classes, based on vegetation characteristics (Becking 1957, Werger 1974).

The Z-M methodology has become popular in southern Africa, these days being regarded as the standard method used in vegetation descriptions (Volk and Leippert 1971 and Werger 1973 in Werger 1974). This methodology has been well described by various workers (Werger 1974, Mueller-Dombois and Ellenberg 1974, Le Houerou 1974). In short, it consists of different phases, viz.: (a) reconnaissance study in which the worker familiarises himself with the flora and the area to be studied, (b) Inventory consisting of detailed data collection by means of relevés, looking at both environmental and floristic characters, (c) data analysis, usually by classification techniques to group the various phytocoenoses into synthetic higher units and (d) usually as an end result the mapping of the defined synthetic units. These units are named according to the guidelines of the International Code of Phytosociological Nomenclature (3rd edition by Weber *et al.* 2000).

Present-day viewpoints of plant communities accept the community-unit theory, and vegetation of a region being a mosaic of such community units (Kent and Coker 1992). Further, it has become common practice to combine concepts of the different schools of thought, especially in the study and description of vegetation patterns linked to underlying environmental gradients. Systematic classifications of communities are verified by ecological criteria simplified by ordination techniques (Mueller-Dombois and Ellenberg 1974, Gauch 1986, Kent and Ballard 1988, Bredenkamp *et al.* 1983).

7. 2. CHOICE OF METHODS OF DATA ANALYSIS IN VEGETATION DESCRIPTION

A wide range of techniques of data analysis have been devised for both classification and ordination, which is often bewildering and confusing to ecologists who are not specialist of these methods themselves. Throughout the literature there seems to be little consensus over which methods should be used in general vegetation descriptions, further compounded by a vast number of publications on methods themselves, rather their practical use. Rather than stating why a specific technique was used, many authors apparently use the "latest", assuming it to be the best method available (Kent and Ballard

1988). Multivariate data analysis has been described in detail by several authors (Mueller-Dombois and Ellenberg 1974, Whittaker 1978 and 1982, Gauch 1986, Kent and Coker 1992).

For the purpose of vegetation description and -mapping, the following has been applied in many publications (see below) and can be recommended:

Relevés should be grouped with a classification procedure, e.g. TWINSPAN (Two-Way Indicator Species Analysis), which is supported by the TWINSPAN PC program. One advantage is that a relatively large data set, which will inevitably be collected for describing vegetation units of a larger area, are easily handled and simplified by such a classification procedure. A TWINSPAN classification is often refined using Braun-Blanquet procedures (Gauch 1986, Kent and Ballard 1988, Kent and Coker 1992, Bredenkamp and Bezuidenhout 1995, Hill 1996, Hoare and Bredenkamp 1999).

The most widely used ordination techniques are Principal Components Analysis (PCA), Detrended Correspondence Analysis (DCA) and Canonical Correspondence Analysis (CCA) (Kent and Ballard 1988). The choice of method depends on the data set available and the outcome hoped for.

PCA is a multivariate statistical technique, determining the axes by a linear combination of weighted species abundances. Much criticism has been given to this ordination technique because it is based on a linear model. It is best applied where data from a relatively narrow range of environmental and compositional data exist. Despite it's shortcomings, this makes it an easy method to apply to "summarised data", e.g. a data-set already classified into communities, adding environmental data, to make some ecological sense of the data set (Ludwig and Reynolds 1988, Kent and Ballard 1988).

DCA is useful to detect possible relationships or gradients in and between plant communities, while also detecting the more important habitat gradients influencing the vegetation. Usually, DCA is performed as a second, independent step after communities have been delimited, but the most important habitat factors influencing these communities need to be defined. DCA, like the classification, ordinates samples according to their floristic characteristics, while environmental gradients are inferred from species composition data, therefore resulting in a indirect gradient analysis patterns (Palmer 1993, Bezuidenhout *et al.* 1994, Hill 1996). Environmental variables used here are not necessarily specifically measured at each relevé.

CCA is a direct gradient analysis, which includes environmental factors as independent variables and species and sample data as dependent variables. CCA is thus useful if no prior classification of communities has been done, but detailed environmental variables have also been recorded for each relevé. Although CCA is regarded the most accurate of all ordination methods (Palmer 1993), its success depends on detailed environmental variables.

7.3. VEGETATION MAPPING WITH THE AID OF REMOTE SENSING

Vegetation classifications themselves are based on measurements made directly in the field. Vegetation maps, on the other hand, while relying on some guidance from field data, are mostly constructed manually or processed digitally from remotely sensed data (Plumb 1991). Thematic maps are in essence highly generalised abstractions of reality, especially in terms of their spatial resolution, boundary delineation and classification detail. Maps derived from remotely sensed data are based on units that can be spectrally separated. A drawback is that cartographers interpreting digital data become so involved in identifying spectrally separable units, that the nature of the vegetation these units represent is neglected (Plumb 1991, Tanser and Palmer 2000). This is further complicated by what cartographers, even after 20 years of development of image processing techniques, refer to as the "difficult third dimension" of vegetation: Existing remote sensing techniques are very effective in detecting vegetation structural types or percentage cover or stress symptoms, but is less able to discriminate different species assemblages like plant communities or variations thereof (Lewis 1998, Bork *et al.* 1999). The use of various vegetation indices, of which the NDVI is probably the best known, are used on a regular basis to assess plant production or drought stress, but cannot be used to delimit vegetation on a much finer scale than biome-level. However, it is exactly this understanding of specific types of vegetation composition which is important to environmental management and monitoring, e.g. on a farmland scale (Lewis 1998, Bork *et al.* 1999, Strohbach 2001). The other reality is that in countries such as Namibia the area to be mapped is so vast and baseline data so limited, that only a small proportion of the area on the ground can actually be visited for field evaluation with common time- and financial constraints (Stoms 1996, Strohbach 2001). It is thus a great advantage if, for the larger part of a potential vegetation map, the cartographer can rely on remotely sensed data, bearing in mind its limitations (Tanser and Palmer 2000, Langley *et al.* 2001).

Vegetation maps of spectral images are created by classification of spectral signatures contained within each pixel (Albertz 2001). Ideally, such image classification should recover the true class of every point in the image. In practice, a classification can only recover dominant classes (spectral signatures) of each pixel. A strong correspondence is definitely apparent between most plant associations classified by traditional field method and the different categories of spectral characteristics, but there are often vegetation types which overlap spectrally (ERDAS 1997, Albertz 2001). Even more confusing is the occurrence of vegetation types, especially with a very patchy structure such as open savannas, are represented by a very broad range of spectral characteristics, which a processing program may inevitably misclassify. Looking at the image itself there may be mixed pixels which may overlap two well-defined classes, or the spectral discrimination between classes is so minute that misclassifications may be common. Such cases are especially true where vegetation is sparse, with a high degree of open soil or rock confusing the spectral image of the vegetation (Plumb 1991, Goodchild 1994, Lewis 1998, Tanser and Palmer 2000). This brings about some major uncertainty in image processing which cannot be resolved without the knowledge of the actual circumstances on the ground. It is very important that vegetation mapping is not done with remote sensing alone, a classification of field measurements of the vegetation is indispensable (Frederiksen and Lawesson 1992, Akthar *et al.* 1995, Bork *et al.* 1999).

The accuracy of an image classification can be compared to a vegetation classification with statistical matrices, of which the Kappa statistic is the most widely used. It calculates the percentage of misclassified pixels. Statistical methods should be used with caution though - accuracy assessments are regarded most effective for small-scale mapping with a high spatial resolution and relatively few classes. The requirements for statistically sound measures of class accuracy are a minimum of 50 ground-samples to be conducted for every spectral class (Congalton 1991 in Stoms 1996 and Lewis 1998). It is appreciable that for larger area maps, such as in this study, such an amount of sampling would be very difficult to achieve for reasons mentioned above already. Added to that, on a larger scale, the cartographer chooses the level of resolution of the map which should meet the mapping objectives - finer-grain features are often treated as inherent heterogeneity. In such case boundary detection should be done either by a pre-determined number of additional samples over vegetation boundaries, or should be derived subjectively from photo-interpretation of satellite-images and/or aerial photographs. Other thematic maps, such as soil maps, may also be used to aid in boundary detection (Stoms 1996).

7.3.1 Some basic technical background on satellite image processing

Images obtained from satellites are, in their initial format, distorted, especially at the edges. This is a simply a result of the roundness of the earth's surface. Further, image quality may be poor due to haze, angle of the sun or other factors, which may be improved by various techniques. This pre-processing is rather complex and, although important, beyond the scope of this study. Following will be based on the assumption that a properly rectified and geo-referenced image is at hand.

The digital image consists of a multivariate field, with each pixel being a representative value of the spectral response measured for that particular point on earth at that particular time. In subsequent scans at a different time of day or year, such value for the same point on earth will inevitably vary (making it difficult to for e.g. combine successive or multi-temporal images). Pixel size varies for different satellite systems. For LANDSAT -7-TM, from which our images were derived, the pixel size represents roughly 30 x 30 m on the ground, meaning that relevé size of field surveys may not be smaller than this size, but preferably bigger to be used for image processing. In comparison, AVHRR images - commonly referred to as NOAA, used for NDVI calculations, have a pixel size of 1000 x 1000 m.

i. Types of image classification

There are primarily two approaches to image classification:

i.i Unsupervised multispectral classification attempts to delineate major land cover classes without prior knowledge of their identity. This can be useful in planning field sampling procedures, deciding beforehand how many samples should be representative of the classes and where these samples should be taken. Depending on the amount of classes distinguished, however, for reason mentioned above this may lead to the omission of some veld types.

Note: the use of (unclassified) false-colour composite images may be useful to effectively choose representative, homogenous areas to sample, rather than relying on the traditional reconnaissance survey alone.

i.ii ***Supervised multispectral classification*** uses statistical properties of "training sites" to identify land cover classes with similar spectral properties. These "training sites" are most sensibly chosen based on field samples, whose location can be superimposed onto a digital image, and include a pre-set minimum of pixels around this sampling point which are as closely related to the field sample as possible. Training sites are selected on screen, using imaging software such as ERDAS.

ii. Multi-temporal or single date scanned image, and which date is best?

Following the literature, there is as much argument for the use of multi-temporal images as against. Multi-temporal merely refers to the combination of images of the same scene taken at different times of the year, combined, and then classified. The successful use of any digital image for classification depends on adequate spectral contrast between vegetation types, which some authors tried to obtain by combining wet- and dry-season images. The idea behind this practice is to take advantage of phenological differences between vegetation types being more pronounced during different seasons (Lewis 1998). This approach proved very successful to discriminate between crops, but not as good for natural vegetation. Several workers have found that a single date-image, taken at the "dry-off" season, produced the best classification results. During the dry-off season (after the peak of the rainy season), some parts of the vegetation may be fully grown, other already starting to die back, thus representing the most diverse phenological stages between vegetation types (compare with Lewis 1998, Langley *et al.* 2001, Clark *et al.* 2001).

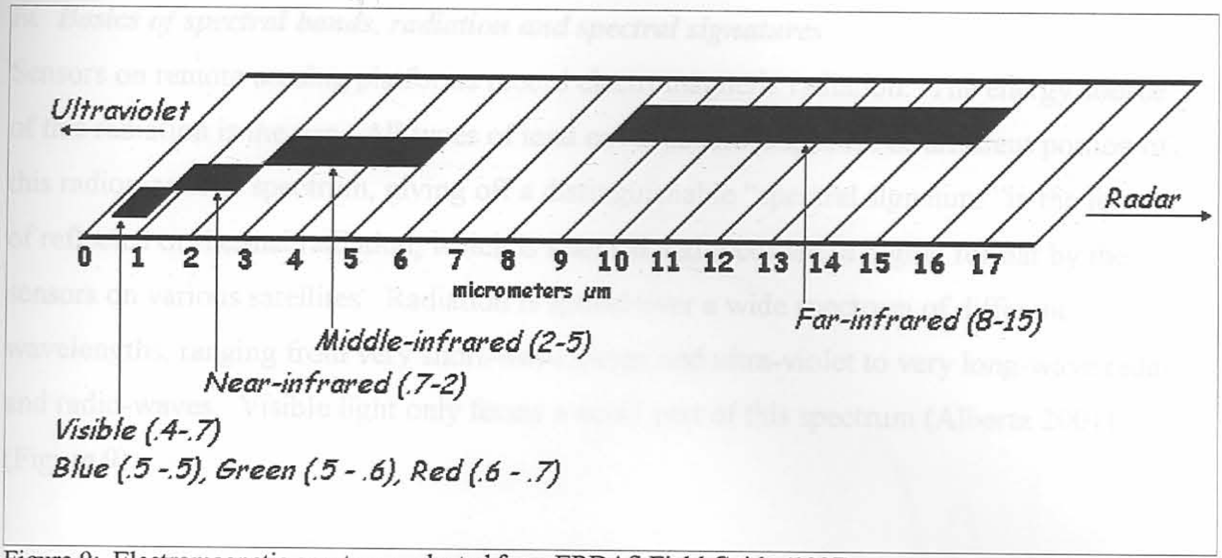


Figure 9: Electromagnetic spectrum, adapted from ERDAS Field Guide (1997).

iii. Minimum requirements of field sampling and data analysis for the most realistic spectral classification

Several early workers have collected floristic data only, but that alone will not suffice to try to understand very heterogeneous vegetation patterns. Based on above discussions, it is thus recommended that for the best correlation of classifications of a digital image with objective numeric vegetation classifications, following guidelines should be followed:

- to quantify vegetation, plant cover estimates rather than density or presence/absence should be recorded
- inclusion of physical cover, e.g. % bare soil or summation of total vegetation cover is often useful, this is especially important in more arid habitats where total vegetation cover is sparse
- incorporation of abiotic factors (habitat) for vegetation classification is likely to result in a stronger relationship between spectral and vegetation classification
- use of an objective classification of field data prior to satellite image classification is advisable; should certain standardized classification methods be preferred in a region, e.g. TWINSPAN in southern Africa, use such methods on a preferential (albeit not exclusive) basis
- when choosing training sites for the spectral classification, select as many sample sites typical of vegetation-units (identified by the classification of the field-data) as possible. Avoid outliers, as these will most likely also result in "outlier" spectral signatures, which should be excluded from the classification of satellite data.

iv. Basics of spectral bands, radiation and spectral signatures

Sensors on remote sensing platforms record electromagnetic radiation. The energy source of this radiation is the sun. All types of land cover absorb a specific or different portion of this radiomagnetic spectrum, giving off a distinguishable "spectral signature" in the form of reflected or thermal radiation, which is scanned and recorded in digital format by the sensors on various satellites. Radiation is spread over a wide spectrum of different wavelengths, ranging from very short-wave x-rays and ultra-violet to very long-wave radar and radio-waves. Visible light only forms a small part of this spectrum (Albertz 2001) (Figure 9).

Specific wavelengths are absorbed by gases in the atmosphere, some so strong, that scanned values do not give sensible images. Multispectral scanners such as LANDSAT -7-ETM (ETM = Enhanced Thematic Mapper), have different sensors scanning different wavelengths, which are carefully selected to avoid wavelengths which are mostly absorbed (Albertz 2001) (Figure 10).

LANDSAT ETM band 3 (0.63 - 0.69 µm) is an important band for vegetation discrimination, known as the red chlorophyll absorption band. It is largely controlled by chlorophylls a and b, as well as leaf pigments such as carotenoids, xanthophylls and anthocyanins. Band 4 (0.76 - 0.90 µm) is sensitive to canopy cover of vegetation biomass - it is controlled by cell structures. Leaves from the top of the canopy may reflect 50-60% of the near-infrared radiation, while lower leaves may re-transmit such radiation back through the upper canopy. Band 5 (1.55 - 1.73 µm) is sensitive to the water-content of vegetation, hence reflect vegetation stress or disease, which affects leaf turgor. Wilted leaves scatter less light, therefore increasing the reflectance of red (band 3) and a decrease in mid-infrared due to a decrease of chlorophyll and water content. Thus, band 3,4, and 5 are usually selected for image processing in vegetation studies (Albertz 2001, Langley *et al.* 2001).

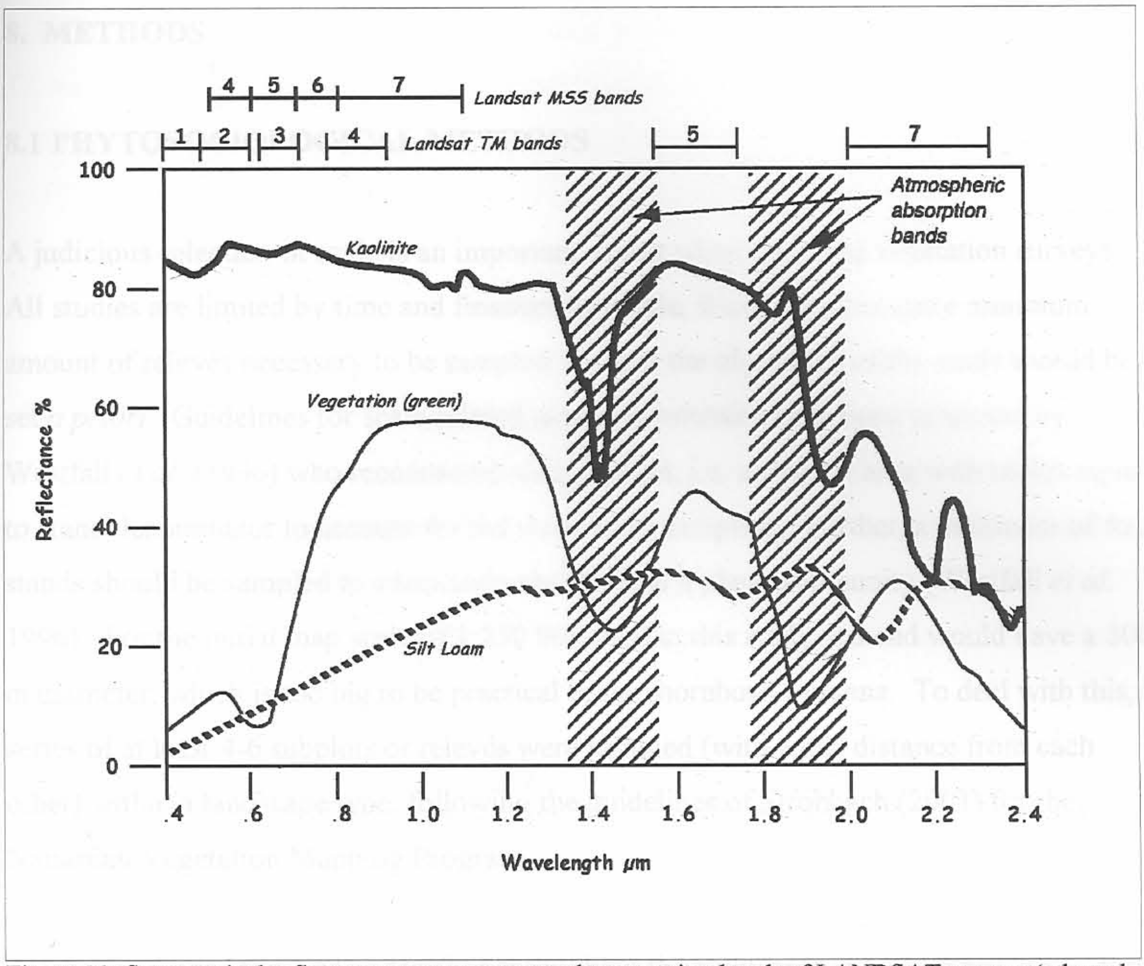


Figure 10: Some typical reflectance spectra compared to scanning-bands of LANDSAT sensors (adapted from ERDAS field guide)

8. METHODS

8.1 PHYTOSOCIOLOGICAL METHODS

A judicious selection of scale is an important aspect when initiating vegetation surveys. All studies are limited by time and finances available, thus an approximate minimum amount of relevés necessary to be sampled to reach the objectives of the study should be set *a priori*. Guidelines for scale-related sampling intensity have been proposed by Westfall *et al.* (1996) who recommend using a stand, i.e. a circular area with radius equal to stand denominator to account for the scale when sampling. Further, a minimum of four stands should be sampled to adequately characterise a plant community (Westfall *et al.* 1996). For the initial map scale of 1:250 000 used in this study, a stand would have a 500 m diameter, which is too big to be practical in the thornbush-savanna. To deal with this, a series of at least 4-6 subplots or relevés were sampled (with equal distance from each other) within a landscape type, following the guidelines of Strohbach (2001) for the Namibian Vegetation Mapping Program.

A reconnaissance trip was undertaken throughout the study area in early April 2001, during the peak rainy season, when especially herbs and lower shrubs were in flower and could be collected for positive identification. At this time, only notes were taken on major vegetation structures and types encountered, and a priority-list of areas (commercial farms) to be investigated compiled.

For the purposes of the study, The German Remote Sensing Data Centre of the German Aerospace Centre (DLR) acquired satellite maps of LANDSAT-7-ETM for the study area. The study area was covered by images 178/74 and 178/75 (Numbers indicating Path and Row of the satellite), for May 2000 and again May 2002. From these images, a false-colour composite image of bands 4/5/3 (maps 1 and 2, Appendix 4) was used to refine the priority-list of the reconnaissance survey, ensuring that all major vegetation types occurring within the study area would be adequately sampled. It was estimated that a minimum of 250 - 300 sample sites should be sufficient to sample the vegetation types. Of course, once being in the field, this number rose as different variations of vegetation types were also regarded large enough to warrant a separate characterisation. In total, 425 relevés were recorded during the main growing seasons (Mid-February to Mid-May) of

2001 and 2002. A set of 42 relevés was added to the data set from the BIOTA Observatories situated on the farms Erichsfelde and Omatako-Ranch (Austermühle 2001) and forming part of the vegetation transect. Keeping with BIOTA sampling procedures and limited by time, sampling was strictly kept to the plains, occasional inselbergs within the study area were left out.

In accordance with the standardisation of methods for BIOTA as well as the Namibian Vegetation Survey, the size of relevés was pre-set at 1000 m^2, measuring 20 x 50 m. Samples were laid out in an W-E direction, unless where topography or other landscape features such as relatively narrow riverine vegetation made this impractical, to ensure the homogeneity of the sampling area. Bearing in mind the pixel size of the satellite imagery (30 x 30 m), relevés on narrow strips of distinct vegetation types were always placed in a manner to avoid going below this pixel size.

For every sampling site, a relevé with the following data was produced (see standard data sheet (Strohbach 2001) in Appendix 3):

- GPS reading, with the GPS set to the Schwarzeneck Map Datum. Additional information on locality includes region, district, farm- or locality name, and short description of sampling site.

- Habitat information including slope, terrain type, aspect, stone cover estimation, parent material (lithology) where visible, erosion severity, disturbances and surface sealing/crusting. Following the "Feel Method" (Figure 11) (Foth *et al.* 1980, Arbeitsgruppe Boden 1996), soil texture was determined.

- The NARIS database (AEZ 2001) was used to derive long-term mean annual rainfall and major soil types for each relevé. Similarly, geological substrata and formations were derived from the Geological Map of Namibia (Geological Survey 1980).

- Vegetation information recorded: a full list of species present. Unless geophytes could be positively identified, not much attention is given to them (following Strohbach 2001). Herbarium specimens with corresponding collection data were collected for all unknown species for subsequent identification at the National Botanical Research Institute in Windhoek.

- Each species was recorded according to height class, following Edwards (1983) together with major growth form - tree, shrub, grass, and herb. Cover abundance for species in every height class was estimated using crown cover, recorded as actual percentage cover. For the purpose of developing skills in estimating crown cover, the Plant Number Scale methodology of Westfall & Panagos (1988) was used initially, and was also compared to estimates of co-workers of BIOTA whenever possible.

- Each sampled relevé was photographed to document landscape as well as vegetation structure at the time of survey.

The TURBOVEG PC package (Hennekens 2000) was used for data entry. The Megatab-function of this package was further used to execute a TWINSPAN (Hill 1979) classification on the data set. The TWINSPAN classification with refined by combining small TWINSPAN groupings into definable vegetation associations. Further, within each association species order was re-arranged to have a better overview of common, dominant and diagnostic species (see TWINSPAN Tables in Appendix 1.2.).

The main environmental factors responsible for the distribution of the defined species associations were determined by subjecting the divided data-set (divided into the groups of the first TWINSPAN separation - see Figure 16 under Section 9.2) to both PCA and DCA ordination, using PC-ORD (McCune & Mefford 1995).

Plant communities identified by the TWINSPAN program were combined into associations, which can be regarded as management units (see introduction) following the approach of Acocks (1988). The International Code of Phytosociological Nomenclature, (Weber *et al*. 2000) was followed for the naming of the associations after their most characteristic species. However, a formal classification and naming of plant communities and associations was beyond the scope of this study, as it only covered a strip of larger vegetation types and needs to be verified in future studies for the entire vegetation type. This would also make it irrelevant to select type relevés, which would be required to formerly name such plant communities or associations (Weber *et al*. 2000).

To Start:

take a small handful of soils and add water until the soil is plastic and molable like moist putty

↓

does soil remain in a ball when squeezed? **no** **yes→** ↓	**SAND**

form a ribbon of uniform width and thickness with the soil and push up between thumb and forefinger

↓

does soil form a ribbon? **yes** **no→** ↓	**LOAMY SAND**

allow the ribbon to extend over the forefinger, breaking from its own weight

↓

ribbon weak and less than 2.5 cm long before breaking **yes** **no→** ↓	ribbon medium strength and 2.5 - 5 cm long before breaking **yes** **no→** ↓	ribbon strong and >5cm before breaking **yes** ↓

excessively wet a part of the soil and rub between fingers

↓

SANDY LOAM	does soil feel very gritty **←yes** **no** ↓	**SANDY CLAY LOAM**	does soil feel very gritty **←yes** **no** ↓	**SANDY CLAY**	does soil feel very gritty **← yes** **no** ↓
SILT LOAM	does soil feel very smooth **←yes** **no** ↓	**SILTY CLAY LOAM**	does soil feel very smooth **← yes** **no** ↓	**SILTY CLAY**	does soil feel very smooth **← yes** **no** ↓
LOAM	neither grittiness or smoothness predominates **←**	**CLAY LOAM**	neither grittiness or smoothness predominates **←**	**CLAY**	neither grittiness or smoothness predominates **←**

Figure 11: determining soil texture by the "Feel Method", adapted from Foth *et al.* (1980)

8.2. IMAGE PROCESSING OF SATELLITE DATA TO ASSESS THE DISTRIBUTION OF THE MAJOR VEGETATION TYPES OF THE STUDY AREA

All image processing was done at and with the assistance of staff of the DLR in Porz, Germany. All processing was done using the ERDAS PC package (ERDAS 1997).

8.2.1 Pre-processing of the satellite image

For the classification process, LANDSAT-7-ETM images 178-74 and 178-75, both taken on 17 May 2000, were used. Both images were previously spectrally enhanced and geo-rectified. Image classification is based on the same process as vegetation classification - taking all samples (here pixels) of a data set (here the entire image) and assigning them to a vegetation class. Looking at the false-colour composite images (and confirmed by rough unsupervised classifications of the entire scene), on the image there are several vegetation types which are not represented in the study area, thus not sampled, and it would be unrealistic to include these in a classification. Further, as sampling was limited to plains only, including the reflectance of the few inselbergs present would lead to further misclassifications. Hence, an AOI (Area of Interest) was defined for both images, which extracted the image of the study area only, while Inselbergs were removed from the scene using an elevation model. These AOI's were used for further image processing.

8.2.2. Image Classification process

i. For every region on earth, ideal projection-parameters have been set for geographic data - this has been set according to the path the satellites follow, as well as the curvature of the earth in relationship with the scanned image, ensuring a correct projection of remotely-sensed data onto a map. For Namibia, maps are projected according to the Schwarzeneck map-datum - which is used when e.g. collecting reference points with GPS on the position of a sample. Unfortunately, ERDAS can convert data back into Schwarzeneck, but has problems working with Schwarzeneck data, as the system does not have this map datum as an option. As the classification process is a relatively exact science, relying on the correct assignment of single pixels to a vegetation group, all GPS reference points were first converted to WGS 84, before being transformed into lat.-long data which could be placed onto the satellite image.

ii. Starting with the mapped GPS reference points and going back to field notes, where it was recorded in which direction the sample was laid out (and hence more homogenous vegetation could be found), training sites were selected manually around every point. The basic operation compares the similarity of surrounding pixels to the "model pixel" according to a predefined similarity-limit, and then marks the pixels as a polygon-class, which can be used in the classification process. A minimum of 4, but preferably 8-12 pixels were considered desirable for a training site. Some samples could not yield enough pixels for a training site - meaning the vegetation is too heterogeneous to be used in a satellite classification, and were removed from the classification.

iii. As every vegetation association is still relatively diverse, especially when looking at the typical shrub/grass structure of savannas - a rough classification may lead to over-generalisation errors in the classification. For a successful satellite-image classification, spectral signatures of a class must be as "clean" as possible, thus should follow nearly identical peaks and curves. To speed up the signature-selection process, the original classification-classes of TWINSPAN (53 in total, see Dendogram Figure 16 under Section 9.2.) were used to assign the training sites to, thus obtaining preliminary classes of training sites.

iv. For all classes of training sites, the spectral signatures were viewed - combined into higher classes when they were very similar, but usually subdivided further where definite groups of signatures could be identified. A minimum of 3-4 similar signatures were considered sufficient to define a signature-class, samples with single very different signatures were discarded from the classification.

v. A supervised classification was done using the signature-classes defined above, and the print-out of this classification was compared to field notes to assess accuracy as well as interpret possible reasons for differences in spectral signatures - usually a result of differing vegetation structure and density.

vi. This classification was repeated until the author was satisfied that classes identified by ERDAS were representative of the vegetation on the ground. Subsequently, these "subclasses" were simply combined using the same colour-coding for the different classes into the vegetation associations defined by the phytosociological classification to view the distribution of these associations throughout the study area.

vii. For a first approximation of mappable vegetation types (on a scale of 1:250 000 and smaller), vegetation associations were grouped together based on vegetation data as well as comparisons to previous vegetation descriptions (e.g. Giess 1971). Again, associations were combined into "approximate vegetation types" by assigning the same colour coding to the associations of a vegetation type.

9. RESULTS AND DISCUSSION

9.1 TAXONOMIC OVERVIEW OF SPECIES RECORDED DURING THE SURVEY

During surveys conducted for this study, a total of 457 plant species were recorded. An overview of the number of species per recorded vegetation layer, as well as taxonomic groupings are given in Tables 2 and 3 respectively. A fully annotated species list is given in Appendix 2.

Table 2: Number of species per recorded layer, based on fully-grown specimens (e.g. *Albizia anthelmintica* is calculated as tree, although it may often appear as low shrub).

Layer recorded	***Number of plant species per layer***
Herbs	218
Annual grasses	33
Perennial grasses	52
High shrubs (nano-phanerophytes)	52
Low shrubs (chamaephytes/hemicryptophytes)	84
Trees (micro- and meso-phanerophytes)	18
Total	*457*

It should be noted here that throughout the analysis of data species names, as they are represented in the last update of TURBOVEG, have been kept to avoid potential errors and omissions whilst running various PC-programs. The latest name changes (Craven and Kolberg 1999) are indicated on the species list in Appendix I. Further, based on available literature (Ross 1979, Coates Palgrave 1984, Van Wyk and Van Wyk 1997) as well as identifications by taxonomists of the National Botanical Research Institute in Windhoek, no distinction could be made between the species *Acacia reficiens* Wawra ssp. *reficiens* and *Acacia luederitzii* Engl. var. *luederitzii*. Hence, these two species were treated throughout the study as *A. reficiens*.

Table 3: Taxonomic grouping of recorded plant species of the study area, indicating number of species per genera in the various families

Family	Number of genera (Species)	Genera (species)
Ophioglossaceae	1 genus (1 species)	*Ophioglossum* (1)
Pteridaceae	1 genus (1 species)	*Cheilanthes* (1)
Marsileaceae	1 genus (1 species)	*Marsilea* (1)
Poaceae	36 genera (84 species)	*Andropogon* (2), *Anthephora* (2), *Aristida* (8), *Bothriochloa* (1), *Brachiaria* (6), *Cenchrus* (1), *Chloris* (1), *Coelachyrum* (1), *Craspedorhachis* (1), *Cymbopogon* (1), *Cynodon* (1), *Dactyloctenium* (2), *Dichanthium* (1), *Digitaria* (3), *Diplachne* (1), *Eleusine* (1), *Enneapogon* (3), *Eragrostis* (16), *Fingerhuthia* (1), *Heteropogon* (2), *Melinis* (3), *Microchloa* (1), *Monelytrum* (1), *Oropetium* (1), *Panicum* (3), *Pogonarthria* (2), *Schmidtia* (2), *Setaria* (2), *Sorghum* (1), *Sporobolus* (3), *Stipagrostis* (2), *Tragus* (2), *Tricholaena* (1), *Triraphis* (1), *Urochloa* (3), *Willkommia* (1)
Cyperaceae	6 genera (9 species)	*Bulbostylis* (1), *Cyperus* (4), *Kyllinga* (1), *Kyllingiella* (1), *Mariscus* (1), *Monandrus* (1)
Commelinaceae	1 genus (3)	*Commelina* (3)
Colchicaceae	2 genera (2 species)	*Gloriosa* (1), *Ornithoglossum* (1)
Asphodelaceae	1 genus (2 species)	*Aloe* (2)
Hyacinthaceae	2 genera (2 species)	*Urginea* (1), *Lindneria* (1)
Asparagaceae	1 genus (3 species)	*Asparagus* (3)
Amaryllidaceae	2 genera (2 species)	*Boophane* (1), *Nerine* (1)
Velloziaceae	1 genus (1 species)	*Xerophyta* (1)
Iridaceae	2 genera (3 species)	*Gladiolus* (1), *Lapeirousia* (2)
Santalaceae	1 genus (1 species)	*Thesium* (1)
Olacaceae	1 genus (2 species)	*Ximenia* (2)
Polygonaceae	1 genus (2 species)	*Oxygonum* (2)
Chenopodiaceae	1 genus (2 species)	*Chenopodium* (2)
Amaranthaceae	10 genera (12 species)	*Achyranthes* (2), *Aerva* (1), *Alternanthera* (1), *Amaranthus* (1), *Hermbstaedtia* (2), *Kyphocarpa* (1), *Leucosphaera* (1), *Nelsia* (1), *Pupalia* (1), *Sericorema* (1)
Nyctaginaceae	3 genera (4 species)	*Boerhavia* (2), *Commicarpus* (1), *Phaeoptilum* (1)
Gisekiaceae	1 genus (2 species)	*Gisekia* (2)
Molluginaceae	2 genera (5 species)	*Limeum* (4), *Mollugo* (1)
Aizoaceae	3 genera (3 species)	*Aizoon* (1), *Tetragonia* (1), *Trianthema* (1)
Portulacaceae	2 genera (6 species)	*Portulaca* (2), *Talinum* (4)
Caryophyllaceae	1 genus (1 species)	*Polycarpaea* (1)
Illecebraceae	1 genus (1 species)	*Pollichia* (1)
Brassicaceae	2 genera (2 species)	*Erucastrum* (1), *Lepidium* (1)
Capparaceae	3 genera (11 species)	*Boscia* (2), *Cleome* (6), *Maerua* (3)
Crassulaceae	2 genera (3 species)	*Crassula* (1), *Kalanchoe* (2)
Vahliaceae	1 genus (1 species)	*Vahlia* (1)
Fabaceae	28 genera (57 species)	*Acacia* (12), *Albizia* (1), *Chamaecrista* (2), *Crotalaria* (6), *Cullen* (1), *Dichrostachys* (1), *Dolichos* (1), *Elephantorrhiza* (1), *Indigastrum* (1), *Indigofera* (7), *Lablab* (1), *Lessertia* (1), *Lonchocarpus* (1), *Lotononis* (2), *Macrotyloma* (1), *Mundulea* (1), *Neorautanenia* (1), *Otoptera* (1), *Peltophorum* (1), *Ptycholobium* (1), *Requienia* (1), *Rhynchosia* (3), *Rothia* (1), *Senna* (1), *Sesbania* (1), *Tephrosia* (4), *Tylosema* (1), *Zornia* (1)
Geraniaceae	1 genus (1 species)	*Monsonia* (1)
Oxalidaceae	1 genus (1 species)	*Oxalis* (1)
Zygophyllaceae	1 genus (1 species)	*Tribulus* (1)
Simaroubaceae	1 genus (1 species)	*Kirkia* (1)
Burseraceae	1 genus (6 species)	*Commiphora* (6)
Malpighiaceae	1 genus (1 species)	*Triaspis* (1)
Polygalaceae	1 genus (1 species)	*Polygala* (1)
Euphorbiaceae	7 genera (10 species)	*Acalypha* (2), *Cephalocroton* (1), *Chamaesyce* (2), *Croton* (1), *Euphorbia* (1), *Jatropha* (1), *Phyllanthus* (2)
Anacardiaceae	3 genera (5 species)	*Lannea* (1), *Ozoroa* (2), *Rhus* (2)

Family	Number of genera (Species)	Genera (species)
Celastraceae	1 genus (1 species)	*Maytenus* (1)
Rhamnaceae	2 genera (3 species)	*Helinus* (2), Ziziphus (1)
Vitaceae	1 genus (4 species)	*Cyphostemma* (4)
Tiliaceae	2 genera (7 species)	*Corchorus* (1), *Grewia* (6)
Malvaceae	5 genera (12 species)	*Abutilon* (1), *Gossypium* (1), *Hibiscus* (7), *Pavonia* (1), *Sida* (2)
Sterculiaceae	4 genera (9 species)	*Dombeya* (1), *Hermannia* (5), *Melhania* (2), *Waltheria* (1)
Cactaceae (alien invasive)	1 genus (1 species)	*Opuntia* (1)
Thymelaeaceae	1 genus (1 species)	*Gnidia* (1)
Combretaceae	2 genera (5 species)	*Combretum* (3), *Terminalia* (2)
Ebenaceae	1 genus (1 species)	*Euclea* (1)
Oleaceae	1 genus (1 species)	*Olea* (1)
Periplocaceae	1 genus (2 species)	*Raphionacme* (2)
Asclepiadaceae	6 genera (9 species)	*Gomphocarpus* (1), *Marsdenia* (2), *Pentarrhinum* (2), *Pergularia* (1), *Sarcostemma* (1), *Stapelia* (2)
Convolvulaceae	7 genera (18 species)	*Convolvulus* (1), *Evolvulus* (1), *Ipomoea* (12), *Jacquemontia* (1), *Merremia* (1), *Seddera* (1), *Xenostegia* (1)
Boraginaceae	3 genera (7 species)	*Cordia* (1), *Ehretia* (1), *Heliotropium* (5)
Verbeneceae	3 genera (5 species)	*Chascanum* (1), *Lantana* (3), *Priva* (1)
Lamiaceae	8 genera (11 species)	*Acrotome* (2), *Becium* (1), *Clerodendrum* (2), *Hemizygia* (1), *Leucas* (2), *Ocimum* (1), *Plectranthus* (1), *Tinnea* (1)
Solanaceae	3 genera (13 species)	*Lycium* (3), *Solanum* (9), *Withania* (1)
Scrophulariaceae	8 genera (10 species)	*Aptosimum* (3), *Craterostigma* (1), *Hebenstretia* (1), *Hiernia* (1), *Lindernia* (1), *Peliostomum* (1), *Selago* (1), *Striga* (1)
Bignoniaceae	3 genera (3 species)	*Catophractes* (1), *Kigelia* (1), *Rhigozum* (1)
Pedaliaceae	3 genera (4 species)	*Harpagophytum* (1), *Pterodiscus* (1), *Sesamum* (2)
Acanthaceae	11 genera (20 species)	*Barleria* (3), *Blepharis* (4), *Dicliptera* (1), *Hypoestes* (1), *Justicia* (1), *Megalochlamys* (1), *Monechma* (4), *Peristrophe* (1), *Petalidium* (2), *Ruellia* (1), *Ruelliopsis* (1)
Rubiaceae	3 genera (5 species)	*Ancylanthos* (1), *Kohautia* (3), *Oldenlandia* (1)
Cucurbitaceae	8 genera (11 species)	*Acanthosicyos* (1), *Citrullus* (1), *Corallocarpus* (1), *Cucumis* (4), *Dactyliandra* (1), *Momordica* (1), *Trochomeria* (1), *Zehneria* (1)
Asteraceae	27 genera (38 species)	*Artemisia* (1), *Bidens* (1), *Calostephane* (1), *Dicoma* (3), *Eriocephalus* (1), *Felicia* (3), *Flaveria* (1), *Geigeria* (3), *Helichrysum* (3), *Hirpicium* (1), *Kleinia* (1), *Laggera* (1), *Launaea* (1), *Melanthera* (1), *Nidorella* (1), *Ondetia* (1), *Osteospermum* (1), *Pechuel-Loeschea* (1), *Pegolettia* (2), *Platycarpha* (1), *Schkuhria* (1), *Senecio* (1), *Tagetes* (1), *Tarchonanthus* (1), *Ursinia* (1), *Vernonia* (2), *Xanthium* (2)

9.2. PHYTOSOCIOLOGICAL ANALYSES

A classification with TWINSPAN (on MEGATAB) of the entire data set (467 relevés and 457 species) resulted in 53 subdivisions, which were, on inspection and re-arrangement of species sequences on the table, grouped together into 14 definable vegetation associations (Tables 26 to 29 in Appendix 1.2.). These associations, grouped according to the first TWINSPAN division, were further analysed using PCA (Figures 12 and 13) and DCA (Figures 14 and 15) (with PC-ORD), to detect the main underlying environmental factors influencing these vegetation units. These appeared to be primarily soil types, with rainfall gradients and geology playing a relatively strong role as well.

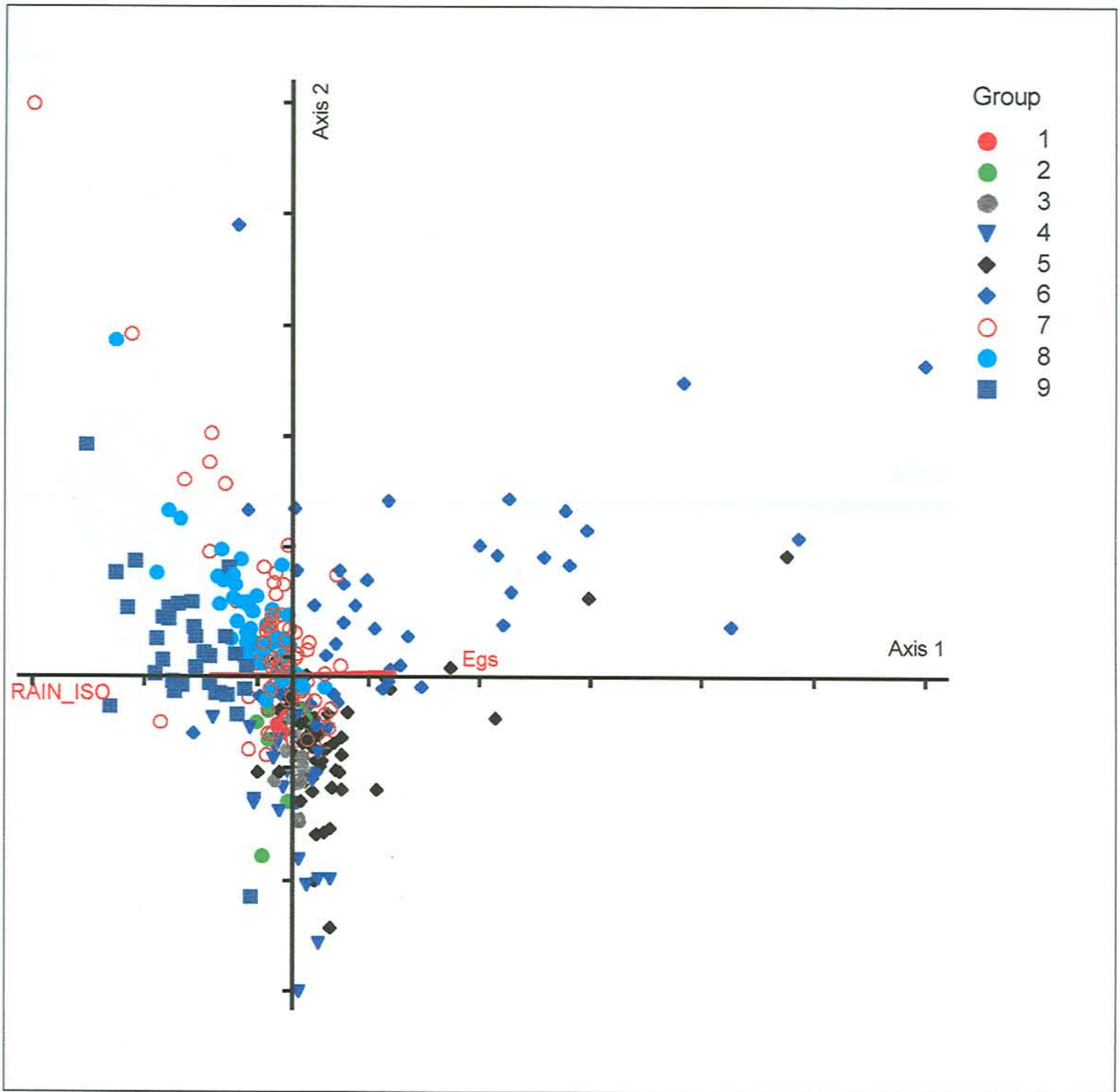


Figure 12: Principal Components Analysis of associations (labelled groups) along axis 1 and 2 for Associations 1 to 9. Egs refers to the geology of the Damara Sequence; RAIN_ISO refers to the long-term mean annual rainfall.

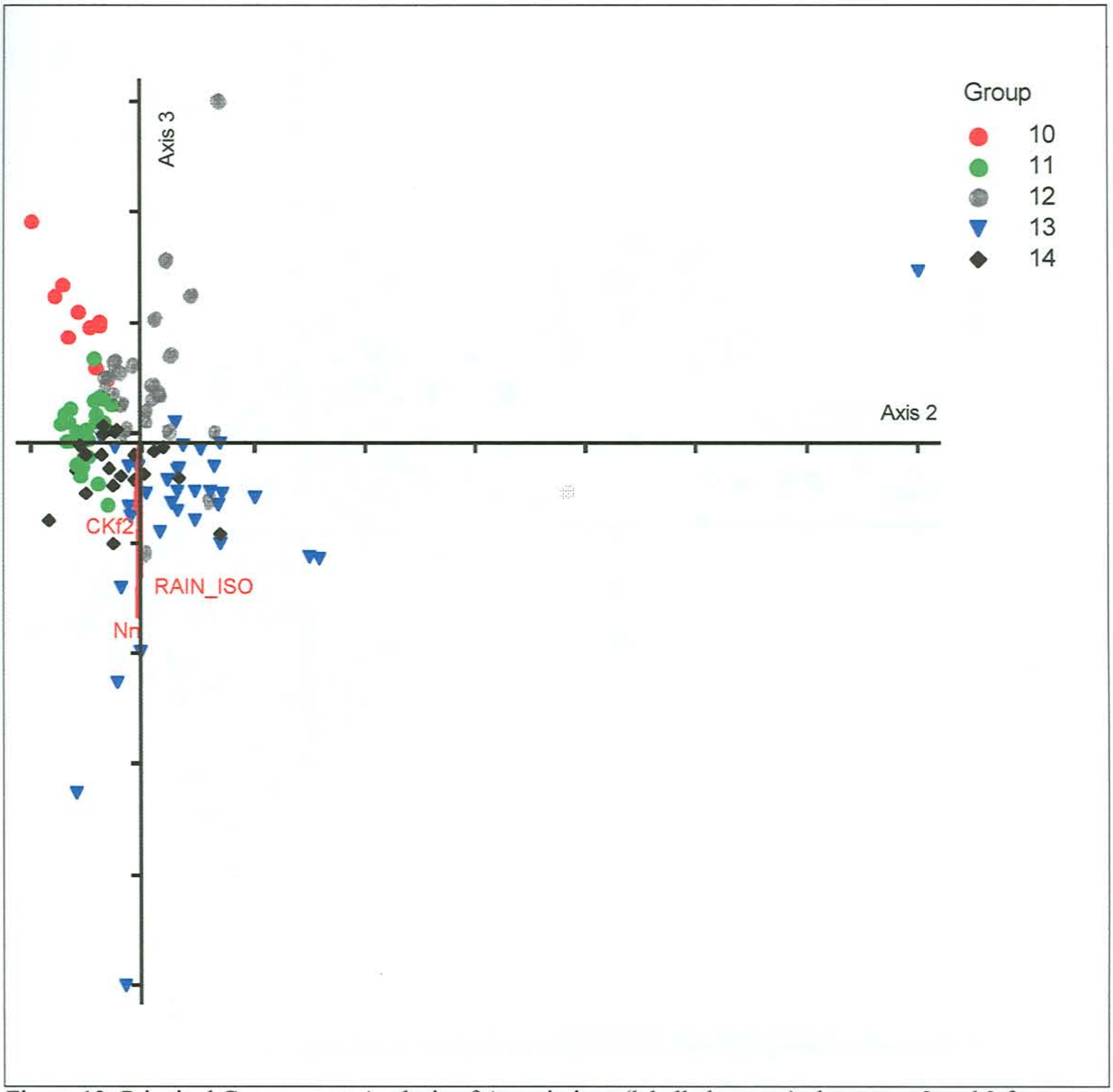


Figure 13: Principal Components Analysis of Associations (labelled groups) along axes 2 and 3 for Associations 10 to 14. CKf2 are leptic Regosols, Nn is part of the Damara Sequence, and RAIN_ISO refers to mean long-term annual rainfall.

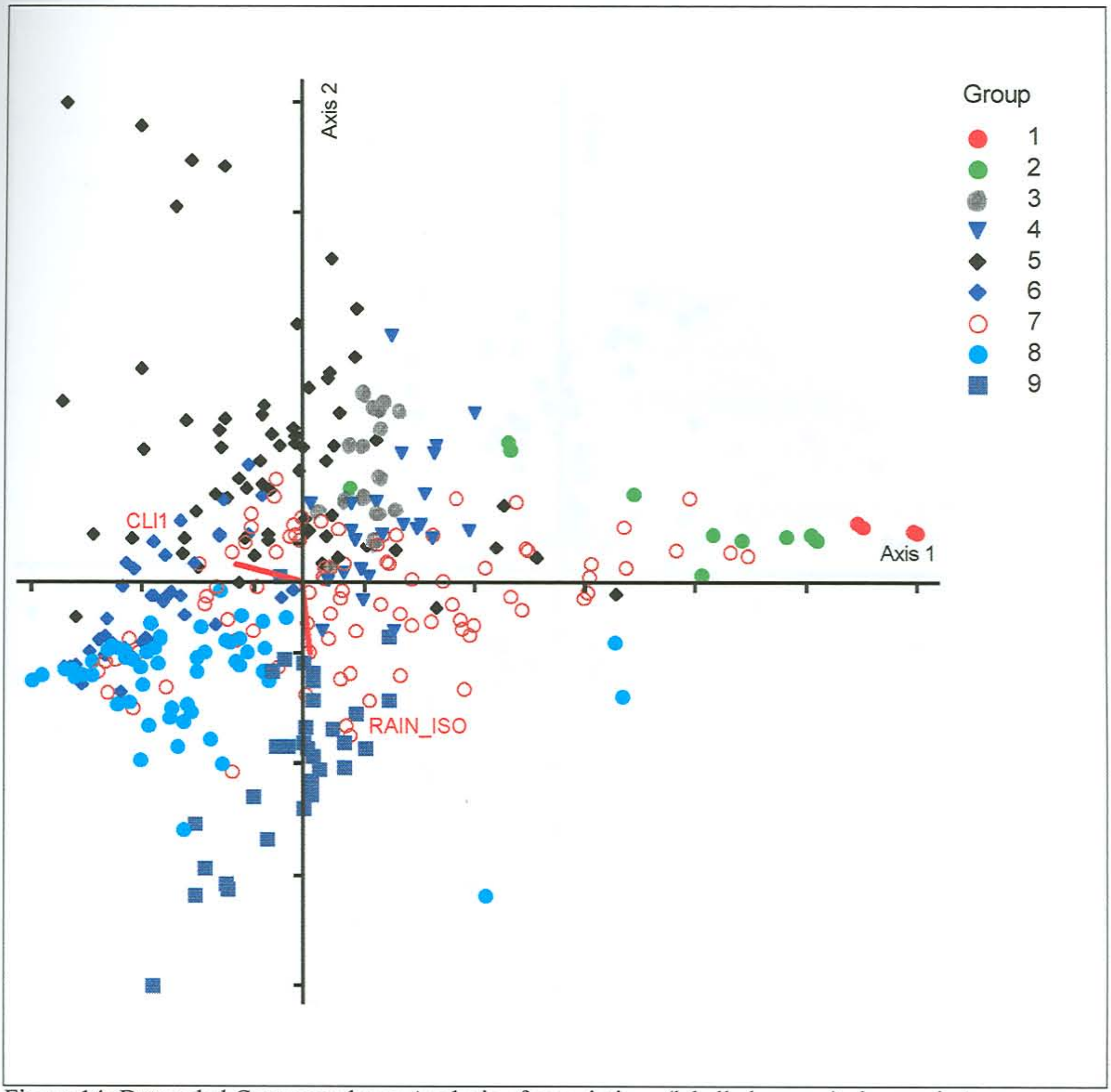


Figure 14: Detrended Correspondence Analysis of associations (labelled groups) along axis 1 and 2 for Associations 1 to 9. CLl1 are chromic Cambisols, RAIN_ISO refers to mean long-term annual rainfall.

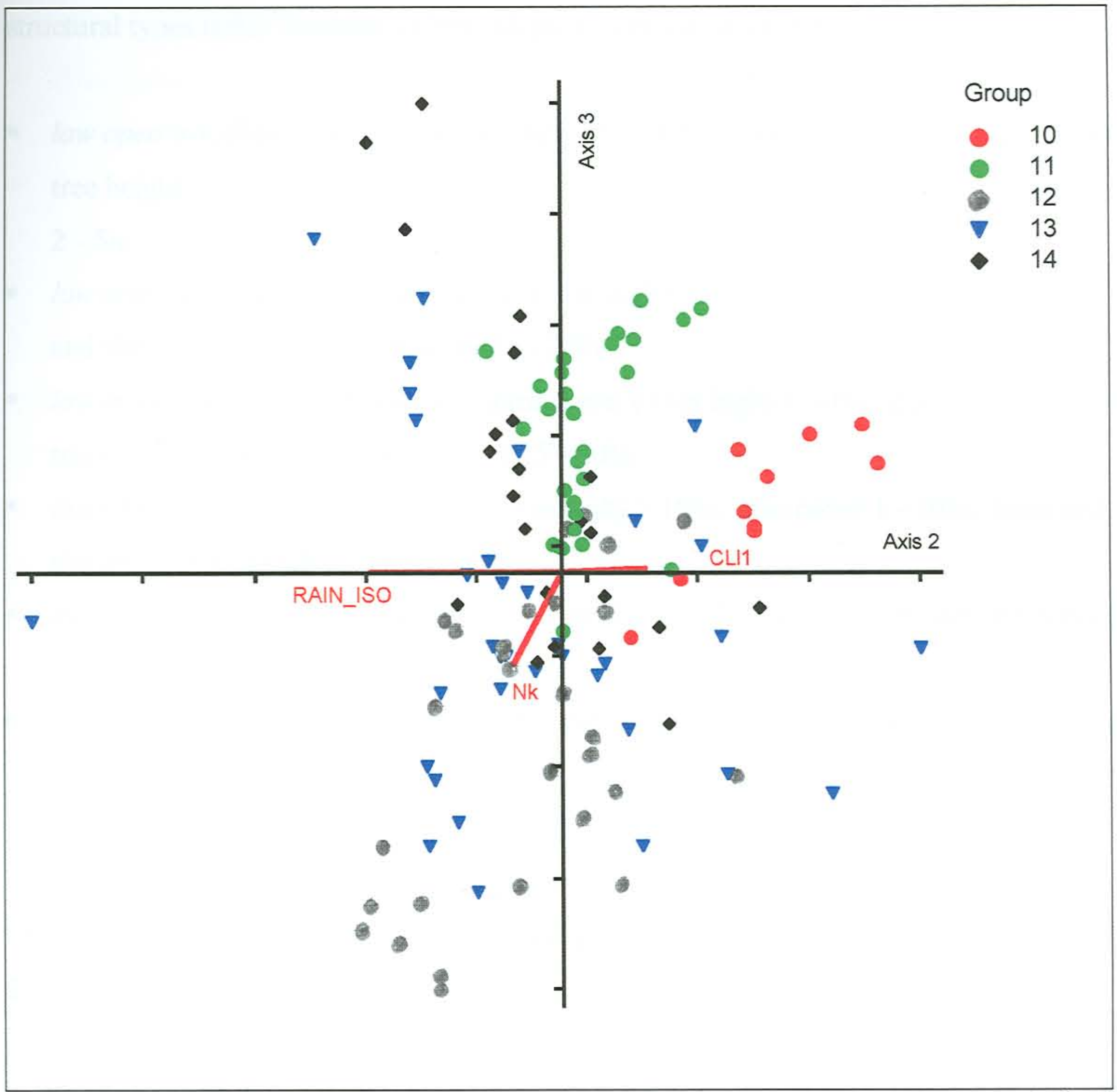


Figure 15: Detrended Correspondence Analysis of Associations (labelled groups) along axes 2 and 3 for Associations 10 to 14. RAIN_ISO refers to mean long-term annual rainfall, Nk is part of the Damara sequence, CLl1 are chromic Cambisols.

Vegetation associations were additionally characterised according to the following structural types (after Strohbach 1998, adapted from Edwards 1983):

- *low open woodland*: shrub cover (>1m high) < 10%; tree cover 0.1 - 1%; dominant tree height 2 - 5m
- *low semi-open bushland*: shrub cover (>1m high) > 10%; tree cover 1 - 10%; trees and shrubs 2 - 5m; shrub cover 10 - 25%
- *low moderately closed bushland:* shrub cover (>1m high) > 10%; tree cover 1 - 10%; trees and shrubs 2 - 5m; shrub cover 25 - 50%
- *low closed bushland:* shrub cover (>1m high) > 10%; tree cover 1 - 10%; trees and shrubs 2 - 5m; shrub cover 50 - 75%
- *low closed shrubland:* tree cover < 1%; shrub cover 10 - 100%; dominant shrub height < 0.5m
- *tall sparse shrubland:* tree cover < 1%; shrub cover 0.1 - 10%; dominant shrub height 1 - 2m

Following the TWINSPAN Classification (Figure 16), the savanna of the study area can be divided into:

1. **The *Acacia mellifera* - *Boscia albitrunca* bushlands**, which occur largely on soils of the Omingonde Formation, with smaller inclusions of granites and quartzes as well as localised areas of undifferentiated metamorphic rocks and calcretes of the Damara Sequence. Long-term average rainfall ranges from 350 - 490 mm p.a., with the predominant part of this vegetation group at a rainfall below 400 mm.

Within this vegetation group, 9 vegetation associations have been identified, viz.:

- Association 1: *Catophractes alexandri - Willkommia sarmentosa* tall sparse shrubland
- Association 2: *Boscia albitrunca - Eragrostis cylindriflora* low open woodland
- Association 3: *Acacia mellifera - Leucosphaera bainesii* low closed shrubland with patches of low open woodland
- Association 4: *Acacia mellifera - Eragrostis rotifer* low moderately closed bushland

- Association 5: *Acacia mellifera - Monechma genistifolium* low semi-open bushland
- Association 6: *Albizia anthelmintica - Stipagrostis uniplumis* low open woodland
- Association 7: *Acacia mellifera - Aristida congesta* low semi-open bushland
- Association 8: *Acacia erioloba - Stipagrostis uniplumis* low semi-open bushland
- Association 9: *Lonchocarpus nelsii - Eragrostis rigidior* low moderately closed bushland and transitional to vegetation group 2

2. The *Acacia mellifera - Dichrostachys cinerea* bushlands, occurring mostly on undifferentiated limestone, dolomite and calcrete of the Damara Sequence, with small inclusions of deeper Kalahari sands. Long-term average rainfall ranges from 410 to 560 mm p.a., with the exception of the *Boscia foetida - Leucosphaera bainesii* bushland, which occurs at a lower rainfall of 350 - 370 mm on patches of surface calcrete.

This vegetation group consists of following 5 vegetation associations:

- Association 10: *Boscia foetida - Leucosphaera bainesii* low semi-open bushland
- Association 11: *Acacia mellifera - Stipagrostis hirtigluma* low moderately closed bushland
- Association 12: *Acacia mellifera - Cenchrus ciliaris* low moderately closed bushland
- Association 13: *Dichrostachys cinerea - Cenchrus ciliaris* low moderately closed bushland
- Association 14: *Terminalia prunioides - Croton gratissimus* low closed bushland

The different vegetation associations and their main environmental attributes are summarised below in Tables 4-6:

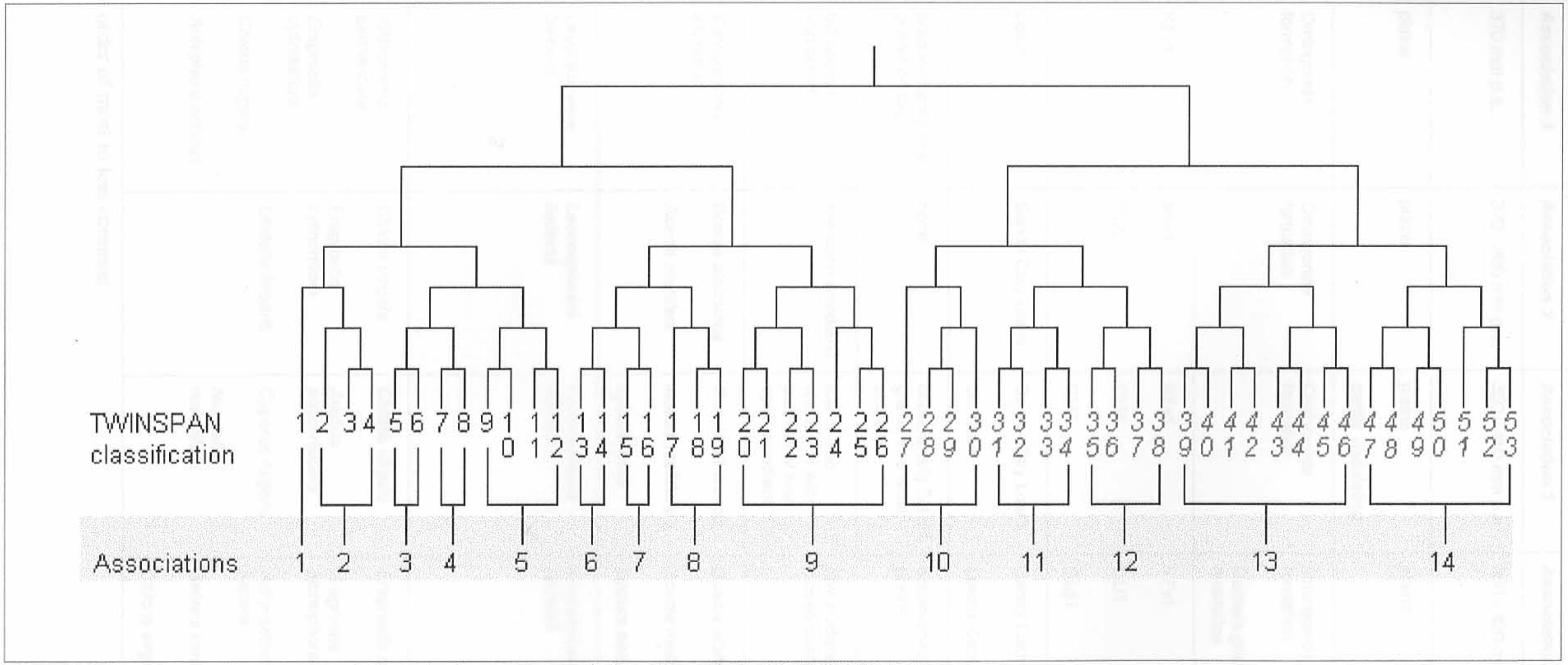


Figure 16: Dendogram showing the relationships between associations identified with TWINSPAN

Table 4: Overview of Vegetation Associations 1-5:

Criteria	*Association 1*	*Association 2*	*Association 3*	*Association 4*	*Association 5*
Long-term average rainfall	370 mm p.a.	370 - 380 mm p.a.	350 - 410 mm p.a.	360 - 420 mm p.a.	350 - 450 mm p.a.
Landform *	plains	plains	plains gently undulating	plains	plains
Geology *	Omingonde formation	Omingonde formation	Omingonde formation	Omingonde formation Damara granites & quartzites	Omingonde formation Damara granites
Soil types *	KFv1	KFv1 CLl2	KFv1 CLl2 CLl1	KFv1 CLl1 CLg1	CLl1 CLl2
Soil surface texture *	Loam	Sandy Clay Loam	Sandy Clay Loam Silt Loam	Sandy Loam Loamy Sand	Sandy Loam Loamy Sand
Gravel, stoniness & rockiness	predominantly fine gravel on top	none	occasionally 5-15% gravel and small stones	occasionally 2-5% gravel	occasionally 5-15% gravel to large stones
Vegetation structure	tall sparse shrubland	low open woodland	low closed shrubland with patches of low open woodland	low moderately closed bushland	low semi-open bushland
Most consistent trees and high shrubs	*Catophractes alexandri*	*Boscia albitrunca* *Acacia mellifera*	*Boscia albitrunca* *Acacia mellifera* *Lycium eenii*	*Boscia albitrunca* *Acacia mellifera* *Lycium eenii*	*Acacia mellifera* *Lycium eenii*
Most consistent low shrubs	*Leucosphaera bainesii*	*Leucosphaera bainesii*	*Leucosphaera bainesii*	*Leucosphaera bainesii*	*Monechma genistifolium* *Leucosphaera bainesii*
Most consistent grasses and herbs	*Willkommia sarmentosa* *Eragrostis cylindriflora* *Chloris virgata* *Antephora schinzii*	*Chloris virgata* *Eragrostis cylindriflora* *Ondetia linearis*	*Chloris virgata* *Aristida adscensionis* *Cyperus fulgens* *Nidorella resedifolia*	*Eragrostis rotifer* *Eragrostis trichophora* *Achyranthes aspera* *Setaria verticillata* *Chloris virgata*	*Enneapogon cenchroides* *Aristida adscensionis* *Cenchrus ciliaris* *Stipagrostis uniplumis*

* Criteria in order of most to less common

Table 5: Overview of Vegetation Associations 6-9:

Criteria	Association 6	Association 7	Association 8	Association 9
Long-term average rainfall	350 - 440 mm p.a.	350 - 410 mm p.a.	360 - 440 mm p.a.	400 - 490 mm p.a.
Landform *	plains	plains	plains	plains low gradient footslopes
Geology *	Omingonde formation Damara granites	Omingonde formation Damara granites & quartzites	Omingonde formation	Damara calcrete and undifferentiated metamorphic rock Damara quartzites
Soil types *	CLl1	CLl1 CLl2	CLl1 KFv1	CKg1 CLl2 CLg1
Soil surface texture *	Sandy Loam Loam	Sandy Clay Loam Loamy Sand	Loamy Sand Sandy Loam	Loamy Sand Sandy Loam
Gravel, stoniness & rockiness	often 5-15% gravel, occasionally 2-5% stones & rock	often 5-15% gravel, seldom 2-5% stones	occasionally 2-5% gravel and small stones	occasionally 2-5% gravel and small stones
Vegetation structure	low open woodland	low semi-open bushland	low semi-open bushland	low moderately closed bushland
Most consistent trees and high shrubs	*Acacia mellifera* *Albizia anthelmintica* *Lycium eenii*	*Lycium eenii* *Acacia mellifera* *Boscia albitrunca*	*Acacia mellifera* *Acacia erioloba* *Boscia albitrunca* *Grewia flava*	*Dichrostachys cinerea* *Acacia mellifera* *Grewia flava* *Grewia bicolor* *Lonchocarpus nelsii*
Most consistent low shrubs	*Monechma genistifolium* *Pupalia lappacea* *Ptycholobium biflorum*	*Ptycholobium biflorum* *Barleria lanceolata* *Leucosphaera bainesii* *Indigofera rautanenii*	*Otoptera burchellii*	*Hibiscus elliottiae* *Pupalia lappacea*
Most consistent grasses and herbs	*Stipagrostis uniplumis* *Enneapogon cenchroides* *Evolvulus alsinoides*	*Stipagrostis uniplumis* *Aristida congesta* *Enneapogon cenchroides* *Talinum arnotii* *Evolvulus alsinoides*	*Stipagrostis uniplumis* *Talinum arnotii* *Melinis repens ssp grandiflora* *Pogonarthria fleckii* *Urochloa brachyura*	*Eragrostis rigidior* *Pogonarthria fleckii* *Eragrostis trichophora* *Evolvulus alsinoides* *Aristida congesta*

* Criteria in order of most to less common

Table 6: Overview of Vegetation Associations 10-14:

Criteria	*Association 10*	*Association 11*	*Association 12*	*Association 13*	*Association 14*
Long-term average rainfall	350 - 370 mm p.a.	470 - 530 mm p.a.	410 - 530 mm p.a.	420 - 560 mm p.a.	420 - 530 mm p.a.
Landform *	plains gently undulating to undulating plains	plains	plains gently undulating to undulating ridges	plains gently undulating to undulating ridges	gently undulating ridges low gradient footslopes
Geology *	Damara calcrete and undifferentiated metamorphic rock Omingonde formation	Damara calcrete and undifferentiated metamorphic rock Kalahari sands on calcareous horizon	Damara calcrete and undifferentiated metamorphic rock Damara quartzites Kalahari sands on calcareous horizon	Damara calcrete and undifferentiated metamorphic rock Damara quartzites Damara limestone & dolomite	Damara quartzites Damara calcrete and undifferentiated metamorphic rock
Soil types *	CLl1	CKl1 CKg1	CKg1 CKl1	CKg1 CKf2 CKl1	CKg1 CKf2 CKl1 CLg1
Soil surface texture *	Loam Sandy Clay Loam	Sandy Loam Sandy Clay Loam	Sandy Loam Sandy Clay Loam	Sandy Loam Sandy Clay Loam	Sandy Clay Loam Sand
Gravel, stoniness & rockiness	predominantly 15-40% gravel, 2-40% small to large stones	predominantly 5-15% small to large stones, often 5-15% rock	sometimes 2-5% gravel and small to large stones	predominantly 2-15% medium to large stones, often 2-40% small stones and rock	predominantly 2 - 40% each of small to large stones as well as rock
Vegetation structure	low semi-open bushland	low moderately closed bushland	low moderately closed bushland	low moderately closed bushland	low closed bushland
Most consistent trees and high shrubs	*Catophractes alexandri* *Acacia mellifera* *Boscia foetida* *Grewia flava*	*Acacia mellifera* *Acacia reficiens* *Catophractes alexandri* *Dichrostachys cinerea*	*Acacia mellifera* *Acacia reficiens* *Dichrostachys cinerea*	*Dichrostachys cinerea* *Acacia mellifera* *Grewia flavescens ssp. flavescens*	*Terminalia prunioides* *Dichrostachys cinerea* *Croton gratissimus* *Combretum apiculatum* *Acacia mellifera* *Acacia reficiens* *Rhus marlothii*

* Criteria in order of most to less common

Table 6 continued

Criteria	*Association 10*	*Association 11*	*Association 12*	*Association 13*	*Association 14*
Most consistent low shrubs	*Leucosphaera bainesii* *Eriocephalus pubescens* *Melhania virescens* *Seddera suffruticosa* *Aizoon virgatum*	*Melhania virescens* *Eriocephalus pubescens* *Clerodendrum ternatum* *Lantana angolensis* *Seddera suffruticosa*	*Melhania virescens* *Leucosphaera bainesii* *Leucas pechuelii*	*Melhania virescens* *Lantana angolensis*	*Melhania virescens* *Seddera suffruticosa*
Most consistent grasses and herbs	*Enneapogon desvauxii* *Stipagrostis uniplumis* *Enneapogon cenchroides* *Cenchrus ciliaris*	*Stipagrostis hirtigluma* *Eragrostis echinochloidea* *Eragrostis trichophora* *Cenchrus ciliaris* *Enneapogon scoparius*	*Cenchrus ciliaris* *Eragrostis trichophora* *Eragrostis echinochloidea* *Corchorus tridens*	*Eragrostis echinochloidea* *Melinis repens ssp grandiflora* *Enneapogon cenchroides* *Eragrostis trichophora*	*Stipagrostis hirtigluma* *Enneapogon cenchroides* *Melinis repens ssp grandiflora* *Heteropogon contortus*

9. 3. CHARACTERISATION OF VEGETATION ASSOCIATIONS

Boundaries of associations are often difficult to detect and define, especially when looking at vegetation on such a large scale. In this section vegetation associations have been characterised according to (a) species which occur in 60% or more of the samples assigned to that association, regardless of their cover, (b) adding common species which, when present, often have a high cover % and (c), somewhat subjectively and based on field notes, species one can expect to find at some stage when walking through that vegetation association. In addition, a brief description of the dominant abiotic factors, on which these associations occur, is provided. As most of these factors were merely recorded or derived from literature or thematic maps (which are also generalisations), but not precisely measured, the specific influence of such factors on species distribution is not viable in this study. Species abundance are extracted from the synoptic tables (associations 1-9 on Table 24, associations 10 - 14 on Table 25, both listed in Appendix 1.1.). Diagnostic species groups have been separated on the TWINSPAN tables (listed in Appendix 2.2.)

9.3.1 Association 1: *Catophractes alexandri - Willkommia sarmentosa* tall sparse shrubland

As can be expected from the characteristic grass *Willkommia sarmentosa*, this is a unique plant association. *Willkommia sarmentosa* is a perennial grass typical of the floodplains or "oshana"- system as it is found throughout the Oshana- and Omusati-Regions of northern Namibia. Such a system consists of large, flat pans that become seasonally flooded. The shallowness causes a quick heating and evaporation of the water in these pans, leading to a substantial enrichment of soluble salts (especially calcium-combinations) of the soil within the pans. In addition, because this is a fluvial system with slow-flowing water, sedimentation of relatively fine soil-particles occurs. It is thus not surprising that the topsoils of this vegetation type are predominantly grey fine-grained loams, forming a relatively hard crust when dry. The soils also tend to form clay-bubbles (Schaumböden) as water evaporates, contributing to the slow water-infiltration rate into these soils (Volk & Geyger 1970).

This vegetation association is (geologically speaking) part of the Kalahari-system, which consists of a thick calcic horizon overlain partly by younger sandy layers. The soil types consist of arenic Fluvisols associated with haplic Calcisols. Average long-term rainfall for this vegetation type is 370 mm p.a.

Within the study area, this vegetation type is extremely localised, having been encountered only on the farm Otjiku and represented by four samples only. Judging from the false-colour satellite image (map 1 Appendix 4 - extract in Figure 17), it is expected that this vegetation association may also occur on two neighbouring farms, viz. Grootgeluk and Marienhof. This oshana system appears to be an accumulation point of drainage coming from the southern part of the Omuramba-Omatako catchment area - the southern portion of the study area - draining into the pans starting on the farm Marienhof, where they spread out without forming distinct rivers, later draining into the Omuramba-Omatako east of Grootgeluk (Figure 17). The system is interrupted and surrounded by low sandy plains, almost resembling low sand dunes, which are part of vegetation association 8. The farmers refer to these plains as the "Omatako-Fläche".

The most prominent plant species of this association, based on an abundance of 100 - 60% in the synoptic table (Table 24 Appendix 1.1.) as well as average percentage cover within the samples is given in Table 7. The structure of this association is characterised by a relatively sparse, but dominant herb/grass layer, with occasional groups of low and high shrubs. The distribution of layer to the species composition as well as to the total percentage cover of the area are represented in Figures 18a and 18b respectively. The diagnostic species group is indicated on Table 26 (Appendix 2.2.).

Table 7: Abundance and cover percentages of predominant species of the *Catophractes alexandri - Willkommia sarmentosa* vegetation association

Species	**abundance (% of samples)**	**average % cover**	**layer**
Willkommia sarmentosa	100	21.3	perennial grass
Eragrostis cylindriflora	100	10.1	annual grass
Antephora schinzii	100	0.1	annual grass
Chloris virgata	100	0.1	annual grass
Leucosphaera bainesii	100	0.5	low shrub
Eragrostis jeffreysii	75	5.2	perennial grass
Brachiaria deflexa	75	0.1	annual grass
Geigeria ornativa	75	0.1	herb
Oldenlandia herbacea	75	0.1	herb
Monandrus squarrosus	75	0.1	herb
Justicia anselliana	75	0.1	herb
Portulaca kermesina	75	0.1	herb
Catophractes alexandri	75	0.5	high shrub
Total nr of species recorded	38		
Average % cover per sample		39.2	

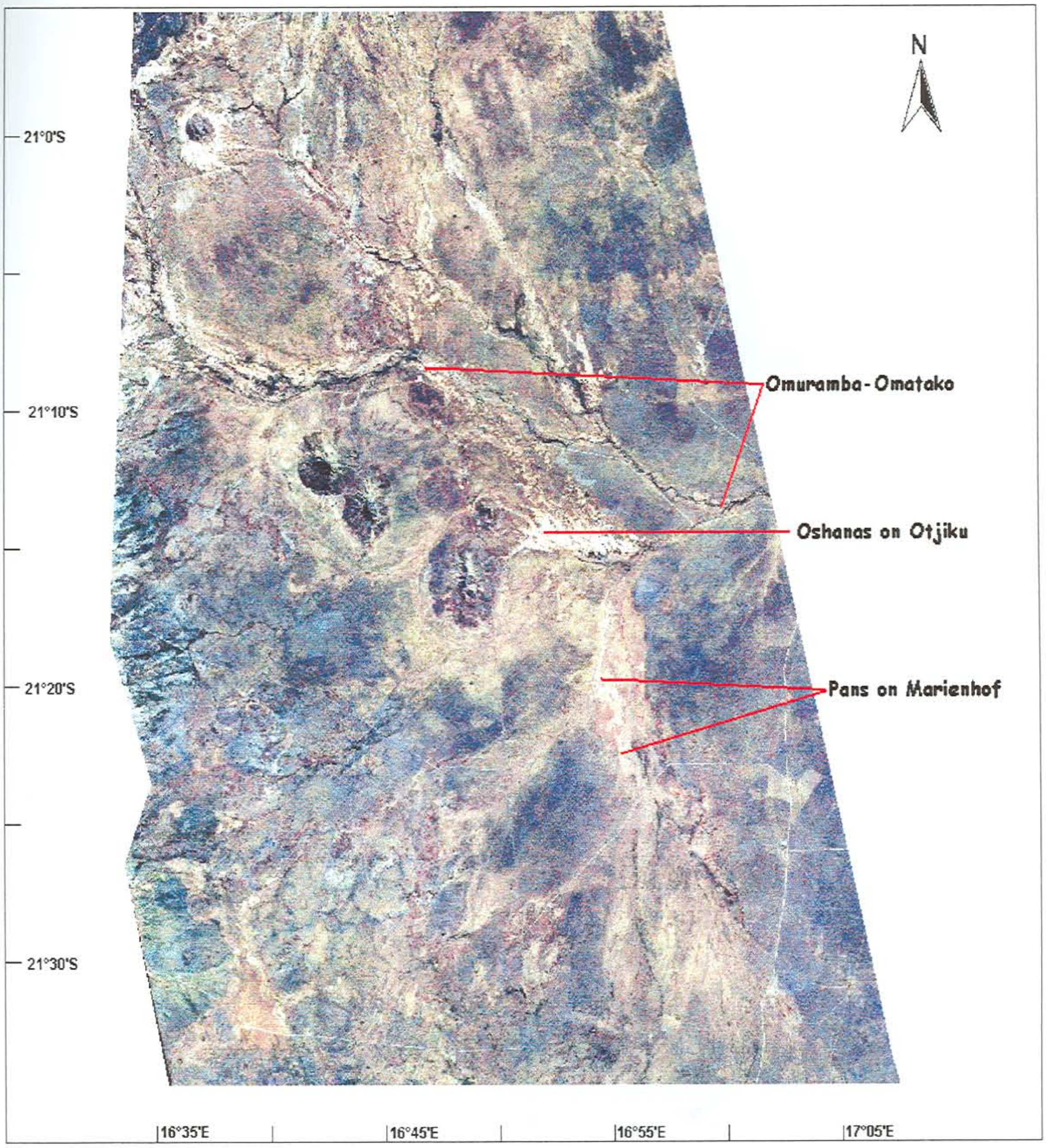


Figure 17: False-colour satellite image of the oshanas on Otjiku and Marienhof. Grootgeluk is east of Otjiku, covering about half of the oshana-system appearing white on the image. Towards the west, below the Omuramba-Omatako, the two peaks of the Omatako Mountains can be seen.

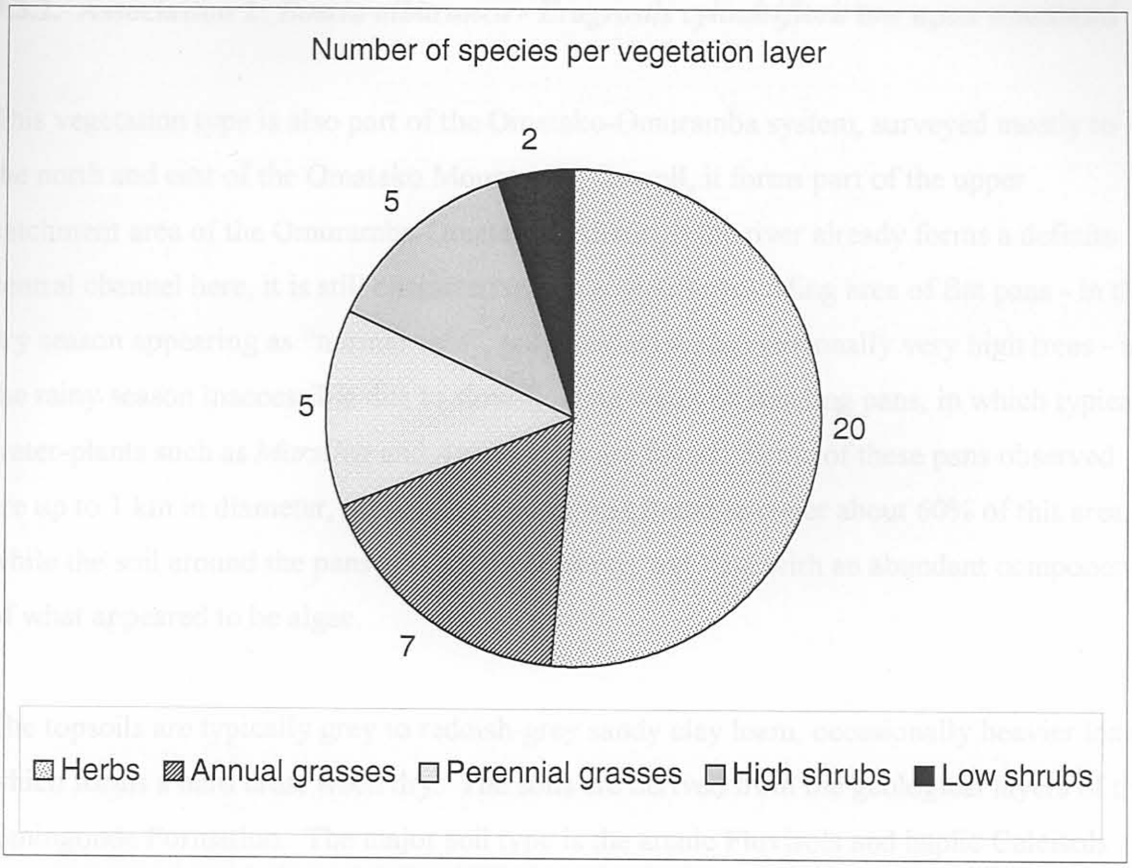


Figure 18a: Pie chart showing the total number of species recorded for each vegetation layer in association 1.

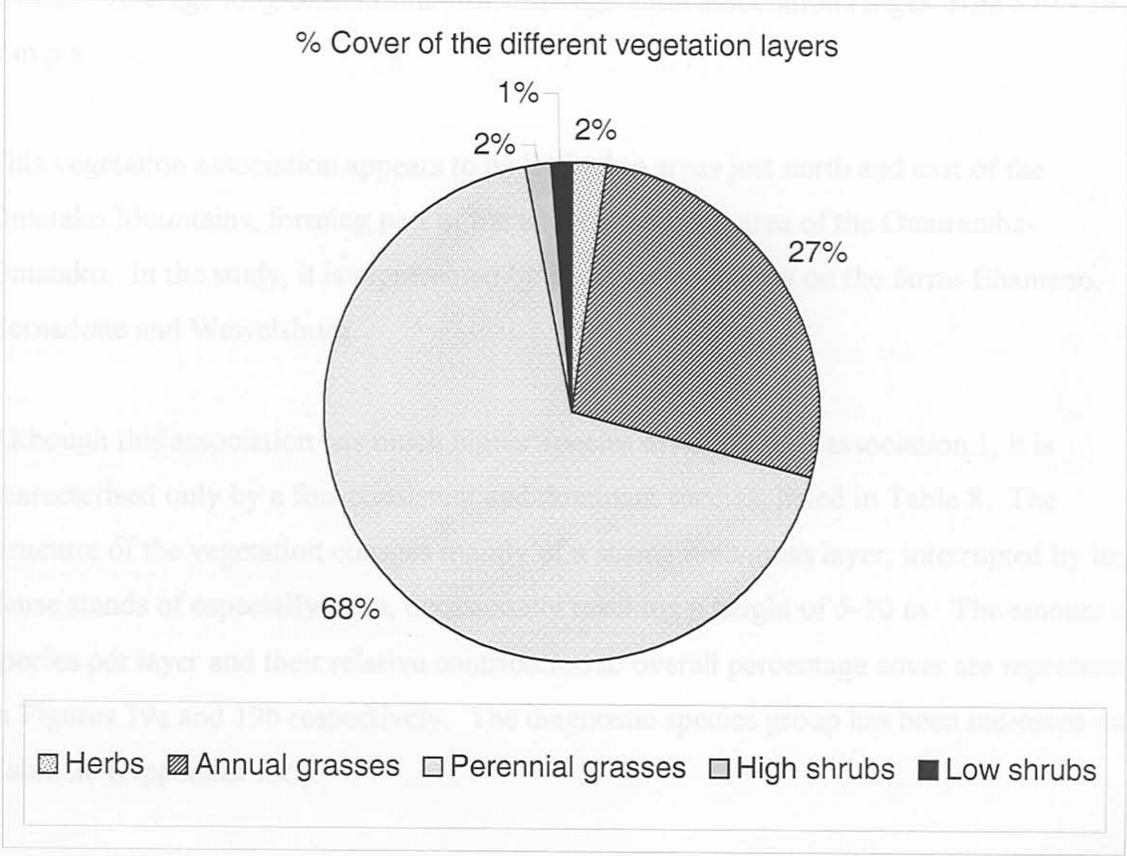


Figure 18b: Pie chart showing the average percentage cover each layer contributes to the total vegetation cover of association 1.

9.3.2. Association 2: *Boscia albitrunca - Eragrostis cylindriflora* low open woodland

This vegetation type is also part of the Omatako-Omuramba system, surveyed mostly to the north and east of the Omatako Mountains. Overall, it forms part of the upper catchment area of the Omuramba-Omatako. Although the river already forms a definite central channel here, it is still characterised by a wide surrounding area of flat pans - in the dry season appearing as "normal veld", only marked with occasionally very high trees - in the rainy season inaccessible due to slow-flowing water or standing pans, in which typical water-plants such as *Marsilea* and *Aponogeton* are found. Some of these pans observed are up to 1 km in diameter, and shallow water was found to cover about 60% of this area, while the soil around the pans was a typical heavy, wet mud with an abundant component of what appeared to be algae.

The topsoils are typically grey to reddish-grey sandy clay loam, occasionally heavier loam, which forms a hard crust when dry. The soils are derived from the geological layers of the Omingonde Formation. The major soil type is the arenic Fluvisols and haplic Calcisols Association, with the chromic Cambisols and leptic-chromic Cambisols Association also present. Average long-term rainfall for this vegetation association ranges from 370 - 380 mm p.a.

This vegetation association appears to be limited to areas just north and east of the Omatako Mountains, forming part of the upper catchment area of the Omuramba-Omatako. In the study, it is represented by 11 samples, mainly on the farms Ehameno, Bernadette and Wewelsburg.

Although this association has much higher species diversity than association 1, it is characterised only by a few consistent and dominant species, listed in Table 8. The structure of the vegetation consists mainly of a strong herb/grass layer, interrupted by local dense stands of especially trees, occasionally reaching a height of 5-10 m. The amount of species per layer and their relative contribution to overall percentage cover are represented in Figures 19a and 19b respectively. The diagnostic species group has been indicated on Table 26 (Appendix 1.2.).

Table 8: Abundance and cover percentages of predominant species of the *Boscia albitrunca - Eragrostis cylindriflora* vegetation association

Species	abundance (% of samples)	average % cover	layer
Chloris virgata	100	5.5	annual grass
Ondetia linearis	100	0.3	herb
Eragrostis cylindriflora	90	19.6	annual grass
Boscia albitrunca	90	2.1	low tree
Leucosphaera bainesii	95	0.5	low shrub
Acacia mellifera	72	1.1	high shrub
Total nr of species recorded	112		
Average % cover per sample		42.1	

Based on percentage cover, other important species include *Eragrostis rotifer*, *Panicum stapfianum*, *Lycium eenii* as well as *Acacia tortilis* and *A. reficiens*. High trees of *Acacia tortilis* occasionally form dense stands of up to 20% coverage, while several large trees with a similar high % cover of *Boscia albitrunca* may be found in an area. Low trees and high shrubs of *Acacia reficiens* as well as *A. mellifera* may form dense, single-species patches contributing to a cover of up to 5%. These species are potential encroacher shrubs, but it is believed that the relative dryness of this system (low rainfall as well as calcic impenetrable soils) limits the establishment of seedlings of these species.

Notable is the high presence of weedy herbs and grasses, such as *Ondetia linearis* and *Aristida adscensionis* and *Eragrostis cylindriflora* (called "Windhalm" in German, referring to its short-lived nature and hence poor grazing status). Other common weedy species (high abundance, low cover) include *Setaria verticillata*, *Achyranthes aspera* and *Pupalia lappacea*.

Species typical of a shady environment found in this association include *Pavonia burchellii*, *Pollichia campestris*, *Brachiaria deflexa*, *Digitaria velutina* and *Crassula rhodesica*. Species typical for pans and standing water found here include *Diplachne fusca*, *Alternanthera nodiflora*, *Commelina subulata*, *Justicia anselliana*, *Marsilea aegyptica* and *Xerophyta humilis*.

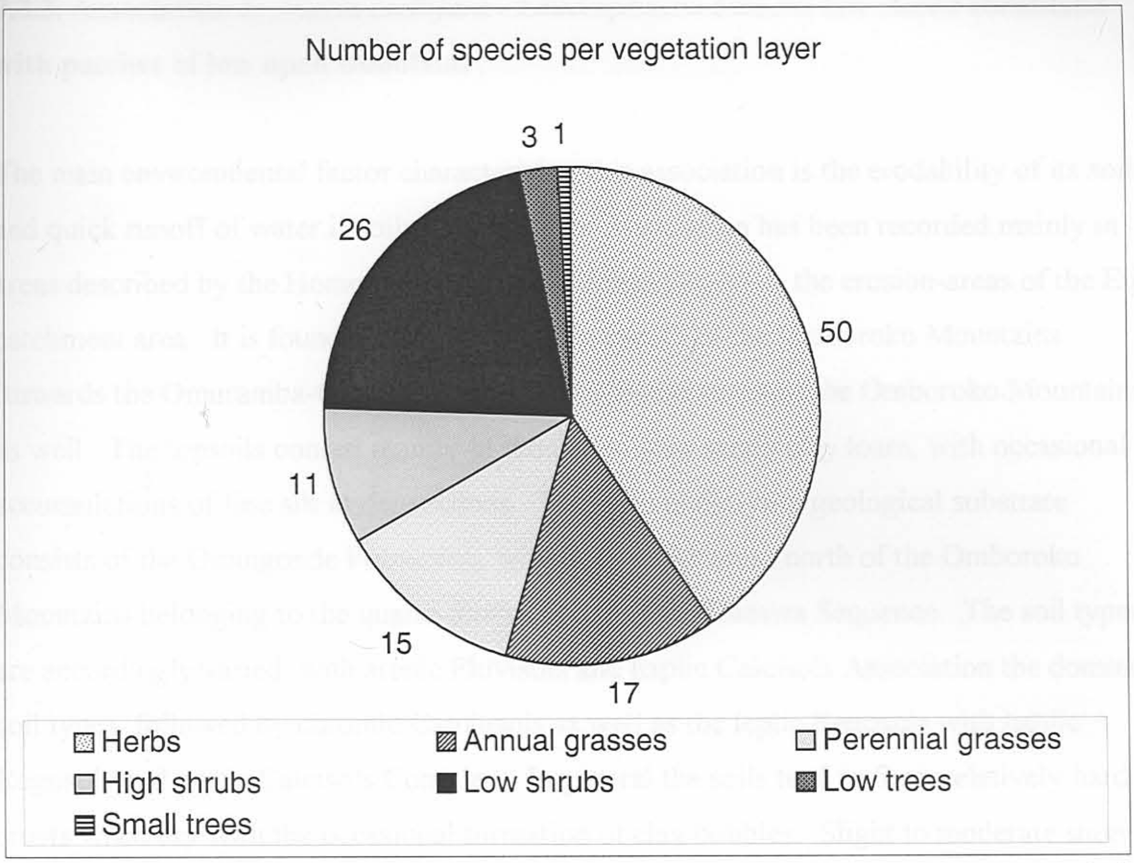


Figure 19a: Pie chart showing the total number of species recorded for each vegetation layer in association 2.

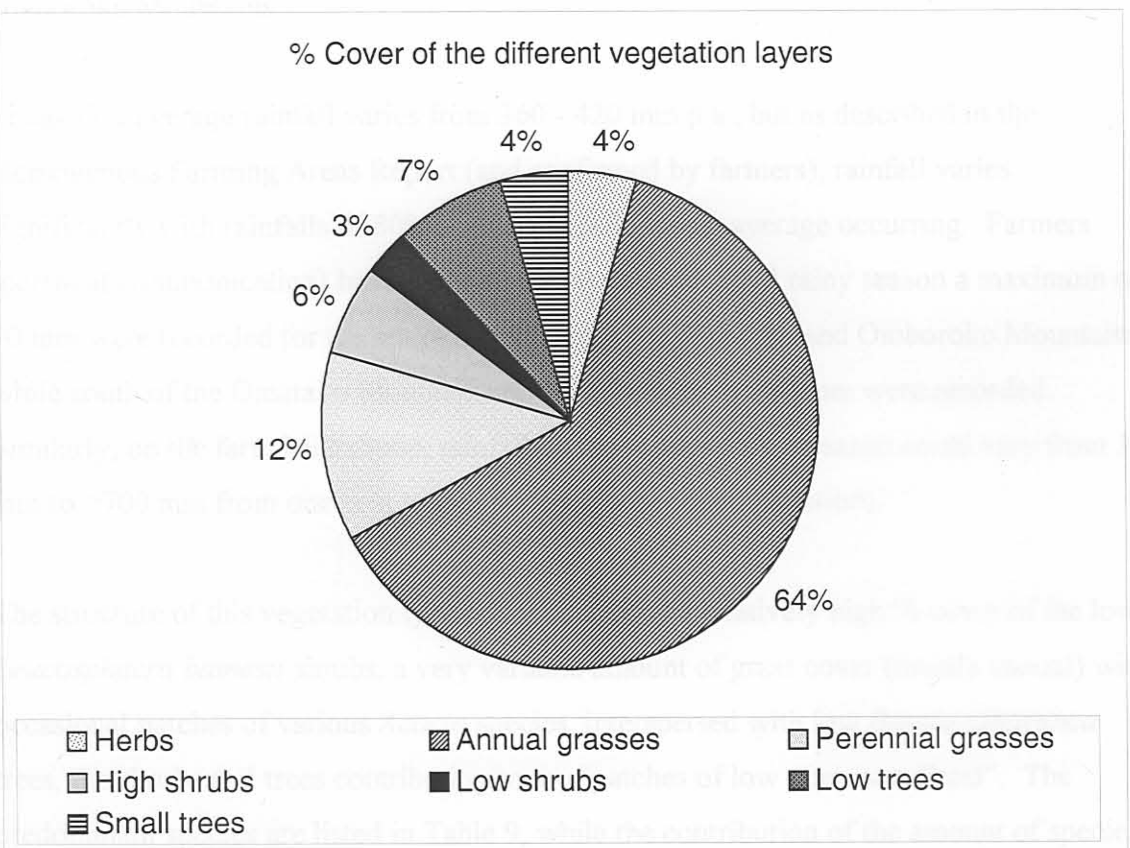


Figure 19b: Pie chart showing the average percentage cover each layer contributes to the total vegetation cover of association 2.

9.3.3. Association 3: *Acacia mellifera - Leucosphaera bainesii* low closed shrubland with patches of low open woodland

The main environmental factor characterising this association is the erodability of its soils and quick runoff of water if soils are bare. The association has been recorded mainly in areas described by the Homogenous Farming Areas Report as the erosion-areas of the Etjo catchment area. It is found on the run-off zones south of the Omboroko Mountains (towards the Omuramba-Omatako) and to some extent north of the Omboroko Mountains as well. The topsoils consist mainly of reddish to grey sandy clay loam, with occasional accumulations of fine silt in depressions. The main underlying geological substrate consists of the Omingonde Formation, with the smaller areas north of the Omboroko Mountains belonging to the quartz-diorite layers of the Damara Sequence. The soil types are accordingly varied, with arenic Fluvisols and haplic Calcisols Association the dominant soil types, followed by chromic Cambisols as well as the leptic Regosols with haplic Regosols and petric Calcisols Complex. In general the soils tend to form relatively hard crusts when dry with the occasional formation of clay bubbles. Slight to moderate sheet erosion is evident throughout the study area, even moderate rill erosion occurs north of the Omboroko Mountains.

Long-term average rainfall varies from 360 - 420 mm p.a., but as described in the Homogenous Farming Areas Report (and confirmed by farmers), rainfall varies significantly with rainfalls of 80% above and 60% below average occurring. Farmers (personal communication) have reported that during the 2002 rainy season a maximum of 90 mm were recorded for the entire area between the Omatako and Omboroko Mountains, while south of the Omatako Mountains rainfalls as high as 350 mm were recorded. Similarly, on the farm Miershoop, rainfall on the farm within a season could vary from 300 mm to >700 mm from one post to another (personal communication).

The structure of this vegetation type is dominated by a relatively high % cover of the low *Leucosphaera bainesii* shrubs, a very variable amount of grass cover (mostly annual) with occasional patches of various *Acacia* species, interspersed with low *Boscia albitrunca* trees, the shrubs and trees contributing to the "patches of low open woodland". The predominant species are listed in Table 9, while the contribution of the amount of species to layers as well as layers to percentage cover is illustrated in Figures 20a and 20b respectively. The diagnostic species group has been indicated on Table 26 (Appendix 1.2.)

Table 9: Abundance and cover percentages of predominant species of the *Acacia mellifera - Leucosphaera bainesii* vegetation association

Species	abundance (% of samples)	average % cover	layer
Leucosphaera bainesii	100	19.5	low shrub
Acacia mellifera	100	6.8	high shrub
Chloris virgata	94	8.4	annual grass
Lycium eenii	83	0.7	low shrub
Aristida adscensionis	77	2.3	annual grass
Nidorella resedifolia	77	1.5	herb
Cyperus fulgens	77	3.3	herb
Boscia albitrunca	72	2.2	low tree
Acacia reficiens	61	3.4	high shrub
Acacia tortilis	61	2.7	high shrub
Acacia tortilis	61	2.0	low tree
Eragrostis porosa	61	1.9	annual grass
Panicum coloratum	61	1.0	perennial grass
Eragrostis rotifer	61	0.9	perennial grass
Total nr of species recorded	124		
Average % cover per sample		72.4	

Further species with relatively high cover include *Aristida hordeacea* (sometimes with 30% cover), *Botriochloa radicans* and *Eragrostis trichophora*. Commonly occurring species, although with low cover, include *Aristida congesta, Ocimum americanum, Ondetia linearis, Talinum arnotii* and *Lycium oxycarpum* (high shrubs). Throughout there is also a high presence of *Acacia mellifera* shrubs below 1 m tall, indicating, together with grasses such as *Aristida* and *Botriochloa* (which are hardly utilised by livestock) that this vegetation type may be degraded and susceptible to bush encroachment. However, the degradation here is largely due to the erosion-aspect, how much farming practices contribute to this degradation could not be assessed.

Several farmers who have large areas of this vegetation association on their have long ceded cattle-farming, deriving their main income from hunting, without actively buying or farming with game. Another question that could be asked is whether this vegetation association is simply a degraded remnant of surrounding vegetation, which consists largely of association 8? This is based on the observation that this vegetation type does not occur in a continuous band, but rather follows main erosion channels within an area of complex soil- and vegetation mosaics.

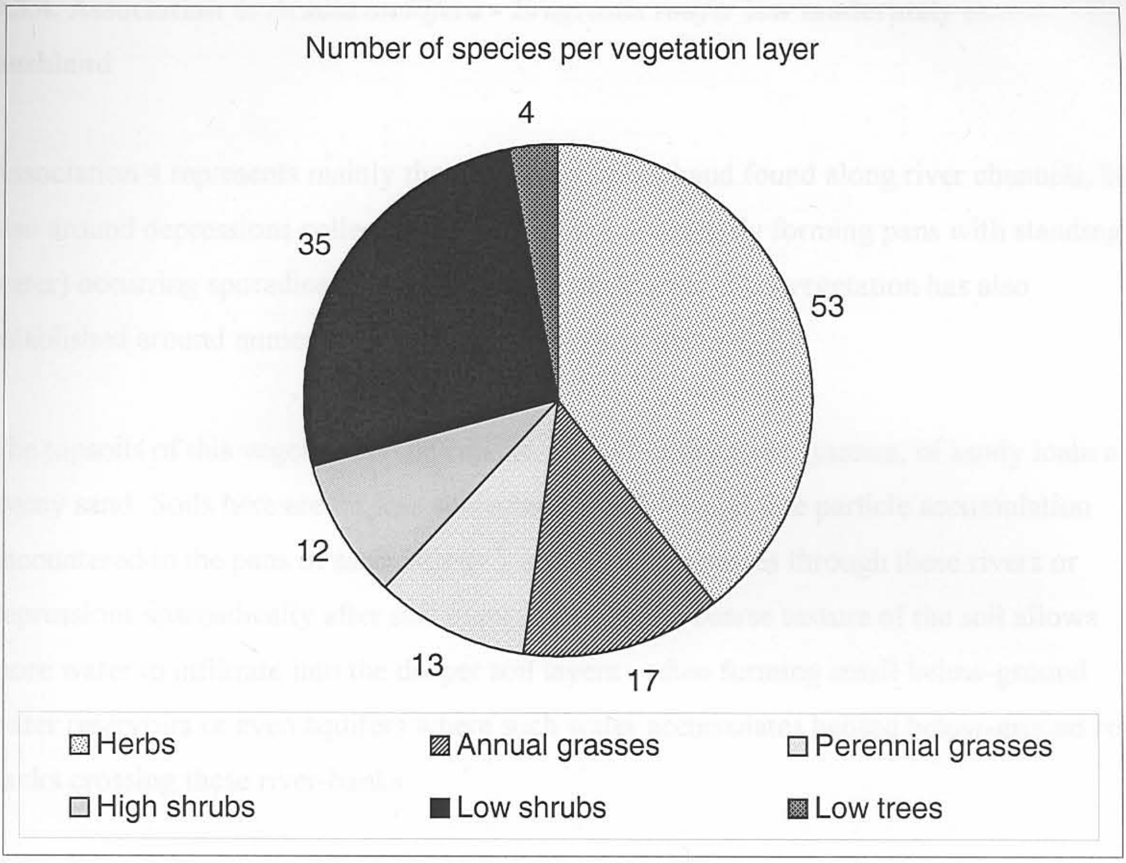


Figure 20a: Pie chart showing the total number of species recorded for each vegetation layer in association 3.

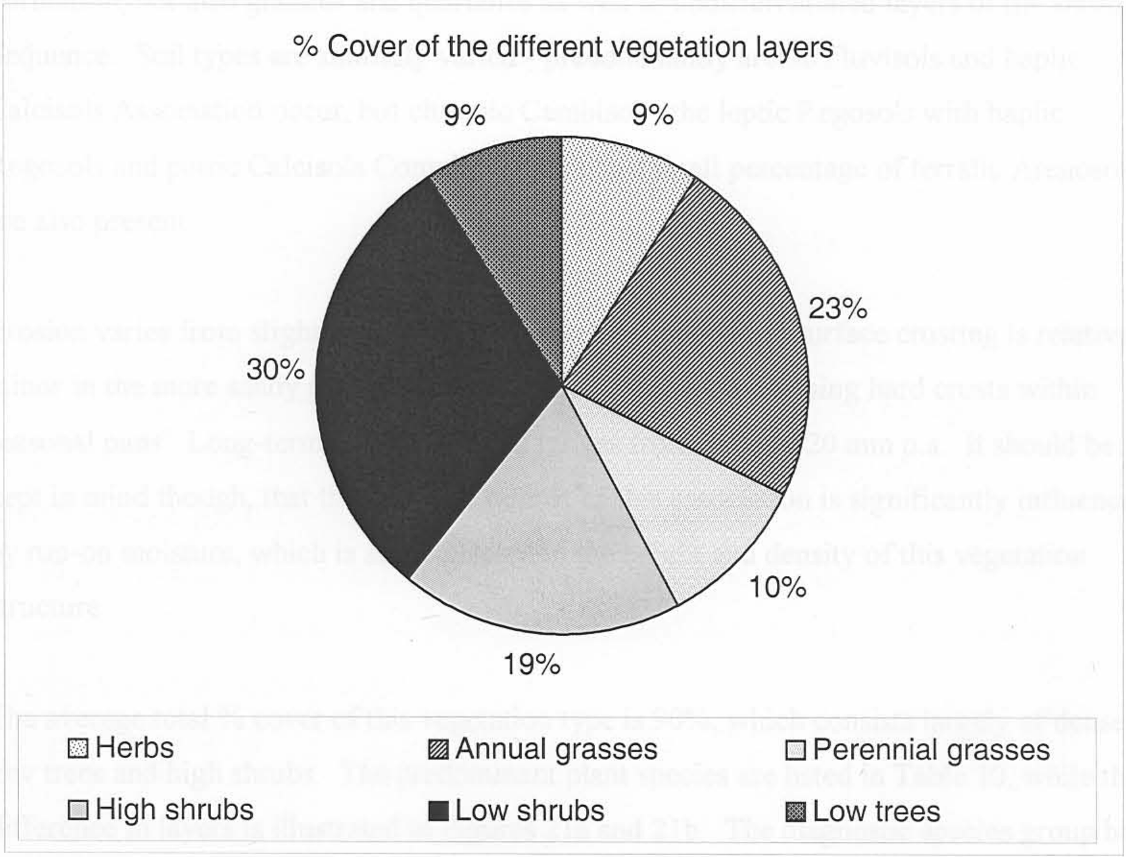


Figure 20b: Pie chart showing the average percentage cover each layer contributes to the total vegetation cover of association 3.

9.3.4. Association 4: *Acacia mellifera - Eragrostis rotifer* low moderately closed bushland

Association 4 represents mainly the dense vegetation band found along river channels, but also around depressions collecting water (but not necessarily forming pans with standing water) occurring sporadically throughout the study area. This vegetation has also established around numerous long-established farm dams.

The topsoils of this vegetation type consist, typical of dry river systems, of sandy loam and loamy sand. Soils here are far less subjected to the lime and fine particle accumulation encountered in the pans of associations 1 and 2. Water passes through these rivers or depressions sparoadically after sufficient rains, but the coarse texture of the soil allows more water to infiltrate into the deeper soil layers - often forming small below-ground water reservoirs or even aquifers where such water accumulates behind below-ground rock banks crossing these river-banks.

The geology of this vegetation type is varied, including to a large extent the Omingonde Formation, but also granites and quartzites as well as undifferentiated layers of the Damara Sequence. Soil types are similarly varied - predominantly arenic Fluvisols and haplic Calcisols Association occur, but chromic Cambisols, the leptic Regosols with haplic Regosols and petric Calcisols Complex as well as a small percentage of ferralic Arenosols are also present.

Erosion varies from slight rill to moderate sheet erosion, while surface crusting is relatively minor in the more sandy parts of this vegetation type, while forming hard crusts within seasonal pans. Long-term average rainfall ranges from 360 to 420 mm p.a. It should be kept in mind though, that the moisture regime of this association is significantly influenced by run-on moisture, which is also reflected in the height and density of this vegetation structure.

The average total % cover of this vegetation type is 90%, which consists largely of dense low trees and high shrubs. The predominant plant species are listed in Table 10, while the difference in layers is illustrated in Figures 21a and 21b. The diagnostic species group has been indicated on Table 26 (Appendix 1.2.).

Table 10: Abundance and cover percentages of predominant species of the *Acacia mellifera - Eragrostis rotifer* vegetation association

Species	abundance (% of samples)	average % cover	layer
Acacia mellifera	95	15.5	high shrub
Eragrostis rotifer	91	5.5	perennial grass
Lycium eenii	91	1.1	low shrub
Chloris virgata	87	7.1	annual grass
Eragrostis trichophora	83	6.0	perennial grass
Leucosphaera bainesii	75	3.1	low shrub
Aristida adscensionis	70	3.5	annual grass
Boscia albitrunca	66	0.8	low tree
Aristida congesta	62	3.9	perennial grass
Achyranthes aspera	62	1.6	herb
Setaria verticillata	62	1.5	annual grass
Total nr of species recorded	187		
Average % cover per sample		90.1	

This vegetation type has a variable species composition, and was also not exhaustively surveyed. However, species which typically occur here, occasionally forming dense stands, are: *Enneapogon cenchroides*, *Setaria pumila* (shade-loving), *Botriochloa radicans*, *Eragrostis jeffreysii*, *Monelytrum luederitzianum*, *Panicum maximum*, with high shrubs to low trees of *Acacia hebeclada*, *A. reficiens*, *A. tortilis*, *A. karroo*, *Dichrostachys cinerea* (occasionally), *Ziziphus mucronata* and occasionally *Albizia anthelmintica*.

The shade rendered by these trees also forms an ideal habitat for weedy species, of which especially *Pupalia lappacea*, *Bidens* spp, *Schkuhria pinnata* and *Xanthium* spp can be found.

Species composition of especially the herb layer can be expected to change dramatically from year to year, especially on the riverbanks. Fast-moving water of rivers in full flood after e.g. a strong rainfall will tear away the outline of the riverbank. During such an event, the herb-layer may be totally removed. Should such a flood be sufficiently large, even the larger shrubs or trees may be swept away with the water. On the contrary, vegetation around depressions in the veld has been found to eventually form impenetrable thickets, unless enough highly palatable grass species (e.g. *Panicum maximum*) grow below the trees attracting animals, which trample seedlings of shrubby species.

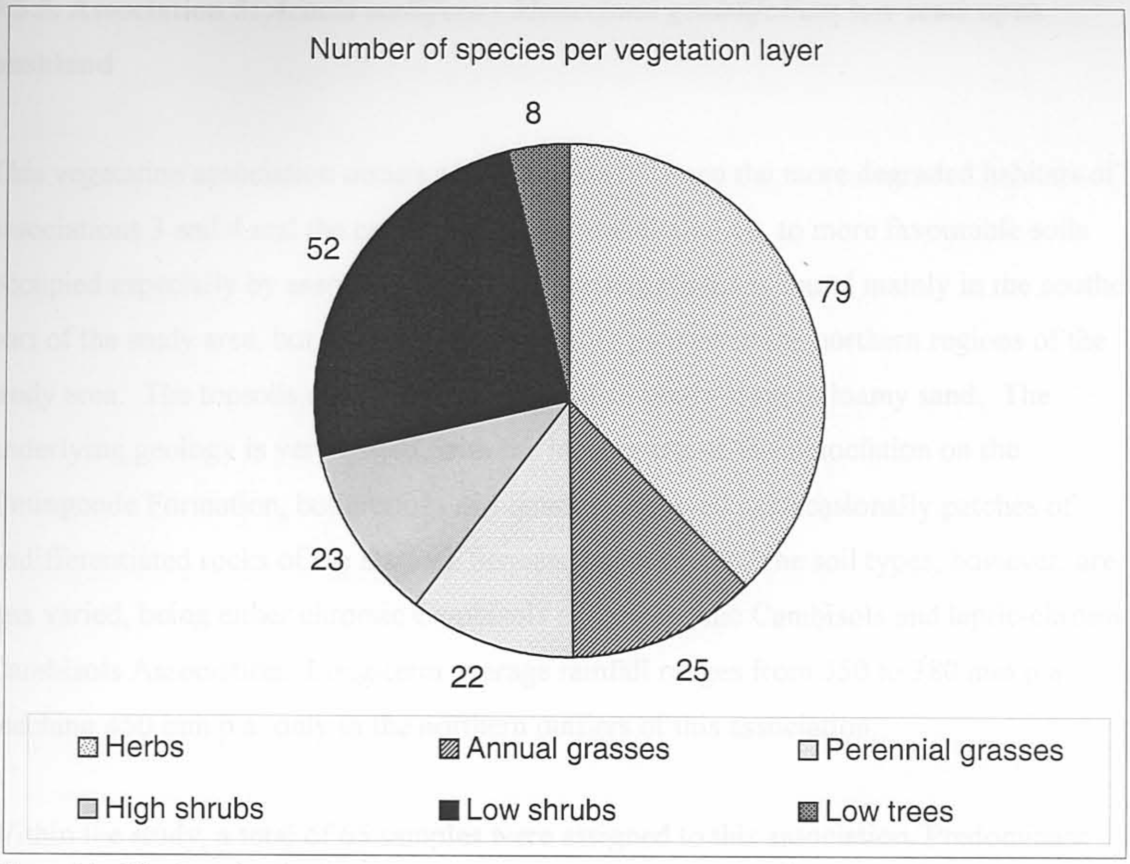


Figure 21a: Pie chart showing the total number of species recorded for each vegetation layer in association 4.

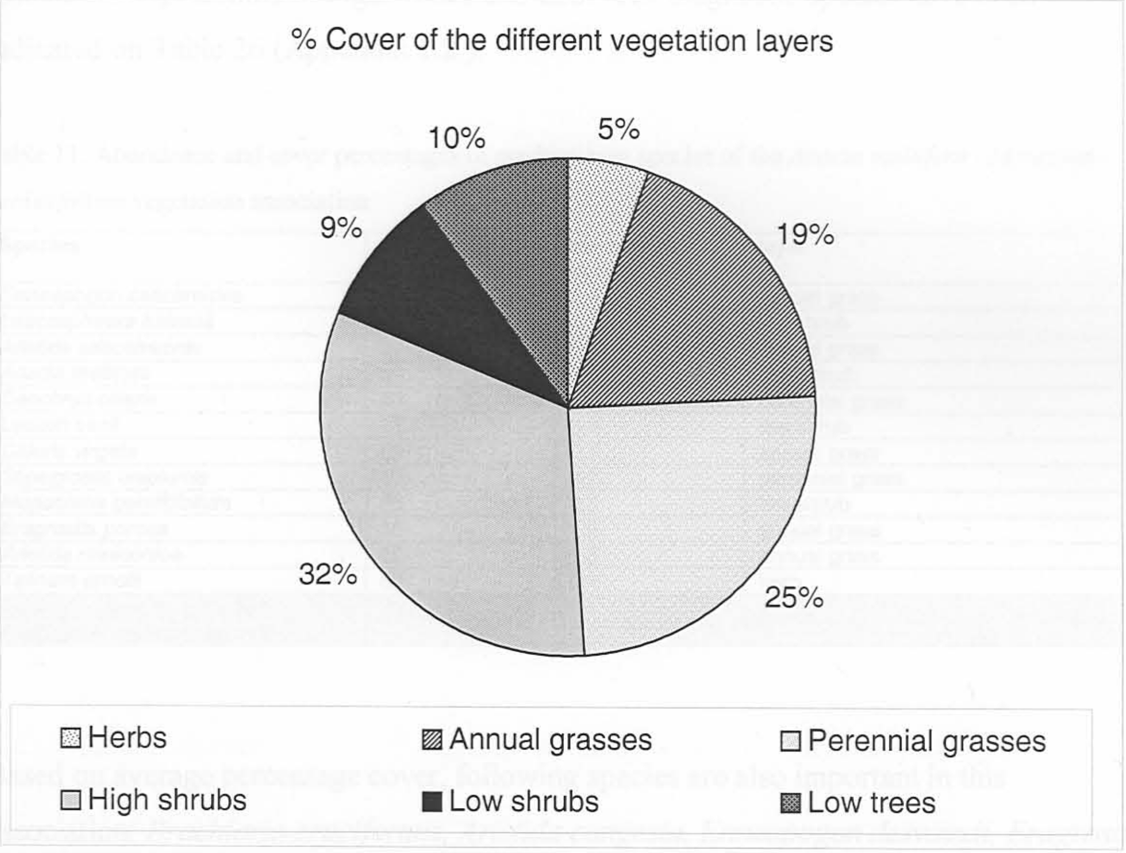


Figure 21b: Pie chart showing the average percentage cover each layer contributes to the total vegetation cover of association 4.

9.3.5. Association 5: *Acacia mellifera - Monechma genistifolium* low semi-open bushland

This vegetation association occurs as a transition between the more degraded habitats of associations 3 and 4 and the calcrete plains of association 10, to more favourable soils occupied especially by associations 6 and 7. Association 5 is found mainly in the southern part of the study area, but is also found in smaller patches in the northern regions of the study area. The topsoils usually consist of reddish sandy loam to loamy sand. The underlying geology is very varied, with the larger parts of this association on the Omingonde Formation, but granites and quartzites as well as occasionally patches of undifferentiated rocks of the Damara Sequence also occur. The soil types, however, are less varied, being either chromic Cambisols or the chromic Cambisols and leptic-chromic Cambisols Association. Long-term average rainfall ranges from 350 to 380 mm p.a. reaching 450 mm p.a. only in the northern outliers of this association.

Within the study, a total of 65 samples were assigned to this association. Predominant species are listed in Table 11, with the contribution of layers to the overall structure of the association represented in Figures 22a and 22b. The diagnostic species have been indicated on Table 26 (Appendix 1.2.).

Table 11: Abundance and cover percentages of predominant species of the *Acacia mellifera - Monechma genistifolium* vegetation association

Species	abundance (% of samples)	average % cover	layer
Enneapogon cenchroides	98	5.4	annual grass
Leucosphaera bainesii	95	2.5	low shrub
Aristida adscensionis	87	8.8	annual grass
Acacia mellifera	81	8.3	high shrub
Cenchrus ciliaris	80	1.4	perennial grass
Lycium eenii	75	0.6	low shrub
Chloris virgata	69	0.7	annual grass
Stipagrostis uniplumis	67	4.2	perennial grass
Monechma genistifolium	66	4.2	low shrub
Eragrostis porosa	66	1.5	annual grass
Aristida rhiniochloa	60	1.3	annual grass
Talinum arnotii	60	0.1	herb
Total nr of species recorded	259		
Average % cover per sample		70.4	

Based on average percentage cover, following species are also important in this association: *Brachiaria eruciformis, Aristida congesta, Enneapogon desvauxii, Eragrostis* *jeffreysii, E. trichophora, Otoptera burchellii* with occasional patches of *Catophractes alexandri*, as well as high shrubs and low trees of *Acacia reficiens* and *A. tortilis* (sometimes reaching 5-6 m height) and a general occurrence of *Boscia albitrunca*, although trees are relatively small with very low crown cover. *Albizia anthelmintica* is often present, either as a low tree or a low shrub. Weeds commonly encountered are *Nidorella resedifolia, Pupalia lappacea* as well as *Geigeria ornativa*.

The structure of this association varies considerably, and appears to be influenced by farming practices as well. On some farms grasses such as *Stipagrostis uniplumis* reach up to 60% cover, on some locations *Aristida congesta* reaches a cover of 40%. Similarly, bush encroachment by especially *Acacia mellifera* appears a problem here, with many samples having cover values between 15 and 50%, while in some samples this bush is absent, indicating the still relatively "open" character of this vegetation type. *Dichrostachys cinerea* does occur here, but does not contribute much to bush-encroachment, presumably due to the drier climate as well as a higher incidence of frost, to which it is sensitive.

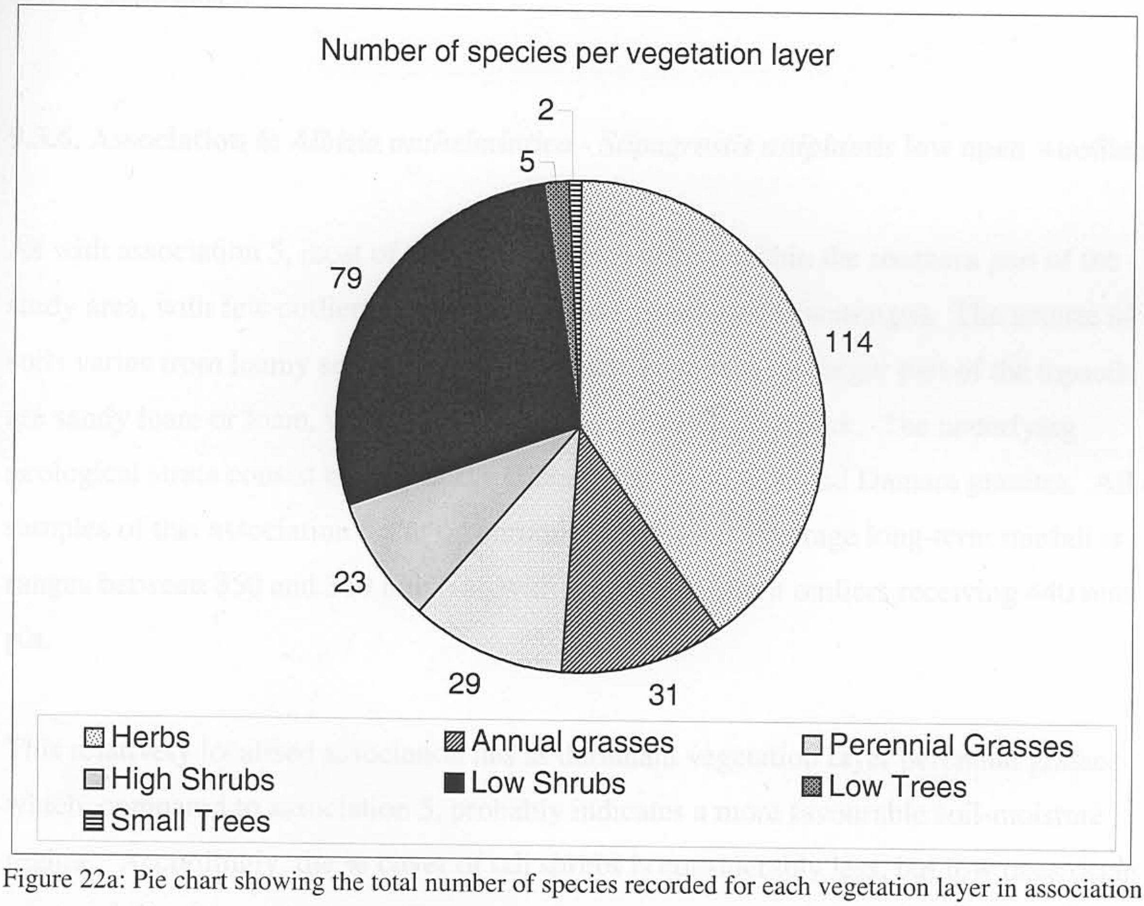


Figure 22a: Pie chart showing the total number of species recorded for each vegetation layer in association 5.

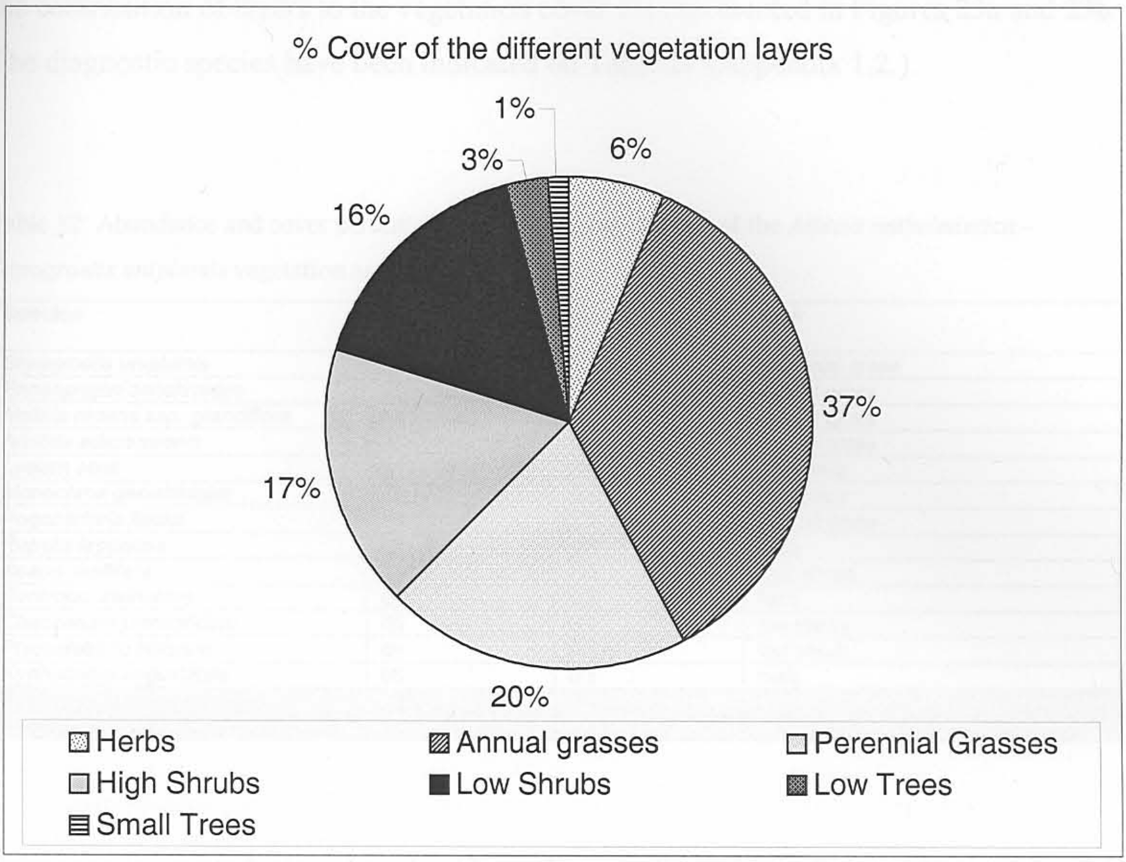


Figure 22b: Pie chart showing the average percentage cover each layer contributes to the total vegetation cover of association 5.

9.3.6. Association 6: *Albizia anthelmintica - Stipagrostis uniplumis* low open woodland

As with association 5, most of this open savanna occurs within the southern part of the study area, with few outliers in the northern part (north of Otjiwarongo). The texture of soils varies from loamy sand to sandy clay loam, however, the larger part of the topsoils are sandy loam or loam, with some form of stoniness or even rock. The underlying geological strata consist mainly of the Omingonde Formation and Damara granites. All 42 samples of this association occur on chromic Cambisols. Average long-term rainfall is ranges between 350 and 360 mm p.a., with only the northern outliers receiving 440 mm p.a.

This relatively localised association has as dominant vegetation layer perennial grasses which, compared to association 5, probably indicates a more favourable soil-moisture regime. Accordingly, the % cover of tall shrubs is considerably less, but low trees occur scattered throughout the area. The predominant plant species are listed in Table 12, while the contribution of layers to the vegetation cover are represented in Figures 23a and 23b. The diagnostic species have been indicated on Table 27 (Appendix 1.2.).

Table 12: Abundance and cover percentages of predominant species of the *Albizia anthelmintica* - *Stipagrostis uniplumis* vegetation association

Species	abundance (% of samples)	average % cover	layer
Stipagrostis uniplumis	97	34.4	perennial grass
Enneapogon cenchroides	97	3.1	annual grass
Melinis repens ssp. grandiflora	92	0.9	annual grass
Aristida adscensionis	85	3.8	annual grass
Lycium eenii	81	1.3	low shrub
Monechma genistifolium	73	4.4	low shrub
Pogonarthria fleckii	73	1.8	annual grass
Pupalia lappacea	73	0.2	herb
Acacia mellifera	71	4.2	high shrub
Evolvolus alsinoides	69	0.5	herb
Chascanum pinnatifidum	66	0.2	low shrub
Ptycholobium biflorum	66	0.1	low shrub
Kyphocarpa angustifolia	66	0.1	herb
Total nr of species recorded	238		
Average % cover per sample		90.1	

Other species contributing considerably to the overall cover are *Eragrostis porosa* and *E. trichophora*, with high shrubs and low trees of *Acacia reficiens, Catophractes alexandri, Albizia anthelmintica* and *Boscia albitrunca*. Occasionally, coverage of 10 - 35% of *Acacia mellifera* lower than 1 m have been recorded, which indicates a potential for bush encroachment even in this vegetation type should the relatively strong grass layer become decimated. % Cover for *Stipagrostis uniplumis* has often been recorded between 30 and 70%, making it very characteristic for this vegetation association.

Species which are often recorded, even with a low cover, are: *Chloris virgata, Acrotome fleckii, Aptosimum lineare, Felicia smaragdina, Geigeria ornativa, Ocimum americanum, Phyllanthus maderaspatensis, Talinum arnotii, Barleria lanceolata* and *Leucosphaera bainesii*. Compared to association 5, it is also notable that weedy species are less frequent in this association.

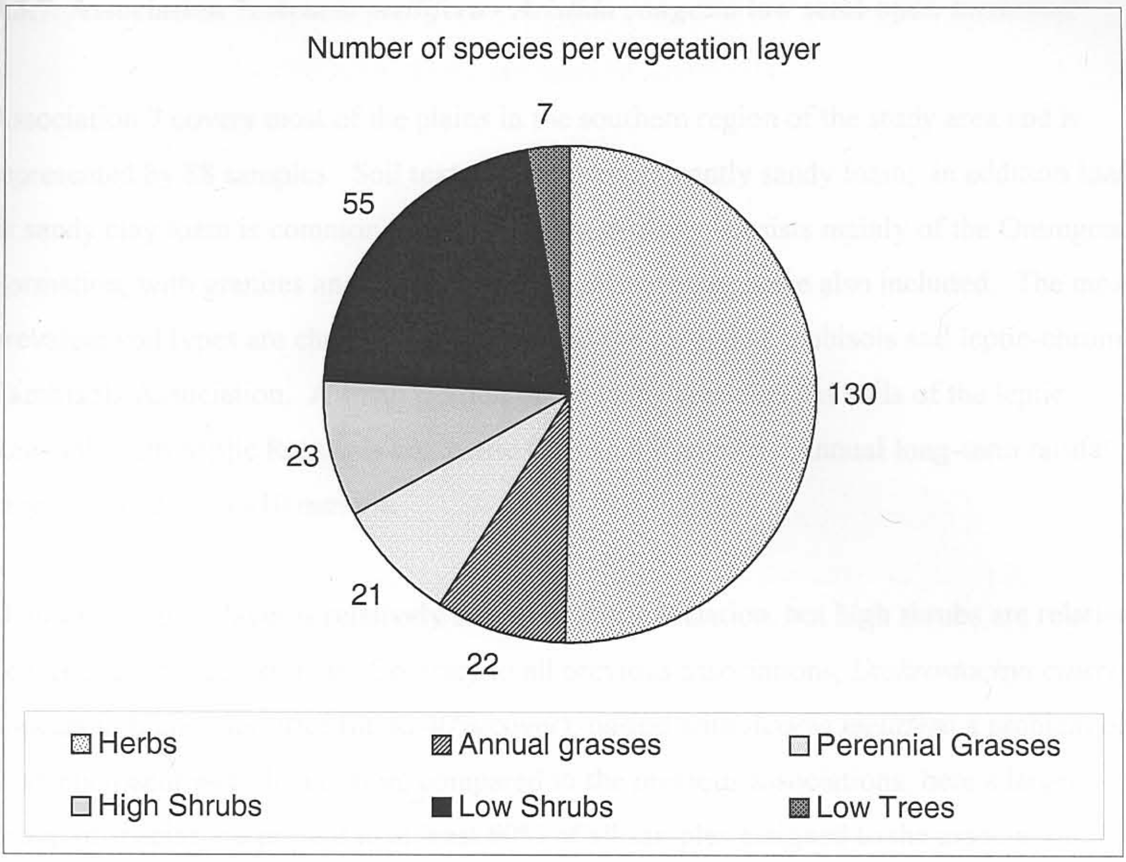


Figure 23a: Pie chart showing the total number of species recorded for each vegetation layer in association 6.

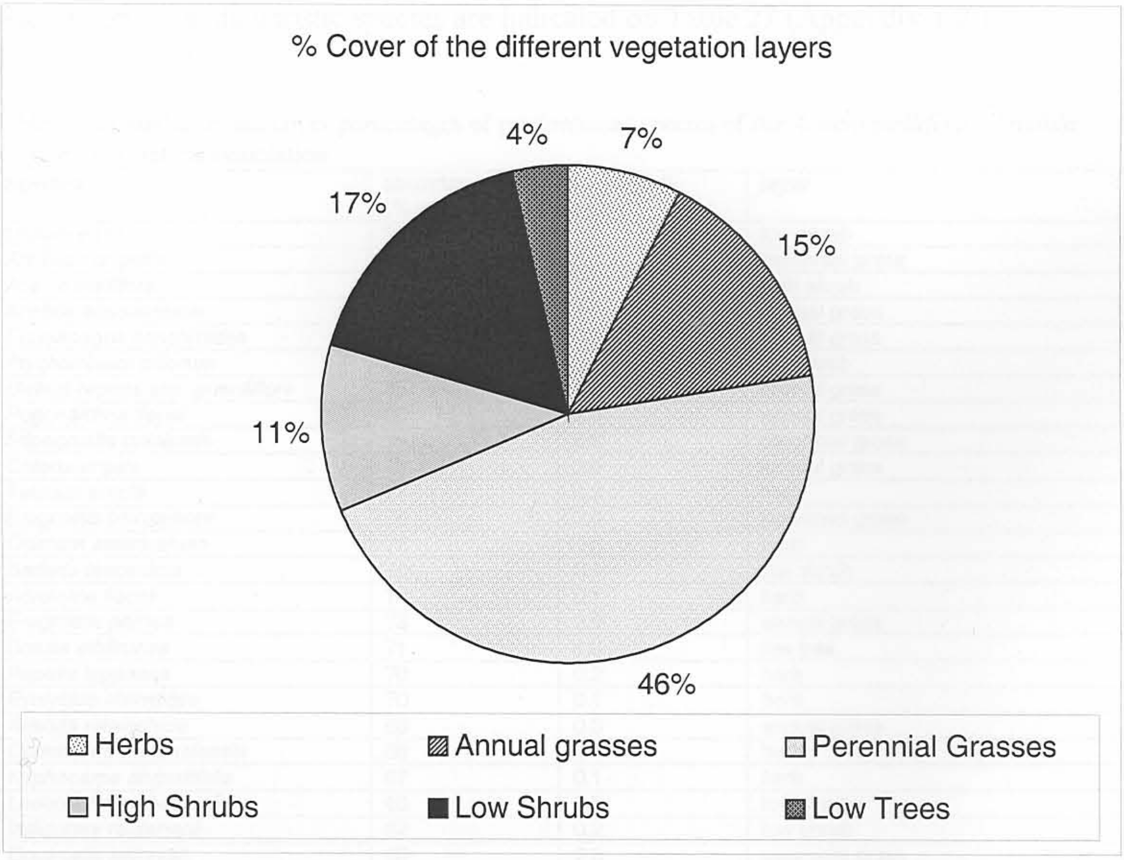


Figure 23b: Pie chart showing the average percentage cover each layer contributes to the total vegetation cover of association 6.

9.3.7. Association 7: *Acacia mellifera - Aristida congesta* low semi-open bushland

Association 7 covers most of the plains in the southern region of the study area and is represented by 88 samples. Soil textures are predominantly sandy loam; in addition loam or sandy clay loam is common. The underlying geology consists mainly of the Omingonde Formation, with granites and quartzites of the Damara Sequence also included. The most prevalent soil types are chromic Cambisols and the chromic Cambisols and leptic-chromic Cambisols Association. A small portion of the study area also has soils of the leptic Regosols with haplic Regosols and petric Calcisols Complex. Annual long-term rainfall ranges from 350 to 410 mm p.a.

Overall, the grass layer is relatively strong in this association, but high shrubs are relatively denser than in association 6. Contrary to all previous associations, *Dichrostachys cinerea* appears in higher densities (up to 40% cover), posing with *Acacia mellifera* a problem of bush encroachment. In addition, compared to the previous associations, here a larger group of species are present in at least 60% of all samples assigned to the association (Table 13). Figures 24a and 24b show the relative importance of the layers within the association. The diagnostic species are indicated on Table 27 (Appendix 1.2.).

Table 13: Abundance and cover percentages of predominant species of *the Acacia mellifera - Aristida congesta* vegetation association

Species	abundance (% of samples)	average % cover	layer
Lycium eenii	93	1.0	low shrub
Aristida congesta	92	8.3	perennial grass
Acacia mellifera	88	7.8	high shrub
Aristida adscensionis	87	3.0	annual grass
Enneapogon cenchroides	86	0.9	annual grass
Ptycholobium biflorum	86	0.1	low shrub
Melinis repens ssp. grandiflora	85	1.5	annual grass
Pogonarthria fleckii	83	2.5	annual grass
Stipagrostis uniplumis	78	8.6	perennial grass
Chloris virgata	78	0.9	annual grass
Talinum arnotii	77	0.2	herb
Eragrostis trichophora	76	2.6	perennial grass
Ocimum americanum	76	0.5	herb
Barleria lanceolata	76	0.2	low shrub
Acrotome fleckii	74	0.1	herb
Eragrostis porosa	73	2.9	annual grass
Boscia albitrunca	71	1.0	low tree
Pupalia lappacea	70	0.2	herb
Evolvulus alsinoides	70	0.1	herb
Aristida rhiniochloa	69	0.3	annual grass
Commelina benghalensis	68	0.1	herb
Kyphocarpa angustifolia	67	0.1	herb
Leucosphaera bainesii	65	0.5	low shrub
Indigofera rautanenii	62	0.2	low shrub
Eragrostis jeffreysii	60	2.8	perennial grass
Total nr of species recorded	289		
Average % cover per sample		72.5	

Other conspicuous species, although with a lower abundance, are *Eragrostis cylindriflora, E. rigidior, E. rotifer* and high shrubs and trees of *Acacia reficiens, Catophractes alexandri, Dichrostachys cinerea* and *Grewia flava*. Also commonly found are *Chascanum pinnatifidum, Hibiscus calyphyllus* (typically in the shade of taller shrubs), *Ipomoea obscura, I. sinensis, Aptosimum angustifolium, Cleome monophylla, C. rubella* and *Cucumis anguira*. Common weedy and poisonous species include *Geigeria acaulis, G. ornativa* and *Ondetia linearis*. Notable is the high amount of undesirable grasses, e.g. *Aristida adscensionis* sometimes having a cover of 10%, *Eragrostis cylindriflora* up to 50%, *Eragrostis porosa* up to 20% and *Aristida congesta* up to 40% cover. *Eragrostis rigidior* also appears to be increasing in several samples, not being utilised due to its hardness, forming stands of up to 30% cover. Accordingly, in samples where the cover of the undesirable species is relatively high, species such as *Stipagrostis uniplumis* have a very low % cover, if at all present.

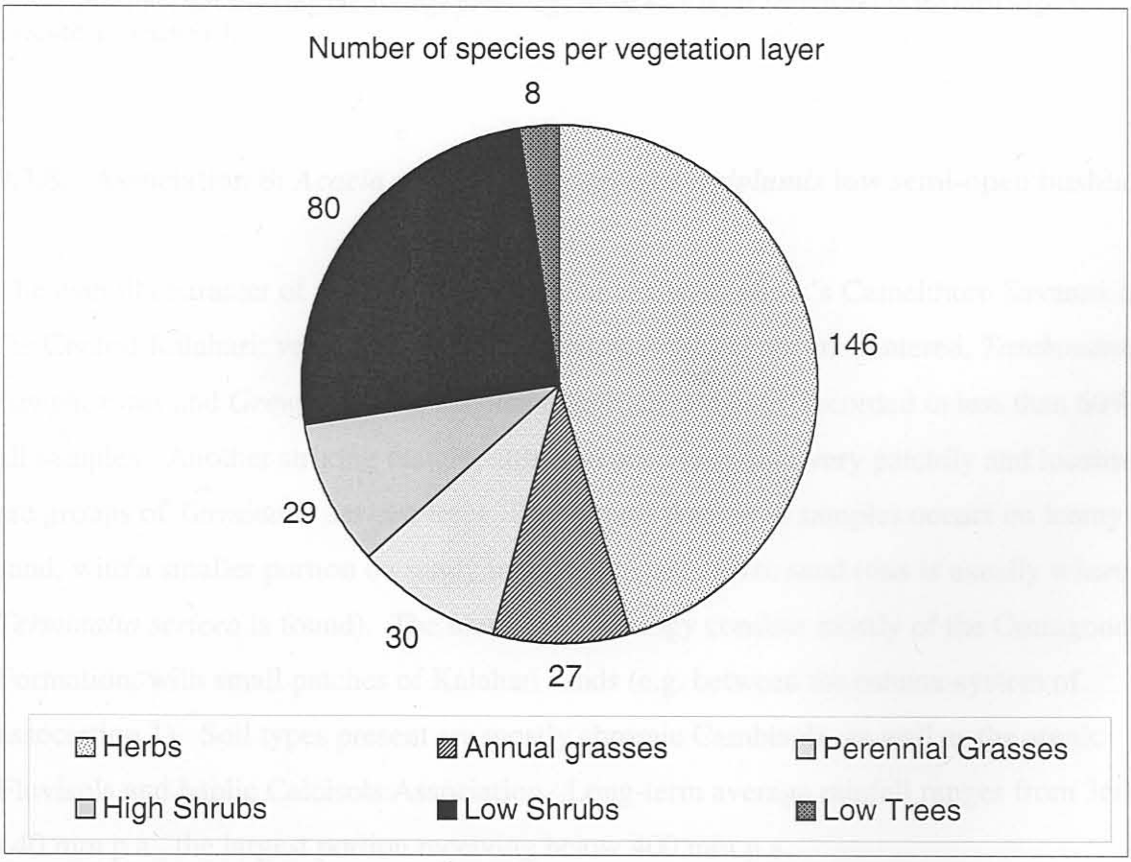


Figure 24a: Pie chart showing the total number of species recorded for each vegetation layer in association 7.

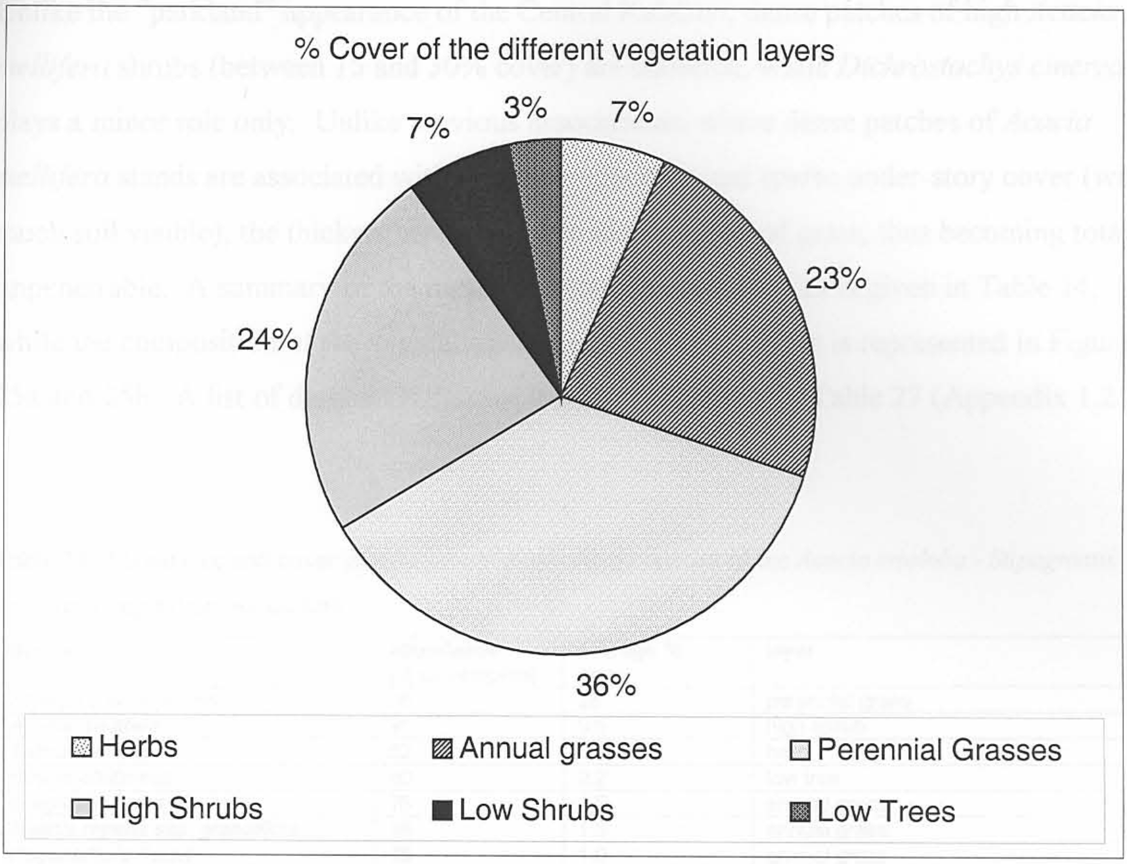


Figure 24b: Pie chart showing the average percentage cover each layer contributes to the total vegetation cover of association 7.

9.3.8. Association 8: *Acacia erioloba - Stipagrostis uniplumis* low semi-open bushland

The overall character of association 8 is similar to that of Giess's Camelthorn Savanna of the Central Kalahari: very often groups of *Acacia erioloba* are encountered, *Tarchonanthus camphoratus* and *Grewia* species become important, although recorded in less than 60% of all samples. Another striking feature, although occurring only very patchily and localised, are groups of *Terminalia sericea* trees. The largest portion of samples occurs on loamy sand, with a smaller portion on sandy loam and loose, coarse sand (this is usually where *Terminalia sericea* is found). The underlying geology consists mostly of the Omingonde Formation, with small patches of Kalahari sands (e.g. between the oshana-system of association 1). Soil types present are mostly chromic Cambisols, as well as the arenic Fluvisols and haplic Calcisols Association. Long-term average rainfall ranges from 360 - 440 mm p.a., the largest portion receiving below 400 mm p.a.

Unlike the "parkland" appearance of the Central Kalahari, dense patches of high *Acacia mellifera* shrubs (between 15 and 30% cover) are common, while *Dichrostachys cinerea* plays a minor role only. Unlike previous associations, where dense patches of *Acacia mellifera* stands are associated with shadow-vegetation and sparse under-story cover (with much soil visible), the thickets here are within dense stands of grass, thus becoming totally impenetrable. A summary of the most predominant plant species is given in Table 14, while the composition of the vegetation in according to its layers is represented in Figures 25a and 25b. A list of diagnostic species has been indicated on Table 27 (Appendix 1.2.).

Table 14: Abundance and cover percentages of predominant species of the *Acacia erioloba - Stipagrostis uniplumis* vegetation association

Species	abundance (% of samples)	average % cover	layer
Stipagrostis uniplumis	96	28	perennial grass
Acacia mellifera	91	9.5	high shrub
Talinum arnotii	82	0.1	herb
Boscia albitrunca	80	2.2	low tree
Eragrostis porosa	78	2.5	annual grass
Melinis repens ssp. grandiflora	78	1.5	annual grass
Pogonarthria fleckii	78	1.0	annual grass
Urochloa brachyura	78	0.6	annual grass
Enneapogon cenchroides	73	0.3	annual grass
Eragrostis rigidior	71	7.9	perennial grass
Grewia flava	69	0.9	high shrub
Lycium eenii	69	0.4	low shrub
Evolvolus alsinoides	67	0.1	herb
Otoptera burchellii	64	0.2	low shrub
Aristida congesta	62	3.2	perennial grass
Gisekia africana	62	0.1	herb
Total nr of species recorded	234		
Average % cover per sample		78.5	

Other important species are *Eragrostis trichophora* with high (and occasionally low) shrubs of *Acacia fleckii, A. hebeclada, Catophractes alexandri, and Lycium bosciifolium*. Characteristic trees are *Acacia erioloba* and *Terminalia sericea*. *Acacia reficiens* also occurs, but with small frequency, while *A. tortilis* and *Albizia anthelmintica* are relatively seldom. Locally, species such *as Grewia flavescens* var. *olukondae, Aptosimum angustifolium, Cleome rubella, Acanthosicyos naudinianus, Hermannia tomentosa* and *Indigofera rautanenii* are common. Another common feature are *Ipomoea* and *Crotalaria* species, of which one is almost always present.

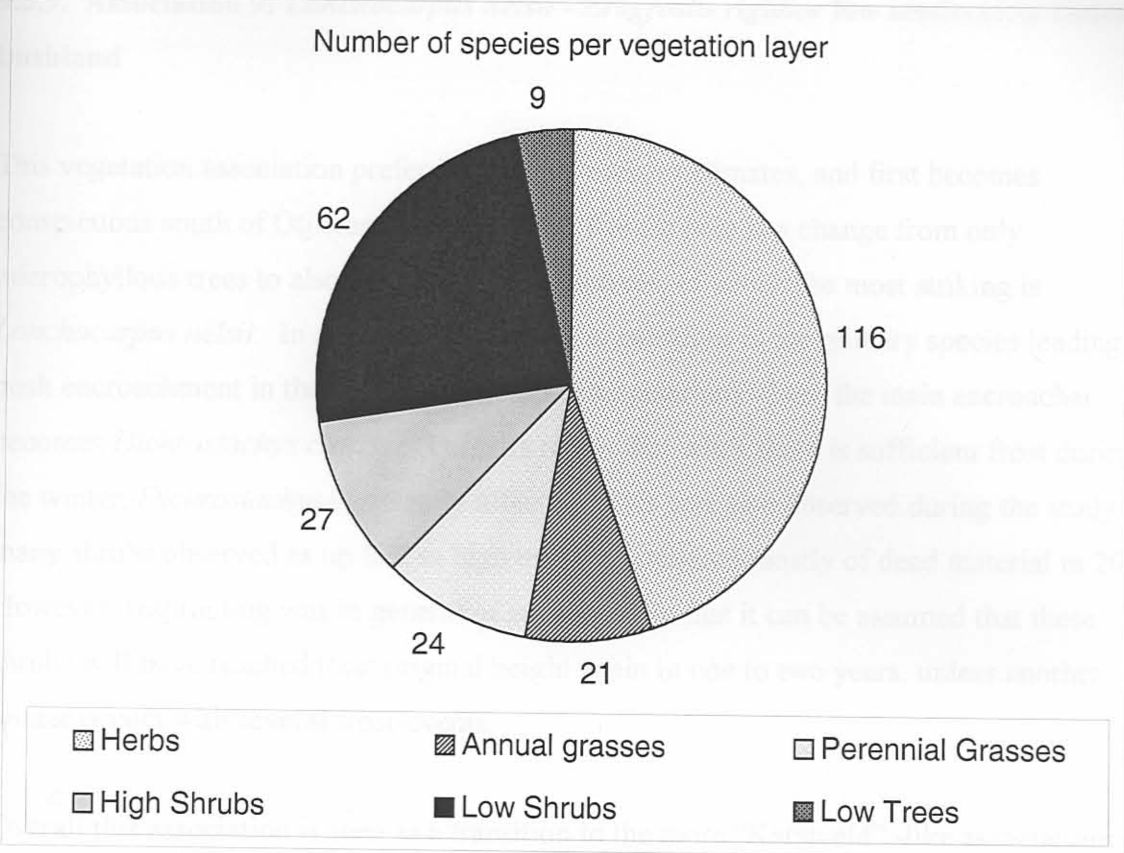


Figure 25a: Pie chart showing the total number of species recorded for each vegetation layer in association 8.

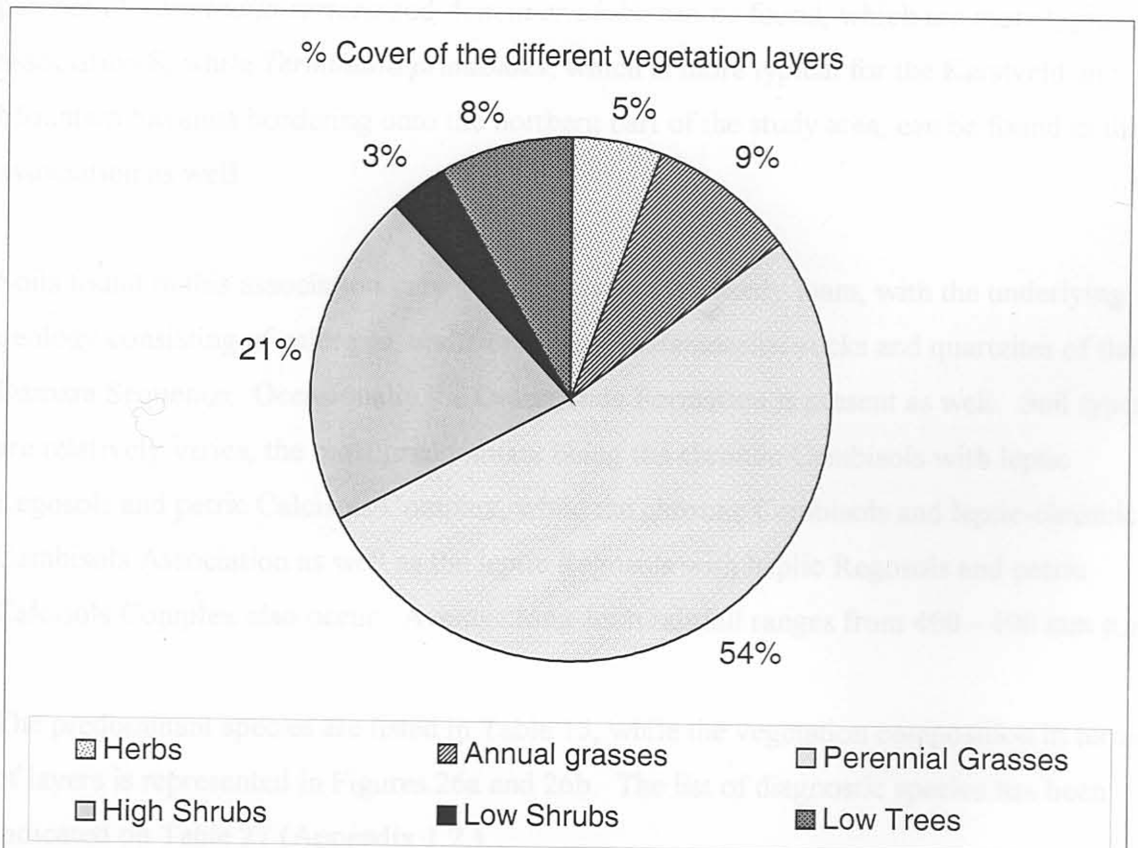


Figure 25b: Pie chart showing the average percentage cover each layer contributes to the total vegetation cover of association 8.

9.3.9. Association 9: *Lonchocarpus nelsii - Eragrostis rigidior* low moderately closed bushland

This vegetation association prefers somewhat moister climates, and first becomes conspicuous south of Otjiwarongo. A typical feature here is a change from only microphyllous trees to also some broad-leaved trees, of which the most striking is *Lonchocarpus nelsii*. In addition, where *Acacia mellifera* is the primary species leading to bush encroachment in the previous vegetation associations - here the main encroacher becomes *Dichrostachys cinerea*. Farmers report that when there is sufficient frost during the winter, *Dichrostachys* is severely affected. This was also observed during the study - many shrubs observed as up to 2 m high in 2001 consisted mostly of dead material in 2002. However, resprouting was in general of such a nature that it can be assumed that these shrubs will have reached their original height again in one to two years, unless another winter occurs with several frost-events.

Overall this association is seen as a transition to the more "Karstveld" -like associations of the northern study area, which is reflected in its variable nature. Occasionally, small patches of *Terminalia sericea* and *Acacia erioloba* can be found, which are more typical of association 8, while *Terminalia prunioides*, which is more typical for the Karstveld and Mountain Savanna bordering onto the northern part of the study area, can be found in this association as well.

Soils found in this association vary from loamy sand to sandy loam, with the underlying geology consisting of calcretes, undifferentiated metamorphic rocks and quartzites of the Damara Sequence. Occasionally the Omingonde Formation is present as well. Soil types are relatively varies, the most predominant being the chromic Cambisols with leptic Regosols and petric Calcisols Complex, while the chromic Cambisols and leptic-chromic Cambisols Association as well as the leptic Regosols with haplic Regosols and petric Calcisols Complex also occur. Average long-term rainfall ranges from 400 - 490 mm p.a.

The predominant species are listed in Table 15, while the vegetation composition in terms of layers is represented in Figures 26a and 26b. The list of diagnostic species has been indicated on Table 27 (Appendix 1.2.).

Table 15: Abundance and cover percentages of predominant species of the *Lonchocarpus nelsii - Eragrostis rigidior* vegetation association

Species	abundance (% of samples)	average % cover	layer
Dichrostachys cinerea	96	13.5	high shrub
Pogonarthria fleckii	90	1.7	annual grass
Eragrostis rigidior	81	9.7	perennial grass
Acacia mellifera	78	4.7	high shrub
Eragrostis trichophora	78	3.9	perennial grass
Evolvolus alsinoides	78	0.1	herb
Melinis repens ssp. grandiflora	71	0.1	annual grass
Ipomoea obscura	71	0.3	herb
Grewia bicolor	68	2.4	high shrub
Eragrostis porosa	68	1.5	annual grass
Commelina benghalensis	68	0.1	herb
Aristida congesta	65	3.0	perennial grass
Grewia flava	65	2.7	high shrub
Lonchocarpus nelsii	65	2.3	low tree
Acacia reficiens	62	2.8	high shrub
Aristida adscensionis	62	1.2	annual grass
Hibiscus elliottiae	62	0.2	low shrub
Pupalia lappacea	62	0.2	low shrub
Talinum arnotii	62	0.2	herb
Total nr of species recorded	234		
Average % cover per sample		83.7	

Other important species include *Enneapogon cenchroides*, *Stipagrostis uniplumis* and *Monechma genistifolium* with high shrubs of *Acacia fleckii*, *Albizia anthelmintica*, *Combretum apiculatum* and *Grewia flavescens* var. *olukondae*. Further common species include: *Dicoma tomentosa, Oxygonum sinuatum, Vernonia poskeana, Barleria lanceolata, Clerodendrum ternatum, Commiphora pyracanthoides, Hibiscus calyphyllus, Ipomoea verbascoidea, Megalochlamys marlothii, Ptycholobium biflorum* and *Solanum kwebense*.

The diversity of shade-loving plants is relatively high in this association. Species such as *Hibiscus calyphyllus, Commelina benghalensis, Megalochlamys marlothii* and *Digitaria velutina* can be found under almost all denser groups of trees. The wide-spread occurrence of *Pupalia lappacea* - listed by Craven and Kolberg (1999) as an exotic species is especially pronounced in this vegetation type. *Geigeria acaulis* appears to be a common poisonous plant, as are *Crotalaria* spp.

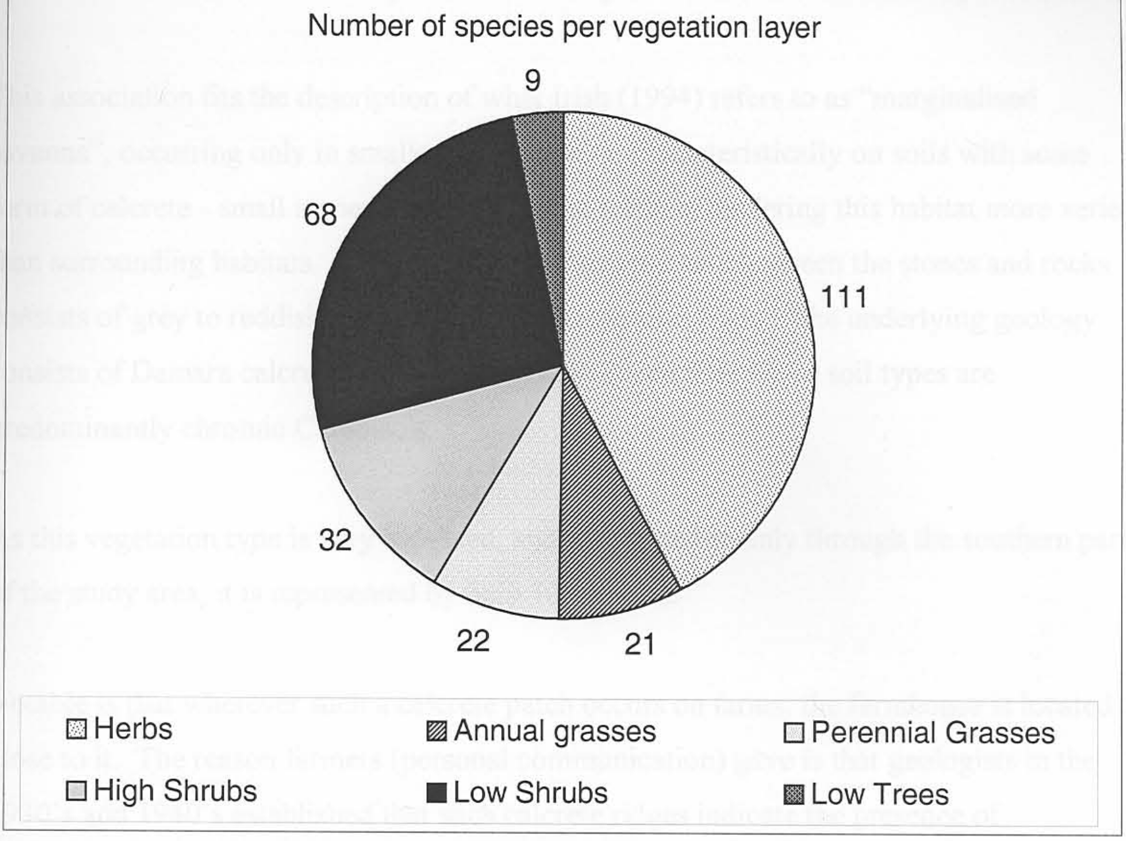


Figure 26a: Pie chart showing the total number of species recorded for each vegetation layer in association 9.

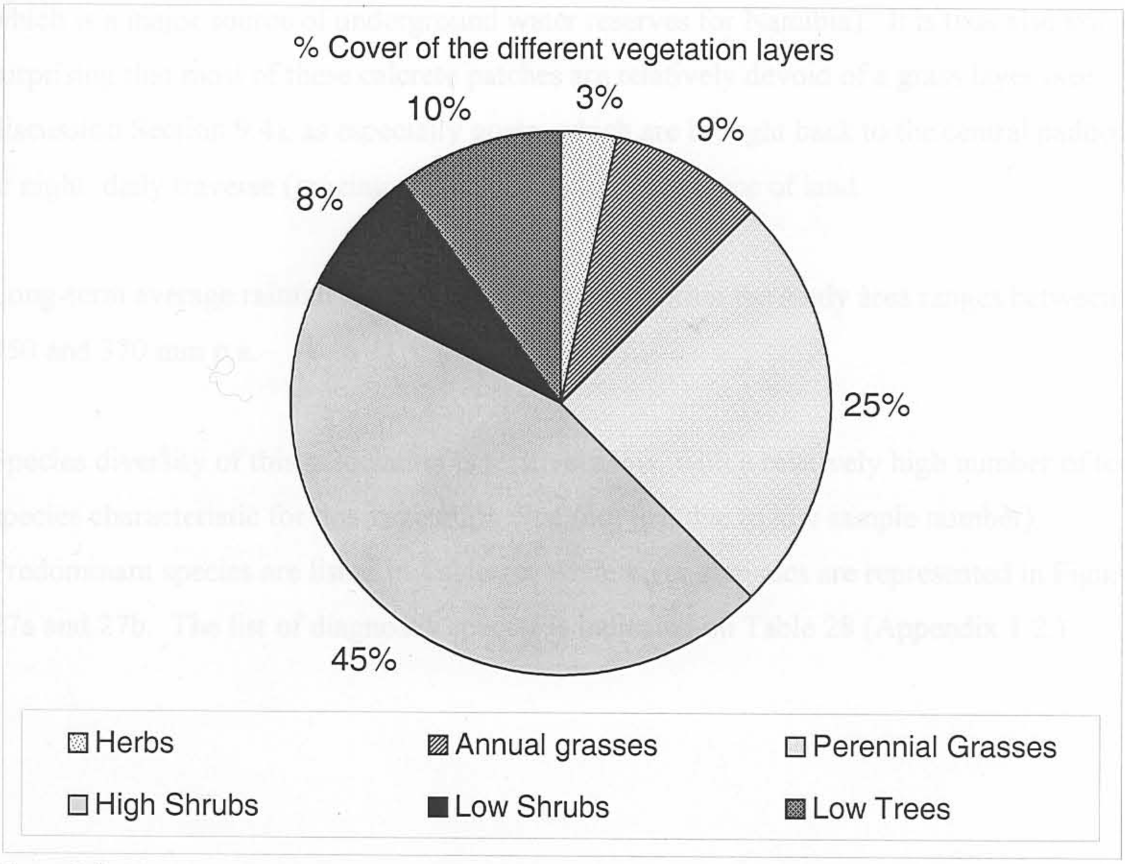


Figure 26b: Pie chart showing the average percentage cover each layer contributes to the total vegetation cover of association 9.

9.3.10. Association 10: *Boscia foetida - Leucosphaera bainesii* low semi-open bushland

This association fits the description of what Irish (1994) refers to as "marginalised savanna", occurring only in smaller patches, very characteristically on soils with some form of calcrete - small stones to rocks - on the surface, rendering this habitat more xeric than surrounding habitats. The soil texture of soil pockets between the stones and rocks consists of grey to reddish-grey loam and/or sandy clay loam. The underlying geology consists of Damara calcretes or the Omingonde Formation, while soil types are predominantly chromic Cambisols.

As this vegetation type is very localised, and distributed mainly through the southern part of the study area, it is represented by only 10 samples.

Notable is that wherever such a calcrete patch occurs on farms, the farmhouse is located close to it. The reason farmers (personal communication) gave is that geologists in the 1930's and 1940's established that such calcrete ridges indicate the presence of underground water (compare to the Karstveld, with large tracts of calcrete and dolomite, which is a major source of underground water reserves for Namibia). It is thus also not surprising that most of these calcrete patches are relatively devoid of a grass layer (see discussion Section 9.4), as especially goats, which are brought back to the central paddocks at night, daily traverse (grazing off and trampling) this piece of land.

Long-term average rainfall for this vegetation type within the study area ranges between 350 and 370 mm p.a.

Species diversity of this association is relatively low, with a relatively high number of total species characteristic for this vegetation type (not just due to low sample number). Predominant species are listed in Table 16, while layer-statistics are represented in Figures 27a and 27b. The list of diagnostic species is indicated on Table 28 (Appendix 1.2.).

Table 16: Abundance and cover percentages of predominant species of the *Boscia foetida - Leucosphaera bainesii* vegetation association

Species	abundance (% of samples)	average % cover	layer
Stipagrostis uniplumis	100	13.8	perennial grass
Enneapogon desvauxii	100	6.5	perennial grass (or biennial)
Enneapogon cenchroides	100	4.3	annual grass
Cenchrus ciliaris	100	3.9	perennial grass
Leucosphaera bainesii	100	3.0	low shrub
Monechma genistifolium	90	9.5	low shrub
Eriocephalus pubescens	90	1.1	low shrub
Eragrostis echinochloidea	90	0.5	perennial grass
Melhania virescens	90	0.3	low shrub
Catophractes alexandri	80	12.1	high shrub
Acacia mellifera	80	4.5	high shrub
Peliostomum leucorrhizum	80	1.1	herb
Sericorema sericea	80	0.4	herb
Otoptera burchellii	80	0.4	low shrub
Seddera suffruticosa	80	0.2	low shrub
Eragrostis porosa	80	0.1	annual grass
Acacia reficiens	70	0.9	high shrub
Boscia foetida	70	0.4	high shrub
Barleria lanceolata	70	0.2	low shrub
Lycium eenii	70	0.2	low shrub
Fingerhutia africana	70	0.2	perennial grass
Ocimum americanum	70	0.1	herb
Aristida adscensionis	60	1.0	annual grass
Grewia flava	60	0.5	high shrub
Sida ovata	60	0.4	low shrub
Leucas pechuelii	60	0.2	low shrub
Eragrostis jeffreysii	60	0.1	perennial grass
Aizoon virgatum	60	0.1	low shrub
Total nr of species recorded	97		
Average % cover per sample		70.1	

Other commonly encountered species with varying cover percentages are: *Eragrostis annulata*, *Oropetium capense*, *Stipagrostis hirtigluma*, *Boscia albitrunca*, *Kleinia longiflora* and *Lycium* spp, while a species such as *Hermannia damarana* was only found within this association.

One interesting observation: while *Leucosphaera bainesii* occurs in much higher densities in other vegetation types - only here this shrub (considered in southern Namibia as one of the more valuable fodder shrubs) was visibly being utilized. A viable explanation for this could not be established - possibly the daily grazing patterns by goats. Likewise, wherever *Boscia albitrunca* was only a shrub, it was likely to remain such due to grazing impact. Such shrubs often had very gnarled low stems, and were at times difficult to distinguish from *Boscia foetida*.

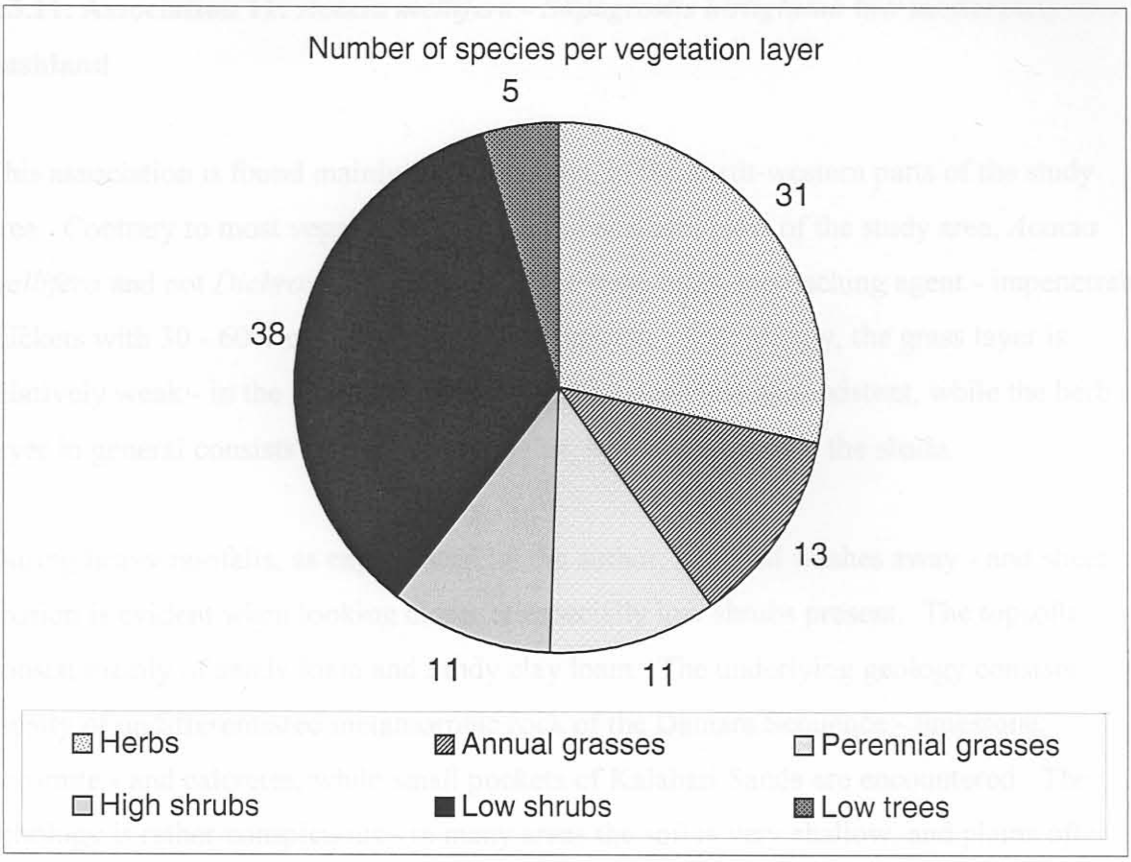


Figure 27a: Pie chart showing total number of species recorded for each vegetation layer in association 10.

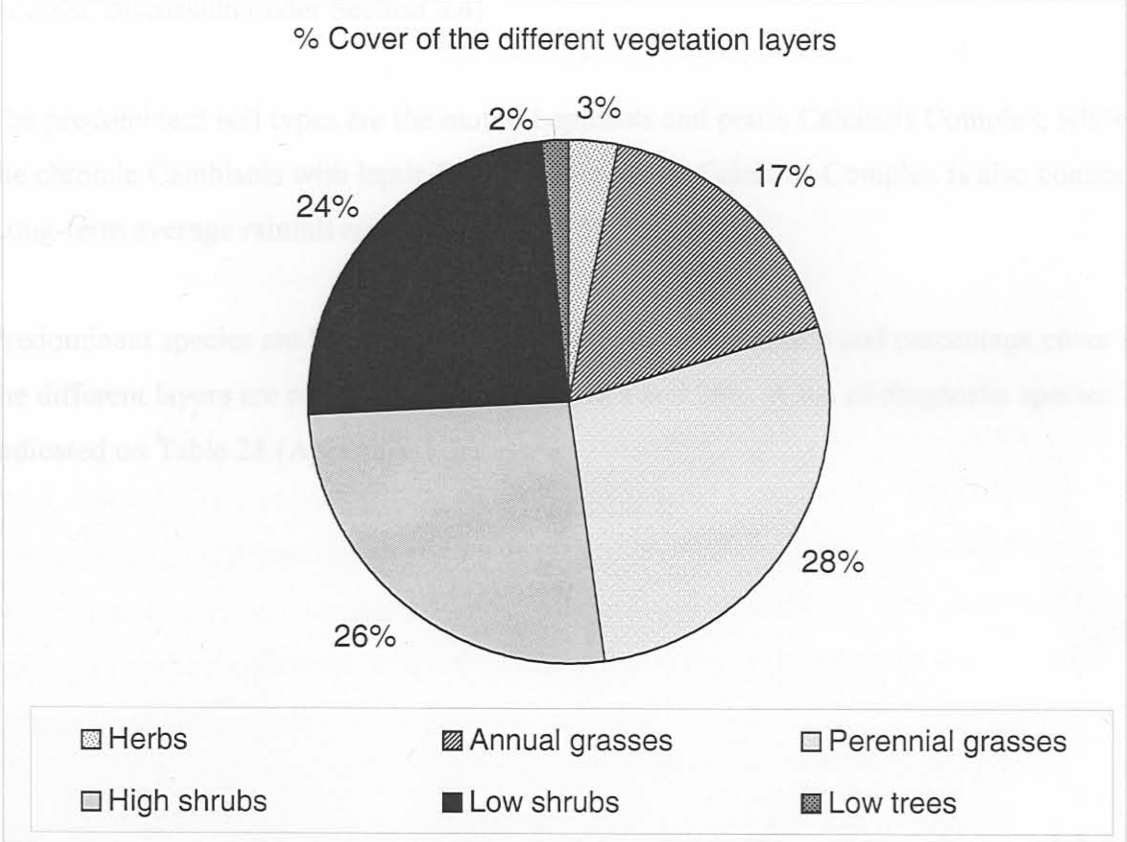


Figure 27b: Pie chart showing the average percentage cover each layer contributes to the total vegetation cover of association 10.

9.3.11. Association 11: *Acacia mellifera - Stipagrostis hirtigluma* low moderately closed bushland

This association is found mainly towards Otavi, in the north-western parts of the study area. Contrary to most vegetation found in the northern parts of the study area, *Acacia mellifera* and not *Dichrostachys cinerea* is the main bush-encroaching agent - impenetrable thickets with 30 - 60% cover are relatively common. Accordingly, the grass layer is relatively weak - in the most severely affected areas almost non-existent, while the herb layer in general consists of sparse individulas, which can tolerate the shade.

During heavy rainfalls, as experienced by the author, bare soil washes away - and sheet erosion is evident when looking closer at especially low shrubs present. The topsoils consist mainly of sandy loam and sandy clay loam. The underlying geology consists mostly of undifferentiated metamorphic rock of the Damara Sequence - limestone, dolomite - and calcretes, while small pockets of Kalahari Sands are encountered. The lithology is rather conspicuous - in many areas the soil is very shallow, and plains often consist of a large portion of flat bedrock or large stones, explaning it's tendency to degrade (see also discussion under Section 9.4)

The predominant soil types are the mollic Leptosols and petric Calcisols Complex, while the chromic Cambisols with leptic Regosols and petric Calcisols Complex is also common. Long-term average rainfall ranges from 470 - 530 mm p.a.

Predominant species are listed in Table 17, while the composition and percentage cover of the different layers are represented in Figures 28 a and 28b. A list of diagnostic species is indicated on Table 28 (Appendix 1.2.).

Table 17: Abundance and cover percentages of predominant species of the *Acacia mellifera - Stipagrostis hirtigluma* vegetation association

Species	abundance (% of samples)	average % cover	layer
Acacia mellifera	100	29.8	high shrub
Melhania virescens	100	0.5	low shrub
Stipagrostis hirtigluma	92	5.8	perennial grass
Acacia reficiens	85	5.1	high shrub
Eragrostis echinochloidea	85	1.8	perennial grass
Seddera suffruticosa	82	0.2	low shrub
Eragrostis trichophora	75	1.1	perennial grass
Cenchrus ciliaris	71	1.9	perennial grass
Eriocephalus pubescens	71	1.2	low shrub
Otoptera burchellii	71	0.1	low shrub
Catophractes alexandri	67	2.8	high shrub
Clerodendrum ternatum	67	0.3	low shrub
Dichrostachys cinerea	64	2.3	high shrub
Enneapogon scoparius	64	1.5	perennial grass
Leucas pechuelii	64	0.3	low shrub
Lantana angolensis	64	0.1	low shrub
Geigeria ornativa	64	0.1	herb
Ptycholobium biflorum	64	0.1	low shrub
Ruellia sp. nova	64	0.1	herb
Fingerhutia africana	60	0.2	perennial grass
Phyllanthus maderaspatensis	60	0.1	herb
Becium filamentosum	60	0.1	herb
Total nr of species recorded	181		
Average % cover per sample		75.3	

Other species with locally high cover % are: *Enneapogon cenchroides, E. desvauxii, Stipagrostis uniplumis, Grewia flava, Tarchonanthus camphoratus*, low shrubs of *Croton gratissimus, Hiernia angolensis, Monechma genistifolium* and *Petalidium engleranum*. *Petalidium* often forms localised dense patches, and may not be found again on the remainder of a farm. The same applies to *Aloe littoralis* - several to hundreds of individuals may be found within a very limited area on a farm only. Trees such as *Acacia erioloba* and *Peltophorum africanum* are general, although sparsely distributed.

In general there seemed to be a higher diversity of succulent plants in this vegetation type (see synoptic Table, Table 25, Appendix 1.1.), e.g. *Plectranthus neochilus, Aloe zebrina* and *A. littoralis*, an alien *Opuntia* sp., *Kalanchoe* spp and *Stapelia* spp. Farmers (personal communication) reported that the *Opuntia* sp. (called wild-fig, possibly *Opuntia ficus-indica* or close relative) occasionally reached troublesome densities. In such cases, farmers managed to obtain cochineal, which they report can bring the infestations under control within two to three years.

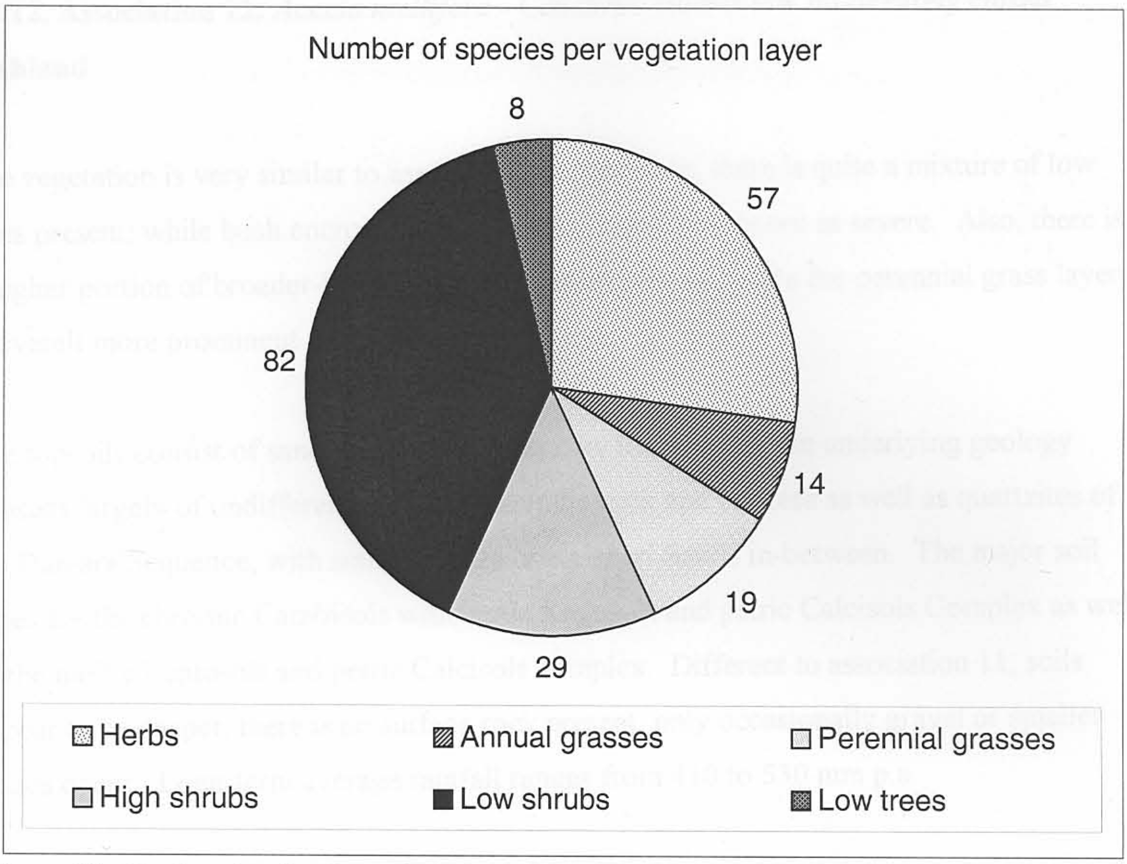


Figure 28a: Pie chart showing the total number of species recorded for each vegetation layer in association 11.

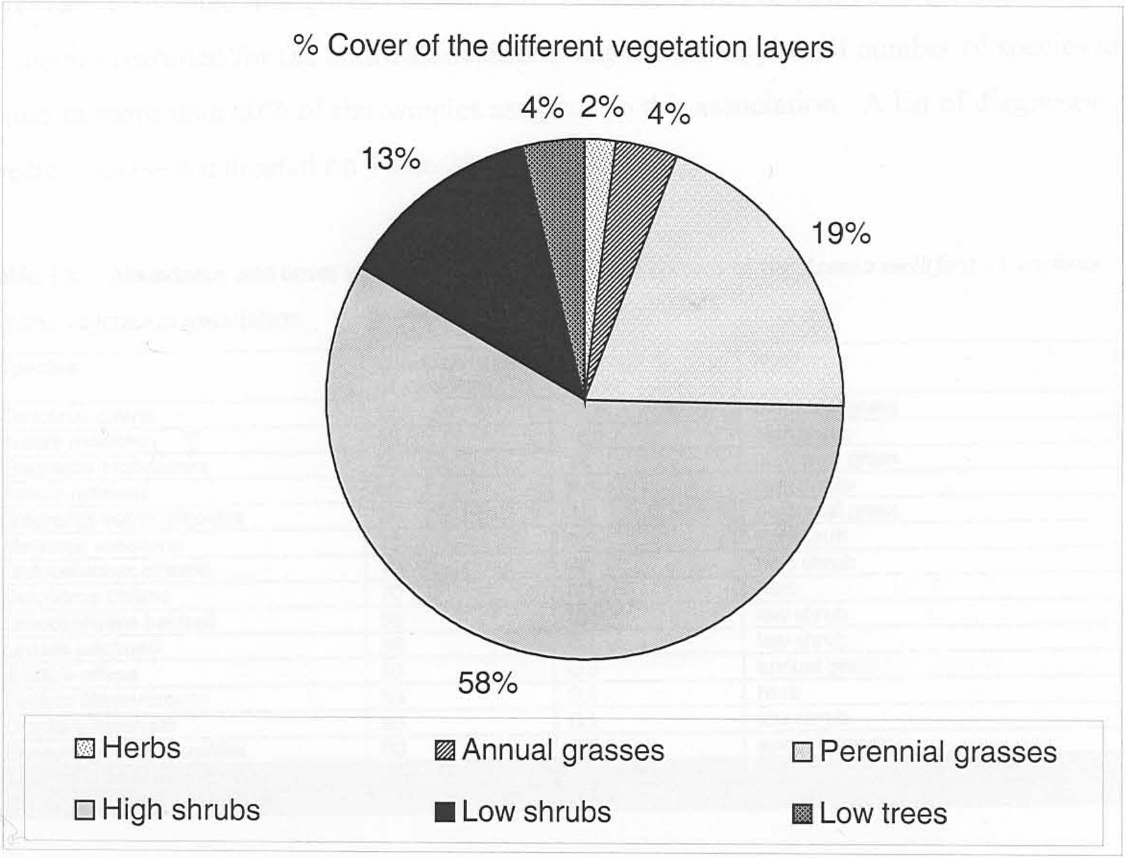


Figure 28b: Pie chart showing the average percentage cover each layer contributes to the total vegetation cover of association 11.

9.3.12. Association 12: *Acacia mellifera - Cenchrus ciliaris* low moderately closed bushland

The vegetation is very similar to association 11, however, there is quite a mixture of low trees present, while bush encroachment by *Acacia mellifera* is not as severe. Also, there is a higher portion of broader-leafed shrubs and trees present, while the perennial grass layer is overall more prominent than high shrubs.

The topsoils consist of sandy loam and sandy clay loam, while the underlying geology consists largely of undifferentiated metamorphic rock and calcrete as well as quartzites of the Damara Sequence, with small patches of Kalahari Sands in-between. The major soil types are the chromic Cambisols with leptic Regosols and petric Calcisols Complex as well as the mollic Leptosols and petric Calcisols complex. Different to association 11, soils appear to be deeper, there is no surface rock present, only occasionally gravel or smaller stones occur. Long-term average rainfall ranges from 410 to 530 mm p.a.

Predominant species are listed in Table 18, while composition and % cover of the different layers are illustrated in Figures 29a and 29b. Notable is that compared to the high number of species recorded for the entire association, only a relatively small number of species are found in more than 60% of the samples assigned to this association. A list of diagnostic species has been indicated on Table 28 (Appendix 1.2.).

Table 18: Abundance and cover percentages of predominant species of the *Acacia mellifera - Cenchrus ciliaris* vegetation association

Species	abundance (% of samples)	average % cover	layer
Cenchrus ciliaris	96	12.8	perennial grass
Acacia mellifera	93	15.1	high shrub
Eragrostis trichophora	90	11	perennial grass
Acacia reficiens	90	8.4	high shrub
Eragrostis echinochloidea	86	3.2	perennial grass
Melhania virescens	76	0.3	low shrub
Dichrostachys cinerea	70	4.3	high shrub
Corchorus tridens	70	0.1	herb
Leucosphaera bainesii	66	0.5	low shrub
Leucas pechuelii	66	0.1	low shrub
Aristida effusa	63	0.3	annual grass
Becium filamentosum	63	0.1	herb
Otoptera burchellii	63	0.1	low shrub
Enneapogon cenchroides	60	0.5	annual grass
Total nr of species recorded	283		
Average % cover per sample		84.3	

A very conspicuous element in this association is the generally high cover of *Cenchrus ciliaris* - reaching cover percentages of 45 %, especially where farmers have put much effort into de-bushing the area.

Other species with locally high percentage cover include *Enneapogon scoparius, Stipagrostis hirtigluma, Stipagrostis uniplumis* and *Monechma genistifolium*, with high shrubs and trees of *Acacia tortilis*. Occasionally small groups of *Acacia erioloba, Combretum imberbe* and *Lonchocarpus nelsii* as well as single trees of *Albizia anthelmintica* and *Boscia albitrunca* can be found.

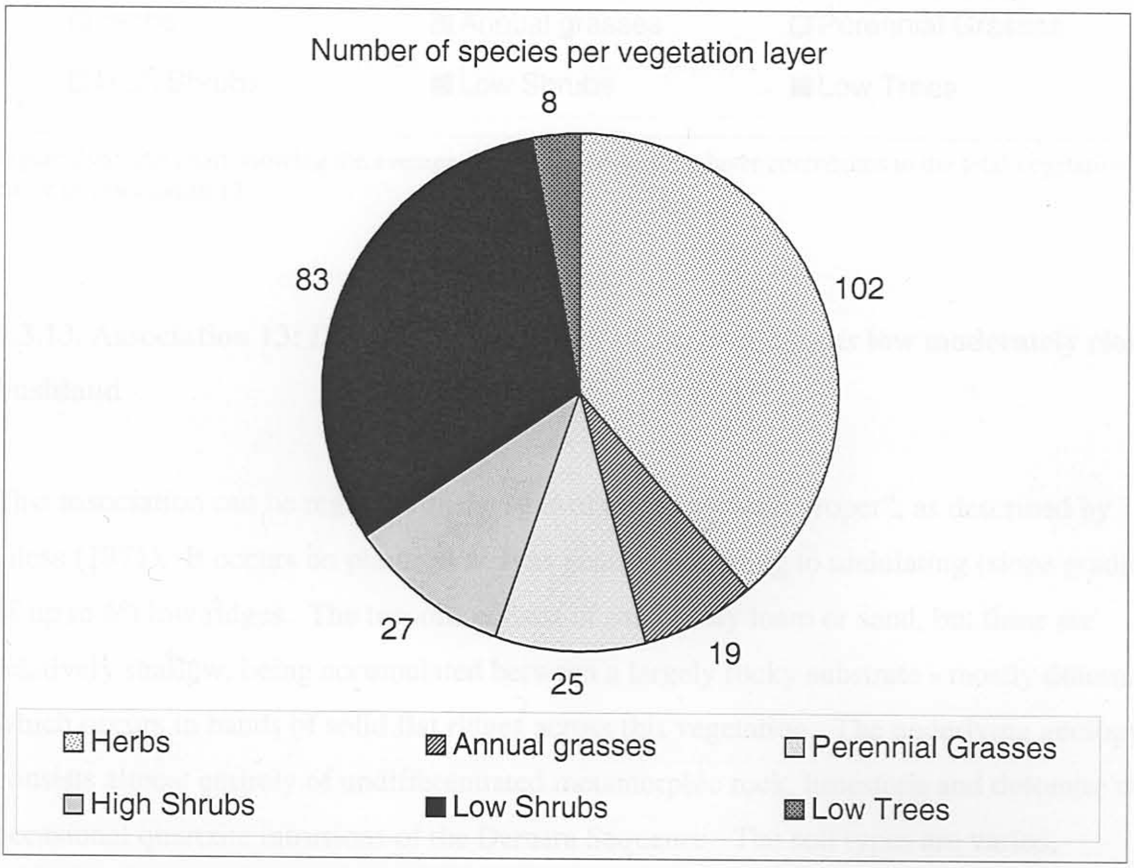


Figure 29a: Pie chart showing the total number of species recorded for each vegetation layer in association 12.

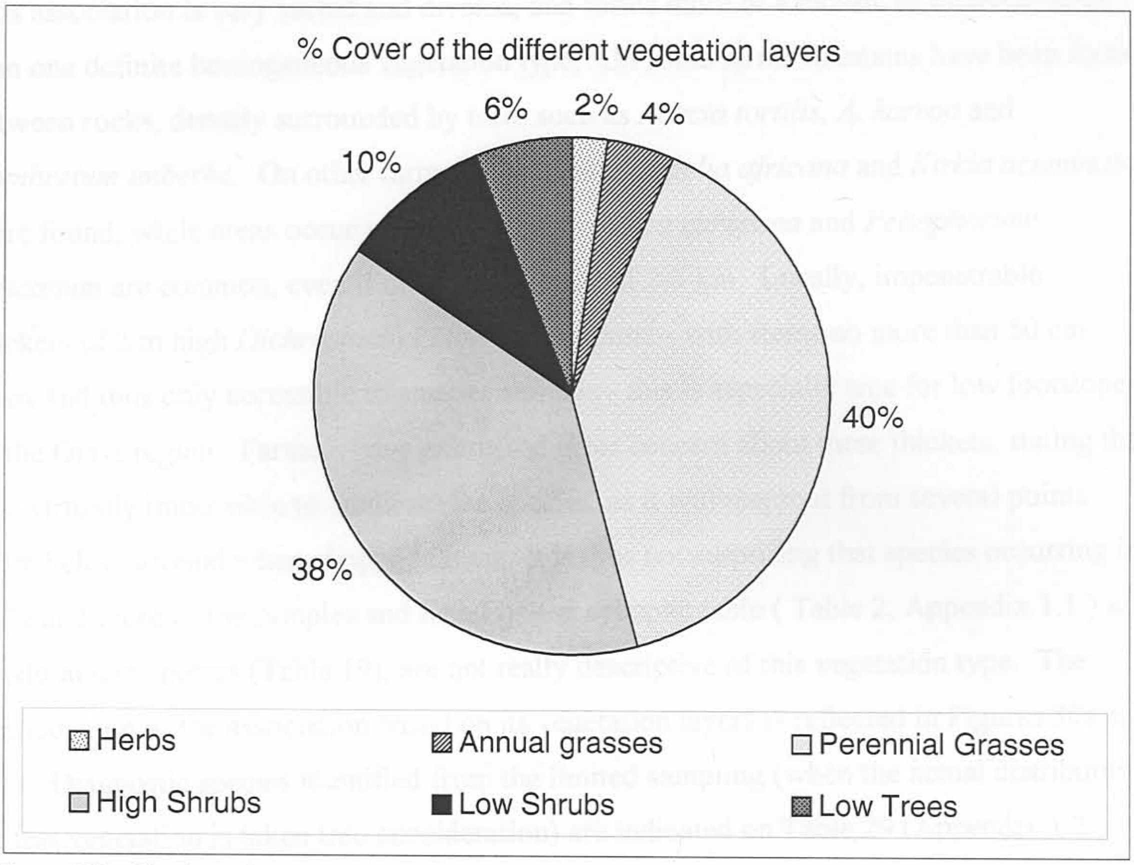


Figure 29b: Pie chart showing the average percentage cover each layer contributes to the total vegetation cover of association 12.

9.3.13. Association 13: *Dichrostachys cinerea - Cenchrus ciliaris* low moderately closed bushland

This association can be regarded as the start of the "Karstveld proper", as described by Giess (1971). It occurs on plains as well as gently undulating to undulating (slope gradient of up to 6°) low ridges. The topsoils consist of sandy clay loam or sand, but these are relatively shallow, being accumulated between a largely rocky substrate - mostly dolomite, which occurs in bands of solid flat ridges across this vegetation. The underlying geology consists almost entirely of undifferentiated metamorphic rock, limestone and dolomite with occasional quartzite intrusions of the Damara Sequence. The soil types are varied, including especially the chromic Cambisols with leptic Regosols and petric Calcisols Complex, leptic Regosols as well as the mollic Leptosols and petric Calcisols Complex. Long-term average rainfall ranges from 420 - 560 mm p.a.

This association is very varied and diverse, and forms more of a mosaic of different units than one definite homogeneous vegetation type. On some farms fountains have been found between rocks, densely surrounded by trees such as *Acacia tortilis, A. karroo* and *Combretum imberbe*. On other farms large trees of *Kigelia africana* and *Kirkia acuminata* were found, while areas occur where low trees of *Olea europaea* and *Peltophorum africanum* are common, even if only for a stretch of 2-5 km. Locally, impenetrable thickets of 2 m high *Dichrostachys cinerea* are found - with stems no more than 50 cm apart and thus only accessible to smaller animals - this is especially true for low footslopes in the Otavi region. Farmers have expressed great concern about these thickets, stating that it is virtually impossible to eradicate the species, as it will resprout from several points from below-ground when chopped down. It is thus not surprising that species occurring in 60% and more of the samples and listed on the synoptic table (Table 2, Appendix 1.1.) as predominant species (Table 19), are not really descriptive of this vegetation type. The composition of the association based on its vegetation layers is reflected in Figures 30a and 30b. Diagnostic species identified from the limited sampling (when the actual distribution of this vegetation is taken into consideration) are indicated on Table 29 (Appendix 1.2.).

Table 19: Abundance and cover percentages of predominant species of the *Dichrostachys cinerea - Cenchrus ciliaris* vegetation association

Species	**abundance (% of samples)**	**average % cover**	**layer**
Cenchrus ciliaris	94	3.8	perennial grass
Acacia mellifera	91	8.7	high shrub
Dichrostachys cinerea	82	9.7	high shrub
Melhania virescens	82	0.6	low shrub
Eragrostis echinochloidea	77	1.6	perennial grass
Grewia flavescens var. flavescens	74	1.1	high shrub
Melinis repens ssp. grandiflora	74	0.9	annual grass
Enneapogon cenchroides	74	0.7	annual grass
Becium filamentosum	71	0.1	herb
Eragrostis trichophora	65	2.6	perennial grass
Evolvolus alsinoides	65	0.1	herb
Acacia reficiens	62	3.1	high shrub
Tragus berteronianus	62	0.1	annual grass
Lantana angolensis	62	0.1	low shrub
Urochloa brachyura	60	0.9	annual grass
Aristida effusa	60	0.2	annual grass
Total nr of species recorded	260		
Average % cover per sample		68.25	

Other species with high cover percentages include *Eragrostis porosa, Digitaria seriata, Heteropogon contortus, Stipagrostis uniplumis, Urochloa oligotricha, Aptosimum decumbens, Craterostigma plantagineum* and *Xerophyta humilis* (very high cover, but very localised). Typical, but localised shrubs and low trees include *Acacia ataxacantha, A. fleckii, A. karroo, A. tortilis, Aloe littoralis* (very small patches with 10 to hundreds of individuals), *Catophractes alexandri, Combretum apiculatum, C. hereroense, C, imberbe, Croton gratissimus* (here mostly high shrubs), *Grewia bicolor, Tarchonanthus camphoratus* and *Terminalia prunioides*.

Species commonly present include: *Brachiaria deflexa, Aristida effusa, Eragrostis nindensis, Limeum sulcatum, Ocimum americanum, Phyllanthus pentandrus, Rhynchosia* spp, *Solanum* spp, *Commiphora* spp, *Euclea undulata, Petalidium engleranum, Ozoroa paniculosa, Hiernia angolensis, Tinnea rhodesiana* and *Maytenus senegalensis*.

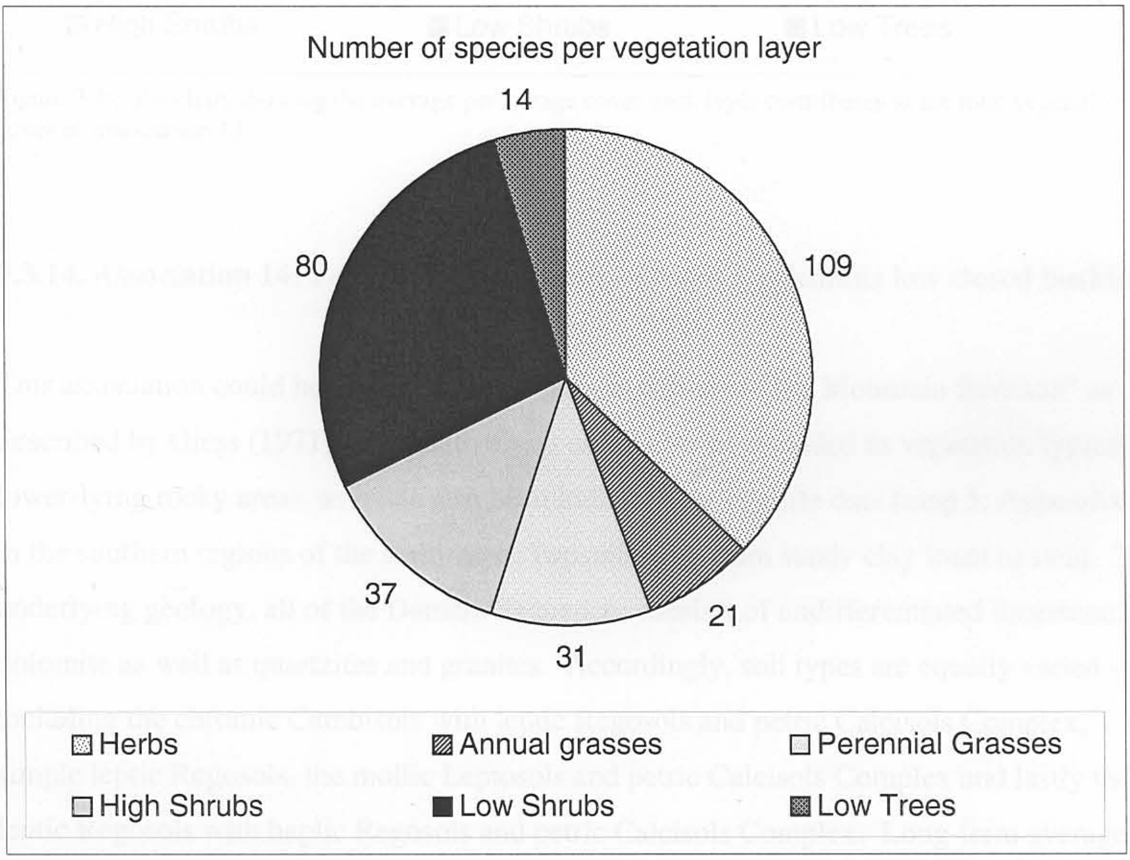


Figure 30a: Pie chart showing the total number of species recorded for each vegetation layer in association 13.

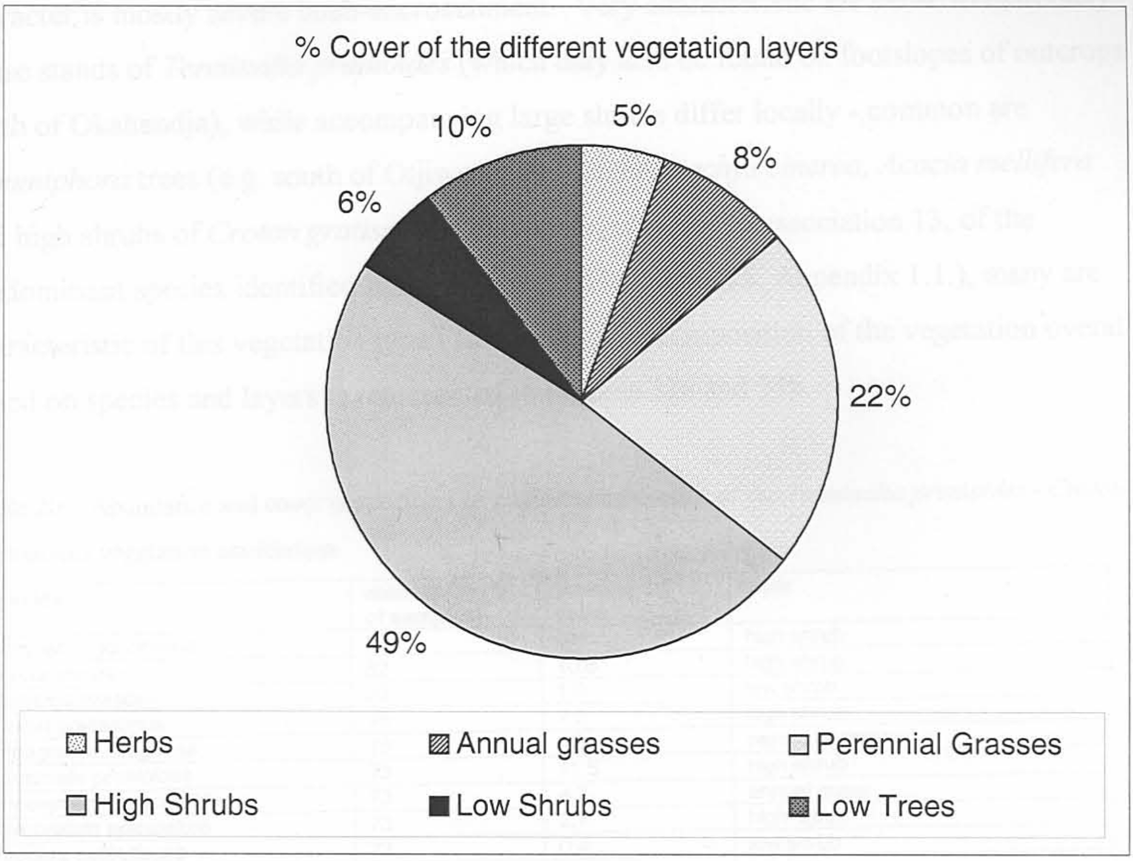


Figure 30b: Pie chart showing the average percentage cover each layer contributes to the total vegetation cover of association 13.

9.3.14. Association 14: *Terminalia prunioides - Croton gratissimus* low closed bushland

This association could be classified as the "lower outliers of the Mountain Savanna" as described by Giess (1971). Alternatively, it could also be regarded as vegetation typical of lower-lying rocky areas, as it has also been indicated by satellite data (map 5, Appendix 4) in the southern regions of the study area. Topsoils vary from sandy clay loam to sand. The underlying geology, all of the Damara Sequence, consists of undifferentiated limestone, dolomite as well as quartzites and granites. Accordingly, soil types are equally varied - including the chromic Cambisols with leptic Regosols and petric Calcisols Complex, simple leptic Regosols, the mollic Leptosols and petric Calcisols Complex and lastly the leptic Regosols with haplic Regosols and petric Calcisols Complex. Long-term average rainfall ranges from 420 - 560 mm p.a.

Considering the varied geology and soils, it is not surprising that similar to association 13, this vegetation consist of a number of varying units in a mosaic. One unfortunate unifying character is mostly severe bush-encroachment. Very characteristic are dense to extremely dense stands of *Terminalia prunioides* (which may also be found on footslopes of outcrops north of Okahandja), while accompanying large shrubs differ locally - common are *Commiphora* trees (e.g. south of Otjiwarongo), *Dichrostachys cinerea, Acacia mellifera* and high shrubs of *Croton gratissimus*. However, contrary to association 13, of the predominant species identified in the synoptic table (Table 25, Appendix 1.1.), many are characteristic of this vegetation type (Table 20). The composition of the vegetation overall based on species and layers is represented in Figures 31a and 31b.

Table 20: Abundance and cover percentages of predominant species of the *Terminalia prunioides - Croton gratissimus* vegetation association

Species	abundance (% of samples)	average % cover	layer
Dichrostachys cinerea	95	8.5	high shrub
Acacia mellifera	82	10.8	high shrub
Melhania virescens	82	1.0	low shrub
Croton gratissimus	78	7.2	high shrub
Stipagrostis hirtigluma	78	4.3	perennial grass
Terminalia prunioides	73	11.5	high shrub
Enneapogon cenchroides	73	4.3	annual grass
Combretum apiculatum	73	2.1	high shrub
Seddera suffruticosa	73	0.4	low shrub
Acacia reficiens	69	3.9	low tree
Eragrostis echinochloidea	69	2.5	perennial grass
Melinis repens ssp. grandiflora	69	1.2	annual grass
Rhus marlothii	69	0.5	high shrub
Aristida effusa	65	1.5	annual grass
Catophractes alexandri	60	2.8	high shrub
Heteropogon contortus	60	1.2	perennial grass
Total nr of species recorded	170		
Average % cover per sample		95.7	

Other species with occasionally high cover include: *Aristida adscensionis, A. effusa, Eragrostis porosa, Cenchrus ciliaris, Enneapogon desvauxii, E. scoparius, Eragrostis nindensis, Hypoestes forskaolii, Combretum hereroense, C. imberbe, Grewia flava, G. flavescens* var. *flavescens, Commiphora tenuipetiolata* and *Peltophorum africanum*. Grass species in particular vary significantly from farm to farm (see further discussion under Section 9.4).

Further typical species include *Commiphora* spp, *Dombeya rotundifolia, Euclea undulata, Hibiscus caesius, Otoptera burchellii*, while single large trees of *Ozoroa insignis* and *Lannea discolor* can be found. Further up the slopes south-east of Otavi, but not considered part of the survey, are several large trees of *Sclerocarya birrea*.

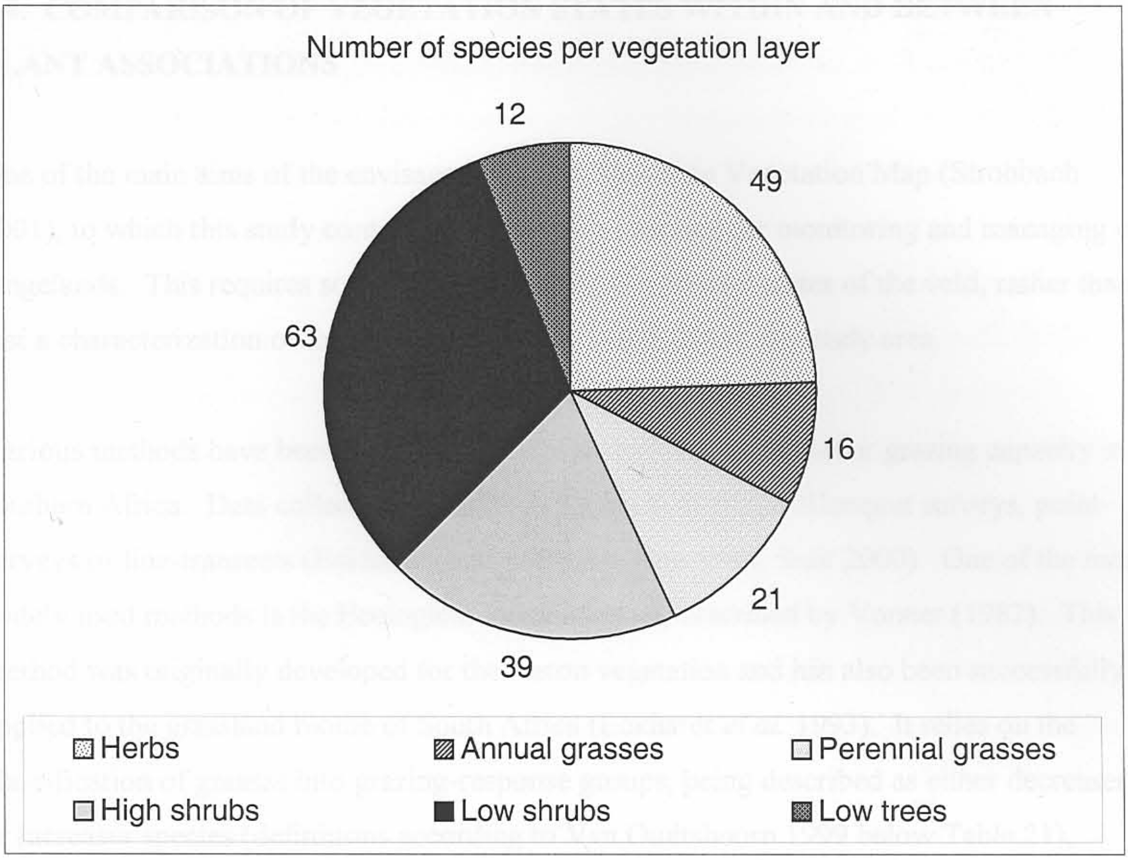


Figure 31a: Pie chart showing total number of species recorded for each vegetation layer in association 14.

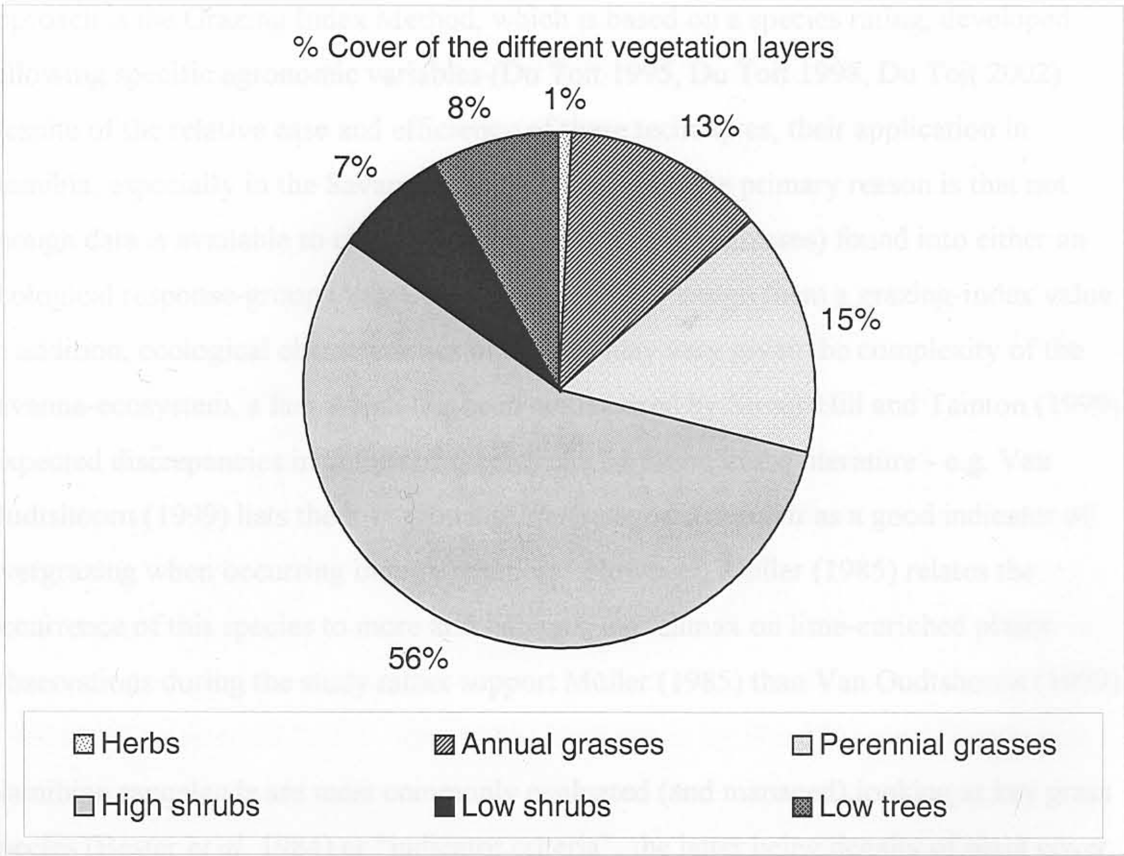


Figure 31b: Pie chart showing the average percentage cover each layer contributes to the total vegetation cover of association 14.

9.4. COMPARISON OF VEGETATION STATES WITHIN AND BETWEEN PLANT ASSOCIATIONS

One of the main aims of the envisaged updated Namibian Vegetation Map (Strohbach 2001), to which this study contributes, is to serve as a tool for monitoring and managing of rangelands. This requires some indication of the conditional states of the veld, rather than just a characterization of the plant associations found within the study area.

Various methods have been developed to assess veld condition and/or grazing capacity in southern Africa. Data collected are either in the form of Braun-Blanquet surveys, point-surveys or line-transects (Eckhardt *et al*. 1993, Du Toit 1998, Smit 2000). One of the most widely used methods is the Ecological Index Method, described by Vorster (1982). This method was originally developed for the Karoo vegetation and has also been successfully applied to the grassland biome of South Africa (Eckhardt *et al.* 1993). It relies on the classification of grasses into grazing-response groups, being described as either decreaser or increaser species (definitions according to Van Oudtshoorn 1999 below Table 21), which is then used to calculate a veld-condition-index value for each relevé. A different approach is the Grazing Index Method, which is based on a species rating, developed following specific agronomic variables (Du Toit 1995, Du Toit 1998, Du Toit 2002). Despite of the relative ease and efficiency of these techniques, their application in Namibia, especially in the Savanna, has been limited. The primary reason is that not enough data is available to classify all species (especially grasses) found into either an ecological response-group (Van Oudtshoorn 1999) or assign them a grazing-index value. In addition, ecological characteristics of species may vary given the complexity of the savanna-ecosystem, a fact which has been emphasized by Stuart-Hill and Tainton (1999). Expected discrepancies in values of species can be found in the literature - e.g. Van Oudtshoorn (1999) lists the low-growing *Enneapogon desvauxii* as a good indicator of overgrazing when occurring in high numbers. However, Müller (1985) relates the occurrence of this species to more arid habitats, e.g. climax on lime-enriched plains. Observations during the study rather support Müller (1985) than Van Oudtshoorn (1999).

Namibian rangelands are most commonly evaluated (and managed) looking at key grass species (Bester *et al*. 1984) or "indicator criteria", the latter being density of plant cover, botanical composition, plant vigour, condition of soil surface as well as damage by insects or rodents (Bester 1988). Although this is a very subjective and crude method, it does allow the detection of trends if repeated regularly. Given the above pro's and cons of various techniques, it was decided to define different "vegetation states" which could be identified from the data collected during the survey. Criteria for these vegetation states were developed to be suitable either for the rapid appraisal of a rangeland management unit (farm camp or farm) or as a baseline for vegetation monitoring by physical inspections, studies in vegetation dymanics over time or "change detection" techniques with satellite imagery - a technique currently receiving increased attention (Vogel 2002, personal communication).

"Mismanagement" of Namibian rangelands has a long history: bush encroachment was already perceived as a problem in the 1920's (Schlettwein 1994). The Grootfontein, Otjiwarongo and Okahandja districts, in which the study area is located, were then and are still considered the regions most seriously affected by increasing bush densities. Logging operations active around Tsumeb (providing construction materials for mine-shafts in Tsumeb) were already considered in the 1900's to affect grazing by removing the majority of tall trees found on the plains (Schlettwein 1994). This was followed by high stocking rates and drought periods, which further severely stressed the savanna ecosystem (Volk 1966, Schlettwein 1994). Giess (1971) and the Homogenous Farming Areas Report (1979) re-emphasize the bush-encroachment issue as being serious in Central Namibia.

In the 1970's farmers in the Otjiwarongo and Okahandja districts observed extensive dieback of *Acacia mellifera*. By the mid 1980's, this had reached "epidemic proportions", affecting the entire area previously affected by bush-encroachment. The disease is caused by a fungus, which kills the heartwood of the shrubs (Holz and Schreuder 1989). Not much is clear on how this effected the total bush encroachment issue then, but today signs of such massive dieback *of Acacia mellifera* are not evident - rather bush encroachment.

Several attempts and studies have been undertaken to understand the dynamics of bush-encroachment in savannas (Walter 1954, Knoop and Walker 1985, Skarpe 1992, O'Connor 1995 and Roques *et al*. 2001). The conclusion reached by Ward (in prep) is that these dynamics are still poorly understood, and are in general a response to a combination of causal factors, each of which have direct and indirect effects on the system. For example - heavy grazing reduces the fuel load which reduces the heat and/or frequency of fires

(O'Connor 1995) or too light grazing causes grasses adapted to short-term heavy grazing to become moribund, thus loosing their competitive ability (Illius and O'Connor 1999). This all re-emphasizes the need for an opportunistic management approach in savanna ecosystems (Westoby *et al*. 1989). Illius and O'Connor (1999) sum this up very adequately in their statement: "rather than ignoring degradation, policy-makers and ecologists should seek to identify the characteristics of grazing systems that predispose some systems towards degradation, while others appear to be resistant … focus on the spatial heterogeneity in susceptibility to grazing impacts and on preserving the productive capacity of key resource areas."

In accordance with above statement, baseline criteria for defining vegetation states were based on the composition of the grass-layer of all samples within a plant association, being considered the vegetation layer most vulnerable to effects of management practices. Relying on information available on grazing response groups, grazing value as well as grasses grazed preferentially (Müller 1985, Bester 1988, Van Oudtshoorn 1999, Du Toit 2001, Du Toit 2002), grass species were classified into annual, valuable perennial- and low value perennial grasses (see Table 21). Bester (1988) found that within the thornbush savanna, annual grasses, despite some species being highly palatable, constitute a very small part of the diet of livestock, and these were accordingly regarded as less important species. A dominance of annual grasses, especially weedy species, represents generally degraded grazing (and veld) conditions (Müller 1985, O'Connor 1995, Cornelius and Schultka 1997). Valuable perennial grasses are regarded as grasses with a high leaf production, high palatability, and are often regarded as decreaser species (Van Oudtshoorn 1999). Low value perennial grasses would generally be classified as increaser species (Van Oudtshoorn 1999), being either unpalatable due to terpentines or other compounds or due to their low leaf-production or overall hardiness (Bester 1988). A large amount of such grasses generally indicates a degeneration of veld condition (Müller 1985, O'Connor 1995, Van Oudtshoorn 1999). Pending verification of grass response groups under local environmental conditions, such degeneration could be ascribed to over- or under-utilization of veld. It should be emphasised here that the vegetation states and overall condition of vegetation types should not be seen as a definite prognosis on overall rangeland condition (especially as no data on veld management practices has been collected), but this exercise does indicate possible trends in veld condition and susceptibility to degardation, which should be recognised by rangland managers and adapted to where necessary.

Table 21: Values assigned to each grass species for the definition of vegetation states. Also added are important ecological criteria derived from Müller (1985) and Van Oudtshoorn (1999), which can aid to describe vegetation states.

SPECIES NAME	GRASS VALUE (USED IN VEGETATION - STATE DEFINITION)	GRASS VALUE (MÜLLER 1985)	PERIODICITY	ECOLOGICAL INDEX (VAN OUDTSHOORN 1999)
Anthephora schinzii	unimportant	palatable pioneer	annual grass	
Aristida adscensionis	unimportant	indicates degradation	annual grass	increaser 2
Aristida effusa	unimportant	indicates degradation	annual grass	
Aristida hordeacea	unimportant	indicates degradation	annual grass	
Aristida rhiniochloa.	unimportant	indicates degradation	annual grass	increaser 2
Brachiaria deflexa	unimportant	palatable pioneer	annual grass	increaser 2
Brachiaria eruciformis	unimportant	palatable pioneer	annual grass	increaser 2
Brachiaria malacodes	unimportant	palatable pioneer	annual grass	
Brachiaria xantholeuca	unimportant	palatable pioneer	annual grass	
Chloris virgata	unimportant	pioneer	annual grass	increaser 2
Dactyloctenium aegyptium	unimportant	palatable pioneer	annual grass	increaser 2
Dactyloctenium giganteum	unimportant	palatable	annual grass	increaser 2
Digitaria velutina	unimportant		annual grass	increaser 2
Eleusine indica. ssp. indica	unimportant		annual grass	
Eragrostis annulata	unimportant		annual grass	
Eragrostis biflora	unimportant		annual grass	increaser 2
Eragrostis cylindriflora	unimportant	pioneer	annual grass	
Eragrostis dinteri	unimportant		annual grass	
Eragrostis omahekensis	unimportant	pioneer	annual grass	
Eragrostis pilgeriana	unimportant		annual grass	
Eragrostis porosa	unimportant	indicates degradation	annual grass	
Eragrostis viscosa	unimportant		annual grass	increaser 2
Heteropogon melanocarpus	unimportant	hard	annual grass	
Melinis kallimorpha	unimportant		annual grass	
Melinis repens ssp. grandiflora	unimportant	pioneer	annual grass	increaser 2
Pogonarthria fleckii	unimportant	indicates degradation	annual grass	
Schmidtia kalihariensis	unimportant	indicates degradation	annual grass	increaser 2
Setaria pumila	unimportant		annual grass	increaser 2
Setaria verticillata	unimportant	palatable pioneer	annual grass	increaser 2
Sporobolus panicoides	unimportant		annual grass	
Tragus berteronianus	unimportant		annual grass	increaser 2
Tragus racemosus	unimportant		annual grass	increaser 2
Urochloa brachyura	unimportant		annual grass	
Urochloa trichopus	unimportant		annual grass	
Brachiaria schoenfelderi	unimportant	palatable pioneer	biennial grass	
Enneapogon cenchroides	unimportant	palatable pioneer	biennial grass	increaser 2
Enneapogon desvauxii	unimportant	climax on lime	biennial grass	increaser 2
Sorghum versicolor	unimportant		biennial grass	increaser 2
Tricholaena monachne	unimportant	subclimax	biennial grass	increaser 2

SPECIES NAME	GRASS VALUE (USED IN VEGETATION - STATE DEFINITION)	GRASS VALUE (MÜLLER 1985)	PERIODICITY	ECOLOGICAL INDEX (VAN OUDTSHOORN 1999)
Andropogon chinensis	good grazing	climax	perennial grass	increaser 1
Andropogon gayanus var. *polycladus*	low value	hard climax	perennial grass	increaser 1
Anthephora pubescens	good grazing	climax	perennial grass	decreaser
Aristida congesta ssp. *congesta*	low value	recovering veld	perennial grass	increaser 2
Aristida meridionalis	low value	subclimax	perennial grass	increaser 3
Aristida pilgeri	low value	indicates degradation	perennial grass	
Aristida stipitata ssp. *stipitata*	low value		perennial grass	increaser 2
Bothriochloa radicans	low value	indicates degradation	perennial grass	increaser 2
Brachiaria nigropedata	good grazing	climax	perennial grass	decreaser
Cenchrus ciliaris	good grazing	climax	perennial grass	decreaser
Coelachyrum yemenicum	low value		perennial grass	
Craspedorhachis rhodesiana	low value		perennial grass	
Cymbopogon plurinodis	low value	aromatic climax	perennial grass	increaser 1 or 3
Cynodon dactylon	good grazing	pioneer to climax	perennial grass	increaser 2
Dichanthium annulatum var. *papillosum*	good grazing		perennial grass	decreaser
Digitaria eriantha	good grazing	subclimax	perennial grass	decreaser
Digitaria seriata	good grazing	climax	perennial grass	
Diplachne fusca	good grazing		perennial grass	decreaser
Enneapogon scoparius	good grazing	climax	perennial grass	increaser 3
Eragrostis echinochloidea	good grazing	pioneer to subclimax	perennial grass	increaser 2
Eragrostis jeffreysii	low value	hard	perennial grass	
Eragrostis lehmanniana var. *lehmanniana*	good grazing	subclimax to climax	perennial grass	increaser 2
Eragrostis nindensis	good grazing	climax	perennial grass	increaser 2
Eragrostis rigidior	low value	hard subclimax	perennial grass	increaser 2
Eragrostis rotifer	good grazing	green for long	perennial grass	
Eragrostis superba	good grazing	climax	perennial grass	increaser 2
Eragrostis trichophora	good grazing	pioneer to subclimax	perennial grass	increaser 2
Fingerhuthia africana	good grazing	climax	perennial grass	decreaser
Heteropogon contortus	good grazing	subclimax	perennial grass	increaser 2
Melinis repens ssp. *repens*	good grazing	subclimax	perennial grass	increaser 2
Microchloa caffra	low value	pioneer	perennial grass	increaser 2
Monelytrum luederitzianum	good grazing	pioneer	perennial grass	
Oropetium capense	low value		perennial grass	increaser 2
Panicum coloratum var. *coloratum*	good grazing	climax	perennial grass	decreaser
Panicum maximum	good grazing	climax	perennial grass	decreaser
Panicum stapfianum	good grazing	climax	perennial grass	
Pogonarthria squarrosa	low value	pioneer	perennial grass	increaser 2
Schmidtia pappophoroides	good grazing	subclimax	perennial grass	increaser 2/ decreaser
Sporobolus festivus	low value		perennial grass	increaser 2
Sporobolus fimbriatus	good grazing	climax	perennial grass	decreaser
Stipagrostis hirtigluma	good grazing		perennial grass	increaser 2
Stipagrostis uniplumis var. *uniplumis*	good grazing	subclimax	perennial grass	increaser 2

SPECIES NAME	GRASS VALUE (USED IN VEGETATION - STATE DEFINITION)	GRASS VALUE (MÜLLER 1985)	PERIODICITY	ECOLOGICAL INDEX (VAN OUDTSHOORN 1999)
Triraphis ramosissima	low value	hard subclimax	perennial grass	
Triraphis schinzii	low value	palatable but rare	perennial grass	
Urochloa oligotricha	good grazing	climax	perennial grass	decreaser
Willkommia sarmentosa	good grazing		perennial grass	

Definitions (according to Van Oudtshoorn 1999):

Decreaser: abundant in good veld, decreases in numbers when the veld is overgrazed.

Increaser 1: abundant in under-utilized veld, usually unpalatable and hard

Increaser 2: abundant in overgrazed veld, mostly pioneer ans subclimax grasses with a high seed-production

Increaser 3: commonly found in overgrazed veld, usually unpalatable dense climax grasses and strong competitors

Relevés of the plant associations were divided into 5 vegetation states according to following criteria:

State 1 - very poor:

- total grass cover < 15%

State 2 - poor:

- total grass cover 15 - 20%, with annual grasses often dominating

State 3 - degraded veld:

- total grass cover > 20%, with the combined cover of annual and low value perennial grasses exceeding that of valuable perennial grasses by 5%

State 4 - moderate veld:

- total grass cover > 20%, with % cover of the annual and low value perennial grasses combined not much more (maximally 5% difference) than valuable perennial grasses, or the latter most abundant, but not exceeding 30% cover

State 5 - good veld:

- total grass cover > 30%, with valuable perennial grasses significantly more than annual and low value perennial grasses combined.

Within states 1-3, there is often a strong weedy plant component present - either in the form of weedy or poisonous herbs or, in a more irreversible state, in the form of bush encroachment. As the survey was originally aimed at characterizing the vegetation in terms of its associations and not specifically at determining veld condition, it was decided that a potential State 6 - excellent - should not be defined at this stage, but may form part of future studies defining benchmark sites for different vegetation types. Further, definite conclusions about veld condition in the study area cannot be based on data available. However, considering the amount of relevés of each association, which were not sampled prior to an understanding of veld condition, which are representative of a vegetation condition, trends in or tendencies to especially degradation can be identified.

As a general overview, ranges and averages of percentage cover within the associations, as well as species diversity have been listed in Table 22 and Table 23 respectively.

Table 22: Comparison of statistics on total cover percentages of associations.

Association	Number of samples	Minimum % cover	Maximum % cover	Average % cover	Standard Deviation
1	4	14	63	39.3	22.3
2	11	17	80	41.2	19.1
3	18	18	95	71.2	21.8
4	24	13	97	77.2	23.0
5	58	22	98	65.5	24.0
6	8	64	97	81.3	13.8
7	88	24	95	70.3	18.7
8	56	15	97	74.9	21.2
9	32	33	96	76.8	22.5
10	10	50	89	70.8	13.4
11	28	45	97	73.6	16.5
12	30	33	97	77.6	17.4
13	35	26	97	66.6	18.3
14	23	46	97	89.1	12.2

Table 23: Comparison of statistics on total species recorded in associations.

Association	Number of samples	Minimum Nr of species	Maximum Nr of species	Average Nr of species	Standard Deviation
1	4	18	23	20	2.5
2	11	11	56	33	15.8
3	18	13	54	31	12.7
4	24	19	64	43	10.6
5	58	13	60	42	12.1
6	8	40	61	51	6.1
7	88	37	68	56	6.8
8	56	21	61	46	9.1
9	32	29	77	50	12.2
10	10	28	47	38	6.1
11	28	26	60	47	8.4
12	30	34	72	49	8.9
13	35	37	77	54	8.3
14	23	30	60	40	8.3

The vegetation composition of typical vegetation states within each association are given below:

9.4.1. Association 1: *Catophractes alexandri - Willkommia sarmentosa* tall sparse shrubland

This vegetation type in general has a low percentage cover (Figure 32), which can be attributed to the relatively xeric moisture regime encountered in these lime-enriched pans. A high productivity can thus not be expected from this system. A critical evaluation of vegetation states here is thus not feasible. The grasses contributing most to the overall vegetation cover are *Willkommia sarmentosa* - itself not a very vigorous grower here, as well as *Eragrostis cylindriflora*. The latter may form dense stands at the peak of the growing season, but disintegrates quickly when dry (thus commonly called "windhalmgras"). Overall, farmers regard this system as little utilised and only of value during the peak growing season.

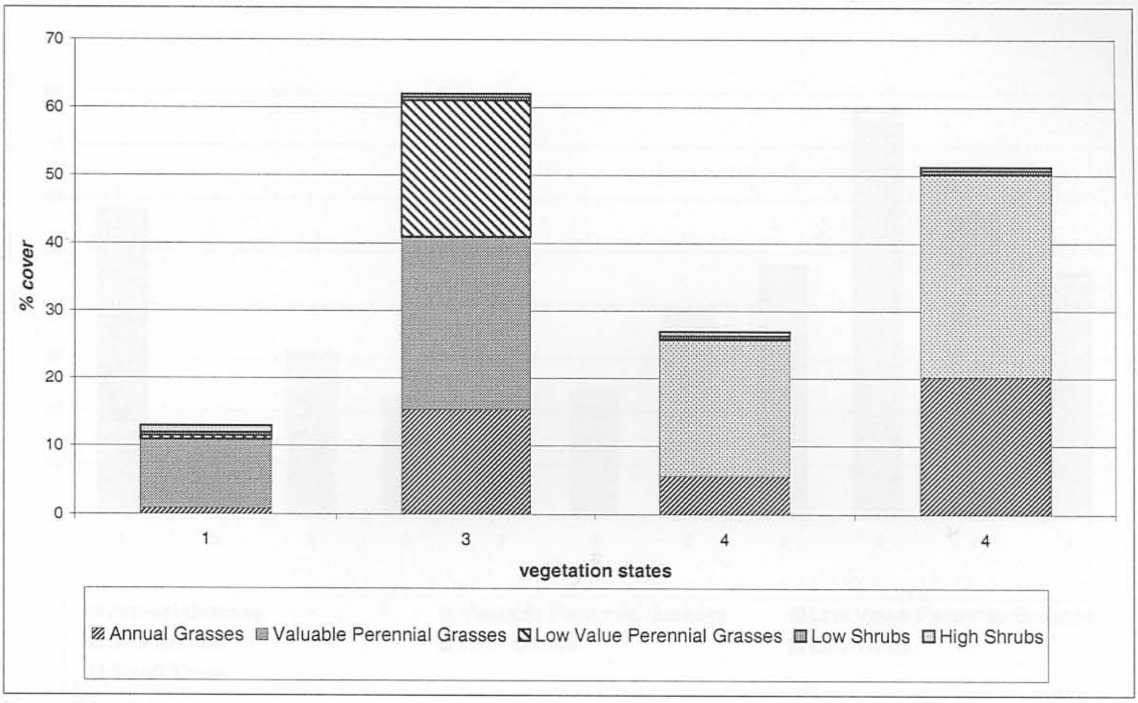


Figure 32: Samples representing the different vegetation states found in association 1.

9.4.2. Association 2: *Boscia albitrunca - Eragrostis cylindriflora* low open woodland

This vegetation type, found in the upper small omurambas (sometimes pans, sometimes part of a water-flow system, depending on amount of rains), appears to be another veld type with relatively low grass production (Figure 33). This may be attributed to the heavier soil types, combined with sheet erosion and occasional waterlogging during the rainy season. Farmers state that these areas are not easily accessible to man or beast during the peak rainy season due to the thick, sticky mud forming at this time, which makes movement difficult. Thus utilisation of grasses present at this time may also be restricted. More than 60% of all relevés of this association are, on the basis of their grass cover, considered to be in poor condition. The bulk of the grass cover is made up of *Chloris virgata* and *Eragrostis cylindriflora*, both regarded as pioneer grasses on disturbed areas or bare patches (Müller 1985). This main agent causing this disturbance is most probably sheet erosion, which may be coupled with trampling of the soil as cattle rest under the trees during dry or hot months, but this needs to be verified.

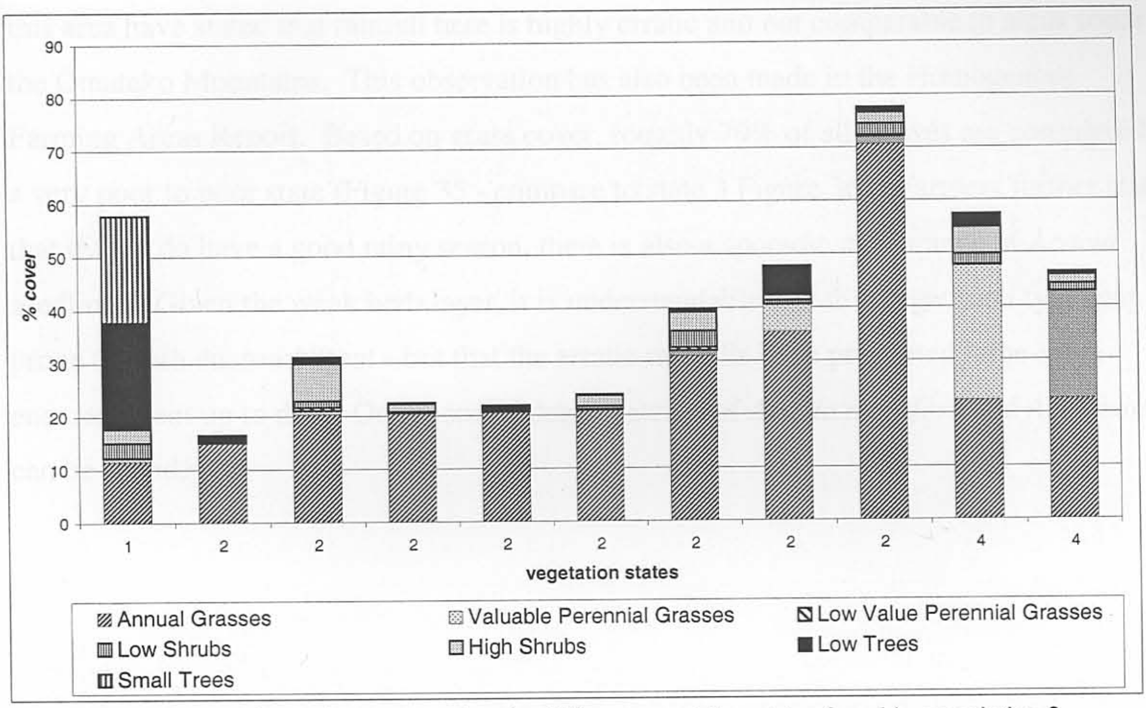


Figure 33: Selection of samples representing the different vegetation states found in association 2.

9.4.3. Association 3: *Acacia mellifera - Leucosphaera bainesii* low closed shrubland with patches of low open woodland

This vegetation is found mainly on the plains of the upper catchment of the Omuramba-Omatako - an area characterised by lime-enriched, crust-forming soils with frequent signs of large-scale sheet erosion. A conspicuous element of these plains is the presence of *Leucosphaera bainesii* - a shrub characteristic of a drier soil-moisture regime, which contributes to most of the low shrub layer.

Still, when considering that species such as *Aristida adscensionis, A. hordeacea, Eragrostis porosa* and *Botriochloa radicans* often contribute to a large portion of the grass layer, it can be assumed that this vegetation type overall is degraded (states in Figure 34). This is most likely due to habitat factors being less favourable to grass establishment, combined with ill-adjusted management practices. Even one of the most common and abundant valuable perennial grasses, *Eragrostis trichophora*, is considered a subclimax grass or increaser 2 (Table 21). Another common feature of this vegetation is a prominent weedy component, especially *Cyperus fulgens* and *Nidorella resedifolia*. Most farmers in this area have stated that rainfall here is highly erratic and not comparable to areas south of the Omatako Mountains. This observation has also been made in the Homogenous Farming Areas Report. Based on grass cover, roughly 70% of all relevés are considered in a very poor to poor state (Figure 35 - compare to state 3 Figure 36). Farmers further state that if they do have a good rainy season, there is also a sporadic appearance of *Acacia* seedlings. Given the weak herb layer, it is understandable that this vegetation type may be prone to bush encroachment - but that the erratic rainfalls have prevented large-scale encroachment up to date. Occasionally dense patches of *Acacia mellifera* and *A. reficiens* can be found.

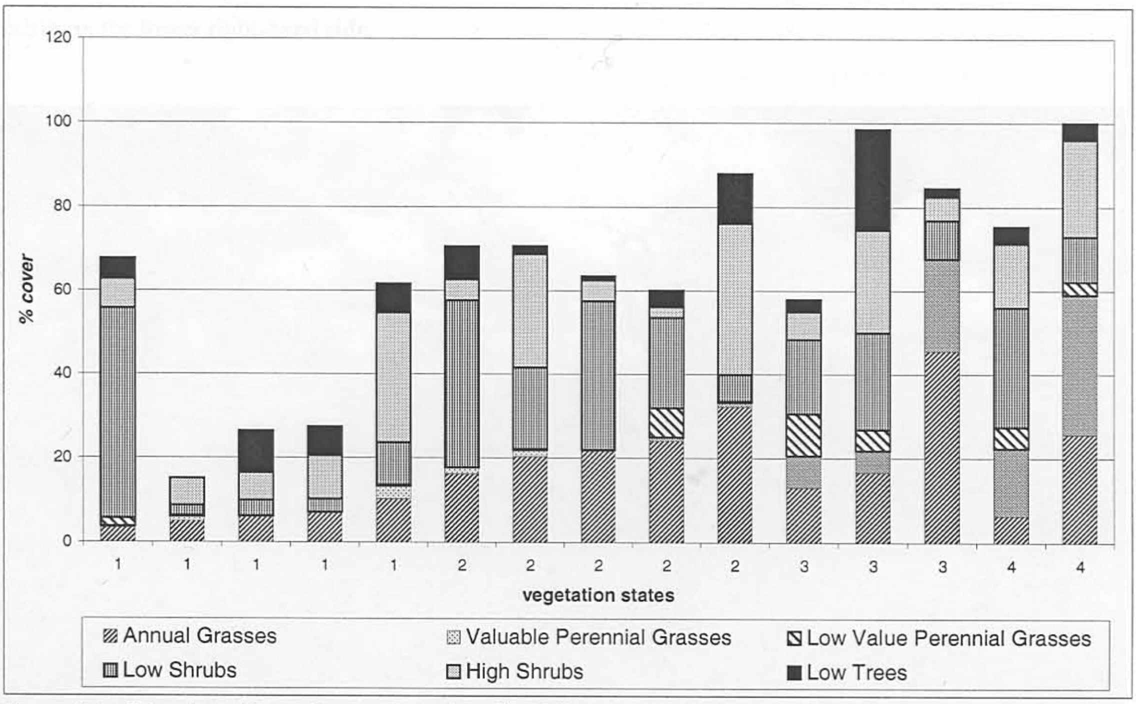


Figure 34: Selection of samples representing the different vegetation states found in association 3.

Figure 35: Example of vegetation of association 3 in state 1 (very poor). Take note of surface crusting visible on the lower right-hand side.

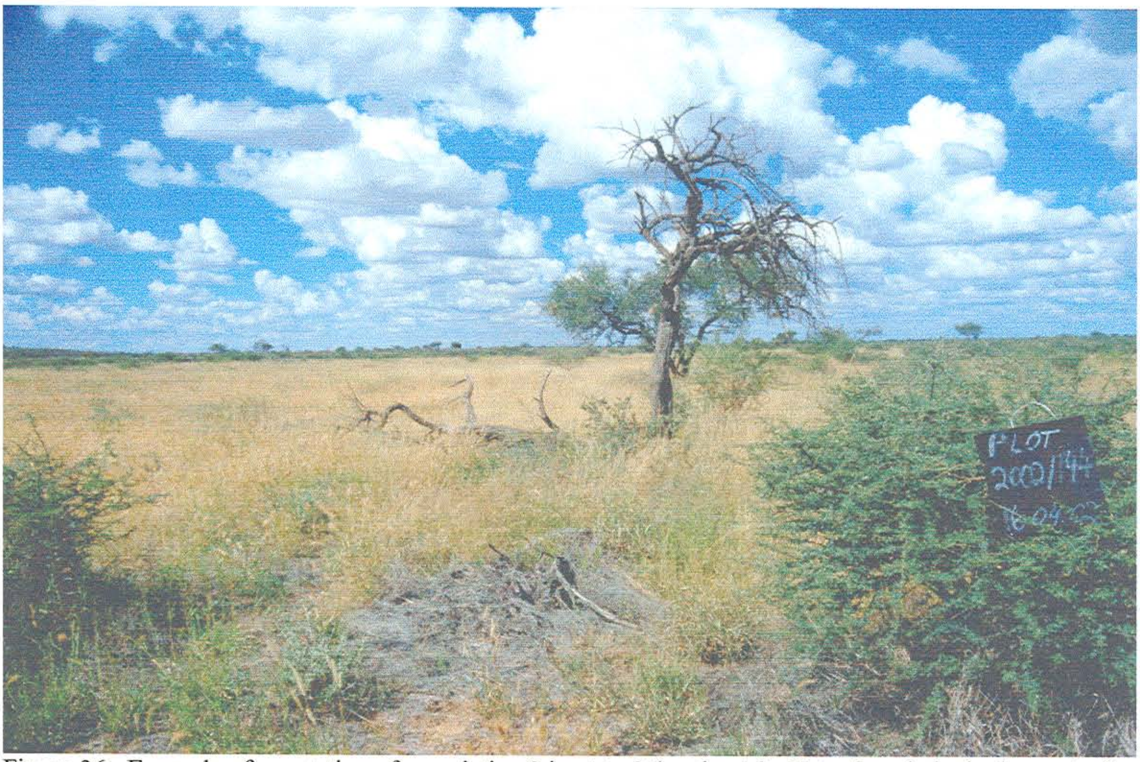


Figure 36: Example of vegetation of association 3 in state 3 (moderate). Note the relatively dense shrub cover (*Acacia mellifera*) surrounding this pan-like area.

9.4.4. Association 4: *Acacia mellifera - Eragrostis rotifer* low moderately closed bushland

This vegetation is found mainly on the banks of small to larger seasonal rivers (Figure 38), around farm dams as well as small pans which form in depressions in the veld (Figure 39) without necessarily being linked to a specific water drainage system. It can thus be expected that the vegetation states (Figure 37) of this vegetation will be highly variable and will also change as riverbank dynamics are influenced by rainfall events. Further, this vegetation is subject to high impact animal movement - animals coming to water or resting in the shade of the relatively large trees - which is reflected in a strong weedy component in the herb-layer, e.g. *Setaria verticillata, Achyranthes aspera* as well as varying degrees of alien species.

This vegetation cannot really be regarded as a manageable unit due to its small size as well as dynamics described above. It would be advisable though to guard against and prevent large-scale infestations by alien weeds, as seeds are further distributed by waterflow and may slowly pose an increasing problem.

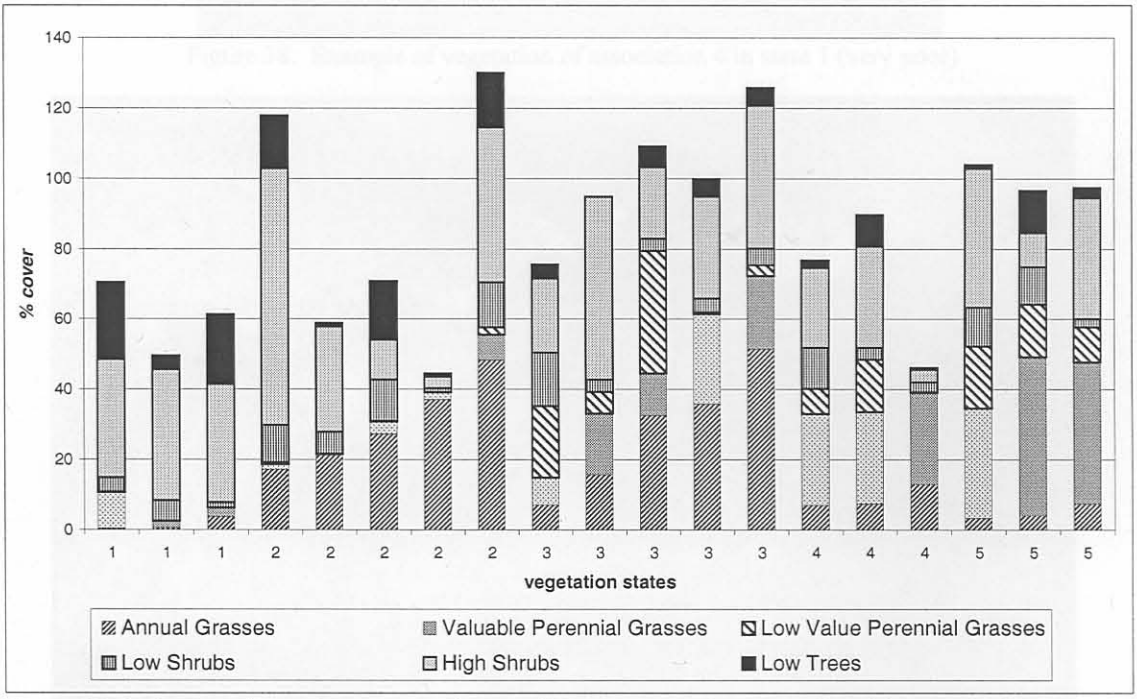


Figure 37: Selection of samples representing the different vegetation states found in association 4.

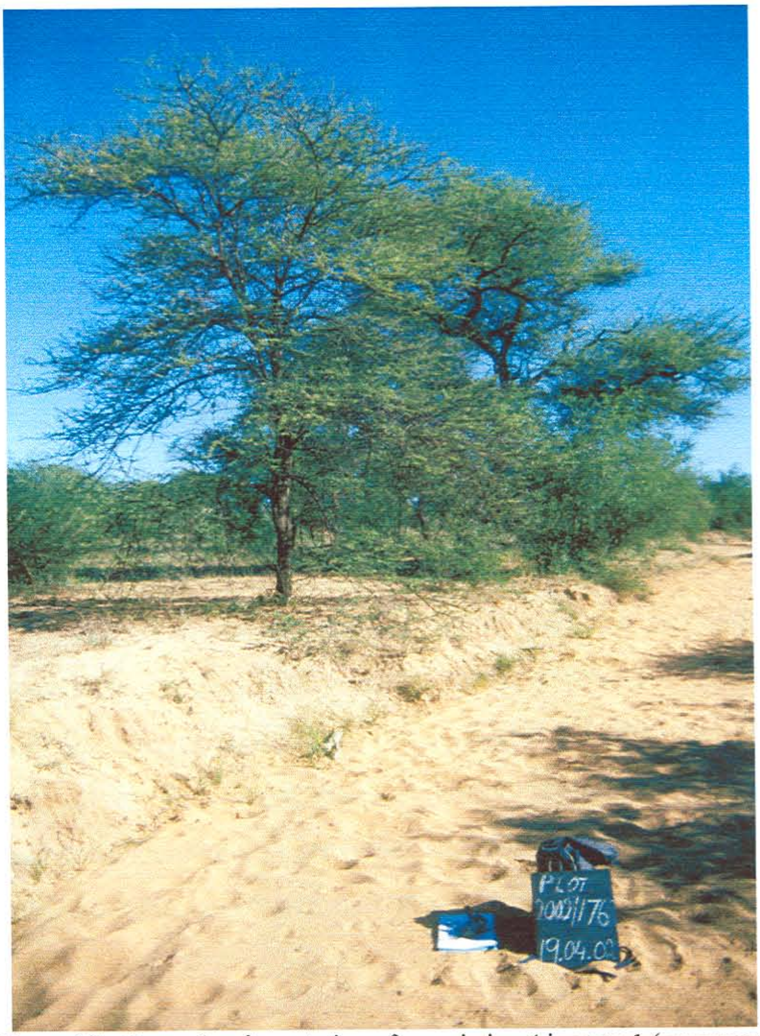


Figure 38: Example of vegetation of association 4 in state 1 (very poor)

Figure 39: Example of vegetation of association 4 in state 5 (good).

9.4.5. Association 5: *Acacia mellifera - Monechma genistifolium* low semi-open bushland

This vegetation is fairly wide-spread especially south of the Omatako Mountains. 60 % of relevés of this vegetation are regarded to be in a very poor to poor state (Figure 41), another 26 % as degraded while only 14 % of relevés show a moderate to good grass cover. When looking at the habitat, it could be assumed that soils have a less favourable moisture regime than those found in association 6, which has a generally better condition while also occurring in more or less the same range. However, soil records thus far are not detailed enough to draw any definite conclusion. It may, however, be assumed that this vegetation is in general over-utilised.

Such assumption is based on the species composition of grasses found in this vegetation (vegetation states are shown in Figure 40). By far the most common grass species, sometimes reaching densities of 30 - 60% cover is *Aristida adscensionis*. If one considers that this grass is a relatively small plant, one tuft hardly measuring more than 10-15 cm diameter, the above cover percentages are rather significant. The more palatable *Enneapogon cenchroides*, also a pioneer, only reaches densities of 5-15%, but is also generally found in all relevés.

Relevés considered in a good state show a fair cover of mostly *Stipagrostis uniplumis*, but also *Cenchrus ciliaris*, indicating that overall the grass layer could be improved.

The above degradation of grass layer is may also explain the relatively consistent levels of bush encroachment found here (by *Acacia mellifera*). Notable is that, compared to other vegetation types - this bush encroachment appears to be more recent - the highest densities are recorded for shrubs up to 1 m height. In general, bush densities of 15 to 30% are recorded throughout this vegetation type.

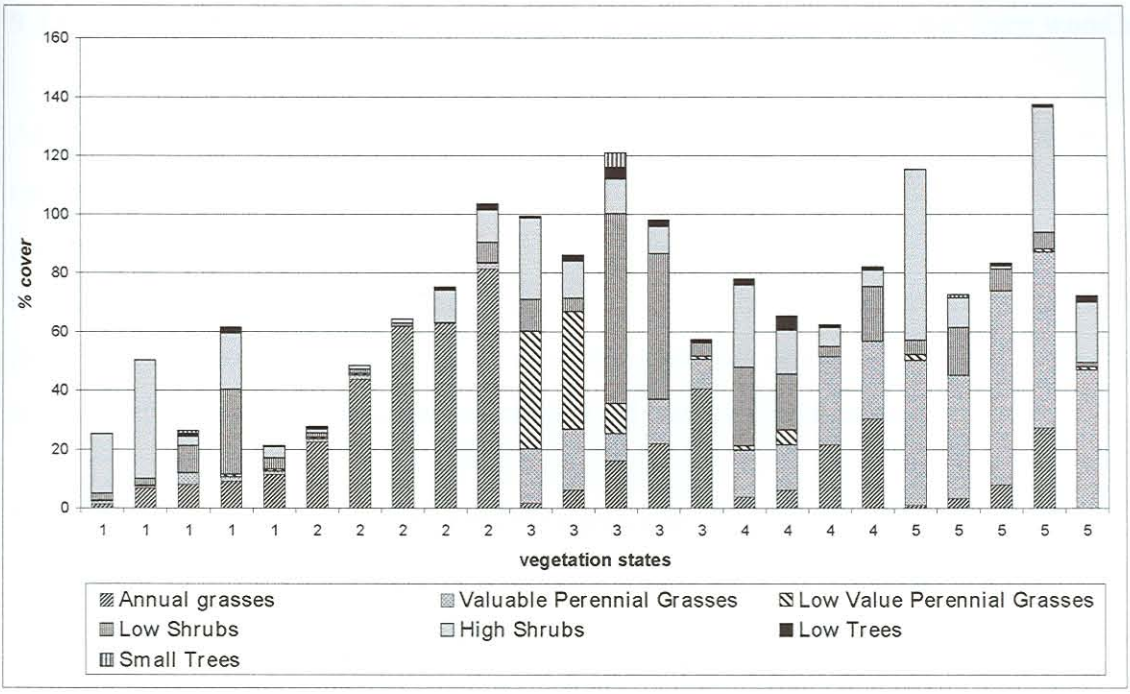


Figure 40: Selection of samples representing the different vegetation states found in association 5.

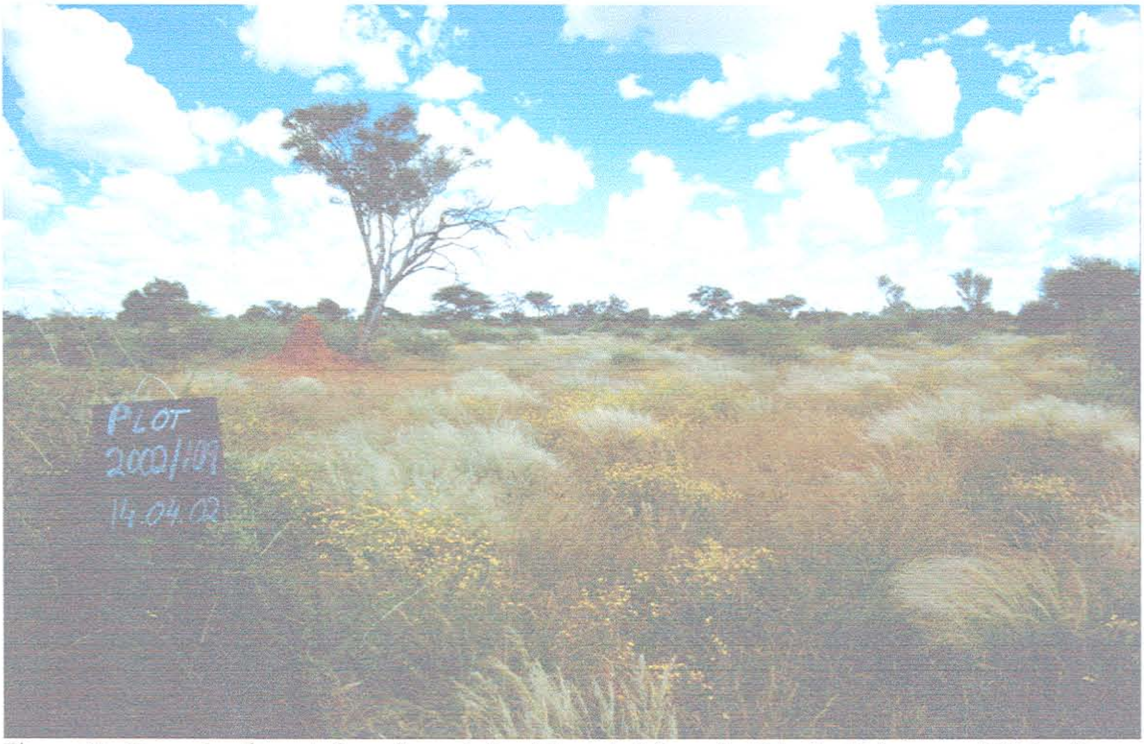


Figure 41: Example of vegetation of association 5 in state 2 (poor). Note the high cover of *Nidorella resedifolia* with its conspicuous yellow flowers and *Aristida adscensionis* (lower grass without plumes).

9.4.6. Association 6: *Albizia anthelmintica - Stipagrostis uniplumis* low open woodland

As already indicated above, association 6 is also found mainly south of the Omatako mountains, but only in relatively small patches. 63 % of relevés of this vegetation are in a good state (Figure 43). Only 7 % of relevés are classified as very poor to poor, with 12 % regarded as degraded and 19 % regarded as moderate. The main difference in habitat so far visible is a more common presence of coarse materials (gravel, stones and some degree of rock-banks) in the soil surface, which may aid water infiltration rates.

The most common and abundant grass throughout this vegetation type is *Stipagrostis uniplumis* - densities of 50 % cover are common. On the other hand, the most common annual grasses found throughout this vegetation type are *Aristida adscensionis, Eragrostis porosa* and *Pogonarthria fleckii* - all indicators of degradation of grazing. The only other commonly present valuable grass is *Eragrostis trichophora*, which is regarded as a subclimax grass. These trends (Figure 42) clearly show that this vegetation type is also being utilised more than it should be - although not that visible at this stage, future management practices should be aware that this vegetation type may also progressively degrade under high utilisation levels.

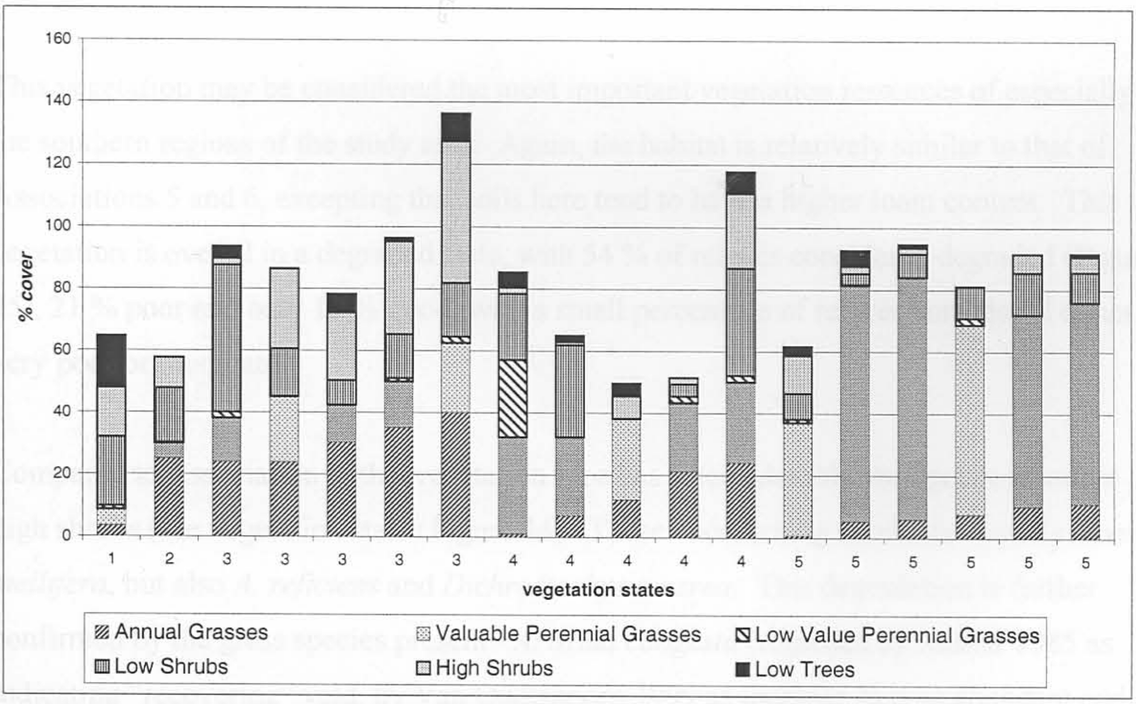


Figure 42: Selection of samples representing the different vegetation states found in association 6.

Figure 43: Example of vegetation of association 6 in state 5 (good).

9.4.7. Association 7: *Acacia mellifera - Aristida congesta* low semi-open bushland

This vegetation may be considered the most important vegetation resources of especially the southern regions of the study area. Again, the habitat is relatively similar to that of Associations 5 and 6, excepting that soils here tend to have a higher loam content. This vegetation is overall in a degraded state, with 54 % of relevés considered degraded (Figure 45), 21 % poor and only 18 % good, with a small percentage of relevés considered either very poor or moderate.

Compared to Association 5, this vegetation type has a considerably stronger component of high shrubs (see vegetation states Figure 44). These encroaching shrubs are mainly *Acacia mellifera*, but also *A. reficiens* and *Dichrostachys cinerea*. This degradation is further confirmed by the grass species present - *Aristida congesta* (regarded by Müller 1985 as indicating "recovering" veld, by Van Oudtshoorn 1999 as inceaser 2) is as abundant and common as *Stipagrostis uniplumis*. There is also an increasing presence of hard, little utilised species such as *Eragrostis rigidior* and *E. jeffreysii*. *Eragrostis rotifer* as well as *E. trichophora* make up the remainder of the more valuable perennial grasses.

Looking at the more degraded relevés, the most common grasses are *Eragrostis cylindriflora, E. porosa, Aristida adscensionis* and *Pogonarthria fleckii*. Overall it would appear that this vegetation type is largely over-utilised.

One aspect very noticable on some farms was a high presence of poisonous plants - especially *Geigeria ornativa* and *Ondetia linearis*. Farmers as especially concerned about the latter, where cover percentages of up to 5 % have been recorded in one sample. Farmers in general have stated that once this plant is established in their veld, its density often doubles from one year to the next if the grass layer is not dense enough. *Ondetia* is one of the first species to have green foliage after the dry season, and one farmer reported great losses of both game and cattle due to this plant during a year where rains only started very late.

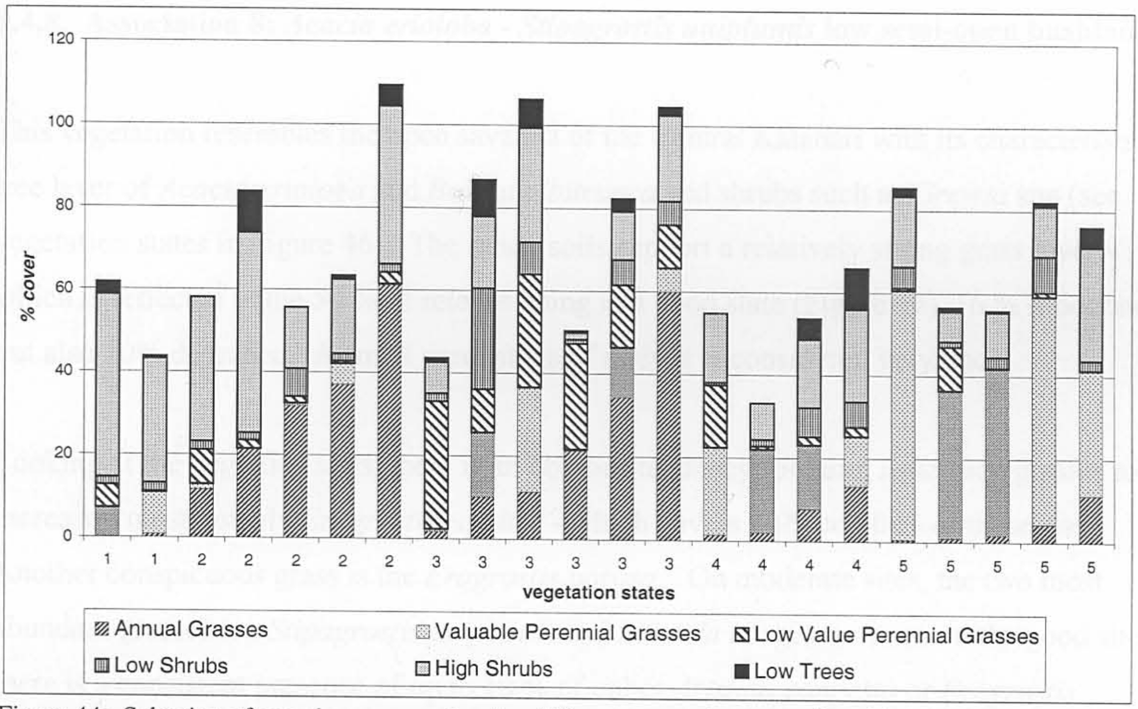


Figure 44: Selection of samples representing the different vegetation states found in association 7.

Figure 45: Example of vegetation of association 7 in state 3 (degraded). Note the large amount of dead garss material - all from hard grasses not utilised by cattle, as well as the increasing density of *Acacia mellifera*.

9.4.8. Association 8: *Acacia erioloba - Stipagrostis uniplumis* low semi-open bushland

This vegetation resembles the open savanna of the Central Kalahari with its characteristic tree layer of *Acacia erioloba* and *Boscia albitrunca* and shrubs such as *Grewia* spp (see vegetation states in Figure 46). The sandy soils support a relatively strong grass layer - which is reflected in the 50 % of relevés being in a good state (Figure 47), 16 % moderate, but also 30% degraded. A small percentage of relevés is considered very poor.

Looking at the degraded sites, there is an obvious tendency for hard, little used grasses to increase - most notably *Eragrostis rigidior* - which covers 20 % to 60 % of these sites. Another conspicuous grass is the *Eragrostis porosa*. On moderate sites, the two most abundant grasses are *Stipagrostis uniplumis* and *Aristida congesta* - even on the good sites there is a consistent presence of up to 10 % of either *Aristida congesta* or *Eragrostis rigidior* - leading to the assumption that this vegetation is over-utilised and may easily degrade further. Further, although this vegetation type has a naturally higher component of shrubs (especially *Grewia* spp) - degraded sites tend to become encroached with *Acacia mellifera*. In both degraded and moderate sites stands of 15 % - 30% have been recorded.

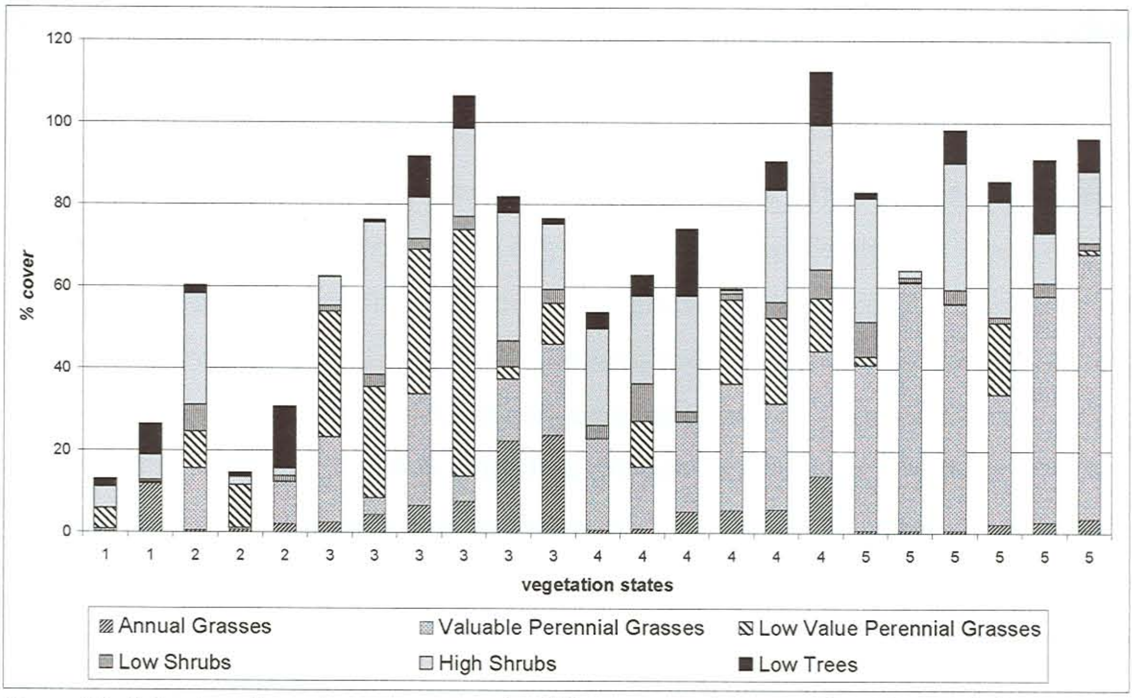


Figure 46: Selection of samples representing the different vegetation states found in association 8.

Figure 47: Example of vegetation of association 8 in state 5 (good).

9.4.9. Association 9: *Lonchocarpus nelsii - Eragrostis rigidior* low moderately closed bushland

This vegetation appears to be overall very degraded (Figure 48) - 31 % of relevés are considered very poor, 6 % poor, 47 % degraded and 16 % moderate. No sites were considered to be in a good state. Looking at the grasses of degraded sites, the dominant grasses *are Eragrostis rigidior, Aristida congesta* and *A. pilgeri*. Valuable grasses consist mostly of *Eragrostis trichophora*, with *Stipagrostis uniplumis* only occasionally occurring. Added to this, cover of 5 to 10 % of the fine *Aristida adscensionis, Eragrostis porosa, Pogonarthria fleckii* and *Enneapogon cenchroides* are found - all indicating degradation and pioneer status of the herb layer. This vegetation type is situated, as far as rainfall in the study area is considered, in a higher-rainfall region. It can thus be assumed that vegetation here has been over-utilised to a large degree in the past, leading to the often high levels of bush encroachment by *Dichrostachys cinerea* as well as *Acacia mellifera*. This has often been confirmed by farmers in the area - some farmers stated that their grandparents "could" stock up to 4 times as much cattle as they presently can, and that old photos show open grassy plains in these areas. Even species such as *Grewia* and *Combretum apiculatum* tend to form impenetrable thickets of 20 % to 40 % cover where the grass layer has disappeared.

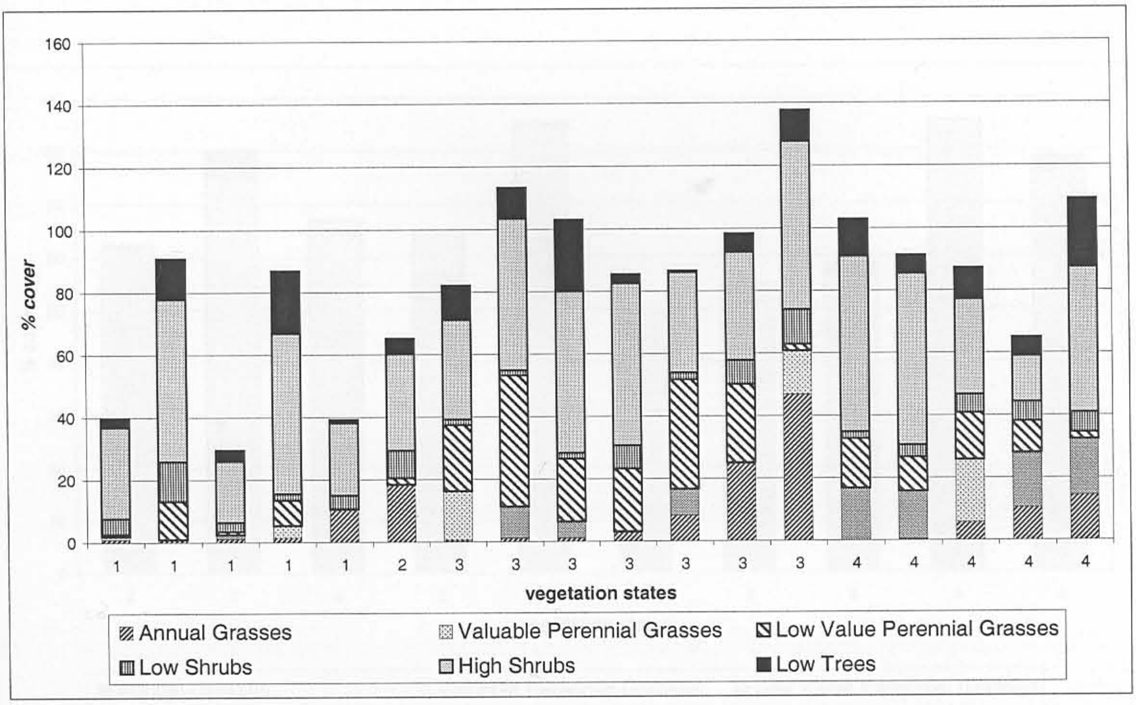


Figure 48: Selection of samples representing the different vegetation states found in association 9.

9.4.10. Association 10: *Boscia foetida - Leucosphaera bainesii* low semi-open bushland

This vegetation is typically found on small patches of surface calcrete, which occurs more commonly in the southern regions of the study area. Owing to the more xeric soil moisture regime of this lime-enriched soil, this vegetation type has in general a lower productivity (vegetation states Figure 49) - especially as far as grasses are concerned - and is thus also prone to degradation by overgrazing. Typical grasses found throughout this vegetation are *Aristida adscensionis* - indicating degradation, but also *Enneapogon desvauxii* (typical climax here), *Cenchrus ciliaris* (up to 10 % cover) and *Stipagrostis uniplumis*. As has been mentioned in Section 9.3, many of these calcrete plains are close to farmhouses and subjected to daily trampling and grazing especially by goats. Even where such plains are not daily traversed by e.g. goats, some calcrete plains have been found in very poor, others in moderate to good condition. Of all samples of this vegetation type, 50 % can be regarded as moderate to good, while 50 % can be regarded as poor (Figure 50). It is condisered a vegetation type which degrades easily. It is also realised that it is not easy to apply special management practices to such plains either due to their proximity to central paddocks or because of their limited size, which makes it unrealistic to fence off as a separate camp and management unit.

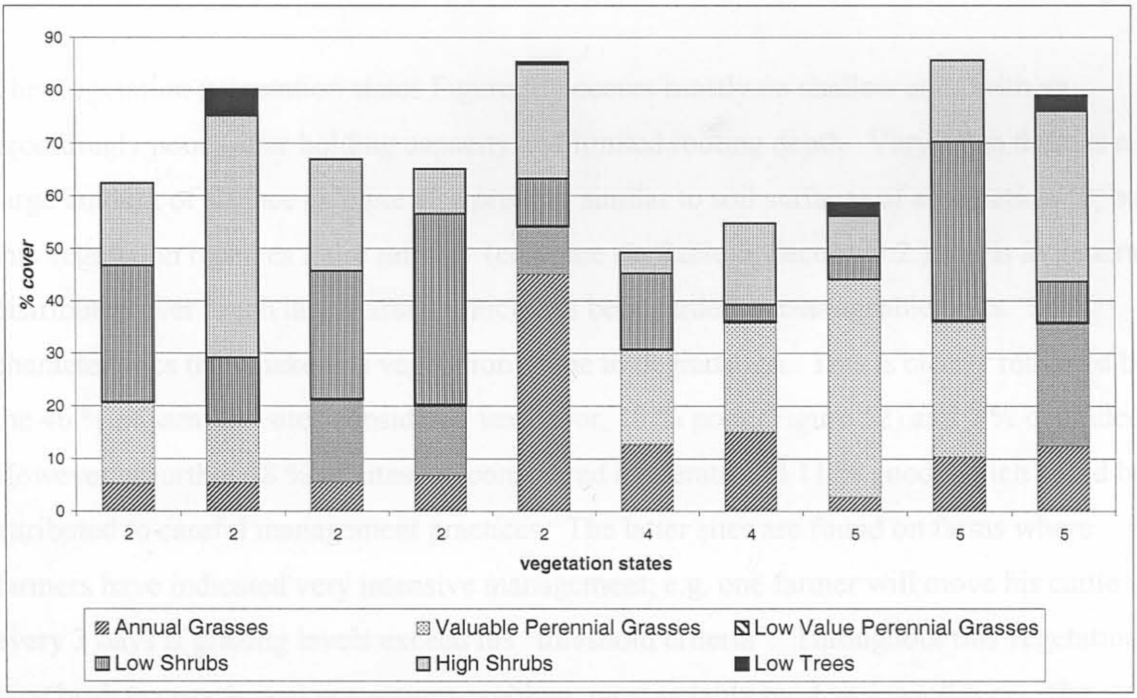


Figure 49: Selection of samples representing the different vegetation states found in association 10.


Figure 50: Example of vegetation of association 10 in state 2 (poor).

9.4.11. Association 11: : *Acacia mellifera - Stipagrostis hirtigluma* low moderately closed bushland

This vegetation (vegetation states Figure 51) occurs mostly on shallow soils with an accordingly poor water holding capacity and limited rooting depth. Very often there is a large amount of surface calcrete also present, similar to soil surfaces of association 10, but this vegetation receives more rainfall (compare on Table 6, Section 9.2.) and is in general distributed over much larger areas, which can be regarded as manageable units. Soil characteristics thus make this vegetation prone to degradation. This is clearly reflected by the 46 % of sampled sites considered very poor, 18 % poor (Figure 52) and 7 % degraded. However, a further 18 % of sites are considered moderate and 11 % good, which could be attributed to careful management practices. The latter sites are found on farms where farmers have indicated very intensive management; e.g. one farmer will move his cattle every 3 days if grazing levels exceed his "threshold criteria". Throughout this vegetation type bush encroachment is a serious problem, most notably by *Acacia mellifera*. The average % cover of this shrub for all sampled sites of this vegetation is 30 %, but in general ranges between thickets of 30 % and 60 % cover. Also unpalatable low shrubs such as *Clerodendron ternatum* (which can be detected by its strong unpleasant smell from a distance already) are increasingly common in degraded and poor samples.

Opposed to the previous associations where the total cover of valuable perennial grasses comprised of one or two species only, the diversity of valuable grasses here increases (see vegetation description in Section 9.2) - probably due to the higher rainfall regime present. Notably this is the vegetation type where *Antephora pubescens* (a highly valued grass) has been recorded most frequently, although often only as individual plant. This higher rainfall regime also causes reason for concern - the herb layer on most of the poor sites is so denuded that soils below the high shrubs are generally bare, and large scale sheet erosion with associated nutrient and seed loss is evident throughout this vegetation type. Added to this is that should grasses germinate, they will do so under a dense canopy where light levels are considerably reduced.

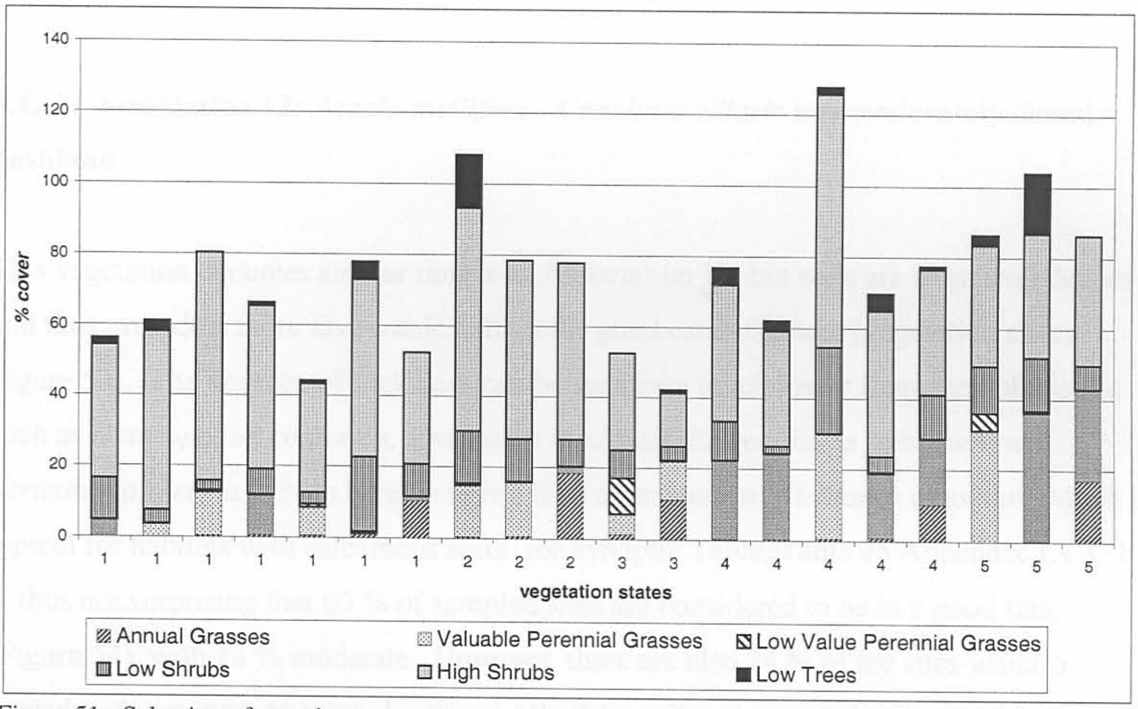


Figure 51: Selection of samples representing the different vegetation states found in association 11.

Figure 52: Example of vegetation of association 11 in state 2 (poor). Note the dense stands of *Acacia mellifera* and *Dichrostachys cinerea*.

9.4.12. Association 12: *Acacia mellifera - Cenchrus ciliaris* low moderately closed bushland

This vegetation occupies similar ranges as Association 11, but soils are in general deeper and thus provide a more favourable habitat for grass establishment (vegetation states Figure 53). The absence of rockiness can be seen by a much lower frequency of species such as *Heteropogon contortus, Eragrostis nindensis, Eriocephalus pubescens* and *Sericorema sericea*. Even here there is a high abundance of *Melhania virescens*, which is typical for habitats with calcareous soils (see synoptic Table, Table 25 Appendix 1.1.). It is thus not surprising that 60 % of sampled sites are considered to be in a good state (Figure 54), with 13 % moderate. However, there are also 24 % of the sites which a considered very poor to poor. Looking at the latter sites, the most dominant grass is *Eragrostis porosa*. Still, in all these sites valuable perennial grasses are present - but only in corners inaccessible to livestock due to the dense shrub layer - which is an added problem on these sites. Stands of *Acacia mellifera* usually reach densities of 30 % to 50 % cover, occasionally *Dichrostachys cinerea* is equally dense.

Compared to association 11, an increased presence in weedy species can be found. Such species include *Pupalia lappacea, Solanum incanum, Acalypha indica, Tribulus terrestris* and *Chenopodium olukondae.*

On good sites, cover % of *Cenchrus ciliaris* ranged from 15 % to 45 %, with *Eragrostis trichophora, Stipagrostis hirtigluma* and *Sporobolus fimbriatus* being amongst the other more common valuable grasses. *Urochloa oligotricha* has also been recorded most abundant in this vegetation type (see Table 25 Appendix 1.1.), although present in mostly low densities. Discussions with farmers here have shown that condition of the veld clearly reflects management strategies. On a farm, which has consistently high densities of *Cenchrus ciliaris*, only conservative numbers of small-frame Sanga-cattle are kept. The farm was de-bushed in 1980, and as necessary, follow-up treatments using fire are applied time and again - but only if fuel loads are sufficient for an intensive fire.

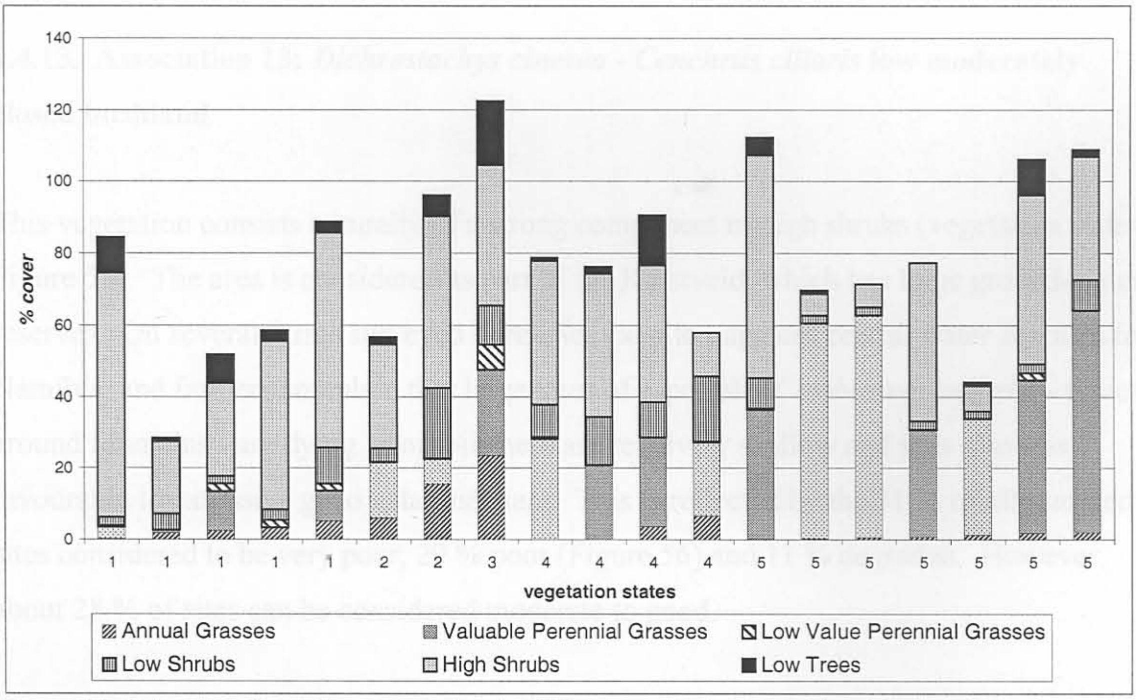


Figure 53: Selection of samples representing the different vegetation states found in association 12.

Figure 54: Example of vegetation of association 12 in state 5 (good). The dominant grass here is *Cenchrus ciliaris*.

9.4.13. Association 13: *Dichrostachys cinerea - Cenchrus ciliaris* low moderately closed bushland

This vegetation consists naturally of a strong component of high shrubs (vegetation states Figure 55). The area is considered as part of the Karstveld, which has large ground-water reserves. On several farms surveyed boreholes exist to augment central water supplies for Namibia, and farmers complain that large trees of especially *Combretum imberbe* - typical around fountains - are dying. Topsoils here are relatively shallow and thus also less favourable to extensive grass establishment. This is reflected by the 31 % of all sampled sites considered to be very poor, 29 % poor (Figure 56) and 11 % degraded. However, about 28 % of sites can be considered moderate to good.

Common and abundant grasses in the poor and degraded vegetation states are, in order of importance, *Eragrostis porosa, Melinis repens* ssp. *grandiflora, Enneapogon cenchroides* and *Urochloa brachyura* - all indicating the pioneer-like state of the herb layer here. The most common valuable grasses on the better sites are *Cenchrus ciliaris, Eragrostis echinochloidea, E. trichophora* and *Heteropogon contortus*. Notably there is not, as in previous associations, a clear trend of high shrub invasion couples to weak grass layer. Several sites with very poor grass layer also only have 15 % shrub cover and overall vegetation cover is low. On the other hand, shrub densities on good sites may reach 30 % to 50 % cover - valuable grasses found here include *Enneapogon scoparius* and up to 10 % *Urochloa oligotricha* - grasses which are believed to disappear first under high grazing pressures. These particular sites were found on a farm with very strict rotational grazing management practices. However, even on this farm sites of very poor condition were found - indicating that the condition of grass layer is strongly influenced by habitat conditions.

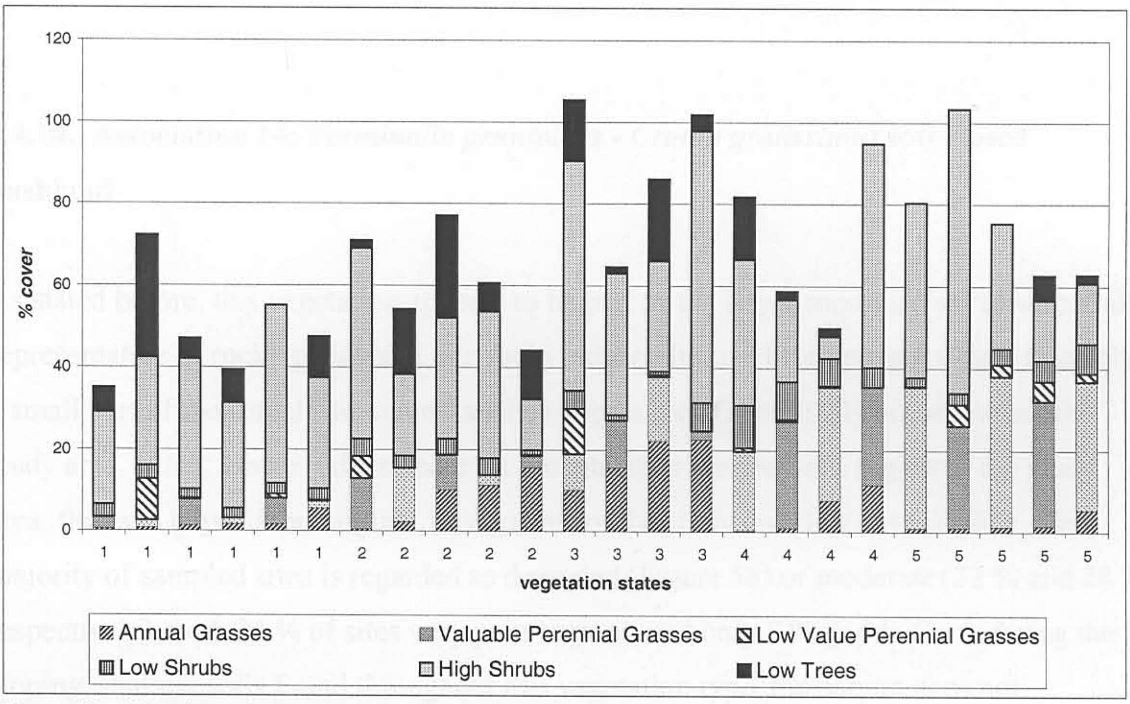


Figure 55: Selection of samples representing the different vegetation states found in association 13.

Figure 56: Example of vegetation of association 13 in state 2 (poor).

9.4.14. Association 14: *Terminalia prunioides - Croton gratissimus* low closed bushland

As stated before, this vegetation appears to be part of the larger mountain savanna, but also representative of rocky plains and low rocky ridges. It must be emphasised here that only a small part of the actual Mountain Savanna vegetation (Giess 1971) occurs within the study area. Also, where it does occur on mountains in the southern region of the study area, this was beyond the original focal points of the study and thus not sampled. The majority of sampled sites is regarded as degraded (Figure 58) or moderate (32 % and 28 % respectively), with 24 % of sites very poor to poor, and only 8 % good. Considering the sloping, shallow soils found throughout this vegetation type, the habitat does not necessarily support a dense grass layer and is easily over-utilised (vegetation states Figure 57). Although this vegetation has a naturally dense shrub component, it was found that especially *Terminalia prunioides* but also *Dichrostachys cinerea* and *Acacia mellifera* form impenetrable thickets, especially on footslopes of mountain ridges.

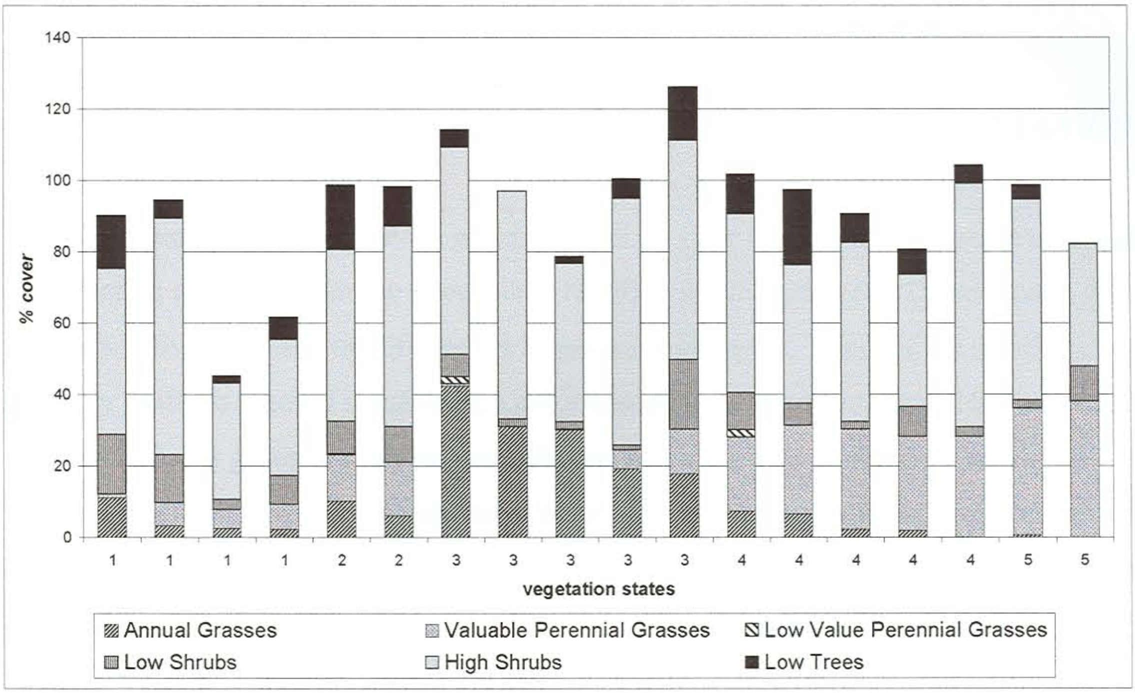


Figure 57: Selection of samples representing the different vegetation states found in association 14.

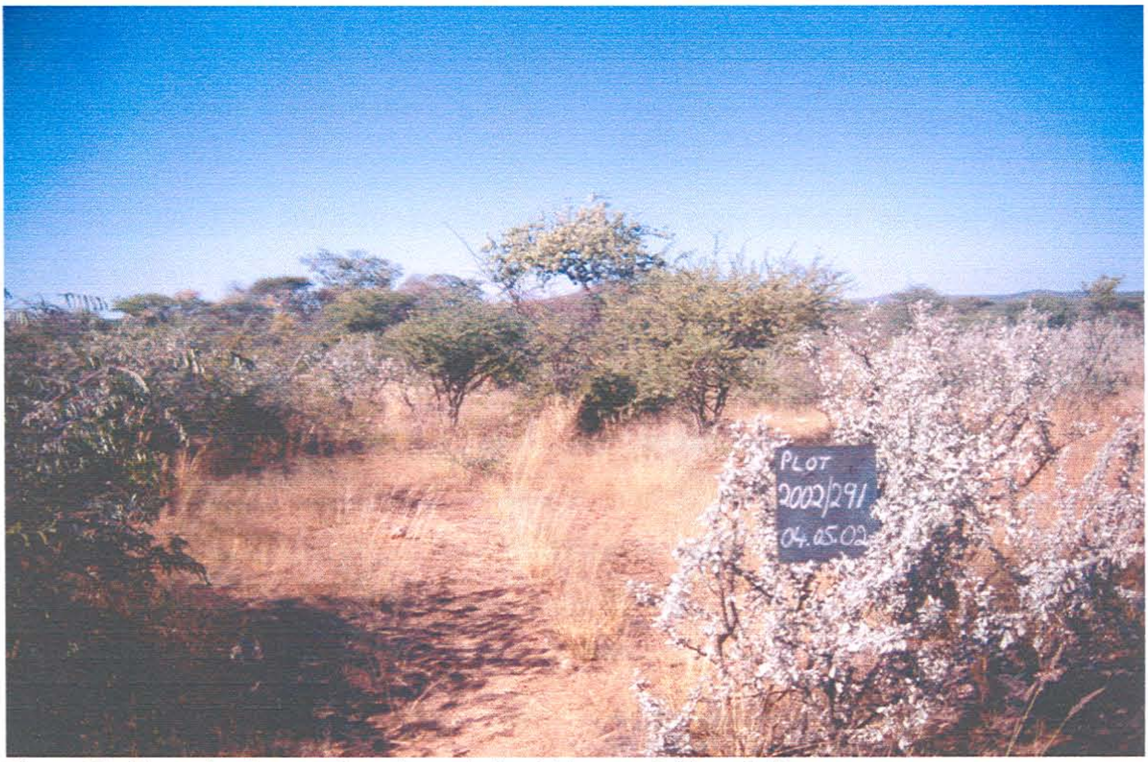


Figure 58: Example of vegetation of association 14 in state 3 (degraded).

10. VEGETATION MAPPING

10.1. MAPPING OF SATELLITE CLASSIFICATIONS OF THE VEGETATION

Initially, the original TWINSPAN groupings (all 53 - see dendogram Figure 16) were used for selecting groups of training sites on the rectified satellite images. These groups were further subdivided based on differences inspectral signatures. Some of the smaller groups had very uniform spectral signatures, e.g. for association 1, but for group 16 of association 7, eight different groups of relatively uniform spectral signatures could be separated. Outlier signatures and their training sites were excluded from the final classification. The initial classification of satellite data was done using the data of the study area only (with mountain ranges removed, as discussed earlier under methods), using all uniform spectral subgroups of the TWINSPAN groupings.

The resultant classification - a separate classification for every satellite image - was mapped and compared to field data for correctness. As a next step all signature groups and TWINSPAN groups were colourcoded according to their respective associations, as defined in section 9.2. This classification is shown for the southern section of the study area in maps 3 and 4 in Appendix 4.

Classification of the northern satellite image proved more difficult, as some farms have been drastically debushed (removal of the entire shrub- and tree layer), on several farms there are planted pastures and, further, there is some "image-contamination" by occasional small clouds and their shadows. These elements had similar spectral signatures to either dense vegetation or pans, and their classification as seprate entities resulted in a complete misclassification of the image. It was thus decided to leave these elements in the classification, but to take note of their true identity when viewing the final map. An example of such "problem areas" is shown in Figure 59.

Overall, the mapping of the separate associations proved relatively useful and well interpretable when looking at individual areas such as farms or individual pan-systems. On a smaller scale, however, this typical mosaic of vegetation types is impossible to map or even to transfer to a GIS data base.

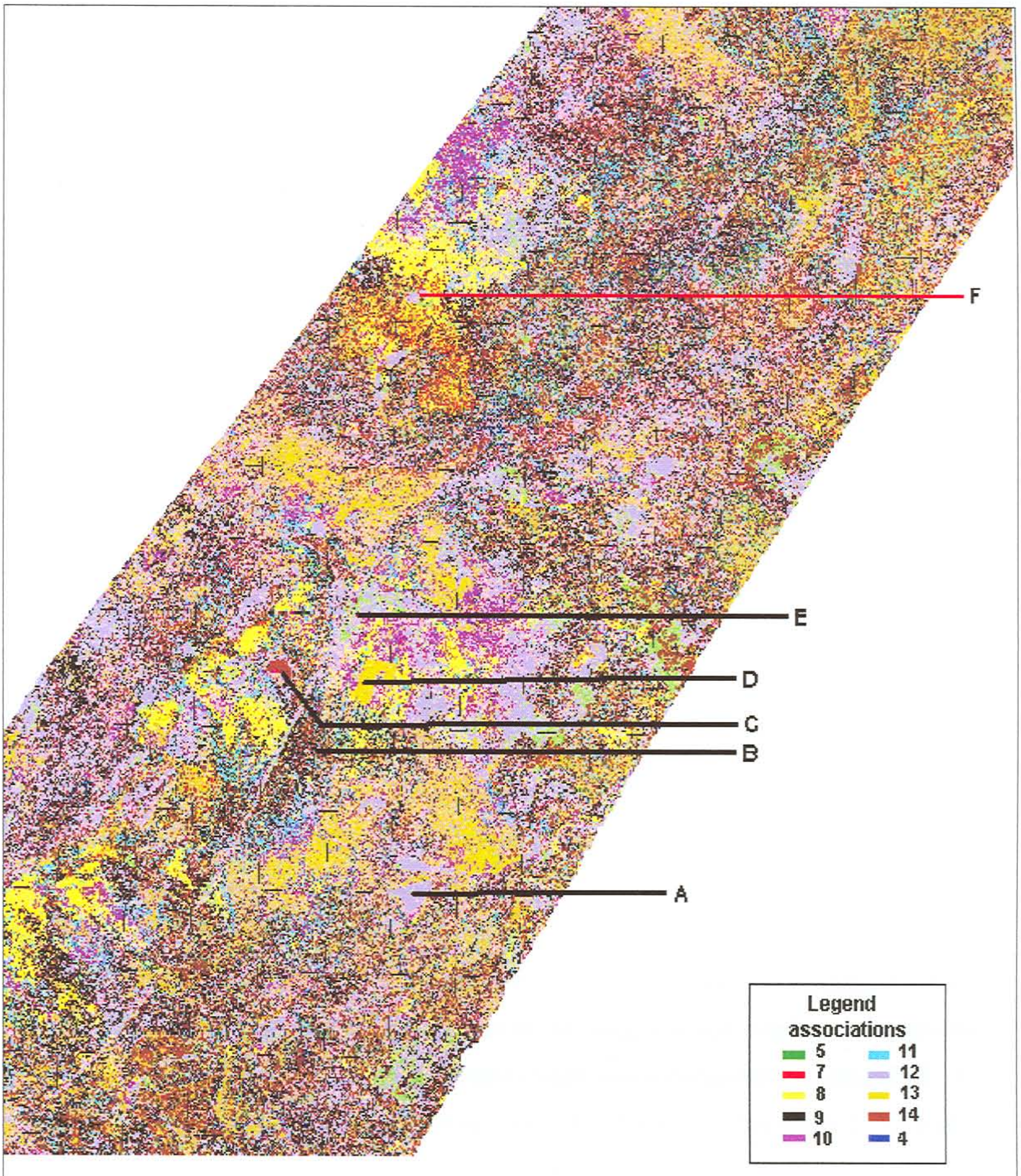


Figure 59: Classification of part of the northern satellite image according to the TWINSPAN associations. A and F refer to planted grazing lands, mostly *Cenchrus ciliaris*, which ERDAS classifies as association 12. C is a seasonal pan, recognised by ERDAS as association 14. D and E are areas that have been bulldozed around 1990 as a de-bushing exercise, but where a dense layer of 50 - 90 cm high shrub is currently re-emerging. ERDAS currently classifies D as association 13, but it is believed that the area originally resembled area B, which consists mostly of association 9 and 14.

It was thus decided to return to the TWINSPAN classification and see which associations could, on the basis of their floristic and structural composition, be further grouped together:

- Associations 1-4 were combined to represent erosion plains of the Omatako catchment area as well as small rivers and drainage channels. It would, at a later stage, be feasible to separate definite riverine vegetation. However, this will require intensive sampling of such vegetation as it is relatively variable.
- Associations 6 and 7 were combined to represent a mixed tree- and shrub savanna. This would represent the most typical form of the Thornbush Savanna described by Giess (1971).
- Associations 11 and 12 were combined to represent vegetation situated on soils overlying dolomitic rock banks. This could be seen as a transition between the Thornbush Savanna and the Karstveld as defined by Giess (1971).

To effectively map these vegetation types for the entire study area, the classifications of the two satellite images had to be merged - a process with many inherent problems. First, the above combinations of vegetation types were re-colourcoded on both images. Here it already became very clear that vegetation types, which occur predominantly on the southern satellite image and physically sampled there, were not accurateley classified on the northern satellite image due to a lack of suitable training sites. The same occurred for the reverse situation. To try and curb this problem, the two images were merged, and additional training sites selected on the areas of the images which overlap - a narrow band between 20°40' S and 20°50' S. The merged image was subsequently re-classified. This classification of vegetation types can be seen on maps 5 and 6 in Appendix 2. Overall this classification can be regarded as relatively successful, but not yet perfect. Classifications of especially very dense vegetation on footslopes and ridges on undulating landscapes in the southern regions of the study area need to be sampled and compared to associations 13 and 14, into which these areas are currently grouped. Such sampling was omitted during the present study as the BIOTA focus for vegetation mapping thus far was strictly on plains. Associations 13 and 14 are able to persist on the plains in the northern regions of the study area, as the habitat there is sufficiently moist. In the southern regions of the study area, however, sufficiently moist habitats suitable for these associations are limited to the rocky environments of especially foot- and midslopes of the few mountains present.

Water is able to infiltrate between these rocks, where it is retained far longer than in soils on the plains.

10.2. COMPARISON OF THE SATELLITE -DATA MAP TO EXISTING VEGETATION MAPS

The preliminary mapping of the vegetation types according to satellite data facilitated a comparison with the vegetation-types described in the Homogenous Farming Areas Report (Figure 61). Basic similarities of the asscociations defined in this study could be established with vegetation types of the Report. On a first glance, the distribution of these associations (and combined vegetation types) did show some similarity with the maps of the Homogenous Farming Areas. However, a formal attempt at delineating the vegetation types defined in this study was not regarded feasible at this stage, as vegetation types extend beyond the study area. Such a vegetation map would be a generalisation in itself, and it will be advisable to first extrapolate the classification of the transect to the entire satellite image, establishing the wider boundaries of each vegetation unit. Then, again with the help of either the false-colour satellite images or aerial photography, as well as soil- and geological maps, boundaries of the vegetation units will have to be defined. This process will be relatively subjective, and will again have to be verified by specific field surveys.

An overwiev of the relationship between the vegetation types defined by Giess (1971) and the Homegenous Farming Areas Report (1979) is indicated in Figure 60.

GIESS Thornbush Savanna or Tee and Shrub Savanna

1. *A6: Okahandja Thornbush Savanna*
2. *A5: Osire Sandveld*
3. *C: Erosion Areas of the Etjo Catchment Area*
4. *A4: Otjiwarongo Thornbush savanna*
5. *A3: Otjenga Plains*
6. *A9: Namibian Maize Triangle*

GIESS Karstveld & Mountain Savanna

Figure 60: Relationship of the Prelimary Vegetation Map of Namibia by Giess (1971) and the Homogenous Farming Areas Report (Dept. Agricultural Technical Services 1979).

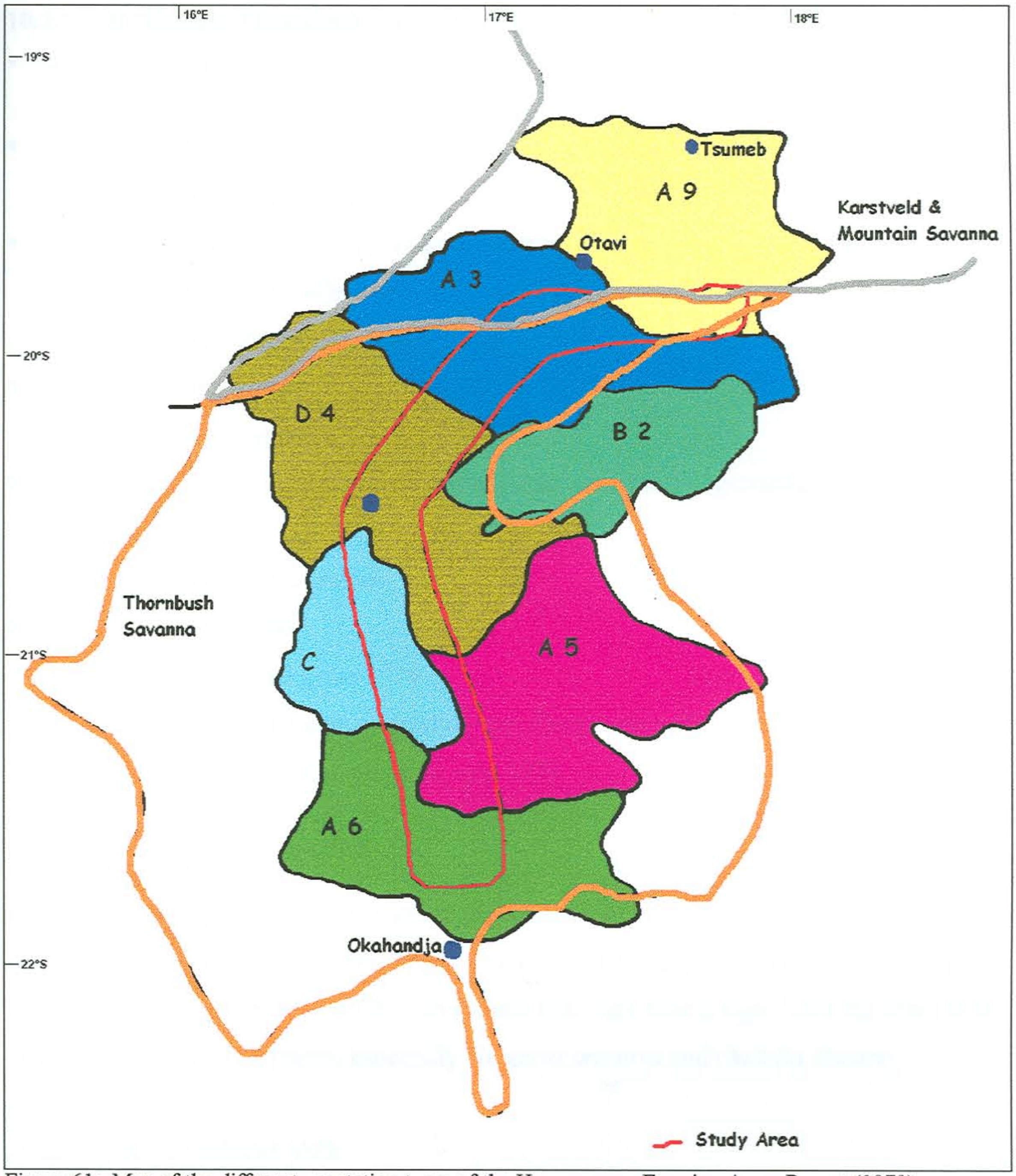


Figure 61: Map of the different vegetation types of the Homogenous Farming Areas Report (1979), compared to the Preliminary vegetation Types of Namibia by Giess (1971) and the location of the study area. The various units of the Homogenous farming Areas Report are: A6: Okahandja Thornbush Savanna, A5: Osire Sandveld, C: Erosion Areas of the Etjo Catchment Area, A4: Otjiwarongo Thornbush savanna, A3: Otjenga Plains, A9: Namibian Maize Triangle

As the map of the Homegenous Farming Areas Report (1979) can be regarded as a subdivision and re-delineation of the Giess (1971) map, the vegetation types classified and described in this study have been compared to vegetation types described in the Homegenous Farming Areas Report (1979).

10.2.1. Okahandja Thornbush Savanna (A6)

- <u>dominant species</u>
  - ⇒ <u>notes</u>
- *Acacia mellifera*
  - ⇒ causes bush encroachment
- *Tarchonanthus camphoratus, Leucosphaera bainesii, Monechma genistifolium, Boscia albitrunca, Albizia anthelmintica*
  - ⇒ common shrubs and trees
- *Combretum apiculatum*
  - ⇒ on rocky outcrops
- *Antephora pubescens, Brachiaria nigropedata, Urochloa oligotricha, Schmidtia pappophoroides*
  - ⇒ original climax grasses
- *Stipagrostis uniplumis*
  - ⇒ main perennial grass 1979
- annual *Eragrostis* spp, annual *Aristida* spp, *Eragrostis pallens, E. rigidior*
  - ⇒ major grasses on overgrazed veld 1979

The Okahandja Thornbush Savanna compares well to Associations 5, 6, 7 and 10. Notable is the almost complete lack of *Antephora pubescens, Brachiaria nigropedata* and *Urochloa oligotricha* from survey data. From data given in the Homogenous Farming Areas Report, it may be assumed that from 1979 up to present there has been a significant increase in the occurree of poisonous plants, especially *Geigeria ornativa* and *Ondetia linearis*.

10.2.2. Osire Sandveld (A5)

- <u>dominant species</u>
  - ⇒ <u>notes</u>
- *Acacia mellifera*
  - ⇒ bush encroachment on sandy loams
- *Acacia tortilis, Dichrostachys cinerea*
  - ⇒ causes bush encroachment
- *Tarchonanthus camphoratus, Boscia albitrunca, Terminalia sericea, Grewia* spp, *Lonchocarpus nelsii*
  - ⇒ common shrubs and trees

- *Geigeria ornativa, Urginea sanguinea*
  - ⇒ main poisonous plants
- *Antephora pubescens, Brachiaria nigropedata, Cenchrus ciliaris, Panicum maximum, Panicum coloratum, Urochloa oligotricha, Dichanthium annulatum, Heteropogon contortus, Cymbopogon plurinodes, Schmidtia pappophoroides, Digitaria eriantha*
  - ⇒ original climax grasses
- *Stipagrostis uniplumis*
  - ⇒ major subclimax grass
- *Eragrostis rigidior*
  - ⇒ "invader" grass in 1979: problematic on many farms - hard and unpalatable, outcompeting other grasses, becoming a stable state which blocks veld improvement
- *Aristida meridionalis, Eragrostis lehmanniana, E. porosa,* annual *Aristida* spp
  - ⇒ major grass in the veld 1979

The association most similar to the Osire Sandveld would be Association 8. The distribution of this association is relatively patchy within the study area - indicating that these may be outliers of this vegetation type. Observations on *Eragrostis rigidior* made in the report are again confirmed by the study - an indication of how little this grass it utilized and how stable that state is once established (O'Connor 1995). Outliers of association 9 are also identified in this area by the satellite classification. The distribution of *Lonchocarpus nelsii*, which is considered characteristic for association 9, has been confirmed this far south (Coates Palgrave 1984), but the actual vegetation type needs further investigation to verify its distribution here.

10.2.3. Erosion Areas of the Etjo Catchment Area (C)

- <u>dominant species</u>
  - ⇒ <u>notes</u>
- *Acacia mellifera , Dichrostachys cinerea*
  - ⇒ causes bush encroachment
- *Tarchonanthus camphoratus, Boscia albitrunca, Terminalia sericea, Grewia* spp, *Lonchocarpus nelsii, Combretum apiculatum*
  - ⇒ common shrubs and trees

- *Geigeria ornativa, Crotalaria* spp
  - ⇒ main poisonous plants
- *Antephora pubescens, Fingerhutia africana, Cenchrus ciliaris, Panicum maximum, Panicum coloratum, Urochloa oligotricha*
  - ⇒ original climax grasses, surveys in the 70's showed that this area is very senitive to overgrazing-damage during drought years, erosion is a major problem

Associations 1,2 and 3 could be considered part of this unit. Association 4 can be included at this stage, although it will be feasible to separate riverine vegetation when vegetation is mapped beyond the boundaries of the study area. The distribution of these vegetation types also matches the distribution of the Etjo Erosion areas to a large extent (compare figure with maps 5 and 6. As mentioned above, association 9 has been mapped by the satellite data this far south as well, but more data should be collected to verify its actual distribution in the southern region of the study area.

Compared to the above species listing, *Crotalaria* spp were found to be relatively infrequent, but it can be accepted that this will vary from year to year. However, *Geigeria ornativa* and *Ondetia linearis* have incrased significantly. Several farmers have reported incidences of poisoning of especially cattle in the early summer - but have stated that most poisonings are non-fatal.

10.2.4. Otjiwarongo Thornbush savanna (A4)

- <u>dominant species</u>
  - ⇒ <u>notes</u>
- *Acacia mellifera, A. tortilis, Dichrostachys cinerea*
  - ⇒ Bushencroachment a major problem in 1979 - reasons given are poor grazing management and overstocking, at least 25% of most farms affected
- *Tarchonanthus camphoratus, Boscia albitrunca, Terminalia sericea, Grewia* spp, *Lonchocarpus nelsii, Combretum apiculatum, Leucosphaera bainesii*
  - ⇒ common shrubs and trees
- *Geigeria ornativa, Urginea sanguinea*
  - ⇒ main poisonous plants

- *Antephora pubescens, Brachiaria nigropedata, Dichanthium annulatum, Cenchrus ciliaris, Panicum maximum, Panicum coloratum, Urochloa oligotricha, Heteropogon contortus, Cymbopogon plurinodes, Eragrostis superba*
  - ⇒ original climax grasses
- *Eragrostis trichophora, E. rigidior, E. lehmanniana, E. nindensis, E. porosa, Chloris virgata, Botriochloa radicans, Stipagrostis uniplumis, Aristida congesta, Schmidtia pappophoroides, Fingerhutia africana, Cympopogon excavatus,* other *Aristida* spp
  - ⇒ dominant subclimax 1979

Association 9 and 14 were regarded most similar to the above summary. Looking at maps 5 and 6 it does become clear that both vegetation types occur in a closely-knit mosaic, which will require additional sampling, also beyond the study area, for a clearer classification and delineation. In general, association 9 occurs on the plains south and north of Otjiwarongo, while association 14 occurs on footslopes of inselbergs as well as on ridges common around Otjiwarongo. The latter is thus similar to the Mountain Savanna of Giess (1971), which has not been adequately sampled in this study. Both associations merge strongly with the Otjenga plains described below.

Brachiaria nigropedata was not recorded in this vegetation type during the study. The incidence of poisonous plants in associations 9 and 14 has been found to be very low. The most frequently recorded species is *Geigeria acaulis*, while e.g. *Geigeria ornativa* or *Ondetia linearis* were very infrequent or not recorded at all. The presence of *Urginea sanguinea* could not be confirmed, as this plant usually emerges during early summer (November - January) and, if present, was not visible any more during the time of the survey.

10.2.5. Otjenga Plains (A3)

- <u>dominant species</u>
  - ⇒ <u>notes</u>
- *Acacia mellifera, A. erubescens, Dichrostachys cinerea, Terminalia prunioides*
  - ⇒ causes dense bush encroachment
- *Ficus sycomorus, Sclerocarya birrea, Kirkia acuminata, Albizia anthelmintica, Combretum imberbe*
  - ⇒ common shrubs and trees on outcrops and mountains

- *Terminalia sericea, Lonchocarpus nelsii*
    - ⇒ common shrubs and trees on plains
- *Peltophorum africanum, Acacia erioloba, A. karroo, A. tortilis*
    - ⇒ common shrubs and trees on sandy plains
- *Antephora pubescens, Brachiaria nigropedata, Cenchrus ciliaris, Panicum coloratum, Urochloa oligotricha, Heteropogon contortus, Fingerhutia africana*
    - ⇒ original climax grasses
- *Eragrostis rigidior, E. porosa, Chloris virgata, Stipagrostis uniplumis, Schmidtia pappophoroides, Enneapogon cenchroides*, annual *Aristida* spp
    - ⇒ dominant subclimax 1979

The associations most similar here are 11 and 12, which have also been grouped into one vegetation type. Also similar is association 13. The distribution of both vegetation types is relatively patchy and very much integrated with association 14 as stated above.

10.2.6. Namibian Maize Triangle (A9)

- dominant species
    - ⇒ notes
- *Kirkia acuminata, Acacia tortilis, A. karroo, Combretum imberbe, Sclerocarya birrea, Ficus* spp, *Albizia anthelmintica, Peltophorum africanum, Lonchocarpus nelsii, Spirostachys africana, Olea europaea, berchemia discolor, Dombeya rotundifolia, Lannea discolor, Ximenia* spp
    - ⇒ common trees
- *Catophractes alexandri, Commiphora* spp, *Combretum apiculatum, Rhus* spp, *Grewia* spp, *Acacia mellifera, Dichrostachys cinerea, Croton gratissimus, Ziziphus mucronata, Mundulea sericea, Tarchonanthus camphoratus*
    - ⇒ common shrubs
- *Cymbopogon excavatus, Hyparrhenia hirta, Andropogon gayanus, Botriochloa* spp, *Antephora pubescens, Brachiaria nigropedata, Panicum* spp, *Urochloa oligotricha, Heteropogon contortus, Fingerhutia africana, Aristida meridionalis*
    - ⇒ grasses on "better" veld
- annual *Aristida* and *Eragrostis* spp
    - ⇒ on degraded veld

11. CONCLUSION

The combination of a phytosociological description of vegetation, coupled with a supervised classification of satellite data proved relatively successful in this study. Limitations of the data to fully delineate all associations and vegetation types described can be based on the study design and delineation of the study area. BIOTA up to date focussed strictly on the vegetation of plains as the project overall looks at major environmental gradients spanning over several biomes (refer back to Figure 1). There is thus a contradiction in scale in the study design: the transect layout may be sufficient to get an overview of vegetation on a larger (e.g. biome) scale. For the aims of the Namibian Vegetation Map, however, the placement of the transect proved to be limiting. The main reasons are that the transect only bordered several pre-delineated vegetation types, thus only "outliers" of these were sampled; also, mountains should have been included, even though it can be expected that mountain flora will vary from one inselberg to the next. These shortcomings should not be seen as strictly negative, however - one of the aims of BIOTA Phase I (which is regarded as a preliminary phase) is not only to gather baseline data, but also to verify study design. The initial maps obtained from this study will form the "baseline data" from which the extend of various vegetation units within central Namibia may be extrapolated and verified with comparably little additional effort.

This study also showed that when considering the use of satellite imagery for vegetation mapping, the process of field sampling and classification of satellite data should be considered an iterative process, until an acceptable result is achieved. The classification of vegetation shown on maps 5 and 6 (Appendix 4) should be seen as a first interim result. It has become very clear that areas, where the satellite images overlap should be identified in advance and sampled more intensely to allow for a more accurate merging of different satellite scenes where one continuous vegetation map is desired as a result. However, the satellite classification also clearly showed where more samples are required, which will enable more efficiently targeted fieldwork for follow-up surveying of vegetation. As experienced in this study, initial survey-stratification should be rather based on false-colour satellite maps than on a-priori unsupervised satellite classification. In the case of this study it would have been too much of a generalisation, which would have led to under-sampling of the vegetation and a poor description of vegetation types.

The vegetation description and preliminary delineation with satellite data showed relatively good similarities with veld types described in the Homogenous Farming Areas Report. In the southern region of the study area, the Okahandja Thornbush Savanna (unit A6 of the Homogenous Farming Areas Report) can be further subdivided into *Acacia mellifera - Monechma genistifolium* low semi-open bushland (association 5), Albizia *anthelmintica - Stipagrostis uniplumis* low open woodland (association 6), Acacia *mellifera - Aristida congesta* low semi-open bushland (association 7) and *Boscia foetida - Leucosphaera bainesii* low semi-open bushland (association 10).

In the central-eastern parts of the study area, the Osire Sandveld (unit A5 of the Homogenous Farming Areas Report) can be described in terms of the *Acacia erioloba - Stipagrostis uniplumis* low semi-open bushland (association 8), with inclusions of the *Lonchocarpus nelsii - Eragrostis rigidior* low moderately closed bushland (association 9).

These veld types also merge into the Erosion Areas of the Etjo Catchment Area (unit C A6 of the Homogenous Farming Areas Report). These erosion areas can be subdivided into *Catophractes alexandri - Willkommia sarmentosa* tall sparse shrubland (association 1), Boscia *albitrunca - Eragrostis cylindriflora* low open woodland (association 2) and Acacia *mellifera - Leucosphaera bainesii* low closed shrubland with patches of low open woodland (association 3).

To the north, the Etjo Catchment Area merges into the Otjiwarongo Thornbush Savanna (unit A4 of the Homogenous Farming Areas Report), which can be subdivided into *Lonchocarpus nelsii - Eragrostis rigidior* low moderately closed bushland (association 9) and *Terminalia prunioides - Croton gratissimus* low closed bushland (association 14).

The northern region of the study area mainly resembles the Otjenga Plains (unit A3 of the Homogenous Farming Areas Report), which can be subdivided into *Acacia mellifera - Stipagrostis hirtigluma* low moderately closed bushland (association 11), Acacia *mellifera - Cenchrus ciliaris* low moderately closed bushland (association 12) and Dichrostachys *cinerea - Cenchrus ciliaris* low moderately closed bushland (association 13).

Although the Namibian Maize Triangle (unit A9 of the Homogenous Farming Areas Report) is indicated as covering the north-eastern tip of the study area and has some resemblance to *Terminalia prunioides - Croton gratissimus* low closed bushland (association 14), it is felt that this part of the study area should rather be included in the Otjenga plains with its different vegetation types. Mountainous vegetation bordering this area should be surveyed in more detail and reclassified.

A formal delineation and description of major vegetation types for the study area will only be feasible by an extension of the study area to vegetation types identified by the study, but so far only marginally covered.

Within the study area, environmental variables most strongly influencing the distribution of vegetation are soil texture and -type, rainfall gradients as well as underlying geology.

Acacia mellifera - Eragrostis rotifer low moderately closed bushland (association 4) is not part of any specific vegetation type, but is distributed especially along all riverine systems.

From a management point of view, *Catophractes alexandri - Willkommia sarmentosa* tall sparse shrubland (association 1), *Boscia albitrunca - Eragrostis cylindriflora* low open woodland (association 2) and *Acacia mellifera - Leucosphaera bainesii* low closed shrubland with patches of low open woodland (association 3) have a relatively low value as farming (grazing) lands. Under prevailing environmental conditions, grass cover is generally low and the dominant grasses present have little leaf mass or low grazing values (Müller 1985, Van Oudtshoorn 1999).

The *Acacia mellifera - Monechma genistifolium* low semi-open bushland (association 5), Albizia *anthelmintica - Stipagrostis uniplumis* low open woodland (association 6) and Acacia *mellifera - Aristida congesta* low semi-open bushland (association 7) form the basis of farming practices especially south of the Omatako Mountains. *Albizia anthelmintica - Stipagrostis uniplumis* low open woodland , although very localised, appears to be more resilient to over-utilisation (due to possibly a more favourable soil-moisture regime), which is apparent in associations 5 and 7. All three vegetation types can be regarded prone to bush encroachment (especially by *Acacia mellifera*) as a result of degradation. *Boscia foetida - Leucosphaera bainesii* low semi-open bushland (association 10) occurs sporadically throughout these vegetation types and is, based on its calcrete soils, prone to degradation.

Acacia erioloba - Stipagrostis uniplumis low semi-open bushland (association 8) and *Lonchocarpus nelsii - Eragrostis rigidior* low moderately closed bushland (association 9) are the basis of farming practices especially in the central regions of the study area. Although the former vegetation types is still in relatively good condition, it is equally prone to an increasing establishment of hard, unpalatable grasses as the latter vegetation type as a result of degradation. Degradation is more widespread in the *Lonchocarpus nelsii - Eragrostis rigidior* low moderately closed bushland, which many farmers attribute to past very high stocking rates. It is also severely affected by bush-encroachment of especially *Acacia mellifera* and *Dichrostachys cinerea*.

Acacia mellifera - Stipagrostis hirtigluma low moderately closed bushland (association 11) *Acacia mellifera - Cenchrus ciliaris* low moderately closed bushland (association 12) and *Dichrostachys cinerea - Cenchrus ciliaris* low moderately closed bushland (association 13) are the basis of farming resources in the northern regions of the study area. All three vegetation types are susceptible to high degrees of bush encroachment, but associations 11 and 13 are especially prone to degradation due to their shallow soils.

Terminalia prunioides - Croton gratissimus low closed bushland (association 14) occupies more rocky habitats and has a naturally weak herb- and grass layer. This layer is easily degraded. Further, this vegetation tends to high levels of thickening of shrubby vegetation, especially by *Terminalia prunioides*. This vegetation thus has a low value as a farming resource.

Overall, veld types recorded in the study area will benefit from more conservative and/or carefully planned management practices to avoid over-utilisation of resources and resultant, usually irreversible degradation. Restoration practices of degraded rangelands may be possible, but will often require an initial drastic reduction (not total removal) of the invading shrubs, which is an expensive process.

SUMMARY

Vegetation description and mapping along a strip transect in central Namibia with the aid of satellite imagery.

by

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The main objectives of this study, which is part of the BIOdiversity monitoring Transect Analysis in Africa Project (BIOTA), were to document, classify and describe the changes of phytodiversity along a strip transect in central Namibia, paying attention to vegetation structure and floristic composition. Distribution of the vegetation types was obtained by supervised classification of satellite data for the study area.

The study area is located on a 30 x 320 km stretch between 21°45'00" S and 19°45'00" S, roughly following the main road Okahandja - Otavi - Grootfontein, concentrating on the plains and avoiding mountain ranges. Long-term average rainfall varies from 300 mm in the south to 600 mm in the north, falling mainly during January to March. Mean maximum temperature ranges from 28 to 30° C in January, mean minimum temperatures in July range from 3-8° C with occasional frosts.

Original selection of sampling areas was based on false-colour maps of satellite images 178/74 and 178/75. 425 Relevés were collected during mid-February to mid-May of 2001 and 2002, another 42 relevés were added from the BIOTA observatories located within the study area. These data were classified using TWINSPAN and refined with Braun-

Blanquet-procedures. Main environmental gradients were identified with DCA and PCA ordinations.

The classification of the floristic data resulted in four different phytosociological tables, which include following vegetation types:

Table 1:

Association 1: *Catophractes alexandri - Willkommia sarmentosa* tall sparse shrubland
Association 2: *Boscia albitrunca - Eragrostis cylindriflora* low open woodland
Association 3: *Acacia mellifera - Leucosphaera bainesii* low closed shrubland with patches of low open woodland
Association 4: *Acacia mellifera - Eragrostis rotifer* low moderately closed bushland
Association 5: *Acacia mellifera - Monechma genistifolium* low semi-open bushland

Table 2:

Association 6: *Albizia anthelmintica - Stipagrostis uniplumis* low open woodland
Association 7: *Acacia mellifera - Aristida congesta* low semi-open bushland
Association 8: *Acacia erioloba - Stipagrostis uniplumis* low semi-open bushland
Association 9: *Lonchocarpus nelsii - Eragrostis rigidior* low moderately closed bushland

Table 3:

Association 10: *Boscia foetida - Leucosphaera bainesii* low semi-open bushland
Association 11: *Acacia mellifera - Stipagrostis hirtigluma* low moderately closed bushland
Association 12: *Acacia mellifera - Cenchrus ciliaris* low moderately closed bushland

Table 4:

Association 13: *Dichrostachys cinerea - Cenchrus ciliaris* low moderately closed bushland
Association 14: *Terminalia prunioides - Croton gratissimus* low closed bushland

The delineation of these associations was established using a supervised classification of satellite data of the study area. The delineation of a formal vegetation map will require the combination of some of these vegetation types into larger units, as well as additional sampling of vegetation types only marginally covered by the study area.

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APPENDIX 1.1: SYNOPTIC TABLES

For ease of comparison, species have been listed according to the layer in which they were recorded:

gr = grass
hl = herb
s1 = high shrubs, 1-5 m
s2 = low shrubs, 30 cm - 1 m
t3 = low trees, 2-5 m
t2 = small trees, 5-10 m

Values indicate percentage abundance within each association, thus 100 would indicate that the species has been recorded in every relevé assigned to that association.

Within each layer, species have been listed alphabetically, diagnostic species groups for each association have been indicated on the TWINSPAN Tables in Appendix 1.2.

Table 24: Synoptic Table of associations 1 to 9

Vegetation type		1	2	3	4	5	6	7	8	9
Number of samples		4	11	18	24	65	42	89	56	32
Andropogon chinensis	gr	.	18	.	4	15	.	8	.	.
Anthephora pubescens	gr	.	.	.	.	.	.	.	2	.
Anthephora schinzii	gr	100	36	.	8	12	.	6	13	6
Aristida adscensionis	gr	.	46	78	71	88	86	88	48	63
Aristida congesta	gr	.	27	44	63	43	29	92	63	66
Aristida effusa	gr	.	.	6	17	26	33	46	11	34
Aristida hordeacea	gr	.	9	50	13	19	2	1	.	.
Aristida meridionalis	gr	.	.	.	.	.	14	5	2	3
Aristida pilgeri	gr	.	.	.	.	.	.	5	4	6
Aristida rhiniochloa	gr	.	18	39	42	60	21	70	13	28
Aristida stipitata	gr	.	.	6	.	3	.	2	5	6
Bothriochloa radicans	gr	.	.	39	25	14	2	2	7	.
Brachiaria deflexa	gr	75	55	.	29	9	.	18	21	19
Brachiaria eruciformis	gr	.	.	11	4	8	.	.	.	.
Brachiaria malacodes	gr	.	9	6	21	25	5	8	.	13
Brachiaria nigropedata	gr	.	.	.	.	.	2	.	.	.
Brachiaria schoenfelderi	gr	.	.	6	4	12	.	.	.	.
Brachiaria xantholeuca	gr	.	.	.	.	.	5	.	.	.
Cenchrus ciliaris	gr	.	9	17	33	80	57	26	21	28
Chloris virgata	gr	100	100	94	88	69	60	79	46	34
Craspedorhachis rhodesiana	gr	25	.	.	.	.	.	.	.	.
Cymbopogon plurinodis	gr	.	.	.	13	.	.	9	4	.
Dactyloctenium aegyptium	gr	50	36	.	13	2	.	8	9	.
Dactyloctenium giganteum	gr	.	9	.	.	.	.	.	.	.
Dichanthium annulatum	gr	.	.	.	4	6	2	.	.	3
Digitaria eriantha	gr	.	.	.	.	.	2	.	.	.
Digitaria seriata	gr	.	.	.	.	.	.	.	2	.
Digitaria velutina	gr	.	9	6	25	5	.	20	2	31
Diplachne fusca	gr	.	9	.	.	.	.	.	.	.
Enneapogon cenchroides	gr	25	27	22	46	99	98	87	73	53
Enneapogon desvauxii	gr	.	.	.	4	29	7	1	.	3
Enneapogon scoparius	gr	.	.	.	4	3	.	1	5	3
Eragrostis annulata	gr	.	.	.	8	3	12	2	.	3
Eragrostis biflora	gr	.	.	6	8	2	12	20	13	16
Eragrostis cylindriflora	gr	100	91	.	13	12	.	39	14	.
Eragrostis dinteri	gr	.	.	.	.	11	.	7	30	.
Eragrostis echinochloidea	gr	.	.	6	21	43	19	5	.	13
Eragrostis jeffreysii	gr	75	18	6	54	40	12	61	18	19
Eragrostis lehmanniana	gr	.	.	.	.	5	14	.	.	.
Eragrostis nindensis	gr	.	.	.	.	8	.	14	4	.

Vegetation type		1	2	3	4	5	6	7	8	9
Eragrostis omahekensis	gr					3	14	1	16	
Eragrostis porosa	gr		36	61	54	66	43	73	79	69
Eragrostis rigidior	gr		18		8	8	5	49	71	81
Eragrostis rotifer	gr	50	55	61	92	51	10	47		16
Eragrostis superba	gr				4	2		2	2	
Eragrostis trichophora	gr	50	36	50	83	52	60	76	45	78
Eragrostis viscosa	gr						7	5		28
Fingerhuthia africana	gr					2			2	
Heteropogon contortus	gr				4	2	2	3	4	6
Heteropogon melanocarpus	gr					2	2			
Melinis kallimorpha	gr						2			
Melinis repens s0 grandiflorum	gr			22	42	42	93	85	79	72
Melinis repens s0 repens	gr		9		4	9	5	11	20	22
Microchloa caffra	gr					2	5	12		22
Monelytrum luederitzianum	gr		36	33	21	29	5	14	11	6
Oropetium capense	gr					2				3
Panicum coloratum	gr			61	46	8		10	2	9
Panicum maximum	gr		9		38	2		19	9	9
Panicum stapfianum	gr	50	46	6	17	17		9		
Pogonarthria fleckii	gr		9		17	11	74	83	79	91
Schmidtia kalihariensis	gr							2	2	
Schmidtia pappophoroides	gr		27	17	8	15	12	38	52	22
Setaria pumila	gr		36	6	50	3		5		22
Setaria verticillata	gr		55	11	63	40	14	12	11	6
Sorghum versicolor	gr					2				
Sporobolus festivus	gr					3		3		
Sporobolus fimbriatus	gr		9					1	2	
Stipagrostis hirtigluma	gr					2	2	3		
Stipagrostis uniplumis	gr		18	22	17	68	98	79	96	53
Tragus berteronianus	gr			11	21	25	14	36	32	31
Tragus racemosus	gr					2				
Tricholaena monachne	gr						12		2	3
Triraphis ramosissima	gr						5			
Urochloa brachyura	gr	25	46	44	42	40	31	51	79	59
Urochloa oligotricha	gr				8	5		3		13
Urochloa trichopus	gr				13	8		9		
Willkommia sarmentosa	gr	100								
Acalypha indica	hl				17	26	7	11	11	6
Acalypha segetalis	hl					5				
Acanthosicyos naudinianus	hl						14	11	30	31
Achyranthes aspera v0 aspera	hl	25	55	11	63	32	10	37	5	19
Achyranthes aspera v0 sicula	hl				4		17			
Acrotome fleckii	hl		27		8	14	52	74	13	3
Acrotome inflata	hl		36	11	50	23	5	36	4	53
Alternanthera nodiflora	hl		9							
Amaranthus thunbergii	hl				17	6	7	10	2	
Aptosimum angustifolium	hl			17	42	9	2	46	45	19
Aptosimum decumbens	hl									22
Aptosimum lineare	hl		9	22	8	29	50	18	2	
Becium filamentosum	hl				21	15	2	7		6
Bidens biternata	hl		27	6	50	29	7	10	4	9
Blepharis integrifolia	hl			6	4			14	5	
Blepharis leendertziae	hl			44	25	22	5	14	5	9
Blepharis mitrata	hl		27		4	8	2	12		3
Boophane disticha	hl						2	2	4	
Bulbostylis hispidula	hl						5	19	11	22
Calostephane divaricata	hl					3		1		
Chamaecrista absus	hl								4	3
Chamaecrista biensis	hl						7	2	4	3
Chamaesyce inaequilatera	hl			11	8	14	10	8	25	31
Cheilanthes viridis	hl							1		
Chenopodium amboanum	hl					11	38			
Chenopodium olukondae	hl		27	17	50	17	2	10	9	
Citrullus lanatus	hl						2	2	4	
Cleome angustifolia s0 diandra	hl					2	2			
Cleome elegantissima	hl						2			
Cleome gynandra	hl					2			2	
Cleome hirta	hl						2		4	6
Cleome monophylla	hl	50	36	11	33	6		38	23	28
Cleome rubella	hl				4	2	21	47	48	19
Commelina benghalensis	hl	50	36	11	46	14	19	69	41	69
Commelina livingstonii	hl			11			21	6	4	6
Commelina subulata	hl	50	36						2	
Commicarpus pentandrus	hl					3				
Convolvulus ocellatus	hl							1		
Corallocarpus welwitschii	hl					5				9

Vegetation type		1	2	3	4	5	6	7	8	9
Corchorus tridens	hl	50	9	6	8	6	2	5	.	28
Crassula rhodesica	hl	.	9	.	.	.	.	2	.	6
Craterostigma plantagineum	hl	.	.	.	.	2	.	6	.	3
Crotalaria heidmannii	hl	.	.	.	.	3	7	16	21	9
Crotalaria pisicarpa	hl	.	.	.	.	.	17	24	13	6
Crotalaria podocarpa	hl	.	18	28	4	.	17	8	38	3
Crotalaria sphaerocarpa	hl	.	.	.	.	.	2	1	9	.
Crotalaria steudneri	hl	.	36	.	.	2	.	14	.	9
Cucumis africanus	hl	.	.	.	.	2	.	.	.	.
Cucumis anguria	hl	.	36	6	29	26	21	49	14	9
Cucumis kalahariensis	hl	.	.	.	.	.	10	.	.	.
Cucumis sagittatus	hl	.	.	.	.	2	2	.	.	.
Cullen obtusifolia	hl	.	.	.	.	3	.	.	.	.
Cyperus amabilis	hl	.	.	.	.	.	.	3	.	.
Cyperus cuspidatus	hl	.	.	.	.	.	.	6	.	.
Cyperus fulgens	hl	.	.	72	38	17	7	29	16	25
Cyphostemma cirrhosum	hl	.	.	.	.	.	.	1	.	.
Cyphostemma hereroense	hl	.	.	.	.	2	.	.	2	3
Cyphostemma omburense	hl	.	.	.	.	2	2	.	.	
Dactyliandra welwitschii	hl	.	.	.	.	6	2	6	4	3
Dicliptera eenii	hl	.	9	.	.	.	2	1	.	.
Dicoma capensis	hl	.	.	.	4	2	2	8	2	3
Dicoma schinzii	hl	.	.	.	.	2	.	.	2	3
Dicoma tomentosa	hl	.	.	6	.	11	12	38	29	41
Dolichos linearis	hl	.	.	.	.	.	2	.	.	.
Eleusine indica	hl	.	27	.	.	9	.	.	.	.
Erucastrum arabicum	hl	.	27	11	21	35	33	30	4	13
Euphorbia crotonoides	hl	.	.	.	.	2	.	2	.	22
Evolvulus alsinoides	hl	.	9	11	33	6	69	71	68	78
Felicia smaragdina	hl	25	27	.	.	2	55	36	18	38
Flaveria bidentis	hl	.	.	.	.	.	2	.	.	.
Geigeria acaulis	hl	.	.	.	4	26	19	47	14	41
Geigeria ornativa	hl	75	18	6	29	45	60	42	30	3
Gisekia africana	hl	.	9	6	.	.	2	29	63	13
Gisekia pharnacoides	hl	.	.	.	.	.	2	.	.	.
Gladiolus permeabilis	hl	.	.	.	.	.	2	3	.	.
Gloriosa superba	hl	.	.	.	.	.	.	1	2	.
Harpagophytum procumbens	hl	.	.	.	.	.	2	9	27	13
Hebenstretia integrifolia	hl	.	.	.	.	.	.	.	2	.
Helichrysum candolleanum	hl	.	.	.	.	.	2	3	.	.
Heliotropium ciliatum	hl	.	.	.	.	.	5	1	.	.
Heliotropium marifolium	hl	.	.	.	.	.	2	3	2	.
Hemizygia petrensis	hl	.	.	.	.	2	5	.	.	.
Hermannia modesta	hl	.	36	17	17	32	38	44	16	34
Hermannia quartiniana	hl	.	.	.	17	3	.	5	2	3
Hermannia tomentosa	hl	.	.	.	.	2	12	7	45	9
Hermbstaedtia odorata	hl	.	.	.	13	29	24	20	13	3
Hibiscus calyphyllus	hl	.	.	.	.	3	43	.	.	.
Hibiscus fleckii	hl	.	.	.	.	3	2	20	16	9
Hibiscus palmatus	hl	.	.	.	13	3	5	6	2	13
Hibiscus schinzii	hl	.	.	.	.	2	2	3	5	.
Hirpicium gorterioides	hl	.	9	6	8	11	19	18	30	16
Indigastrum costatum	hl	.	.	.	.	.	2	.	.	.
Indigofera alternans	hl	.	.	.	.	.	.	5	18	3
Indigofera charlieriana	hl	.	27	6	8	9	7	14	4	3
Indigofera daleoides	hl	.	.	.	.	.	2	.	2	.
Indigofera hochstetteri	hl	25	27	6	.	17	.	17	13	13
Indigofera holubii	hl	.	.	.	.	8	.	1	.	6
Indigofera vicioides	hl	.	18	6	8	2	2	35	11	9
Ipomoea bolusiana	hl	.	.	22	8	6	12	19	30	16
Ipomoea coptica	hl	25	27	.	.	2	.	2	.	.
Ipomoea coscinosperma	hl	.	.	6	.	8	.	.	.	.
Ipomoea crassipes	hl	25	.	.	4	.	.	8	25	13
Ipomoea hackeliana	hl	.	.	.	.	.	2	2	5	.
Ipomoea hochstetteri	hl	.	18	.	8	.	.	2	.	.
Ipomoea magnusiana	hl	.	.	.	.	.	.	.	.	3
Ipomoea oblongata	hl	.	.	.	.	.	5	1	5	6
Ipomoea obscura	hl	.	.	28	13	8	14	46	39	72
Ipomoea sinensis	hl	.	36	.	8	17	38	56	46	28
Jacquemontia tamnifolia	hl	.	.	.	.	.	.	1	2	.
Jatropha erythropoda	hl	.	.	.	.	.	.	1	9	9
Justicia anselliana	hl	75	55	11	13	.	.	6	.	.
Kalanchoe lanceolata	hl	.	.	.	4	3	.	.	.	6
Kalanchoe rotundifolia	hl	.	.	.	.	.	.	1	.	3
Kohautia azurea	hl	.	.	.	.	.	.	1	.	.
Kohautia caespitosa	hl	.	.	.	8	11	7	25	13	34

Vegetation type		1	2	3	4	5	6	7	8	9
Kohautia cynanchica	hl				4		10	8	27	9
Kyllinga alba	hl	25		6	4			8	7	13
Kyllingiella microcephala	hl							3		
Kyphocarpa angustifolium	hl		27		25	34	67	67	34	50
Lablab purpureus	hl							1		
Laggera decurrens	hl					5				
Lapeirousia bainesii	hl					2		1	5	
Lapeirousia coerulea	hl			6				1		
Launaea intybacea	hl								2	
Lepidium africanum	hl			11	4			2		
Leucas martinicensis	hl					6	19			
Limeum argute-carinatum	hl	25	46	6		19	14	45	14	16
Limeum fenestratum	hl						2	2	13	
Limeum myosotis	hl					5	2	2	9	3
Limeum sulcatum	hl			6	4	5	10	7	21	3
Lindernia nana	hl							2		
Lindneria clavata	hl					5	19		38	28
Lotononis listii	hl							8		3
Lotononis platycarpa	hl		27	11		19	10	35	13	
Macrotyloma axillare	hl							1		
Marsdenia macrantha	hl				4					
Marsilea aegyptiaca	hl		9							
Merremia palmata	hl			6		3	5	2	2	3
Mollugo cerviana	hl				8	6	10	27	4	28
Momordica balsamina	hl			11		6	2	6	4	16
Monandrus squarrosus	hl	75						2		
Monsonia umbellata	hl							2		
Nelsia quadrangula	hl		18	11	33	22	7	37	9	6
Nerine laticoma	hl			6						
Nidorella resedifolia	hl		36	78	42	57	24	28	32	3
Ocimum americanum	hl		27	56	54	46	50	76	36	28
Oldenlandia herbacea	hl	75	18					1		
Ondetia linearis	hl		100	50	38	29	21	54	5	
Ophioglossum polyphylla	hl	50	9	6	4	2	5	3	2	3
Ornithoglossum viride	hl							3	2	
Osteospermum muricatum	hl		36		4	5				3
Oxalis purpurascens	hl				4	2	2	2		16
Oxygonum alatum	hl							14	18	3
Oxygonum sinuatum	hl		9	6	8	3	7	20	39	56
Pegolettia senegalensis	hl					3		2		3
Peliostomum leucorrhizum	hl					35	24	11	9	
Pergularia daemia	hl					3	7		4	6
Peristrophe hereroensis	hl						2	1		
Phyllanthus maderaspatensis	hl		9	28	25	57	48	34	36	13
Phyllanthus pentandrus	hl		9		8	3	7	21	21	16
Platycarpha carlinoides	hl				13	6	5	8		
Plectranthus neochilus	hl				4			1		
Pogonarthria squarrosa	hl							1		
Polycarpaea corymbosa	hl									3
Portulaca kermesina	hl	75	27	6	4		2	6	2	3
Portulaca oleracea	hl				4			5		
Pterodiscus aurantiacus	hl					2		1	2	
Raphionacme lanceolata	hl				4	6		11	18	13
Raphionacme velutina	hl			6				2		6
Requienia sphaerospermum	hl						10		18	
Rhynchosia minima	hl				4	3				
Rhynchosia totta	hl					2	2		5	6
Rothia hirsuta	hl							1		
Ruellia sp nova	hl			17	8			1		6
Ruelliopsis damarensis	hl			28	21	8		8	9	3
Schkuhria pinnata	hl				25			3		
Selago lepida	hl								2	
Senecio eenii	hl						2			
Senna italica	hl					2			2	
Sericorema sericea	hl					9	10	1	2	
Sesamum capense	hl				4	3	7	2	18	3
Sesamum triphyllum	hl						2			
Sesbania macowaniana	hl				4		2			
Sida cordifolia	hl						24	3	9	3
Solanum capense	hl					2	10			
Striga gesnerioides	hl						2			
Tagetes minuta	hl				13			3		
Talinum arnotii	hl		46	44	38	60	50	78	82	63
Talinum caffrum	hl				4					
Talinum crispatulum	hl									13
Talinum tenuissimum	hl							1	2	

Vegetation type		1	2	3	4	5	6	7	8	9
Tephrosia burchellii	hl						2			
Tephrosia dregeana	hl					2	2	3		3
Tephrosia lupinifolia	hl							1	5	
Tephrosia purpurea	hl			6		2		5	16	6
Trianthema triquetra	hl							1		3
Tribulus terrestris	hl					8	2	8	5	3
Trochomeria debilis	hl					2				
Tylosema esculentum	hl						2			9
Urginea sanguinea	hl					2	10			
Ursinia nana	hl							1		
Vahlia capensis	hl		18							
Vernonia fastigiata	hl	25			4	8			2	
Vernonia poskeana	hl				4	11	5	3	13	59
Waltheria indica	hl					2		6	9	6
Withania somnifera	hl							2		
Xanthium spinosum	hl				4					
Xanthium strumarium	hl				4					
Xenostegia tridentata	hl								9	3
Xerophyta humilis	hl	50	27	11	13	2		23	4	3
Zehneria marlothii	hl				13					
Zornia glochidiata	hl						5		7	3
Acacia erioloba	s1						2		7	
Acacia erubescens	s1					6		2	4	
Acacia fleckii	s1							5	13	34
Acacia hebeclada	s1		18		54	17	14	34	38	22
Acacia hereroensis	s1							1		
Acacia karroo	s1				8					
Acacia mellifera	s1	25	73	100	96	82	71	89	91	78
Acacia reficiens	s1	25	27	61	42	32	31	55	21	63
Acacia senegal	s1						2			
Acacia tortilis	s1		55	61	58	49	10	37	16	9
Albizia anthelmintica	s1				4	8	14	7		34
Boscia albitrunca	s1	25	27	22	4	15	12	45	18	38
Boscia foetida	s1					5	10	2		13
Catophractes alexandri	s1	75	9		17	20	19	35	36	6
Combretum apiculatum	s1							7		25
Commiphora africana	s1					2			2	6
Commiphora angolensis	s1					2			9	22
Commiphora glandulosa	s1	25			4		5	1	2	13
Commiphora tenuipetiolata	s1									6
Cordia sinensis	s1				4					3
Dichrostachys cinerea	s1			22	38	14	43	47	39	97
Ehretia rigida	s1			28	29	14	10	33	29	19
Gossypium triphyllum	s1		9							
Grewia bicolor	s1				17	5	2	2	2	69
Grewia flava	s1		18	11	50	34	7	40	70	66
Grewia flavescens v0 flavescens	s1				4	3	5	7	4	25
Grewia flavescens v0 olukokondae	s1			6	8		2	1	16	34
Grewia retinervis	s1								2	19
Helinus integrifolius	s1						2	1		16
Lonchocarpus nelsii	s1									9
Lycium bosciifolium	s1			6	13	17	7	11	57	
Lycium oxycarpum	s1		18	44	38	22	21	42	25	9
Maerua schinzii	s1					2	2			
Maytenus senegalensis	s1				4					
Mundulea sericea	s1							1	2	
Phaeoptilum spinosum	s1				13	5	2	9		
Rhigozum brevispinosum	s1							8	23	13
Rhus ciliata	s1							1		
Rhus marlothii	s1			6	8	2		1	2	3
Solanum kwebense	s1									3
Tarchonanthus camphoratus	s1		18		46	3		15	23	9
Terminalia prunioides	s1									13
Terminalia sericea	s1								7	
Triaspis hypericoides	s1									3
Ziziphus mucronata	s1		18	22	58	11	2	20	16	9
Abutilon austro-africanum	s2		18	22	17	2	7	20	13	3
Acacia erioloba	s2								4	
Acacia erubescens	s2							1		
Acacia fleckii	s2									9
Acacia hebeclada	s2				4	6	5	7	2	
Acacia hereroensis	s2					2				
Acacia karroo	s2				4					
Acacia mellifera	s2	25	46	50	29	45	60	32	14	19
Acacia reficiens	s2		9		8	14	21	7		9
Acacia tortilis	s2		27	6	8	23	5	8	4	

Vegetation type		1	2	3	4	5	6	7	8	9
Aizoon virgatum	s2					15	2	1		6
Albizia anthelmintica	s2			6	8	9	33	9	2	3
Asparagus africanus	s2		9		13	14		16	50	13
Asparagus cooperi	s2			6	29	12	2	3	11	25
Barleria lanceolata	s2		9	28	58	42	48	76	32	41
Barleria rigida	s2					2				
Barleria senensis	s2					2	2	2		3
Blepharis obmitrata	s2					11	10	11		3
Boscia albitrunca	s2		27	50	50	29	43	40	34	34
Boscia foetida	s2					6		1		3
Catophractes alexandri	s2					6	10	6	4	
Chascanum pinnatifidum	s2			6	17	45	67	58	46	22
Clerodendrum ternatum	s2								14	38
Clerodendrum uncinatum	s2								2	19
Combretum apiculatum	s2							3		6
Commiphora africana	s2								2	13
Commiphora angolensis	s2						2	1	2	19
Commiphora pyracanthoides	s2			11	4	14	10	18	23	44
Cordia sinensis	s2									3
Crotalaria argyraea	s2							1		
Croton gratissimus	s2									3
Cyphostemma congestum	s2				4	3		20	9	31
Dichrostachys cinerea	s2		9		4	11	19	8	18	19
Ehretia rigida	s2		36	6	29	20	41	26	13	22
Elephantorrhiza elephantina	s2								2	
Eriocephalus pubescens	s2					8		1		
Felicia anthemidodes	s2		9	44	29	15	2	27	36	
Felicia clavipilosa	s2				4	2	2			
Gomphocarpus fruticosus	s2				4	2			2	3
Gossypium triphyllum	s2					5		7	4	3
Grewia bicolor	s2				4	3		1		9
Grewia flava	s2		9	6	4	25	24	42	25	3
Grewia flavescens v0 flavescens	s2				8	12	43	11		16
Grewia flavescens v0 olukondae	s2							1	4	
Grewia schinzii	s2						7			
Helichrysum tomentosulum	s2									3
Helinus integrifolius	s2				4	2		2	2	9
Helinus spartioides	s2		9			6	5	2	20	
Heliotropium lineare	s2					3				
Heliotropium ovalifolium	s2					6				
Heliotropium steudneri	s2		9	6	25	42	19	39	54	22
Hermannia damarana	s2					3				
Hermannia rautanenii	s2			6	4	2	19	1	11	3
Hibiscus caesius	s2				4		2	3		
Hibiscus calyphyllus	s2		36	39	38	28	14	47	9	41
Hibiscus discophorus	s2							1		
Hibiscus elliottiae	s2			17	8	3	2	38	9	63
Hypoestes forskaolii	s2			11	13			2		3
Indigofera rautanenii	s2			11	13	26	38	63	48	13
Ipomoea verbascoidea	s2					2		1		38
Kleinia longiflora	s2		18	6		5		3		
Lantana angolensis	s2				21	25	19	18	11	19
Lantana camara	s2					2				
Lantana dinteri	s2					2				
Lessertia benguellensis	s2					2				
Leucas pechuelii	s2			17	13	23	17	3	2	6
Leucosphaera bainesii	s2	100	82	100	75	95	57	65	27	25
Lonchocarpus nelsii	s2							1		6
Lycium bosciifolium	s2					6		6	2	
Lycium eenii	s2		55	83	92	75	81	93	70	28
Lycium oxycarpum	s2		36	33	8	25	43	25	11	3
Maerua juncea	s2			6		2		7	23	
Maerua parvifolia	s2					3	2	2		3
Maytenus senegalensis	s2				4	5				3
Megalochlamys marlothii	s2		9	22	13	8	12	14	2	41
Melhania acuminata	s2									6
Melhania virescens	s2					6	2			3
Monechma divaricatum	s2					9		2	4	3
Monechma genistifolium	s2			11	17	66	74	25	7	38
Neorautanenia mitis	s2					2	7	3	46	31
Otoptera burchellii	s2		9	6	21	49	29	26	64	25
Ozoroa paniculosa	s2							2	2	
Pavonia burchellii	s2		36	39	38	22	7	33	25	25
Pechuel-Loeschea leubnitziae	s2			6	13	14		3	2	
Petalidium engleranum	s2									6
Petalidium ramulosum	s2					9			7	

Vegetation type		1	2	3	4	5	6	7	8	9
Phaeoptilum spinosum	s2	.	.	.	.	.	14	2	.	.
Pollichia campestris	s2	.	9	6	13	19	5	21	30	16
Ptycholobium biflorum	s2	.	.	28	8	22	67	87	54	53
Pupalia lappacea	s2	.	46	39	58	55	74	71	34	63
Rhigozum brevispinosum	s2	.	.	.	.	.	.	1	7	3
Rhus ciliata	s2	.	.	.	.	.	.	2	.	.
Rhus marlothii	s2	.	.	.	.	2	.	2	.	.
Seddera suffruticosa	s2	.	.	.	.	5	19	1	11	16
Sida ovata	s2	.	.	.	.	3	2	2	2	.
Solanum burchellii	s2	.	.	33	21	8	5	16	36	9
Solanum catombelense	s2	.	.	.	.	2	.	16	4	.
Solanum delagoense	s2	.	.	.	.	3	.	2	.	13
Solanum dinteri	s2	.	9	.	13	12	2	11	.	.
Solanum incanum	s2	.	.	22	17	11	10	21	18	9
Solanum kwebense	s2	.	.	.	13	3	2	1	.	53
Solanum nigrum	s2	.	.	.	.	3	2	2	.	.
Solanum supinum	s2	.	.	.	4	.	.	6	2	.
Tarchonanthus camphoratus	s2	.	9	.	8	8	.	9	7	9
Terminalia prunioides	s2	.	.	.	.	.	.	.	.	3
Terminalia sericea	s2	.	.	.	.	.	.	.	4	3
Tetragonia calycina	s2	.	9	44	21	14	31	28	.	.
Ziziphus mucronata	s2	.	.	.	13	8	5	10	2	.
Acacia erioloba	t3	.	.	.	.	5	5	.	57	6
Acacia hebeclada	t3	.	.	.	4	.	7	.	4	.
Acacia hereroensis	t3	.	.	.	.	.	.	1	.	.
Acacia karroo	t3	.	.	.	4	.	.	.	.	.
Acacia reficiens	t3	.	27	33	33	19	50	21	21	44
Acacia tortilis	t3	.	46	61	54	20	2	16	7	.
Albizia anthelmintica	t3	.	.	11	4	9	41	23	4	50
Boscia albitrunca	t3	.	91	72	67	39	57	72	80	28
Combretum apiculatum	t3	.	.	.	.	.	.	1	.	.
Combretum imberbe	t3	.	.	.	.	.	.	1	2	.
Commiphora tenuipetiolata	t3	.	.	.	.	.	.	.	.	6
Lonchocarpus nelsii	t3	.	.	.	4	.	.	1	2	66
Ozoroa insignis	t3	.	.	.	.	.	.	.	.	3
Terminalia prunioides	t3	.	.	.	.	.	.	.	.	6
Terminalia sericea	t3	.	.	.	.	.	.	.	13	6
Ziziphus mucronata	t3	.	.	.	4	.	2	.	.	.
Acacia erioloba	t2	.	.	.	.	2	.	.	.	.
Acacia tortilis	t2	.	9	.	.	9	.	.	.	.

Table 25: Synoptic Table of associations 10-14

Vegetation type		10	11	12	13	14
Number of samples		10	28	30	35	23
Andropogon chinensis	gr	.	11	.	.	4
Andropogon gayanus	gr	.	.	.	3	.
Anthephora pubescens	gr	10	36	10	14	22
Anthephora schinzii	gr	.	.	.	3	9
Aristida adscensionis	gr	60	7	30	14	13
Aristida congesta	gr	.	.	17	11	.
Aristida effusa	gr	40	46	63	60	65
Aristida meridionalis	gr	.	.	.	6	.
Aristida rhiniochloa	gr	30	43	20	9	22
Bothriochloa radicans	gr	.	11	27	6	4
Brachiaria deflexa	gr	10	.	30	37	.
Brachiaria malacodes	gr	.	14	10	6	13
Cenchrus ciliaris	gr	100	71	97	94	52
Chloris virgata	gr	.	.	10	9	4
Coelachyrum yemenicum	gr	.	4	.	.	4
Cymbopogon plurinodis	gr	.	.	.	9	.
Cynodon dactylon	gr	.	.	.	3	.
Dichanthium annulatum	gr	.	.	.	.	4
Digitaria seriata	gr	.	.	3	26	.
Digitaria velutina	gr	.	4	17	29	.
Enneapogon cenchroides	gr	100	54	60	74	74

Vegetation type		10	11	12	13	14
Enneapogon desvauxii	gr	100	39	17	.	52
Enneapogon scoparius	gr	.	64	47	26	30
Eragrostis annulata	gr	50	.	.	.	.
Eragrostis biflora	gr	.	4	3	9	.
Eragrostis echinochloidea	gr	90	86	87	77	70
Eragrostis jeffreysii	gr	60	32	17	31	9
Eragrostis nindensis	gr	10	46	17	37	48
Eragrostis pilgeriana	gr	.	.	.	6	.
Eragrostis porosa	gr	80	.	43	51	44
Eragrostis rigidior	gr	.	.	3	29	.
Eragrostis rotifer	gr	.	.	17	14	.
Eragrostis superba	gr	.	.	7	9	.
Eragrostis trichophora	gr	.	75	90	66	17
Eragrostis viscosa	gr	.	21	3	9	.
Fingerhuthia africana	gr	70	61	10	26	48
Heteropogon contortus	gr	.	46	13	34	61
Melinis repens s. grandiflora	gr	30	25	37	74	70
Melinis repens s. repens	gr	.	4	7	20	9
Microchloa caffra	gr	.	11	10	11	.
Monelytrum luederitzianum	gr	10	.	20	.	4
Oropetium capense	gr	20	11	3	6	4
Panicum coloratum	gr	.	4	.	9	.
Panicum maximum	gr	.	.	10	20	4
Panicum stapfianum	gr	.	.	3	.	.
Pogonarthria fleckii	gr	.	7	13	40	30
Pogonarthria squarrosa	gr	.	.	.	11	.
Schmidtia pappophoroides	gr	.	21	.	17	.
Setaria pumila	gr	.	4	17	26	4
Setaria verticillata	gr	30	.	17	29	9
Sporobolus festivus	gr	10	.	.	.	.
Sporobolus fimbriatus	gr	.	.	20	6	9
Sporobolus panicoides	gr	.	18	10	9	17
Stipagrostis hirtigluma	gr	30	93	40	37	78
Stipagrostis uniplumis	gr	100	39	43	43	22
Tragus berteronianus	gr	10	21	47	63	26
Tragus racemosus	gr	10	.	.	.	.
Triraphis schinzii	gr	.	.	.	6	.
Urochloa brachyura	gr	10	21	40	60	17
Urochloa oligotricha	gr	.	11	33	29	4
Urochloa trichopus	gr	.	.	.	6	.
Acalypha indica	hl	10	.	27	17	.
Acanthosicyos naudinianus	hl	.	.	3	.	.
Achyranthes aspera v. aspera	hl	40	.	17	46	17
Acrotome fleckii	hl	10	.	.	29	.
Acrotome inflata	hl	.	.	17	17	30
Amaranthus thunbergii	hl	.	.	.	3	.
Ancylanthos bainesii	hl	.	.	7	.	.
Aptosimum decumbens	hl	.	46	30	49	13
Aptosimum lineare	hl	.	7	17	3	.
Becium filamentosum	hl	.	61	63	71	30
Bidens biternata	hl	.	.	3	40	9
Blepharis integrifolia	hl	.	.	3	6	.
Blepharis leendertziae	hl	10	7	17	14	4
Blepharis mitrata	hl	.	18	7	6	4
Boerhavia coccinea	hl	.	.	.	3	.
Boerhavia diffusa	hl	.	.	3	14	4
Boophane disticha	hl	.	.	3	.	.
Bulbostylis hispidula	hl	.	.	7	9	4
Calostephane divaricata	hl	20	.	3	.	17
Chamaecrista absus	hl	.	.	.	3	.
Chamaecrista biensis	hl	.	.	3	6	.
Chamaesyce glanduligera	hl	10	.	.	.	.
Chamaesyce inaequilatera	hl	20	.	23	14	.

Vegetation type		10	11	12	13	14
Chenopodium olukondae	hl	.	4	3	23	4
Cleome angustifolia s. diandra	hl	.	.	.	.	9
Cleome hirta	hl	.	.	.	3	.
Cleome monophylla	hl	.	.	3	6	.
Cleome rubella	hl	.	.	3	3	.
Commelina benghalensis	hl	.	.	20	40	.
Commelina livingstonii	hl	.	25	23	9	.
Commicarpus pentandrus	hl	.	.	17	.	.
Corchorus tridens	hl	.	25	70	20	9
Crassula rhodesica	hl	.	.	3	.	.
Craterostigms plantagineum	hl	.	.	.	3	.
Crotalaria heidmannii	hl	10	.	7	.	.
Crotalaria podocarpa	hl	.	.	.	3	4
Crotalaria steudneri	hl	.	.	3	.	.
Cucumis anguira	hl	40	.	23	6	.
Cyperus fulgens	hl	.	11	7	9	.
Cyperus margaritaceus	hl	.	.	.	11	4
Cyphostemma hereroense	hl	.	.	10	.	.
Dactyliandra welwitschii	hl	.	.	.	3	.
Dicoma capensis	hl	10	.	.	.	.
Dicoma schinzii	hl	.	4	.	3	.
Dicoma tomentosa	hl	.	4	3	9	9
Erucastrum arabicum	hl	30	4	10	14	.
Euphorbia crotonoides	hl	.	.	.	3	.
Evolvulus alsinoides	hl	10	14	30	66	4
Felicia smaragdina	hl	.	.	7	.	.
Flaveria bidentis	hl	.	.	.	6	.
Geigeria acaulis	hl	.	.	17	3	.
Geigeria ornativa	hl	10	64	30	14	.
Geigeria schinzii	hl	.	7	.	3	.
Gisekia africana	hl	.	.	.	29	9
Gladiolus species	hl	.	.	.	3	.
Gloriosa superba	hl	.	.	3	.	.
Harpagophytum procumbens	hl	.	.	10	3	.
Hermannia modesta	hl	.	4	20	6	.
Hermannia quartiniana	hl	20	32	7	23	4
Hermannia tomentosa	hl	.	14	10	26	4
Hermbstaedtia fleckii	hl	.	.	.	6	9
Hermbstaedtia odorata	hl	10	4	7	3	.
Hibiscus fleckii	hl	.	.	3	6	.
Hibiscus palmatus	hl	.	14	37	6	.
Hirpicium gorterioides	hl	10	14	3	6	.
Indigastrum costatum	hl	.	25	23	9	.
Indigofera charlieriana	hl	10	7	10	14	35
Indigofera vicioides	hl	.	.	7	11	9
Ipomoea bolusiana	hl	.	7	13	.	.
Ipomoea crassipes	hl	.	.	17	.	.
Ipomoea oblongata	hl	.	.	3	.	.
Ipomoea obscura	hl	.	25	10	11	.
Ipomoea sinensis	hl	.	4	30	17	.
Jatropha erythropoda	hl	.	.	3	.	.
Justicia anselliana	hl	.	.	.	3	.
Kalanchoe lanceolata	hl	.	11	10	.	.
Kalanchoe rotundifolia	hl	.	.	.	.	4
Kohautia caespitosa	hl	30	11	13	26	13
Kohautia cynanchica	hl	.	.	.	.	4
Kyllinga alba	hl	.	.	3	17	4
Kyphocarpa angustifolia	hl	.	.	10	9	4
Lapeirousia bainesii	hl	.	.	3	.	.
Lapeirousia coerulea	hl	.	.	.	3	.
Limeum argute-carinatum	hl	.	.	3	3	.
Limeum myosotis	hl	.	.	.	3	.
Limeum sulcatum	hl	.	14	.	57	.

Vegetation type		10	11	12	13	14
Lindneria clavata	hl	30	4	3	.	.
Lotononis platycarpa	hl	10	.	3	.	.
Mariscus chersinus	hl	.	.	.	3	.
Marsdenia sylvestris	hl	.	.	3	9	4
Melanthera triternata	hl	.	.	.	6	.
Merremia palmata	hl	.	7	13	.	.
Mollugo cerviana	hl	.	.	.	14	.
Momordica balsamina	hl	.	4	13	.	.
Monechma debile	hl	.	.	.	20	.
Nelsia quadrangula	hl	.	.	10	.	.
Nidorella resedifolia	hl	10	54	43	23	13
Ocimum americanum	hl	70	32	30	51	44
Ondetia linearis	hl	10	.	.	.	.
Ophioglossum polyphyllum	hl	.	.	3	3	4
Osteospermum muricatum	hl	.	.	7	3	.
Oxalis purpurascens	hl	.	.	.	9	.
Oxygonum alatum	hl	.	.	3	23	.
Oxygonum sinuatum	hl	.	.	3	3	.
Pegolettia pinnatiloba	hl	20	.	.	.	.
Pegolettia senegalensis	hl	.	7	7	9	30
Peliostomum leucorrhizum	hl	80	39	57	9	17
Pentarrhinum abyssinicum	hl	.	.	.	3	.
Pentarrhinum insipidum	hl	.	4	.	23	.
Pergularia daemia	hl	10	.	7	9	.
Phyllanthus maderaspatensis	hl	40	61	47	31	35
Phyllanthus pentandrus	hl	.	39	10	57	35
Plectranthus neochilus	hl	.	4	3	.	4
Polycarpaea corymbosa	hl	.	.	.	3	.
Polygala leptophylla	hl	.	14	.	3	.
Portulaca kermesina	hl	.	11	10	3	.
Portulaca oleracea	hl	.	.	.	6	.
Priva auricoccea	hl	.	4	3	.	.
Pterodiscus aurantiacus	hl	.	.	.	3	.
Raphionacme lanceolata	hl	.	32	33	23	13
Raphionacme velutina	hl	.	4	.	.	.
Rhynchosia minima	hl	.	7	27	29	26
Rhynchosia totta	hl	.	32	17	43	30
Rhynchosia venulosa	hl	.	.	3	.	4
Ruellia sp nova	hl	.	64	47	23	9
Ruelliopsis damarensis	hl	.	25	27	3	.
Schkuhria pinnata	hl	.	.	3	9	.
Senna italica	hl	.	.	7	3	.
Sericorema sericea	hl	80	46	10	37	52
Sida cordifolia	hl	.	.	3	11	4
Stapelia kwebensis	hl	.	4	.	3	.
Stapelia schinzii	hl	.	.	3	.	.
Tagetes minuta	hl	.	.	.	6	.
Talinum arnotii	hl	40	11	27	23	.
Talinum tenuissimum	hl	.	7	7	6	.
Tephrosia dregeana	hl	20	36	7	23	39
Tephrosia purpurea	hl	.	.	7	23	.
Tribulus terrestris	hl	10	11	33	31	22
Trochomeria debilis	hl	.	.	3	.	.
Tylosema esculentum	hl	.	.	3	.	.
Vernonia poskeana	hl	.	.	7	11	4
Waltheria indica	hl	.	4	3	20	.
Xanthium spinosum	hl	.	.	.	.	4
Xerophyta humilis	hl	.	.	.	3	9
Acacia ataxacantha	s1	.	.	.	11	13
Acacia erioloba	s1	.	4	.	.	4
Acacia erubescens	s1	.	4	.	.	.
Acacia fleckii	s1	.	7	.	26	4
Acacia hebeclada	s1	.	4	33	3	9

Vegetation type		10	11	12	13	14
Acacia karroo	s1	.	.	.	3	17
Acacia mellifera	s1	80	100	93	91	83
Acacia nilotica	s1	.	.	3	.	.
Acacia reficiens	s1	70	86	90	63	57
Acacia tortilis	s1	30	11	20	9	.
Albizia anthelmintica	s1	10	4	.		.
Aloe littoralis	s1	.	4	7	9	.
Boscia albitrunca	s1	.	.	10	.	4
Boscia foetida	s1	70	7	.	.	4
Catophractes alexandri	s1	80	68	13	23	61
Combretum apiculatum	s1	.	.	.	17	74
Combretum hereroense	s1	.	7	7	34	22
Combretum imberbe	s1	.	.	.	11	4
Commiphora africana	s1	.	.	.	3	17
Commiphora angolensis	s1	.	4	7	.	13
Commiphora glandulosa	s1	10	7	7	17	30
Commiphora glaucescens	s1	.	.	.	3	.
Croton gratissimus	s1	.	18	.	31	78
Dichrostachys cinerea	s1	.	64	70	83	96
Dombeya rotundifolia	s1	.	.	.	11	39
Ehretia rigida	s1	30	7	23	14	4
Euclea undulata	s1	.	.	3	20	30
Grewia bicolor	s1	.	.	10	51	17
Grewia flava	s1	60	46	37	34	52
Grewia flavescens v. flavescens	s1	.	7	37	74	48
Grewia flavescens v. olukokondae	s1	.	.	7	.	.
Grewia retinervis	s1	.	.	.	6	9
Helinus integrifolius	s1	.	.	.	9	17
Lycium bosciifolium	s1	.	.	7	.	.
Lycium oxycarpum	s1	20	.	3	.	.
Maytenus senegalensis	s1	.	4	.	23	22
Mundulea sericea	s1	.	4	3	20	30
Olea europaea	s1	.	4	.	6	.
Ozoroa insignis	s1	.	.	.	.	13
Ozoroa paniculosa	s1	.	.	.	.	4
Peltophorum africanum	s1	.	11	.	9	.
Phaeoptilum spinosum	s1	.	.	.	.	4
Rhigozum brevispinosum	s1	.	.	.	6	.
Rhus ciliata	s1	.	4	.	.	4
Rhus marlothii	s1	.	32	23	37	70
Solanum kwebense	s1	.	.	.	.	4
Tarchonanthus camphoratus	s1	.	43	20	34	30
Terminalia prunioides	s1	.	7	13	23	74
Tinnea rhodesiana	s1	.	.	.	3	.
Triaspis hypericoides	s1	.	.	.	.	17
Ximenia americana	s1	.	.	10	6	9
Ximenia caffra	s1	.	4	3	9	.
Ziziphus mucronata	s1	20	18	40	26	9
Abutilon austro-africanum	s2	.	.	7	40	17
Acacia fleckii	s2	.	.	7	3	.
Acacia hebeclada	s2	.	4	.	.	.
Acacia mellifera	s2	40	14	23	3	30
Acacia reficiens	s2	20	4	7	3	.
Acacia tortilis	s2	10	7	7	.	.
Aerva leucura	s2	.	11	3	26	13
Aizoon virgatum	s2	60	32	57	43	39
Albizia anthelmintica	s2	.	4	20	.	4
Aloe littoralis	s2	.	4	10	.	.
Aloe zebrina	s2	.	14	.	.	.
Artemisia afra	s2	.	.	3	.	.
Asparagus africanus	s2	.	14	7	9	.
Asparagus cooperi	s2	.	18	40	11	9
Asparagus exuvialis	s2	.	.	.	.	4

Vegetation type		**10**	**11**	**12**	**13**	**14**
Barleria lanceolata	s2	70	7	7	.	.
Barleria senensis	s2	.	36	13	11	9
Blepharis obmitrata	s2	.	4	10	.	35
Boscia albitrunca	s2	10	4	20	.	4
Boscia foetida	s2	10	4	13	.	9
Catophractes alexandri	s2	20	4	7	.	9
Cephalocroton mollis	s2	.	14	.	.	.
Chascanum pinnatifidum	s2	40	25	40	17	26
Clerodendrum ternatum	s2	.	68	10	54	30
Clerodendrum uncinatum	s2	.	4	.	9	.
Combretum apiculatum	s2	.	.	.	14	.
Combretum hereroense	s2	.	50	13	11	13
Combretum imberbe	s2	.	.	.	.	4
Commiphora africana	s2	.	11	.	17	13
Commiphora angolensis	s2	.	29	10	20	9
Commiphora pyracanthoides	s2	20	36	10	17	17
Croton gratissimus	s2	.	32	20	17	9
Cyphostemma congestum	s2	.	.	.	11	.
Dichrostachys cinerea	s2	.	7	17	3	17
Dombeya rotundifolia	s2	.	.	.	3	17
Ehretia rigida	s2	30	43	47	11	17
Eriocephalus pubescens	s2	90	71	23	9	26
Euclea undulata	s2	.	7	3	14	9
Felicia anthemidodes	s2	20	36	37	17	.
Gnidia polycephala	s2	.	7	7	3	.
Gomphocarpus fruticosus	s2	.	.	13	11	4
Gossypium triphyllum	s2	.	4	.	3	4
Grewia bicolor	s2	.	7	17	9	.
Grewia flava	s2	30	43	47	34	17
Grewia flavescens v. flavescens	s2	.	14	23	23	9
Grewia flavescens v. olukokonda	s2	.	.	13	.	.
Helichrysum cerastioides	s2	.	11	.	.	.
Helichrysum tomentosulum	s2	.	14	10	3	30
Helinus integrifolius	s2	.	18	7	3	.
Helinus spartioides	s2	10	39	17	14	13
Heliotropium ovalifolium	s2	.	21	3	26	.
Heliotropium steudneri	s2	10	39	57	26	4
Hermannia damarana	s2	50	.	.	.	.
Hermannia rautanenii	s2	.	.	7	.	.
Hibiscus caesius	s2	10	54	7	43	52
Hibiscus calyphyllus	s2	.	29	53	37	17
Hibiscus discophorus	s2	.	.	13	.	.
Hibiscus elliottiae	s2	.	.	7	14	.
Hiernia angolensis	s2	.	29	7	3	17
Hypoestes forskaolii	s2	.	18	13	17	26
Indigofera rautanenii	s2	20	.	3	9	.
Ipomoea holubii	s2	.	4	.	.	.
Ipomoea verbascoidea	s2	.	7	13	9	.
Kleinia longiflora	s2	20	29	13	.	.
Lantana angolensis	s2	20	64	50	63	26
Lantana camara	s2	.	.	.	3	.
Lantana dinteri	s2	.	21	7	11	17
Leucas pechuelii	s2	60	64	67	26	9
Leucosphaera bainesii	s2	100	43	67	3	4
Lonchocarpus nelsii	s2	.	4	.	.	.
Lycium bosciifolium	s2	.	.	7	.	.
Lycium eenii	s2	70	.	13	.	.
Lycium oxycarpum	s2	10	.	13	.	.
Maytenus senegalensis	s2	.	7	13	17	9
Megalochlamys marlothii	s2	10	14	27	9	.
Melhania acuminata	s2	.	4	3	14	9
Melhania virescens	s2	90	100	77	83	83
Monechma divaricatum	s2	10	46	7	31	22

Vegetation type		10	11	12	13	14
Monechma genistifolium	s2	90	21	47	3	4
Monechma spartioides	s2	.	7	.	11	9
Mundulea sericea	s2	.	4	.	17	9
Neorautanenia mitis	s2	.	4	7	17	4
Olea europaea	s2	.	.	.	3	.
Opuntia species	s2	.	4	3	6	.
Otoptera burchellii	s2	80	71	63	54	52
Ozoroa paniculosa	s2	.	14	.	6	.
Pavonia burchellii	s2	.	11	37	43	30
Pechuel-Loeschea leubnitziae	s2	.	.	20	.	.
Petalidium engleranum	s2	.	14	3	11	.
Pollichia campestris	s2	10	.	20	11	.
Ptycholobium biflorum	s2	50	64	40	20	17
Pupalia lappacea	s2	30	7	40	43	22
Rhus ciliata	s2	.	36	10	23	4
Rhus marlothii	s2	10	.	3	.	4
Sarcostemma viminale	s2	.	.	.	3	.
Seddera suffruticosa	s2	80	82	53	51	74
Sida ovata	s2	60	25	17	26	13
Solanum burchellii	s2	40	4	13	9	4
Solanum incanum	s2	.	14	40	37	.
Solanum kwebense	s2	.	4	23	46	22
Solanum nigrum	s2	10	.	.	.	.
Solanum supinum	s2	.	21	10	6	.
Tarchonanthu camphoratus	s2	.	39	23	17	4
Terminalia prunioides	s2	.	11	20	6	26
Thesium xerophyticum	s2	.	.	.	.	4
Tinnea rhodesiana	s2	.	32	.	3	4
Triaspis hypericoides	s2	.	7	.	3	.
Ximenia americana	s2	.	.	.	6	.
Ziziphus mucronata	s2	.	18	33	9	13
Acacia erioloba	t3	10	18	17	9	.
Acacia karroo	t3	.	.	.	3	.
Acacia reficiens	t3	20	32	40	49	70
Acacia tortilis	t3	10	7	3	3	.
Albizia anthelmintica	t3	10	4	20	.	9
Boscia albitrunca	t3	10	7	17	20	13
Combretum apiculatum	t3	.	.	.	.	13
Combretum hereroense	t3	.	.	3	.	.
Combretum imberbe	t3	.	.	3	37	26
Commiphora glaucescens	t3	.	.	.	6	9
Commiphora tenuipetiolata	t3	.	.	.	.	4
Kigelia africana	t3	.	.	.	3	.
Kirkia acuminata	t3	.	.	.	6	.
Lannea discolor	t3	.	.	.	.	9
Lonchocarpus nelsii	t3	.	4	13	9	9
Maytenus senegalensis	t3	.	.	.	3	.
Ozoroa insignis	t3	.	.	.	.	4
Peltophorum africanum	t3	.	14	.	17	26
Terminalia prunioides	t3	.	4	.	6	9
Ziziphus mucronata	t3	.	.	.	3	.

APPENDIX 1.2.: TWINSPAN TABLES

Overview:

Table 26: TWINSPAN group 1:

association 1

association 2

association 3

association 4

association 5

Table 27: TWINSPAN group 2:

association 6

association 7

association 8

association 9

Table 28: TWINSPAN group 3:

association 10

association 11

association 12

Table 29: TWINSPAN group 4:

association 13

association 14

On each table the diagnostic species groups for the different associations are indicated, as well as characteristic species for a combination of associations and common species of the entire group. Rare species with only 1 or 2 occurrences and a cover of < 0.1% within that TWINSPAN group were not listed here, but are listed on the synoptic tables (Appendix 1.1.). Detailed data sets with environmental data are available from the Ecology Section, National Botanical Research Institute.

Species heights are indicated behind species names as follows:

hl = herb

s1 = high shrubs, 1-5 m

s2 = low shrubs, 30 cm - 1 m

sl = seedlings

t3 = low trees, 2-5 m

t2 = small trees, 5-10 m

Table 26

TWINSPAN TABLE

Association 1

Unique relevé nr.	85046	85044	85042	85040
association	1	1	1	1
diagnostic spp association 1				
Willkommia sarmentosa -hl	6	7	6	5
Oldenlandia herbacea -hl	1	.	1	1
Catophractes alexandri -s1	1	.	1	1
Ophioglossum polyphyllum -hl	1	.	1	.
Corchorus tridens -hl	1	.	1	.
Portulaca kermesina -hl	.	1	1	1
diagnostic spp association 2				
Osteospermum muricatum -hl	.	.	.	.
Crotalaria steudneri -hl	.	.	.	.
Indigofera charlieriana -hl	.	.	.	.
Eleusine indica -hl	.	.	.	.
Felicia smaragdina -hl	.	1	.	.
Ipomoea coptica -hl	.	.	1	.
Blepharis mitrata -hl	.	.	.	.
Lotononis platycarpa -hl	.	.	.	.
Kleinia longiflora -s2	.	.	.	.
characteristic spp ass. 1 and 2				
Eragrostis cylindriflora -hl	6	6	5	1
Brachiaria deflexa -hl	1	.	1	1
Anthephora schinzii -hl	1	1	1	1
Justicia anselliana -hl	1	1	.	1
Commelina subulata -hl	1	.	.	1
Dactyloctenium aegyptium -hl	1	.	1	.
Xerophyta humilis -hl	.	1	.	1
Acrotome fleckii -hl	.	.	.	.
diagnostic spp association 3				
Crotalaria podocarpa -hl	.	.	.	.
Megalochlamys marlothii -s2	.	.	.	.
Ipomoea bolusiana -hl	.	.	.	.
Hibiscus elliottiae -s2	.	.	.	.
Albizia anthelmintica -t3	.	.	.	.
Tetragonia calycina -s2	.	.	.	.
Ruellia sp nova -hl	.	.	.	.
Momordica balsamina -hl	.	.	.	.
Brachiaria eruciformis -hl	.	.	.	.
characteristic spp ass. 3 and 4				
Cyperus fulgens -hl	.	.	.	.
Panicum coloratum -hl	.	.	.	.
Ziziphus mucronata -s1	.	.	.	.
diagnostic spp association 4				
Acacia hebeclada -s1	.	.	.	.
Acrotome inflata -hl	.	.	.	.
Chenopodium olukondae -hl	.	.	.	.
Grewia flava -s1	.	.	.	.
Setaria pumila -hl	.	.	.	.
Tarchonanthus camphoratus -s1	.	.	.	.
Aptosimum angustifolium -hl	.	.	.	.
Panicum maximum -hl	.	.	.	.
Dichrostachys cinerea -s1	.	.	.	.

Association 2

Unique relevé nr.	85094	85093	85024	85082	85081	85080	85079	85029	85031	85030	85028
association	2	2	2	2	2	2	2	2	2	2	2
diagnostic spp association 1											
Willkommia sarmentosa -hl	.	.	.	.	.	.	.	.	.	.	.
Oldenlandia herbacea -hl	.	.	.	.	.	.	.	.	1	.	1
Catophractes alexandri -s1	.	.	.	.	.	.	.	.	.	1	.
Ophioglossum polyphyllum -hl	.	.	.	.	.	.	.	.	.	1	.
Corchorus tridens -hl	.	.	.	.	.	.	.	1	.	.	.
Portulaca kermesina -hl	.	.	.	.	1	.	.	1	1	.	.
diagnostic spp association 2											
Osteospermum muricatum -hl	1	.	1	.	.	.	.	1	1	.	.
Crotalaria steudneri -hl	.	.	1	.	.	.	.	.	1	1	1
Indigofera charlieriana -hl	.	.	.	.	.	.	.	1	1	1	.
Eleusine indica -hl	.	.	1	.	.	1	.	1	.	.	.
Felicia smaragdina -hl	.	.	.	.	.	.	.	.	1	1	1
Ipomoea coptica -hl	.	.	.	.	.	.	.	.	1	1	1
Blepharis mitrata -hl	.	.	.	.	.	1	1	1	.	.	.
Lotononis platycarpa -hl	.	.	.	1	1	1	.	.	.	.	.
Kleinia longiflora -s2	.	.	.	.	1	1	.	.	.	.	.
characteristic spp ass. 1 and 2											
Eragrostis cylindriflora -hl	1	1	.	6	6	5	6	7	6	7	8
Brachiaria deflexa -hl	1	5	1	.	.	.	.	1	.	1	1
Anthephora schinzii -hl	.	.	1	.	.	.	.	.	1	1	1
Justicia anselliana -hl	.	1	1	.	.	.	.	1	1	1	1
Commelina subulata -hl	.	.	.	.	.	.	.	1	1	1	1
Dactyloctenium aegyptium -hl	.	.	.	.	.	.	.	1	1	1	1
Xerophyta humilis -hl	.	.	.	.	.	.	.	.	1	1	1
Acrotome fleckii -hl	.	.	.	.	.	.	.	.	1	1	1
diagnostic spp association 3											
Crotalaria podocarpa -hl	.	.	.	.	.	.	.	1	.	.	1
Megalochlamys marlothii -s2	.	.	.	.	1	.	.	.	.	.	.
Ipomoea bolusiana -hl	.	.	.	.	.	.	.	.	.	.	.
Hibiscus elliottiae -s2	.	.	.	.	.	.	.	.	.	.	.
Albizia anthelmintica -t3	.	.	.	.	.	.	.	.	.	.	.
Tetragonia calycina -s2	1	.	.	.	.	.	.	.	.	.	.
Ruellia sp nova -hl	.	.	.	.	.	.	.	.	.	.	.
Momordica balsamina -hl	.	.	.	.	.	.	.	.	.	.	.
Brachiaria eruciformis -hl	.	.	.	.	.	.	.	.	.	.	.
characteristic spp ass. 3 and 4											
Cyperus fulgens -hl	.	.	.	.	.	.	.	.	.	.	.
Panicum coloratum -hl	.	.	.	.	.	.	.	.	.	.	.
Ziziphus mucronata -s1	.	1	1	.	.	.	.	.	.	.	.
diagnostic spp association 4											
Acacia hebeclada -s1	1	1	.	.	.	.	.	.	.	.	.
Acrotome inflata -hl	1	1	1	.	.	.	.	.	1	.	.
Chenopodium olukondae -hl	1	1	1	.	.	.	.	.	.	.	.
Grewia flava -s1	.	.	.	.	.	.	.	.	1	1	.
Setaria pumila -hl	1	1	1	.	.	.	.	1	.	.	.
Tarchonanthus camphoratus -s1	1	1	.	.	.	.	.	.	.	.	.
Aptosimum angustifolium -hl	.	.	.	.	.	.	.	.	.	.	.
Panicum maximum -hl	.	1	.	.	.	.	.	.	.	.	.
Dichrostachys cinerea -s1	.	.	.	.	.	.	.	.	.	.	.

Association 3

Unique relevé nr.	85373	85370	85312	85311	85310	85309	85302	85290	85316	85314	85313	85289	85288	85287	85284	85283	85269	85251
association	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
diagnostic spp association 1																		
Willkommia sarmentosa -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oldenlandia herbacea -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Catophractes alexandri -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ophioglossum polyphyllum -hl	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Corchorus tridens -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
Portulaca kermesina -hl	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
diagnostic spp association 2																		
Osteospermum muricatum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crotalaria steudneri -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera charlieriana -hl	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Eleusine indica -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Felicia smaragdina -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ipomoea coptica -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Blepharis mitrata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lotononis platycarpa -hl	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.
Kleinia longiflora -s2	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
characteristic spp ass. 1 and 2																		
Eragrostis cylindriflora -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachiaria deflexa -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anthephora schinzii -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Justicia anselliana -hl	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Commelina subulata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dactyloctenium aegyptium -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Xerophyta humilis -hl	3	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Acrotome fleckii -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
diagnostic spp association 3																		
Crotalaria podocarpa -hl	.	.	.	.	.	.	.	.	.	1	.	1	.	1	1	1	.	.
Megalochlamys marlothii -s2	2	1	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.
Ipomoea bolusiana -hl	1	1	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.
Hibiscus elliottiae -s2	1	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Albizia anthelmintica -t3	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tetragonia calycina -s2	.	1	1	1	2	1	1	.	1	.	.	.	.	.	.	.	1	.
Ruellia sp nova -hl	.	.	.	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.
Momordica balsamina -hl	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.
Brachiaria eruciformis -hl	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.
characteristic spp ass. 3 and 4																		
Cyperus fulgens -hl	1	1	.	.	1	1	.	1	5	6	2	.	5	5	5	5	.	1
Panicum coloratum -hl	.	.	.	.	1	1	.	5	1	5	1	.	1	1	1	1	5	.
Ziziphus mucronata -s1	1	1	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.
diagnostic spp association 4																		
Acacia hebeclada -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acrotome inflata -hl	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.
Chenopodium olukondae -hl	.	.	.	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.
Grewia flava -s1	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	1	.
Setaria pumila -hl	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Tarchonanthus camphoratus -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aptosimum angustifolium -hl	.	1	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Panicum maximum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dichrostachys cinerea -s1	1	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.

Association 4

Unique relevé nr.	85426	85423	85410	85375	85371	85369	85308	85301	85295	85292	85291	85412	85405	85404	85403	85384	85379	85286	85285	85092	85091	85090	85089	85025
association	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
diagnostic spp association 1																								
Willkommia sarmentosa -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oldenlandia herbacea -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Catophractes alexandri -s1	.	.	1	.	.	.	1	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Ophioglossum polyphyllum -hl	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Corchorus tridens -hl	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Portulaca kermesina -hl	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
diagnostic spp association 2																								
Osteospermum muricatum -hl	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crotalaria steudneri -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera charlieriana -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.
Eleusine indica -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Felicia smaragdina -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ipomoea coptica -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Blepharis mitrata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Lotononis platycarpa -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kleinia longiflora -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
characteristic spp ass. 1 and 2																								
Eragrostis cylindriflora -hl	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	1	1	.	.
Brachiaria deflexa -hl	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	1	1	1	1
Anthephora schinzii -hl	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Justicia anselliana -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	1
Commelina subulata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dactyloctenium aegyptium -hl	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Xerophyta humilis -hl	.	.	1	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acrotome fleckii -hl	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
diagnostic spp association 3																								
Crotalaria podocarpa -hl	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Megalochlamys marlothii -s2	.	1	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Ipomoea bolusiana -hl	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Hibiscus elliottiae -s2	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Albizia anthelmintica -t3	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tetragonia calycina -s2	.	.	1	.	.	1	.	2	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.
Ruellia sp nova -hl	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Momordica balsamina -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachiaria eruciformis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
characteristic spp ass. 3 and 4																								
Cyperus fulgens -hl	.	.	1	1	.	1	1	1	1	1	1	.	.	.	.	.	.	.	1	.	.	.	.	.
Panicum coloratum -hl	.	.	1	.	1	1	.	.	5	3	1	1	.	1	1	.	.	2	1	.	.	.	.	.
Ziziphus mucronata -s1	.	.	.	1	1	1	1	5	2	1	.	1	1	1	.	6	5	6	6	.	.	.	.	.
diagnostic spp association 4																								
Acacia hebeclada -s1	.	2	5	.	.	5	5	5	2	.	.	1	1	5	5	.	2	.	.	1	.	1	.	.
Acrotome inflata -hl	1	1	1	1	.	1	.	.	.	.	.	1	.	.	.	1	.	.	.	1	1	1	1	1
Chenopodium olukondae -hl	.	.	.	1	1	1	.	.	.	.	1	1	.	1	.	1	1	.	.	1	1	1	.	1
Grewia flava -s1	1	2	.	1	1	1	.	1	1	.	1	5	1	3	.	.	1	.	.	.	.	.	.	.
Setaria pumila -hl	1	.	.	.	.	1	.	.	.	.	.	5	1	6	5	.	1	.	1	1	1	1	1	.
Tarchonanthus camphoratus -s1	.	.	1	1	1	1	.	.	1	1	1	.	.	.	.	.	.	.	.	1	1	1	2	.
Aptosimum angustifolium -hl	.	.	1	1	1	1	1	.	1	.	.	1	1	.	.	.	.	1	.	1	.	.	.	.
Panicum maximum -hl	.	.	.	5	.	1	.	1	.	.	.	.	.	.	.	.	.	1	5	1	1	1	1	.
Dichrostachys cinerea -s1	6	6	.	2	1	2	5	1	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.

Evolvulus alsinoides -hl		. . 1	1 . . . . . 1	1 . . 1 . 1 1 . . . 1 1 1 . . . . . . 1 . . . .
Asparagus cooperi -s2			. . . . 1	1 . . . 1 . 1 1 . . . . . 1 . 1 1 . . . .
Digitaria velutina -hl		. . 1	. 1	1 1 . . . 1 . . . . . 1 . . . 1 1
Schkuhria pinnata -hl				. . . . 1 1 2 1 1 . . 1 . . . .
Becium filamentosum -hl				1 . . . . 1 . 1 . . . 1 . . . 1 . . . .
Hermannia quartiniana -hl				. . . . . . 1 . 1 1 1 . . . .
Pogonarthria fleckii -hl		. . . . 1 . .		. 1 1 . . 1 . . . . . . 1 . . . .
Grewia bicolor -s1				2 2 . 1 . 1 . . . .
Ziziphus mucronata -s2				. . . . 1 1 . . . 1 . . . .
Hypoestes forskaolii -s2			1 . . . . 1	. . . . . . 1 . . . . 3 6 . . . . .
Hibiscus palmatus -hl				. . . 1 . 1 . . . . . 1 . . . .
Phaeoptilum spinosum -s1				. . 1 . . . . 2 1 . . . .
Solanum kwebense -s2				1 1 . 1 . . . .
Eragrostis rigidior -hl		. . . . 1 . 1		. . . . 6 . . 1 . . . .
Vernonia fastigiata -hl	. . . 1			. . . . 2 . . . .
diagnostic spp association 5				
Monechma genistifolium -s2			. . . . 5 1	1 2 . . 5 . . . . 1 . . . .
Chascanum pinnatifidum -s2			1	. . 1 . 1 . . . . . 1 . 1 . . . .
Eragrostis echinochloidea -hl			 1	. . . 1 . . . . 1 . . 1 1 1 . . . .
Heliotropium steudneri -s2		. . . . 1 .	. . . . 1	. . . 1 . . . . . 1 1 . . . 1 1 1
Peliostomum leucorrhizum -hl				. . . .
Enneapogon desvauxii -hl				. . . . 1 . . . .
Aptosimum lineare -hl		1	. . . 1 . . . . 1 . . . 1 1	. . . 1 . . . . . . 1 . . . .
Hermbstaedtia odorata -hl				. . . . 1 . . . . 1 1 . . . .
Geigeria acaulis -hl				. 1 . . . .
Acalypha indica -hl				. . . . 1 . . 1 . . . . 1 . . 1 .
Indigofera rautanenii -s2			. . . . 1 . 1	1 . . . . . 1 . . . . . 1 . . . .
Tragus berteronianus -hl			. . 1 . . . . 1	. 1 . 1 . . 1 . . . . . 1 1
Grewia flava -s2		. . 1	1	. . . . 1 . . . .
Andropogon chinensis -hl		. 1 . . 1		. . . . 1 . . .
Aizoon virgatum -s2				. . . .
Commiphora pyracanthoides -s2			. . . . . . 1 . . . 1	. 1 . . . .
Grewia flavescens v. flavescens -s2				. . . . 1 . . . . 1 . . . .
Brachiaria schoenfelderi -hl			. . . . 1 .	. . . . 1 . . . .
Kohautia caespitosa -hl				. . 1 . . . . 1 . . .
Dicoma tomentosa -hl			. . . . 1	. . . .
Eragrostis dinteri -hl				. . . .
Blepharis obmitrata -s2				. . . .
Vernonia poskeana -hl				. . . . 1 . . . .
Chenopodium amboanum -hl				. . . .
Sericorema sericea -hl				. . . .
Albizia anthelmintica -s2			. . . 1	1 . 1 . . . .
Monechma divaricatum -s2				. . . .
Petalidium ramulosum -s2				. . . .
Acacia tortilis -t2		. . 6		. . . .
Indigofera holubii -hl				. . . .
Eragrostis nindensis -hl				. . . .
Ipomoea coscinosperma -hl			. . . . 1	. . . .
Albizia anthelmintica -s1				. 5 . . . .
Eriocephalus pubescens -s2				. . . .
Lycium bosciifolium -s2				. . . .
Acacia hebeclada -s2				. . . . 1 .
Catophractes alexandri -s2				. . . .
Boscia foetida -s2				. . . .

common spp TWINSPAN group 1				
Enneapogon cenchroides -hl	. . 1 .	. . . . 1 . 1 . . 1 .	2 . . . . 1 . 1 1	2 6 1 2 1 1 . . . . 5 . 2 . 1 1 1
Aristida congesta -hl		. 1 . . . . 1 1	1 1 . . . 1 1 . 5 2 5 2	6 2 5 6 5 . . . 5 5 6 1 6 1 1 . . . . 1 . 1 . 1
Barleria lanceolata -s2		. . . . 1 .	1 1 . . . 1 . . . 1 1	1 1 . 1 1 1 1 1 1 . 1 1 1 . . 1 . . . . . 1 . 1
Setaria verticillata -hl		1 1 1 . 1 1 1	. . . . 1 . 1	1 . 1 1 . 1 . . . 1 . 1 2 . 5 6 1 . 1 1 5 1 5 .
Bidens biternata -hl		. 1 1 . . . . . 1 . .	. . . . 1	1 . . . . 1 1 2 2 1 1 1 . 1 1 1 1 .
Lantana angolensis -s2				. . . 1 . . 1 . . . 1 1 . . . 1 . . . .
Acacia tortilis -t3		1 2 . 1 . . 1 . . . 1	2 5 2 5 . 5 . 1 . . . 5 3 1 5 2 . .	5 . 5 . . . 3 6 . . . . 5 5 5 6 6 6 5 1 . 1 . .
Asparagus africanus -s2		. . . . 1 . .		. . . . 1 1 1 . . . .
Solanum dinteri -s2		. . 1		1 . . . . 1 1
Urochloa trichopus -hl				. . . . 1 . . . . 1 1 . .
Amaranthus thunbergii -hl				. . . . 1 . . . 1 1 1 .
Acacia mellifera -s1	. 1 . .	1 3 2 . . 1 . 1 1 3 2	6 6 2 1 5 5 1 5 5 5 2 2 2 2 5 3 5 6	5 5 2 7 7 . 5 1 6 6 6 7 5 6 7 8 5 2 5 2 2 5 3 7
Leucosphaera bainesii -s2	1 1 1 1	1 1 1 1 1 . . 1 1 2 1	5 5 2 2 6 6 1 6 6 6 6 7 7 7 7 7 5 5	1 5 2 5 5 5 . . 1 5 5 1 1 . . . . 5 5 1 1 1 5 5
Chloris virgata -hl	1 1 1 1	6 6 5 1 1 5 1 5 1 1 1	2 6 5 1 6 5 . 6 1 5 5 5 6 6 1 2 5 5	2 6 1 1 . 6 1 1 5 2 . . 5 6 6 1 2 5 2 1 5 5 7 6
Eragrostis rotifer -hl	. . 1 1	5 6 1 . . . . 5 1 . 1	. . . . 1 . 1 1 1 2 1 . 1 1 1 . 5 2	5 5 7 1 . 1 1 1 1 2 1 1 5 6 6 1 1 . 5 6 1 5 5 1
Eragrostis trichophora -hl	1 . 1 .	. . . . 1 1 . . . 1 1	2 1 . . 1 . 1 . 2 1 1 . . . . . 2 7	6 2 6 6 6 2 2 5 7 5 5 6 2 1 1 . . . 1 1 . 1 1 1
Boscia albitrunca -t3		1 1 6 1 1 1 . 1 1 1 1	5 2 1 . . 5 . 3 4 3 4 1 5 . . 1 2 4	1 1 2 1 . 2 1 2 3 1 2 . 1 . . . . 1 . . 1 1 1 1
Aristida adscensionis -hl		1 1 . . 1 1 . . . 1 .	1 5 . . 1 1 . 1 1 2 5 . 1 1 2 1 5 6	2 5 2 1 . 1 . . 1 2 1 5 5 1 6 1 . . . 5 6 5 1 .
Lycium eenii -s2		1 1 1 . 1 . . . . 1 1	1 . 1 1 2 1 1 2 2 1 1 1 . 1 . 1 1 2	1 1 2 1 1 . 1 1 1 2 5 1 2 3 3 1 1 1 . 1 1 1 1 1
Acacia reficiens -s1	. 1 . .	. . . . 1 1 . . 5 . .	5 6 5 2 5 5 5 5 5 1 1	2 5 . 1 6 2 2 5 2 . 1 . 1 . . . .
Acacia tortilis -s1		1 . . . 1 1 . 1 1 1 .	5 5 3 3 5 5 1 5 . . . 5 . 3 . . . 2	2 . 1 . . . 5 5 2 1 1 . 2 . 5 2 1 . . . 1 2 1 .
Ocimum americanum -hl		. . 1 . . . . . 1 . 1	1 . 1 1 1 1 1 5 1 1 . . . . . . 1 .	1 1 1 . . 1 5 1 1 . 1 . 1 . . 1 . 6 . 1 . 1 . .
Eragrostis porosa -hl		. . 1 1 1 1	5 2 2 5 1 5 5 . . 1 5 . 1 1	. 5 1 1 1 5 1 . . 1 . . 2 1 5 1 1 1
Achyranthes aspera v. aspera -hl	. 1 . .	1 1 1 . . . . . 1 1 1	1 . . . . . . 1	. . 1 . . 1 . . . . . 1 3 5 6 5 1 2 2 1 1 1 1 1
Nidorella resedifolia -hl		1 . 1 . . . . . 1 . 1	1 1 1 5 5 5 1 . 1 5 5 . 1 . 1 . 1 1	. . . . . 1 1 1 . 1 1 . . . . 1 . 1 1 1 1
Pupalia lappacea -s2		1 1 1 . . . . . . 1 1	1 1 . 1 . 1 . 1 1 1	. 1 5 3 1 1 1 1 1 . . 1 . 1 . 5 . . 1 1 . 1 . .
Eragrostis jeffreysii -hl	6 . 1 1	. . . . 1 1 .	1	. 1 5 2 . 1 . . . 2 1 5 6 . 2 1 . 5 5 . . . 1 .
Boscia albitrunca -s2		. . . . . 1 1 . . 1 .	1 1 . 1 . 1 1 . 1 1 . . . 1 . 1 . .	1 1 . 1 1 1 1 . . . 1 1 1 . . 1 . . . 1 . . . 1
Commelina benghalensis -hl	. 1 . 1	1 1 . . . . 1 1	1 . . . . . . 1	. . 1 1 1 1 1 . . . . . 1 . 1 . 1 . . 1 . . 1 1
Aristida rhiniochloa -hl		1 1	. . . . . 1 . 1 1 1 2 . . . . . 1 5	. 1 . . 1 . . . . 1 1 . . 1 . . . . . 1 1 1 1 1
Urochloa brachyura -hl	. . 1 .	1 1 1 . . . . . . 1 1	1 . . 1 . 1 . . . 1 1 1 . 1 . 1 . .	. 1 1 1 . . . . 1 1 . . . 1 . . . 1 . 1 1 . . 1
Melinis repens s. grandflora -hl			1 . . . . 1 . . . . . 1 1	. 1 1 . . . . . 1 2 1 1 5 . 1 . . . . 1 . 1 . .
Talinum arnotii -hl		. . 1 1 1 . . . 1 1 .	1 . 1 1 1 . 1 . 1 1 5	. 1 1 1 1 . 1 . . . 1 . 1 . . . . 1 . . 1
Lycium oxycarpum -s1		1 . 1	. . . 1 2 1 . . 1 1 1 1 3	1 . . . . . 1 1 . . . . . . 1 1 . . . 1 1 1 1 .
Ondetia linearis -hl		1 1 1 1 1 1 1 1 1 1 1	. . 1 1 1 1 1 . . 1 2 . . . 1 . . 1	. . . . . . 1 . . . . 1 1 . . . . . 1 1 1 1 1 1
Hibiscus calyphyllus -s2		1 1 1 . . . . . . 1 .	1 1 . . 1 . . 1 1 1 1	1 1 . . . 1 . 1 1 . . 1 . . . 1 . . . 1 . . . 1
Pavonia burchellii -s2		. 1 1 . . . . . 1 . 1	. 1 . 1 . 1 1 1 . 1 1	. 1 . . . . 2 1 1 . . . . 1 . 1 . . . 1 1 . . 1
Cleome monophylla -hl	. . 1 1	. 1 1 . . . . . 1 . 1	. 1 1	. 1 . . . 1 . . . . . . 1 . 1 . . . . 1 1 . 1 1
Acacia reficiens -t3		. . . . 5 1 1 .	. 5 3 3 2 5 . 6	2 . . . . 6 . 2 . 2 2 . . . . . . 6 5 1
Nelsia quadrangula -hl		. . 1 . . . . . . 1 .	. . . . 1 1	. . 1 1 . 1 . . . . . . 1 1 1 1 1
Cenchrus ciliaris -hl		. . . . 1 .	1 . . . . 5 1	. . . 4 . . . . 1 1 2 1 . . 1 1 2 . . . .
Geigeria ornativa -hl	1 . 1 1	. . . . 1 1 .	. . . . 1	. . . . . 1 . . 1 . 1 1 . . . . 1 1 1 . .
Ehretia rigida -s2		. 1 1 . . . 1 . . 1 .	. . . . 1	. . . . 1 . . . 1 . . 1 1 1 . . . . 1 1
Acacia mellifera -s2	. 1 . .	. . 1 . . . . 1 1 1 1	. 1 1 1 . 1 1 . 1 1 1 . . . . . 1 .	1 . 1 1 . . 1 . . . 1 1 . . . . 1 . . . .
Cucumis anguria -hl		1 1 . 1 . . 1	. . . . 1	. . . . 1 . . 1 1 . 1 1 . 1 1 .
Felicia anthemidodes -s2		. . . . 1 .	1 1 . 1 1 1 1 . . 1 1	. . . 1 1 1 1 1 . . . . 1 . . . 1 . . . .
Ehretia rigida -s1			1 1 . . . 1 . 1 . . 1	. . . . . 1 1 1 . 1 1 . . . 1 1 . . . .
Bothriochloa radicans -hl			. . . . 1 . . 5 1 5 2 . . . 2 . . 1	. . . 1 . . . . 5 1 5 1 . . . . . 5 . . . . . .
Blepharis leendertziae -hl			. 1 1 1 1 1 . . . . 1 1 . 1	. . 1 1 . 1 . 1 . . . . 1 . . 1 . . . .
Kyphocarpa angustifolia -hl		1 1 . . 1		. 1 . . . . 1 1 . . . . 1 1 . 1 .
Phyllanthus maderaspatensis -hl		. . . . 1 .	. . . . . 1 . 1 1 1 1	. . 1 . . . . . 1 1 1 . . . . . 1 1
Erucastrum arabicum -hl		. . 1 . 1 1	. 1 . . 1	. 1 . 1 . . . . 1 . . 1 1
Solanum burchellii -s2			1 . 1 . 1 1 . . . 1 1	1 . . 1 1 1 . . 1 . . . .
Otoptera burchellii -s2		 1	. . . . 1 .	1 . . . . 1 1 1 . . . . . 1 . . . .
Monelytrum luederitzianum -hl		1 . . . . 1 1 1	1 1 . . . . . . 5 . 1 . . . . . 5 1	. . . 1 2 . . . 5 6 . . . . . 1 . . . .
Brachiaria malacodes -hl		. . . . 1 . . .	. . . . 1	1 . . 1 . . . . 1 . . . 1 . . . . . 1 . .
Ruelliopsis damarensis -hl			. 1 . . 1 1 . . . 1 1	. . . . 1 . . . 1 1 . 1 . . . . 1 . .

Aristida effusa -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.
Panicum stapfianum -hl	1	.	.	1	5	5	.	.	1	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	1	1	1	.
Abutilon austro-africanum -s2	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	1	1	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Solanum incanum -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	1
Hermannia modesta -hl	.	.	.	.	.	.	1	.	.	.	1	.	1	1	.	.	.	.	1	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
Stipagrostis uniplumis -hl	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	1	.	.	1	.	1	.	.	.	.	.	.	.	.	5	.	1	.	.	.	.	.	.	.	.	.
Pollichia campestris -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.
Lycium bosciifolium -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	1	5	.	.	.	.	.	.	.
Pechuel-Loeschea leubnitziae -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Leucas pechuelii -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Aristida hordeacea -hl	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5	.	1	5	1	1	1	6	7	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	1
Ipomoea obscura -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	1	1	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Platycarpha carlinoides -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.
Ipomoea hochstetteri -hl	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.
Ipomoea sinensis -hl	.	.	.	.	1	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.
Phyllanthus pentandrus -hl	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
Acacia reficiens -s2	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis annulata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Tarchonanthus camphoratus -s2	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Mollugo cerviana -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Urochloa oligotricha -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhus marlothii -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Hirpicium gorterioides -hl	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Ptycholobium biflorum -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	1	.	.	.	.	.	.	.	1	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lycium oxycarpum -s2	.	.	.	.	.	.	.	1	1	.	.	.	.	1	1	1	1	.	.	.	.	1	1	.	.	.	.	.	1	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Indigofera vicioides -hl	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Schmidtia pappophoroides -hl	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Chamaesyce inaequilatera -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
Oxygonum sinuatum -hl	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia tortilis -s2	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
Eragrostis biflora -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Melinis repens s. repens -hl	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dichrostachys cinerea -s2	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Boscia albitrunca -s1	.	1	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Raphionacme lanceolata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Maytenus senegalensis -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Limeum sulcatum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dichanthium annulatum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Dactyliandra welwitschii -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melhania virescens -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia erubescens -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helinus spartioides -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Heliotropium ovalifolium -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Limeum argute-carinatum -hl	.	1	.	.	.	.	.	.	.	1	1	.	1	1	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera hochstetteri -hl	.	.	1	.	1	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leucas martinicensis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tribulus terrestris -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Monandrus squarrosus -hl	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lepididium africanum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cymbopogon plurinodis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.
Zehneria marlothii -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	.
Tagetes minuta -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Grewia flavescens v. olukondae -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Boscia foetida -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Grewia flavescens v. flavescens -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhynchosia minima -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Kalanchoe lanceolata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Enneapogon scoparius -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sesamum capense -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Hermannia rautanenii -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Kyllinga alba -hl	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyphostemma congestum -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Seddera suffruticosa -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gossypium triphyllum -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Corallocarpus welwitschii -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia erioloba -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acalypha segetalis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis lehmanniana -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Limeum myosotis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Laggera decurrens -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lindneria clavata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Merremia palmata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aristida stipitata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia karroo -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	5	.	.	.	.	.
Oxalis purpurascens -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Heteropogon contortus -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Acacia karroo -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.
Acacia karroo -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.
Ziziphus mucronata -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Xanthium strumarium -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.
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Table 26

TWINSPAN TABLE

Unique relevé nr.	85409	85397	85267	85250	85249	85241	85240	85234	85226	85225	85224	85222	85221	85085	85059	85058	85055	85054	85053	85052	85051	85050	85049	85048	85035	85034	85032	85019	85018	85017	85008	22	12	10	7	4	85425	85401	85400	85399	85394	85391	85385	85383	85382	85380	85378	85367	85315	85266	85248	85217	85204	85201	85097	85095	85083	85078	9	8	85063	85062	85061	85060	85064
association	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
diagnostic spp association 1																																																																	
Willkommia sarmentosa -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oldenlandia herbacea -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Catophractes alexandri -s1	.	1	.	1	.	.	.	2	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	5	.	.	.	7	6	5	3	1	5	.	.	.	.	.	.	.	.	.
Ophioglossum polyphyllum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Corchorus tridens -hl	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Portulaca kermesina -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
diagnostic spp association 2																																																																	
Osteospermum muricatum -hl	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crotalaria steudneri -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera charlieriana -hl	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eleusine indica -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	.
Felicia smaragdina -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ipomoea coptica -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Blepharis mitrata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	1	1	.
Lotononis platycarpa -hl	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	1	.	.	.	1	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	1	1	1	.	.	.	.	.	.	.
Kleinia longiflora -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	1	.	.	.	.	.	.	.
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Eragrostis cylindriflora -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	5	1	2	.	1	1	1	1	.	.	.	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachiaria deflexa -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
Anthephora schinzii -hl	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	1	1	.	.	.	.	1	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Justicia anselliana -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Commelina subulata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dactyloctenium aegyptium -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Xerophyta humilis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acrotome fleckii -hl	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	1	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
diagnostic spp association 3																																																																	
Crotalaria podocarpa -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Megalochlamys marlothii -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Ipomoea bolusiana -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hibiscus elliottiae -s2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Albizia anthelmintica -t3	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	2	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.
Tetragonia calycina -s2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Ruellia sp nova -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Momordica balsamina -hl	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachiaria eruciformis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	6	7	7	6
characteristic spp ass. 3 and 4																																																																	
Cyperus fulgens -hl	.	1	.	.	.	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	1	.	1	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Panicum coloratum -hl	.	.	1	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ziziphus mucronata -s1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Acacia hebeclada -s1	.	.	2	1	.	.	.	.	.	1	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	1	1	.	.	1	.	.	.	.	.	.	.	.
Acrotome inflata -hl	1	1	.	1	.	1	.	.	.	.	.	.	.	.	.	1	1	1	.	1	1	.	.	.	.	.	.	1	.	1	1	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Chenopodium olukondae -hl	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	1	1	1	1	.	.	.	1	.	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Grewia flava -s1	1	1	1	.	.	1	1	.	.	.	.	.	.	.	.	.	1	.	1	1	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	1	1	1	1	2	.	.	.	2	1	1	1	1	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Setaria pumila -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tarchonanthus camphoratus -s1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aptosimum angustifolium -hl	1	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Panicum maximum -hl	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dichrostachys cinerea -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	1	.	.	.	.	1	.	.	.	.	.	.	.	3	.	.	.	.	1	.	.	.	.	.	2	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.

Evolvulus alsinoides -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Asparagus cooperi -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	1	.	.	1	.	.	.	.	1	.	.	1	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Digitaria velutina -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Schkuhria pinnata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Becium filamentosum -hl	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hermannia quartiniana -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pogonarthria fleckii -hl	1	.	.	.	.	2	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Grewia bicolor -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ziziphus mucronata -s2	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hypoestes forskaolii -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hibiscus palmatus -hl	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Phaeoptilum spinosum -s1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Solanum kwebense -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis rigidior -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	5	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vernonia fastigiata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	1	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
diagnostic spp association 5																																																																		
Monechma genistifolium -s2	.	5	1	5	1	.	2	.	.	.	.	.	.	.	1	1	1	1	1	.	1	1	1	1	.	.	.	.	.	.	1	5	2	2	1	1	5	6	6	6	5	5	6	5	6	5	7	5	5	.	5	5	5	1	1	2	5	1	5	5	.	.	.	.	.
Chascanum pinnatifidum -s2	1	1	.	.	.	1	1	1	.	.	.	.	.	.	.	1	1	.	1	.	1	.	1	1	1	.	.	.	.	1	.	1	.	1	.	1	.	.	1	.	1	1	1	.	.	1	.	.	1	.	1	1	1	1	1	.	.	.	1	1	.	.	.	.	.
Eragrostis echinochloidea -hl	1	.	2	.	2	.	.	.	.	.	.	1	.	.	.	.	1	1	.	.	.	1	.	.	1	.	.	1	.	2	.	2	.	2	3	1	1	1	1	1	.	1	.	.	.	.	.	5	1	5	1	1	1	1	.	.	.	.	1	1	.	.	.	.	.
Heliotropium steudneri -s2	.	1	1	1	.	1	1	.	.	.	.	1	.	.	1	.	1	1	.	.	.	1	1	.	.	1	.	1	1	1	1	.	.	.	.	1	.	.	.	1	.	1	.	.	1	1	.	.	1	.	.	1	1	.	1	.	1	1	.	.	.	.	.	.	.
Peliostomum leucorrhizum -hl	.	.	1	.	.	1	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	1	.	5	1	1	1	1	5	1	.	1	1	2	1	1	.	1	.	.	1	1	.	1	.	.	.
Enneapogon desvauxii -hl	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	2	.	1	.	5	.	.	5	1	5	.	5	3	6	5	6	5	7	6	5	2	.	.	.	.	.
Aptosimum lineare -hl	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	1	.	.	.	.	.	.	1	1	.	1	1	1	1	1	.	.	1	.	.	.	1	.	.	.	.	.	1	1	1	1	1	.	.	.	.	.	.
Hermbstaedtia odorata -hl	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	1	.	1	1	1	1	1	.	.	1	.	1	.	.	.	.	1	.	.	.	.	1	1	1	2	.	1	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Geigeria acaulis -hl	1	1	.	.	.	1	.	1	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	1	1	.	1	.	1	.	.	.	.	1	.	.	1	1	1	.	.	1	.	.	.	.	.	.
Acalypha indica -hl	1	1	.	.	1	1	.	1	1	.	.	.	1	.	.	.	1	.	.	1	.	.	.	.	.	.	.	1	1	1	1	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera rautanenii -s2	1	.	1	.	.	1	1	1	.	.	.	.	.	.	.	.	1	1	1	1	1	.	1	1	.	1	1	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tragus berteronianus -hl	.	.	.	.	.	.	1	.	1	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	1	1	1	1	1	1	1	.	1	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.
Grewia flava -s2	.	.	.	1	.	.	.	1	1	.	1	.	.	.	1	.	.	1	.	.	1	.	1	1	1	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Andropogon chinensis -hl	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	1	1	1	.	1	1	1	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aizoon virgatum -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	1	1	1	.	1	1	.	.	.	.	.	.	.
Commiphora pyracanthoides -s2	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	.	1	1	1	.	.	.	.	.	.	.	.	.
Grewia flavescens v. flavescens -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	2	1	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.
Brachiaria schoenfelderi -hl	.	.	.	.	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.
Kohautia caespitosa -hl	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dicoma tomentosa -hl	.	.	.	.	.	1	.	.	1	.	.	.	.	.	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Eragrostis dinteri -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	1	1	.	.	.	.	.	.	.
Blepharis obmitrata -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.
Vernonia poskeana -hl	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chenopodium amboanum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.
Sericorema sericea -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	1	1	.	1	1	.	.	.	.	.	.	.	.	.
Albizia anthelmintica -s2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Monechma divaricatum -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Petalidium ramulosum -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia tortilis -t2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	.	.	5	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Indigofera holubii -hl	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5	1	.	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis nindensis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	1	.	1	5	.	.	.	.	.	.	.	.	.
Ipomoea coscinosperma -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	1
Albizia anthelmintica -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Eriocephalus pubescens -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.
Lycium bosciifolium -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia hebeclada -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Catophractes alexandri -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	5	.	.	.	.	.	2	.	.	.	.	.	.
Boscia foetida -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.

Species	Relevé values
common spp TWINSPAN group 1	
Enneapogon cenchroides -hl	1 5 1 6 6 6 5 5 6 7 1 2 5 1 6 1 6 1 1 1 5 1 1 1 1 1 1 2 5 6 6 2 1 1 1 1 1 1 1 2 5 6 1 1 1 2 5 1 1 . 6 1 5 6 5 5 1 1 7 5 1 1 1 1 1
Aristida congesta -hl	6 5 . 1 . 1 . 1 . . . . . 7 . . 1 5 5 1 1 1 1 1 . 1 6 . 1 1 1 . . . . . 3 1 1 1 . 1 1 1 1 . . . . 1 . . . .
Barleria lanceolata -s2	1 1 . . . . . 1 . . . . 1 1 1 . 1 . . . 1 . . . . . 1 1 1 1 1 1 . 1 1 1 5 1 1 . 1 1 1 1 . 1 1 . . 1 . . . .
Setaria verticillata -hl	1 . . . . 1 . 2 1 . . . 1 . . 1 1 1 . . 1 1 1 5 1 1 . 1 1 1 1 1 . 1 . . . . 1 . . . . . . 1 . . . . 1 1 1 . 1 1
Bidens biternata -hl	1 . . . . . . 1 1 1 1 1 1 1 . . . . 1 1 1 . . . . 1 . . 1 . 1 . . . . 1 1 1 1 1 1
Lantana angolensis -s2	1 . . 1 . 1 1 . 1 . . . . 1 . . 1 1 1 1 . 1 . . . . 1 . . 1 1 . . . . 1 . . . . 1 . . . . . .
Acacia tortilis -t3	. 2 . 5 1 2 . . 5 2 1 . . . . 2 2 . . 2 2 5 . 5 . . . .
Asparagus africanus -s2	. . 1 1 . . . . 1 . . . . . . 1 . . . 1 . 1 1 . . . . 1 . . . . 1 . . . . 1 . . . . .
Solanum dinteri -s2	1 . . . . 1 . . 1 . 1 1 . . . 1 1 . . . . 1 . . . .
Urochloa trichopus -hl	. . . . 1 . 1 1 1 . . 5 . . . .
Amaranthus thunbergii -hl	. . . . 1 . 1 . 1 . . . . 1 . . . .
Acacia mellifera -s1	5 5 7 7 7 5 7 . 6 . 1 1 6 2 . 1 5 5 1 3 7 6 5 1 1 1 1 1 2 1 . . 6 1 5 . . 6 7 5 5 5 6 6 5 4 5 2 5 4 6 1 5 . 1 . . . . 5 1 1 2 1 1 1
Leucosphaera bainesii -s2	2 5 2 1 5 1 1 1 1 1 . 5 6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 1 2 . 1 1 6 6 6 5 5 2 5 5 1 6 . 5 1 2 5 1 1 1 2 1 1 1 1 1 1 1 1 1
Chloris virgata -hl	. 2 . 1 1 1 1 . 1 1 1 1 5 1 . 1 1 1 1 1 1 1 1 1 5 1 1 1 5 5 . . . 1 1 2 1 1 . 1 1 1 1 . 1 . 1 . . 1 . . . . 1 . . 1 1 . . 1 1 1 1 1 1
Eragrostis rotifer -hl	6 1 1 1 6 1 . . . . . . 1 1 . . . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . 1 . . 1 1 5 1 . 1 1 5 1 . 1 1 . 1 . . . . 2 . . . . 1 . . .
Eragrostis trichophora -hl	5 1 6 1 . 6 5 1 1 . 1 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . 1 1 1 . 1 6 1 . . . . . 6 . 1 1 . . 1 . . . . 1 . 5 . 1 . . . .
Boscia albitrunca -t3	2 . . 1 . . . 1 . . . . . . 2 1 . 1 1 1 1 . . . . . . 1 1 1 . 1 1 . 1 . . . 1 2 2 1 1 2 . . . . . . 1 . . 1 1 . . 1 . . . .
Aristida adscensionis -hl	1 7 1 6 5 6 6 6 5 6 8 2 2 5 5 6 5 6 1 5 1 1 5 5 . . 1 1 1 . . 2 1 . 1 7 5 . 6 6 6 5 1 6 2 1 1 1 1 . 5 1 1 . 5 5 1 1 1 1 7 7 6 5 6
Lycium eenii -s2	1 3 1 1 1 1 1 1 1 1 . . 1 . 1 1 1 1 1 2 1 1 1 2 1 . 1 1 1 . 1 1 4 . 1 1 1 1 1 2 1 1 1 1 1 1 1 1 . 1 2 1 1 . 2 1 . 1 1 . 2 . . . . . .
Acacia reficiens -s1	. . . . 1 . 1 . . . 1 2 1 . 1 1 . . 1 . . . . 1 . 1 . . . . 3 . . 1 2 1 . . 5 . 1 . 1 . 1 1 . . . 1 . 3 . . . .
Acacia tortilis -s1	. 2 . 1 . . 1 1 . 5 5 . 1 1 . . . 1 1 1 1 . 1 1 1 . . 1 . . . . . 1 1 1 2 1 1 1 1 1 1 1 . 6 . . . . 1 1 . . 1 1 . . . . . 1 .
Ocimum americanum -hl	1 1 1 1 . 2 1 . . 1 . . . . . . 1 . 1 1 1 1 1 1 1 . . . 1 . . . . 1 . . 1 1 . 1 1 . 1 1 . 5 . 1 . . 5 . 1 . 1 1 1 . 1 . . . . .
Eragrostis porosa -hl	5 1 . 2 . . . 2 . . . . 1 . 1 1 1 1 1 1 1 1 . . . 1 . 6 1 1 1 . 1 . . . . 5 1 1 1 2 5 1 1 5 2 5 1 . . 1 1 5 1 1 1 1 6 . . 1 1 1 1 5
Achyranthes aspera v. aspera -hl	. . . . . . 1 1 1 1 . 1 1 . 1 . 1 1 1 1 1 1 1 1 1 . . . 1 1 . . . . 1 1 . . . . 1 . . . 1 . . . .
Nidorella resedifolia -hl	. 5 5 . . . . 6 2 2 5 . 6 . . 1 1 1 1 1 1 1 1 5 5 1 1 1 1 1 1 1 . 5 . . 1 1 1 . 1 . 6 1 1 . . . . 1 2 . . 1 1 1 . . . 1 1 . . . .
Pupalia lappacea -s2	1 . 1 1 . . . . 1 . . . . . 1 1 1 1 1 1 . 1 1 1 1 . 1 1 . . 1 . 1 . 1 1 1 . 5 2 1 1 5 3 1 1 2 1 . . . . 1 1 . 1 . . 1 5 . . . .
Eragrostis jeffreysii -hl	6 5 . 1 . 1 . 1 1 1 . 1 . . . . 1 . . . . 5 1 . . . . . 1 . . . 2 5 5 5 5 5 1 1 1 5 . 7 . . . 1 . 1 1 . . . .
Boscia albitrunca -s2	. . . . . 1 . . . . 1 . . 1 . . . 1 . . 1 . . . . 1 . . . . 1 . . . 1 . . 1 1 . . 1 1 . 1 . . 1 . 1 . . 1 . . . .
Commelina benghalensis -hl	1 . . . . 1 . . . 1 . . 1 1 . . . . . 1 . . . 1 . . 1 . . . .
Aristida rhiniochloa -hl	1 1 . 1 . 2 5 2 1 1 1 1 1 5 1 1 1 1 1 1 . . 1 . . 1 1 5 6 6 . . 1 . . 2 1 2 1 1 1 5 . . . . . . 1 . 1 1 . . . 1 1 1 1 . . . . . .
Urochloa brachyura -hl	. 1 . 1 . . 1 . 1 1 1 5 5 . . 1 . 1 1 . 1 1 1 1 1 1 5 . 1 2 1 . . . . . 1 . 1 . . . . . . 1 . . . . . . 1 1 . . . .
Melinis repens s. grandflora -hl	1 1 . . . 1 5 2 6 6 . 1 1 . . . 1 . . . 1 . . . 1 1 1 . 1 2 1 1 1 . . . . . 1 . 1 1 1 1 . 1 1 1
Talinum arnotii -hl	1 1 . 1 . 1 1 . 1 1 . . . 1 1 . 1 1 1 . 1 1 . 1 1 . 1 . 1 1 1 . 1 1 1 1 . 1 . . 1 . 1 1 1 1 1 . 1 1 1 1 1 1 . . 1 . . .
Lycium oxycarpum -s1	. . 5 . . . 1 . 5 . . . . 1 . . . . . 1 . . . . 2 . . 1 . 1 . . . 1 1 1 . 2 . 1 . 1 . . . .
Ondetia linearis -hl	1 . . 1 . 1 1 . . . . . . 1 1 . 1 1 1 . . . 1 1 . 1 . . . . 1 1 2 . . . 1 . . . . 1 . . 1 1 . . . .
Hibiscus calyphyllus -s2	. 1 . 1 . . . . 1 . . . . 1 . . . . 5 1 1 1 1 1 1 1 1 1 1 . . 1 . 1 1 . 1 . . . .
Pavonia burchellii -s2	1 . . . . . . 1 . . . . 1 . 1 . 1 1 . 1 1 1 . . . . 1 . 1 . . . . . 1 2 . 1 . . . .
Cleome monophylla -hl	. . . . 1 . 1 1 . 1 . . . .
Acacia reficiens -t3	. . . . 6 . . . . 1 1 2 2 . 5 . . 5 . 2 . . . 5 . . . . 1 . 1 1 . . . .
Nelsia quadrangula -hl	1 1 . 1 . . 1 1 1 1 . . . . 1 1 . . . 1 1 1 . 1 1 . . . .
Cenchrus ciliaris -hl	. . 5 2 5 1 1 1 1 1 . 1 5 . 1 . 1 . 1 1 1 1 1 1 5 1 1 1 1 5 1 4 . 1 . 1 1 . 2 5 1 . 1 1 1 1 5 5 1 6 1 1 1 2 1 1 1 1 1 5 1 . . 1 .
Geigeria ornativa -hl	. 1 1 . . 1 1 1 . 1 1 . . . . . 1 . 1 1 2 1 1 1 . . 1 1 1 1 . 1 . 2 . 1 . . 1 1 . . . . 1 1 . 1 . . . . 1 1 1 . .
Ehretia rigida -s2	. . . . . . 1 . . . . . . 1 1 . . . . . . 1 1 . 1 . 1 . . . 1 . . . . . 1 . . . . 1 1 . . . . 1 1 . . . .
Acacia mellifera -s2	1 1 . . . . . 1 . 5 . . . . . 1 1 1 5 2 . . 1 . . . . 1 . 1 1 6 2 . 7 5 . . 6 1 2 1 . . . 1 . . 1 . . 1 1 . . 1 . . 1 1 . . . . . 1 .
Cucumis anguria -hl	. 1 . . . 1 . 1 . 1 . 1 1 . 1 . . . 1 . . . 1 1 . . . 1 1 . . . . 1 . . . 1 . . . . 1 . . . . . 1 . . . . 1 . .
Felicia anthemidodes -s2	. . . . 1 . . . . . . 1 1 1 1 . . . . 1 . . . . . . 1 . . . 1 . . . . . . 1 1 . . . .
Ehretia rigida -s1	. 1 . 1 . 1 . . . . 1 . . . . 1 1 . 1 1 . . . . 1 . . . .
Bothriochloa radicans -hl	. . 2 1 1 2 1 1 . . . . . 1 . . . . 2 . . . . 1 . . . .
Blepharis leendertziae -hl	. 1 . . . . 1 . 1 1 . . . . 1 . . . . . 1 . 1 1 1 1 1 1 1 . . 1 . . . .
Kyphocarpa angustifolia -hl	. . . . . . 1 . 1 1 . 1 . . 1 1 1 1 1 1 1 1 . 1 1 1 . . 1 . . . 1 . 1 . . 1 . . 1 . . . 1 . . 1 . . . . 1 . . . . . .
Phyllanthus maderaspatensis -hl	1 1 1 1 . 1 1 1 1 1 1 1 1 . . 1 . . 1 1 1 1 1 1 . . . . 1 1 1 . 1 . 1 . 1 1 1 1 1 1 . . 1 . . . . 1 1 1 1 1 1 . . . 1 . . . .
Erucastrum arabicum -hl	. . 1 1 . . . 1 . . . 1 1 . 1 1 . 1 1 . . 1 . . . . 1 1 1 . . 1 1 . 1 . 1 1 . . . . . . 1 . 1 1 . . 1 1 . . .
Solanum burchellii -s2	. . . 1 . 1 1 . . . . 1 . . . . 1 . . . .
Otoptera burchellii -s2	1 . 1 . . 1 1 1 1 . . . . . 1 1 1 . 1 1 1 1 . . . 1 1 1 1 1 . . 1 . 1 . . . 1 1 1 1 . 1 1 1 . . 1 1 1 1 1 . . . . . .
Monelytrum luederitzianum -hl	. . 6 1 . . 1 . 1 . . . . 5 1 . 1 1 . . . . 1 . 5 . 1 . . . . 1 . . . . . 5 1 5 1 . . 1 1 1 . . . . . .
Brachiaria malacodes -hl	. . . 1 5 1 . . . . 1 1 1 1 1 1 1 1 . . . 1 1 1 5 1 1 . . . .
Ruelliopsis damarensis -hl	. . 1 . 1 . . . . 1 1 . . . . 1 . . . .

Aristida effusa -hl	. . . . 1 . . . . 1 1 1 2 2 . 7 . 1 . . 1 1 1 1 . 1 1 1 1 . . . 1 . . . .
Panicum stapfianum -hl	. . . 1 . . . . 1 1 1 . 1 . 1 1 . 1 1 1 . 1 . . . .
Abutilon austro-africanum -s2	. . . . 1 . . . .
Solanum incanum -s2	. . 1 . 1 . . . . 1 . 2 . 1 . . 1 . . . . . 1 . . . .
Hermannia modesta -hl	. . . 1 . 1 . . . . 1 . . 1 . . . . . 1 . . . . 1 1 1 . . . 1 . 1 . . 1 . . . . 1 1 1 . 1 1 1 . . . 1 . . 1 . 1 . 1 . . . .
Stipagrostis uniplumis -hl	1 1 5 1 . 2 1 5 5 1 . . 1 . 5 1 . . 1 1 1 . . 1 2 1 1 . 1 2 . . . 3 2 . 1 1 1 1 6 5 2 1 1 6 5 . 1 6 6 6 6 6 1 1 . . 7 8 . . . . .
Pollichia campestris -s2	1 1 . . . 1 . . 1 1 1 . . . . 1 . . . . 1 . . 1 . . . . 1 . . . . . 1 . . . . 1 . . . .
Lycium bosciifolium -s1	1 . 1 . . . . 6 1 . . . . 1 . 1 1 2 1 . . . . . . 1 . . . 1 . . . .
Pechuel-Loeschea leubnitziae -s2	. . . . . 1 . 1 1 1 . . 1 . . . . . . 1 . . . . 1 . . . . . . 1 . . . . 1 . . . .
Leucas pechuelii -s2	. . . . 1 . 1 1 . . . . 1 . 1 1 . 1 . . . . 1 . . . . 2 . 1 . . 1 . 1 1 . 1 1 . . . .
Aristida hordeacea -hl	. . . 5 1 2 6 . 1 1 1 . . . . 1 . . 1 . . . . . 1 . . . . 1 . . . 1
Ipomoea obscura -hl	. . . 1 . . 1 1 . . . . 1 . . . . 1 . . . .
Platycarpha carlinoides -hl	. . 1 . . . 1 . . . . 1 . . . . 1 . . . .
Ipomoea hochstetteri -hl	. . . .
Ipomoea sinensis -hl	. . . . 1 . . . . . 1 . 1 1 . 1 . . . . . 1 1 . . . . 1 1 . . . . 1 1 . . . .
Phyllanthus pentandrus -hl	. . . . 1 . . . . 1 . . . .
Acacia reficiens -s2	. . . . 1 1 . . . . 1 . . 1 . 1 . 1 . . 1 . . . . 1 . . 1 . . . .
Eragrostis annulata -hl	. . . . 1 . . 1 . . . .
Tarchonanthus camphoratus -s2	. . 1 . . . . 1 . . . 1 1 . . . . . . 1 . . . .
Mollugo cerviana -hl	. . . . 1 . . . . 1 . . . . 1 1 . . . .
Urochloa oligotricha -hl	. . . . 1 1 . . . . 1 . . . .
Rhus marlothii -s1	. . . . . 1 . . . .
Hirpicium gorterioides -hl	. . . . 1 . . . . 1 . . . . 1 1 . . . . 1 1 1 . . . .
Ptycholobium biflorum -s2	. 1 1 . . . 1 . . . . 1 1 1 1 . . . . 1 . . . . 1 . . . . . 1 . 1 1 . . . 1 . . 1 . . . . . .
Lycium oxycarpum -s2	. . . . 1 . . . 1 1 1 . . . . 1 . 1 1 . 1 . 1 1 1 . . . 1 . . 1 . . . . 1 . . . . 1 . . 1 . . . . . .
Indigofera vicioides -hl	. . . . 1 . . . .
Schmidtia pappophoroides -hl	. . 2 . . . . 1 1 . . . . 1 . . . . . 1 . . . . 1 . . . . . 1 1 . . . . 1 . 1 . . . .
Chamaesyce inaequilatera -hl	. . . . 1 . . 1 . . . . 1 . . . . 1 . . . . 1 1 . 1 . 1 . . . . . . 1 . . . .
Oxygonum sinuatum -hl	. . . . 1 . . . . 1 . . . .
Acacia tortilis -s2	. . . . 1 . . . . 1 . 1 1 1 . 1 1 . 1 . . . . 1 . . . 1 . . . . 1 . . . . 1 . . . . . 1 1 1 .
Eragrostis biflora -hl	. . . . 1 . . . .
Melinis repens s. repens -hl	. . . . 1 1 . . . . 1 1 . . . . 1 . . . . 1 . . . .
Dichrostachys cinerea -s2	. . . . 1 1 . . . . . . 1 1 . . 1 1 . . . 1 . . . .
Boscia albitrunca -s1	1 . . . . 1 1 . . . . 1 . . . . 1 . 1 . 1 2 . 1 . . . . 1 . . . .
Raphionacme lanceolata -hl	1 . . . . 1 . . . . 1 . . . . . . 1 . . . .
Maytenus senegalensis -s2	. . . . 1 1 1 . . . .
Limeum sulcatum -hl	. . . . . . 1 . . . . 1 . . . . 1 . . . .
Dichanthium annulatum -hl	. . . . 7 . . . . 2 . 1 1 . . . .
Dactyliandra welwitschii -hl	. 1 . . . . 1 . . . . 1 . . . . 1 . . . .
Melhania virescens -s2	. . . . . . 1 . . . . 1 . . . . . 1 1 . . . .
Acacia erubescens -s1	. . . . 1 . . . . 1 1 . . 1
Helinus spartioides -s2	. . . . 1 . 1 . . . . . 1 . . . . 1 . . . .
Heliotropium ovalifolium -s2	. . . . 1 . . . . 1 . 1 . . . . 1 . . . .
Limeum argute-carinatum -hl	1 . . . . 1 . 1 1 . . . . 1 1 . . . . 1 . . . . . . 1 . . 1 . 1 . . . . 1 1 . . . .
Indigofera hochstetteri -hl	. . . . . . 1 . . . . . . 1 . . 1 1 . . . 1 1 . 1 . . . . . 1 . . . . 1 . 1 1 . . . .
Leucas martinicensis -hl	. . . . 1 1 1 . . . . 1 . . . . . .
Tribulus terrestris -hl	1 . . . . 1 . . . . 1 1 1 . . . .
Monandrus squarrosus -hl	. . . .
Lepididium africanum -hl	. . . .
Cymbopogon plurinodis -hl	. . . .
Zehneria marlothii -hl	. . . .
Tagetes minuta -hl	. . . .
Grewia flavescens v. olukondae -s1	. . . .
Boscia foetida -s1	. . . . 1 . . . 1 . . . . 2 . . . .
Grewia bicolor -s2	. . . . 1 . . . . 1 . . . .
Grewia flavescens v. flavescens -s1	. . . . 1 . . . . 1 . . . .
Rhynchosia minima -hl	. . . . 1 . . . . 1 . . . .
Kalanchoe lanceolata -hl	. . . . 1 . . . . 1 . . . .

Enneapogon scoparius -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sesamum capense -hl	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hermannia rautanenii -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kyllinga alba -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyphostemma congestum -s2	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Seddera suffruticosa -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Gossypium triphyllum -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Corallocarpus welwitschii -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Acacia erioloba -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acalypha segetalis -hl	.	.	.	.	.	.	.	.	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis lehmanniana -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	7	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Limeum myosotis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Laggera decurrens -hl	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.
Lindneria clavata -hl	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.
Merremia palmata -hl	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aristida stipitata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia karroo -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oxalis purpurascens -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Heteropogon contortus -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia karroo -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia karroo -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ziziphus mucronata -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Xanthium strumarium -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia reficiens -sl	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 27

TWINSPAN TABLE

Species	Association 6	Association 7
association	6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7
Unique relevé nr.	4 4 4 4 4 4 4 4 4 4 4 8 8 8 8 8 8 8 8 4 4 4 4 4 4 4 4 2 2 1 1 1 1 1 1 1 1 6 5 3 2 1	8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
	0 0 0 0 0 0 0 0 0 0 0 5 5 5 5 5 5 5 5 0 0 0 0 0 0 0 0 1 0 9 8 7 6 5 4 3 1	5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5
	0 0 0 0 0 0 0 0 0 0 0 4 3 3 2 2 2 2 2 0 0 0 0 0 0 0 0	4 4 4 4 4 4 3 3 3 3 3 3 3 3 3 3 3 3 3 3 2 2 2 2 2 2 2 2 2 2 2 2 2 3 2 2 2
	4 4 3 3 3 3 3 3 2 2 2 1 8 4 4 1 1 0 0 4 4 4 3 3 3 2 2	1 1 0 0 0 0 9 9 9 9 9 9 8 8 8 8 7 7 7 0 9 9 5 4 4 4 4 3 3 3 2 2 0 0 1 1 0
	3 0 8 7 6 5 3 2 9 8 7 4 6 9 3 9 8 3 2 4 2 1 4 1 0 6 5	3 1 8 7 6 2 8 6 5 3 2 0 9 8 7 1 6 4 2 6 4 3 2 6 5 4 2 9 8 3 3 0 5 0 1 0 9
diagnostic spp association 6		
Monechma genistifolium -s2	1 . . . . 3 1 1 . 1 . 7 6 5 5 5 5 5 2 1 . 1 3 . 2 . 1 6 . 1 1 . 5 1 5 1 5 5 6 5 5 5	. . . 1 . 1 . 2 5 . 1 6 . . 5 5 1 5 2 . . . 1 5 . 5 . . 1 . 5 1 2 . . . .
Acacia mellifera -s2	1 5 . . . 1 . . . 3 1 1 1 2 . . . 1 . 2 3 . 7 . 2 1 . 1 2 5 4 . 5 . . 6 1 2 1 1 3 .	1 . 1 1 . . . 1 . . . 1 1 1 1 3 . 1 . . . 3 . . . . 1 . . 1 . . 1 . . . .
Aptosimum lineare -hl	. 1 . . . . 1 1 . 1 . . . . . 1 1 1 1 . . 1 . 1 5 3 2 1 1 1 1 5 2 1 . 1 . .	. . 1 1 . . . 1 1 . . 1 . . 1 1 1 . . . . 1 1
Grewia flavescena v. flavescens -s2	. . . . 1 1 . 1 . . 1 . . . . 1 . . 1 . 2 2 . 5 5 . 5 2 2 . 1 2 1 1 1	. . . . 1 . .
Lycium oxycarpum -s2	1 1 . . 1 1 . . . . 1 . . . 1 1 . . . 1 2 . 1 4 5 2 . . 5 1 . . . . 1 5 1	. . . . 1 . . . . 1 . . . .
Chenopodium amboanum -hl	. . 1 . 1 . 1 1 . . 1 . . . . 1 1 1 1 2 . . 1 1 . . . . 1 . 1 1 . 1	. . . .
Albizia anthelmintica -s2	1 . . 1 . . . 1 1 . 1 . 1 1 . 1 . . . 1 . . 1 . 1 2 2 . . . . 1	. . . . 1 . . . . 1 . 1 1 . 1 . 1 .
Tetragonia calycina -s2	1 . . . 1 . 1 2 . . 1 . . . . 5 1 1 1 2 5 3 1	2 2 . . . . 1 1 1 . . . . . . 1 . . . . . 1 . . . 1 . 1 . 1 . . 1 .
Sida cordifolia -hl	1 . 7 1 5 . . . 6 1 . . . . 1 . 1 . 1 . 1	. . . . 1 . . 1 . . . .
Vigna species -hl	. . . . 1 1 1 . . 1 1 . 1 1 . 1 1 . .	. . . .
Commelina livingstonii -hl	1 . . . 1 . 1 1 . . . . 1 . . . . 1 . 1 1 . 1 .	. . . . 1 . .
Acacia reficiens -s2	. . . . . 1 . . . . . . 1 . . . . . . 1 . . . 4 1 . 1 . . 1 1 . . . . . . 1	1 . . . . 1 . . 1 1 . . . . 1 . . . . . .
Leucas martinicensis -hl	. . . 1 1 . . 1 . . . . 1 . . 1 1 . 1 1	. . . .
Achyranthes aspera v. sicula -hl	. . . . . . 1 1 1 1 . . . . 1 1 . . 1	. . . .
Leucas pechuelii -s2	. . . . 1 1 . 1 1 1 . . . . 1 . 1 .	. . . .
Eragrostis lehmanniana -hl	. . . . 1 . . . 1 . . . . 5 1 6 1	. . . .
Phaeoptilum spinosum -s2	. . . . 1 . 4 1 . . . 1 . . . . 1 1	1 . . . . 1 . . . .
Tricholaena monachne -hl	1 1 . . . . . . 1 . . . . 3 . . . . . 1	. . . .
Eragrostis annulata -hl	. 1 1 . . . . 1 1 . . . 1	. . . . 1 . . . . 1 . . . .
Catophractes alexandri -s2	. . . . 1 . . . . 2 1 . . . . 5 . .	. . . . 1 . . . .
Urginea sanguinea -hl	. . . . 1 1 . . 1 1 .	. . . .
Sericorema sericea -hl	. . . . 1 1 1 1	. . . .
Solanum capense -hl	1 . 1 . 1 . . . . 1	. . . .
Cucumis kalahariensis -hl	. . . . 1 . 1 . . . . 1 1	. . . .
Acacia hebeclada -t3	. . . . 1 1 . . . . 1 .	. . . .
Enneapogon desvauxii -hl	. . . . 1 . . 1 . . . 6	. . . . 1 . . . .
Grewia schinzii -s2	. . . . 1 . . . . 1 . . . . 1 .	. . . .
Ipomoea oblongata -hl	. . . . 3 2	. . . . 1 . . . .
diagnostic spp association 7		
Eragrostis jeffreysii -hl	. . . . 1 . 1 . 1 1 1	6 1 2 2 2 6 2 5 6 1 1 5 1 5 1 . . . . . . 1 5 1 . . 1 3 . 1 5 1 2 . 2 2 2
Aristida rhiniochloa -hl	. . . . 1 . 1 1 . . 1 1 . . 1 . . . . 5 1 . 1 . .	1 1 1 1 . . . 1 1 1 . 1 1 1 1 1 1 1 . . 1 1 1 1 1 1 1 1 1 1 1 . 1 . . . .
Cucumis anguria -hl	. . . . 1 . . . . 1 . . . 1 . . . . 1 . . 1 . 1 . 1 . . 1 . . . 1	1 1 1 . 1 1 1 . . 1 . 1 1 . 1 . . . . . 1 . . . . 1 1 . . . . 1 1 .
Eragrostis rotifer -hl	1 . . . . . 1 . . . . 2 . . 1	1 1 6 5 . 6 1 . . . . . 5 6 . 6 2 5 . . . 1 . . . . 1 5 . 1 1 1 1 . . . 1
Limeum argute-carinatum -hl	. . . . 1 . . . . . 1 1 . 1 . . . 1 . 1	. . . . 1 . 1 1 . . 1 1 . . 1 1 . . . 1 1 . 1 . . 1 . . . 1 1 1 1
Acacia tortilis -s1	. . . . 1 . 2 2 1	1 . 1 2 . 1 . . 1 . . 5 . 5 . . . . 1 5 1 1 . . . 1 1 2 5 1 . . 5 2 . . 1
Nelsia quadrangula -hl	. . . . 1 1 . . 1	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . . . . 1 1 1 1 1 1 1 1 1 1 1 . 1 . 1
Achyranthes aspera v. aspera -hl	. 1 1 . . . . 1 . 1	. . 1 . 1 1 . . . . 1 1 1 . 1 . . . . 3 1 1 . . . 1 . . . 1
Acacia tortilis -t3	. . . . 1	. . 5 5 5 . . . 2 . . 5 . . . 1 . . . 4 2 1 . . . . 2 1 5 . . . . 2 . . .
Phaeoptilum spinosum -s1	. . . . 1	. 1 1 3 2 1 1 2 1 . . . .
Panicum coloratum -hl		2 . . . . . 1 . . . . . 1 . . 2 1 . . . 1 . . . . 1 . . 1 . . . .
Lotononis platycarpa -hl	1 . . . . 1 . . . . . . 1 . . . . 1	. . . . . 1 . 1 1 1 1 . 1 . . . . 1 . . 1 . . . .
Eragrostis cylindriflora -hl		. . . . 5 5
Indigofera vicioides -hl	. . . 1	. . . . 1 . . . . 1 . . . . 1 . 1 1 1 . . . . . . 1 1 .
Xerophyta humilis -hl		1 1 . . . . 1 . . . . 1 1 2 1 . . . . 1 1 .
Ziziphus mucronata -s1	. . . . 1 . .	. . . 1 . . . . 1 . 5 . . . 1 1 2 . . . . 1 . . 1
Panicum maximum -hl		1 . . . . 3 . . 1 1 . . . . 1 . .
Solanum catombelense -s2		. . . .
Eragrostis nindensis -hl		. . . . 1 . . . . 1 . . . .
Blepharis integrifolia -hl		. . . . 1 . . . . . 1 1 . 1 1 1 . . . .
Chenopodium olukondae -hl	. . . . 2	. . . . 1 1 1 1 1 . . . .
Crotalaria steudneri -hl		. . . . 1 . . . .
Blepharis mitrata -hl	. . . . 1	. . . .
Ziziphus mucronata -s2	. . 2 . . . . 1	. . . . 1 . . . 1 . . . .

Amaranthus thunbergii -hl	. . . . 1 . 1 . . . 1	. . . . 1 . 1 . . . .
Lotononis listii -hl		. . . . . . 1 . . . . 1 . .
Platycarpha carlinoides -hl	. . . . 1 . . . 1 . .	1 . . . . . 1 1
Dicoma capensis -hl	. . . . 1	. . . . 1 . 1 . . . . 1 1 . . . . .
Solanum dinteri -s2	. . . . 1	1 . . . . 1 . . . .
Acacia hebeclada -s2	. . . . 1 . . . . 1 . . .	. . . . 1 1 . . . 1 . . . . 1 . . . .
Panicum stapfianum -hl		. . . . 1 . . . .
Craterostigm plantagineum -hl		. . . .
Cymbopogon plurinodis -hl		. . . . 1 1 . . . .
Cyperus cuspidatus -hl		. . . .
Solanum supinum -s2		. . . . 1 1 . . . . . . 1 1
Urochloa trichopus -hl		. . . .
Andropogon chinensis -hl		. . . .
characteristic spp ass 6 and 7		
Ondetia linearis -hl	. . . . 5 . . 1 . . 1 . . . . . . 1 1 1 . . . . . . 5 . 1 3 . .	1 1 1 1 1 1 1 . . . . . 1 1 . . . . 1 . 1 1 1 . 1 . . . 1 . 1 1 1
Blepharis obmitrata -s2	. . . . . 1 . . . . . . 1 . . . . 1 1	. . 1 1 . . . . 1 . 1 . . . . 1 . . . 1 . . . . .
Eragrostis echinochloidea -hl	. . . . 1 1 . . 1 . . . . 1 . . . . 1 1 1 5 . .	. . . . 1 . 1 1 1 . . . .
Peliostomum leucorrhizum -hl	. . . . 1 1 . 1 1 1 . 1 . . . . 1 1 . 1 1	. . . . 1 2 1 1 2 . . 1 1 . . . . 1 . . . .
Aristida meridionalis -hl	6 1 . . . . 1 1 . . 1 . . . . 1	. . . . 5 . .
diagnostic spp association 8		
Acacia erioloba -t3	. . . . 5 . . . . 1 .	. . . .
Asparagus africanus -s2		. . . . 1 . . . . . . 1 . . . . . 1 . . .
Neorautanehia mitis -s2	. . . . 1 1 . . . . 1	. . . . 1 . . . .
Hermannia tomentosa -hl	. 1 . . . . 1 . . . 1 . . . . 1 . . . . 1	. . . . 1 1 . . . . 1 . . . . 1 . . .
Crotalaria podocarpa -hl	. . 1 1 . . . . 1 . 1 . . . . 1 1 . . . . 1	. . . .
Eragrostis dinteri -hl		. . . . 1 1
Harpagophytum procumbens -hl	. . . . 1	. . . . 1 . . .
Kohautia cynanchica -hl	. 1 . 1 1 . . . . . 1	. . . . 1 1 . . . . 1 . . . .
Ipomoea crassipes -hl		. . . .
Rhigozum brevispinosum -s1		. . . . 1 1 . . . 5 . . . . 2 . . .
Helinus spartioides -s2	. . . . 1 . . . 1	. . . .
Requienia sphaerosperma -hl	. . 3 1 2 . . . 5	. . . .
Oxygonum alatum -hl		. . . . 1 . . . . 1 1 .
Sesamum capense -hl	. . . . 1 1 1	. . . .
Indigofera alternans -hl		. . . .
Tephrosia purpurea -hl		. . . .
Eragrostis omahekensis -hl	. . . 3 3 . . . . 2 . . . . 2 . . . . . 1 1 . .	. . . .
Terminalia sericea -t3		. . . .
Limeum myosotis -hl	. . . . 1	. . . .
Crotalaria sphaerocarpa -hl	. . . . 1	. . . .
Terminalia sericea -s1		. . . .
Zornia glochidiata -hl	. . 1 1	. . . .
Bothriochloa radicans -hl	. . . . 1	. . . . 1 . . . . 1 . . . .
Acacia erioloba -s1	. . . . 1	. . . .
Lycium bosciifolium -s1	. . . . 1 . . . . 2 1	. . 1 5 . . . 1 1 5 1 1 . . . . 1 . . 5 . . . .
Rhigozum brevispinosum -s2		. . . .
Ipomoea hackeliana -hl	. . 1	 1
Tephrosia lupinifolia -hl		. . . .
Acacia erioloba -s2		. . . .
Terminalia sericea -s2		. . . .
characteristic spp ass 6, 7 and 8		
Aptosimum angustifolium -hl	. . . . 1	. 1 1 1 1 . 1 . . 1 2 . 5 5 5 2 1 1 1 1 2 2 . . 1 1 1 3 . 1 . . 1 . 1 . 1
Giseka africana -hl	. . 1	. 1 1 . 1 . . . . 1 . 1 . . . . 1 . . 1 . . 1 1 .
Felicia anthemidodes -s2	. . . . 1	. . . . 1 1 1 . 1 1 . . . 1 1 . . . . . 1 1
Crotalaria pisicarpa -hl	1 1 . . . . 1 1 1 . . . . 1 . . . . 1	. 1 . . . . 1 1 1
Hibiscus fleckii -hl	. 1	. . . . 1 . . . . 1 . . . . . 1 . . . . . 1 1 .
Abutilon austro-africanum -s2	. . . . 1 . . . . 1 . . . . 1	. . . . 1 . . . . 1 . 1 . . . . 1 . . 1
Ipomoea bolusiana -hl	. . . . 1 . . . . . 1 . . . . 1 . . . 1 . . 1	. . 1 1 1 . 1 . 1 . . . . 1 . . . . . 1 1 . . . .
Solanum burchellii -s2	. . . . 1 1	. . . . 1 . 1 . 1 1 . . . 1 1 1 1 . 1 1 . 1 1 . . 1 1 .
Tarchonanthus camphoratus -s1		1 . . . . 1 . . . .
Maerua juncea -s2		. . . . . . 1 . . . . 1 . . 1 . . . . 1 . . . . . 1 1 . . . . .
Waltheria indica -hl		. . . . 1 1 . .
Anthephora schinzii -hl		. . . .

diagnostic spp association 9		
Grewia bicolor -s1	. . . . 1	. . . . 1 1 . . . .
Lonchocarpus nelsii -t3		. . . . 1 . . .
Vernonia poskeana -hl	. . . . . . 1 . . . . 1	. . . .
Solanum kwebense -s2	. . . . 1	. . . . 1 . . . .
Combretum apiculatum -s1		. . . .
Grewia flavescens v. olukondae -s1	. . . . 5	 2
Megalochlamys marlothii -s2	. . . . 3 1 . . 2 . . . . 2 . . . 1 . .	. . . . 1 . . . . 1 . . . . .
Ipomoea verbascoidea -s2		. . . .
Albizia anthelmintica -s1	. 1 . . . . . . 1 . . 1 1 . . . . 1 1	. . . . 3 . 1 . . . 1 . . . . . 1 . . . . 1 . . . .
Clerodendrum ternatum -s2		. . . .
Eragrostis viscosa -hl	. 1 3 . . . . . 5	. . . .
Acacia fleckii -s1		. . . . 3 . . . . 2 . . .
Grewia flavescens v. flavescens -s1	. . . . 5 . . . 1	. . . . 1 . . . .
Corchorus tridens -hl	. . . . 1	. . . . 1 . . . . 1 . . . .
Asparagus cooperi -s2	. . . . 1	. . . . 1 1
Euphorbia crotonoides -hl		 1
Aptosimum decumbens -hl		. . . .
Setaria pumila -hl		1 . . . . 1 . .
Microchloa caffra -hl	. 1 . . . . 1	. . . . 1 . . . . 1 1 . . . .
Grewia retinervis -s1		. . . .
Clerodendrum uncinatum -s2		. . . .
Commiphora angolensis -s2	. . . . 1	. . . .
Momordica balsamina -hl	. . . . 1	. . . . 1 . . 1 . . . .
Helinus integrifolius -s1	. . . . 1	. . . .
Oxalis purpurascens -hl	. . . 1	. . . . 1 . . . .
Urochloa oligotricha -hl		. . . .
Terminalia prunioides -s1		. . . .
Boscia foetida -s1	. . . . 2 . . 1 1 . . . . 1	. . . . 1 . . . . 1 . . . . .
Commiphora glandulosa -s1	. 1 . . . . 1	. . . . 1 . . . .
Solanum delagoense -s2		. . . .
Talinum crispatulum -hl		. . . .
Brachiaria malacodes -hl	. . . . 1 1	1 . . . . 1 . . . . 1 . 1 1
Commiphora africana -s2		. . . .
Tylosema esculentum -hl	. . . . 1	. . . .
Helinus integrifolius -s2		. . . .
Acacia fleckii -s2		. . . .
Lonchocarpus nelsii -s1		. . . .
Grewia bicolor -s2		. . . .
Lonchocarpus nelsii -s2		. . . . 1 . . .
Commiphora tenuipetiolata -s1		. . . .
Commiphora africana -s1		. . . .
Terminalia prunioides -t3		. . . .
Combretum apiculatum -s2		. . . . 1 .
Commiphora tenuipetiolata -t3		. . . .
Aristida pilgeri -hl		. . . . 1 . . . .
characteristic spp ass 8 and 9		
Acanthosicyos naudinianus -hl	. . 1 1 1 . 1 1 . . . . 1	. . . . 1 1 . . 1 . . . . 1 . . . .
Commiphora pyracanthoides -s2	. . . . 1 . 1 1 . . . . 1	. . . 1 1 . 1 . . . . 2 . . . 1 1 . 1 . . 1 1 . . 1 . .
Bulbostylis hispidula -hl	. . 1 . . . . 1	1 . . . 1 1 . . . 1 . . 1 . . 1 . . . . 1 . . 1 1 .
Commiphora angolensis -s1		. . . .
Aristida stipitata -hl		. . . . 1 . . . .
Rhynchosia totta -hl	. . . . 1	. . . .
common spp TWINSPAN group 2		
Stipagrostis uniplumis -hl	8 8 5 7 7 8 7 8 5 7 8 6 5 . 6 7 7 7 7 7 8 7 5 7 6 8 5 7 6 7 7 8 5 6 7 7 6 6 6 7 6 7	5 5 2 6 6 1 2 6 5 5 7 6 2 2 6 . . . . 1 5 . 5 2 5 5 5 5 7 3 5 6 5 5 . 2 .
Acacia mellifera -s1	1 . . . 2 . 2 1 . 1 3 6 1 5 3 2 1 . . 5 5 5 . 2 1 . 5 . 6 6 . 2 5 7 . 5 2 2 1 2 5 2	7 6 6 5 5 1 5 2 6 5 3 5 . . 5 . 6 7 6 7 6 5 8 3 5 5 7 6 5 1 1 5 2 6 1 1 6
Talinum arnotii -hl	. . . . 1 1 . . 1 1 1 1 . 1 1 . . . 1 . 1 1 1 1 . . 1 1 1 1 . 1 1 1 1	. 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 1 1 1 . . 1 2 1 1 . 1 1 1
Boscia albitrunca -t3	. . . 5 1 1 2 1 . 3 . 1 2 2 1 . . . 1 3 1 . 1 1 1 . 1 1 1 2 1 . . 1 1 5	. 2 5 2 . 3 3 . . . 1 . 5 . 4 . 1 2 5 . 2 1 2 1 1 1 2 . . 5 1 . 1 . 2 1 .
Urochloa brachyura -hl	. . 1 1 . 1 . . . 1 1 . . 1 1 . 1 1 1 . 1 1 . . . . 1	. 1 . . 1 1 1 1 . 1 1 1 1 . 1 1 . . 1 1 . 1 . 1 1 . . 1 1 . . 1 1 . 1 1 1
Pogonarthria fleckii -hl	5 5 5 1 . 2 5 3 3 3 3 2 1 2 . 1 1 . . 1 5 1 2 . 1 1 . 3 5 1 1 2 . 2 5 1 . . 1 . 1 .	2 3 1 5 1 1 1 1 1 1 1 1 2 5 5 5 . . . . 2 . 1 1 2 5 5 2 1 . . 1 . 1 6 6 .
Eragrostis porosa -hl	1 . . 3 1 . 1 . . . 1 5 2 7 1 1 1 1 5 2 1 . . . . . 1 . . 3 . 1	5 7 5 6 5 2 5 1 1 2 1 5 5 1 6 5 5 1 2 1 5 1 1 6 6 6 1 . . 2 1 1 5 . 5 . .
Melinis repens s. grandiflora -hl	1 2 1 1 2 2 2 1 1 2 2 1 . 1 . 1 1 2 2 1 1 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 1 1 1 . . 1	1 1 1 1 1 2 2 1 1 1 2 1 5 5 1 1 . 1 1 1 5 1 . . 1 1 1 . 1 1 1 1 1 . 5 5 5
Enneapogon cenchroides -hl	1 1 1 2 2 2 5 2 . 5 2 6 1 2 5 1 1 5 5 3 1 1 5 3 6 1 6 1 1 1 1 1 1 1 3 1 1 1 1 1 1 1	1 1 1 1 1 2 1 1 1 1 1 1 . 1 1 2 1 1 1 1 1 5 1 2 1 5 5 1 5 1 2 5 5 . 1 . 1
Eragrostis rigidior -hl	. 1 . . . . 1	. . 1 . . . . 5 1 2 2 5 . 1 2 1 . 2 . . 1 . . . 1 . 1 .

Species		
Lycium eenii -s2	. 1 . 1 . 1 4 . . . 1 1 2 1 1 . 1 2 1 1 1 1 1 1 5 . 1 5 5 5 4 4 1 1 1 1 1 1 1 1 2 1 1	2 2 5 2 3 2 3 1 2 2 2 1 2 5 2 1 1 1 1 5 2 1 1 1 2 1 5 5 1 1 1 1 3 . 1 1 1
Grewia flava -s1	. . . . 1 . . . 2 1	5 1 5 1 2 2 2 1 . 1 2 1 2 5 . 5 . 1 . 2 2 2 . . . . 5 5 1 . . . . . . 1 . 5
Evolvulus alsinoides -hl	2 1 1 1 1 1 1 1 . . 1 . . . . 1 1 1 . . 1 1 . 1 1 1 3 2 1 1 1 1 1 1 1 1 1 1 5	1 1 1 . . . . . 1 . . 1 . . . . 1 1 1 1 1 1 . 1 1 1 . . . . . 1 . . . 1 1 1 1 1 .
Otoptera burchellii -s2	. . . . 1 1 . 1 1 1 1 1 . . . . 1 . 1 . . . . 5 1 1	. . . . 1 . 1 . 1 1 1 . 1 . . 1 2 . . . . . 1 1 1 1 1 . 1 1 . . . 1 2 . . . .
Aristida congesta -hl	. . 2 . . . . 2 1 2 1 . 1 1 . 1 . 1 2 . . . . 2 6	6 5 6 5 6 6 7 5 6 6 5 1 5 5 1 5 2 5 1 2 6 1 5 2 6 5 2 . . 5 5 1 . 5 1 5 .
Ptycholobium biflorum -s2	. . . 1 1 1 1 . . . 1 1 1 . 1 1 1 1 1 1 1 1 1 1 . 1 1 1 . 1 . 1 1 1 . 1 1 . . 1 1 1	. 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . 1 1
Heliotropium steudneri -s2	. . . . 1 1 1 1 1 . 1 . . . . 1 . . 1	. . . . . . 1 . . 1 . 1 . . 1 . . . . . 1 1 1 . 1 1 1 . . 1 . . . 1 1 . 1 1 1
Schmidtia pappophoroides -hl	. 1 . 1 . . . . 1 . . . 1 . . . . 1	. . . . 1 1 . . . 1 1 . . . . 5 5 . . . 1 . . . . . 1 1 . . . . .
Cleome rubella -hl	. . 1 1 . 1 . . 1 1 . . . 1 . . . . . . 1 . . . . 1 1	. 1 1 1 . 1 1 1 1 1 1 . . 1 1 1 . . . . . 1 . . 1 . . . 1 . . 1 1 . . 1 1 .
Indigofera rautanenii -s2	1 . . 1 . . . . . . 1 . . . 1 . . . . 1 . . . . . . 1 1 1 1 1 1 1 1 1 1 2 . . . 1 . 2	. 1 2 . . . 1 1 . . . . . . 1 . . . . . 1 1 1 . 1 2 1 1 1 . . . . . 1 1 1 1
Aristida adscensionis -hl	2 1 5 1 . . 5 1 1 2 2 1 1 1 6 . . 1 1 4 1 1 5 3 1 1 5 1 6 2 3 3 5 7 6 5 5 1 3 . 1 .	5 5 5 5 5 1 1 5 5 5 1 2 5 1 1 1 2 . . 2 2 1 5 6 5 5 6 6 5 3 5 1 1 . 2 1 2
Chascanum pinnatifidum -s2	. 1 . . . . 1 1 . . 1 1 1 1 1 . . 1 1 1 1 1 . . . . . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 1 1 3 2 . 1 2 1 1 2 1 1 1 1 1 . 1 1 1 1 1 . 1 . 1 1 . 1 1 1 . 1 1 1 1 1
Ipomoea sinensis -hl	. 1 . . . . 1 . 1 1 1 . . . 1 . . . 1 1 1 1 1	1 . . . . 1 . . . . . 1 . . 1 1 1 .
Chloris virgata -hl	1 1 . 1 1 1 . . . . 1 . . . . . . 1 . 1 1 1 . . . 1 . . 1 1 1 1 1	1 6 5 1 1 . 1 . . 1 . 1 1 1 1 1 4 1 1 1 1 2 . 1 1 2 . 1 1 . . 1 1 . 1 2 2
Eragrostis trichophora -hl	. 1 . 1 1 . 1 1 . 1 2 . . 2 1 . . 1 1 1 2 1 5 1 1 1 1 1 . 1 1 . 1 1 . 1	5 1 2 1 5 5 1 . . . 1 1 . 2 . 2 5 6 6 5 5 5 5 3 2 2 5 1 1 . . 1 1 2 . 1 .
Commelina benghalensis -hl	1 1 6 3 4 3 5 1 6 2 2 . . 2 5 . . 1 . 5 . 6 5 7 5 2 5 . 1 1 2 1	. . 1 1 1 1 . 1 . 1 . 1 1 1 . 1 1 . 1 1 1 . . . . . 1 1 1 1 . 1 . . 1 . 2
Ipomoea obscura -hl	. 1 . 1 . . . . 1 . 1 . 1 1 . . . 1 . . . . . . 1 . . . . 1 2	. 1 1 1 1 . 1 . . . 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 . . . . 1 1
Dichrostachys cinerea -s1	. . . . 1 1 1 . 1	1 1 2 . 1 . 2 . . . . . 1 1 . 1 5 1 1 . . . . 1 . . . . . 1 5 1 6 5 6 5
Oxygonum sinuatum -hl	2 . . 1 1 2 . . 1 . 2 2 1 . 2 . 5 1 . . 2 . . 1 . 1 . 4 . 1 . . 2 . . 3	1 1 . 1 . 1 . . . . . . 1 1 1 . . 1 . . . . 1 . . . 1
Acacia hebeclada -s1	. . 1 1 . . . . 1	5 . . . 1 . . . . 1 2 . . 5 . . . . . 5 . 1 . . . 1 1 . 1 . . . 1 . . 1 .
Lindneria clavata -hl	. . . . 2 1 1 . 1 1 . . . . 3	. . . .
Ocimum americanum -hl	. . . . 1 . 1 1 . 1 . . . . 1 . 1 1 1	1 . 2 5 1 . 1 1 1 1 2 . 1 1 2 2 1 1 . 1 5 5 1 1 . 2 2 2 1 . 1 . 1 1 . . 1
Catophractes alexandri -s1	1 1 . 1 1 1 1 1 . . 1 . . . 1 1 1 . . 1 2 2 1 . 1 1 . . . . . . 1 1 1 1	. 3 . 2 5 . 2 . . . . . . 1 . . . . . . 5 . . 1 . . . 5 5 . . . 5 . 5 5 .
Phyllanthus maderaspatensis -hl	. . . . 5 . . 5 5 . 5 6 . . . . 1 . . . . . 1 . 5 .	1 . . . 1 1 1 1 1 . 1 1 1 . . . . . . 1 1 . . . 1 . . . 1 1 1 1 1
Boscia albitrunca -s2	. . . . 1 1 1 1 1 . . . . 1 . . . 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 2	1 . . 1 1 1 . . 1 1 1 1 . . . . . . 1 1 1 . . 1 . . 1 . 1 . . . . 1 . 1 . .
Pupalia lappacea -s2	. . . . . 1 1 . . 3 1 . 1 . 1 . . . 1 3 . 1 . 1 3 2 1 2 . 2 . . . . . 1 1 1	1 1 1 1 1 1 1 1 1 1 1 . 1 1 . 2 1 1 2 . 1 . 1 . 1 1 1 1 1 . . 1 . 1 . . . 1
Kyphocarpa angustifolia -hl	1 1 . 1 1 1 1 1 . 1 1 1 2 . . . . 1 1 1 1 1 1 1 1 1 . 1 1 1 . 1 . 1 1 1 1 1 1 1	. . . . 1 1 1 . 1 1 . . . . . 1 . . . . 1 1 . 1 1 1 1 1 1 .
Tragus berteronianus -hl	1 1 . 1 1 1 1 1 1 1 1 . . . . 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . . . . 1 . 1	. 1 . . 1 1 1 . 1 1 1 1 . 1 . 1 1 . 1 . . 1 . . . . 1 . 1 1 . . .
Nidorella resedifolia -hl	. . . . 1 1 1 . . . 2 1 . . 1 . . . . 1 . . 2 1 1 . 1 . 1	. . . . 6 1 2 5 . . . . 1 . . 1 1 . . 1 . . . . 6 1 1 . 1 1 1
Barleria lanceolata -s2	. . . . 1 . 1 1 . . . . 1	2 1 1 1 1 1 . 1 1 . . . 1 1 . 1 1 1 1 1 1 . 1 1 1 1 1 1 1 . 1 . 1 1 1 1 1
Hirpicium gorterioides -hl	. . . . 1 1 1 . 1 . 1 . 1 . 1 1 1 . . . 1 1 . 1 1 . . 1 1 . . . 1 . 1 1 1 2	. . . . 1 . . 1 .
Geigeria ornativa -hl	. 1 . . . . 1 . . . . 1 . . . . 1 . . . 1 . . 1 . 1	. 1 . . . . 1 . . . . 1 . . . . . . 1 . . . . . 1 . . . 1 . . . . . 1 1 1 .
Pollichia campestris -s2	1 1 . 1 . 1 1 1 . . 1 . . . . 1 . . 1 1 1 1 1 . . . 1 . 1 1 1 1 5 2 2 1 2 1 1	. 1 . . 1 . . . 1 . 1 1 . 1 . . 1 . . 1 1 1 . . 1 . . 1 . 1 . . 1 . . . . .
Ehretia rigida -s1	. . . . 1 1	. 1 1 1 . . 1 . 1 . . . 1 1 . 1 . . 1 . . 1 . . . . 1 . 1 1
Dicoma tomentosa -hl	1 . . . . 1 . . . . 1 . . . . 1	. . . . 1 1 . 1 1 1 1 1 . . . 1 . . . 1 1 . 1 1 1 1 . 1 . . 1 . .
Leucosphaera bainesii -s2	. . . . 1 . . . . . 1 . . . 1 1 . 1	. 1 1 1 1 1 2 1 1 1 1 5 2 1 . 1 2 . 1 . 1 1 1 1 1 1 1 5 . 1 1 1 2 1 . . .
Grewia flava -s2	. . . . . . 1 . . . . 1 1 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 1 . . . . 2 2 . 1 1 1 . . 1	. . . . 1 . . . . . 1 . 1 . 1 . . . . . 1 1 1 . . . . 1 . . 1 .
Lycium oxycarpum -s1	1 2 1 3 . . . . 1 1 1 . . . . . 1 1 1	. . . . 1 1 1 1 2 1 2 1 1 . . 2 . . . 1 1 2 1 1 . 3 1 . . . . . .
Chamaesyce inaequilatera -hl	. . 2 . . . . 1 5 2 . . 2 . . . 1 . . . . 3 . . . . 5 . . . . 1	. . . . 1 . . . . 1 . . . . .
Pavonia burchellii -s2	. . . . 1 1 1 1	. 1 . . . . 1 . . . . . . 1 . . 1 1 1 5 . 1 . . . 1 1 1 . . . . 1 . . . 1
Cleome monophylla -hl	. . . . 1 . . . . 1 1	. . . . 1 . . . 1 . . . 1 . . . . . 1 . . 1 . . 1 . 1
Phyllanthus pentandrus -hl		. . . . 1 . . . .
Crotalaria heidmannii -hl	. . 1 1 . . . . 1	. 1 . . . . 1 . . 1 . . . . . . 1 1 .
Acacia reficiens -s1	. 1 1 1	2 . . . 1 . . . . 1 1 . . 5 1 . 6 . 5 . 2 5 . 5 1 1 . 2 . . 1 . . 5 . 5 5
Acacia reficiens -t3	1 . . . . 1 . 2 5 7 . . 5 . . 5 . 1 . 5 5 3 . 1 . . . . 1 . . .	. . . . 2 . 2 . 2 . . . . 5 . 5 . . . 5 . . . . 2 5
Brachiaria deflexa -hl	1 . . 1 . 1 5 3 . 2 1 5 6 2 . . 2 . . 1 1 1 4 . 5 5 1 . . . . 2 5 2 . .	. . . . 1 . 1 . . . . 1 . 1
Limeum sulcatum -hl	. . . . 1	. . . 1 . . . . 1 . . . . 1 . . . .
Cenchrus ciliaris -hl	. . 1 . . . 1 . . . . 1	1 . . . . . . 1 . . . . . 1 . 1 2 . . . 1 . 2 . . . . 1 . . . . .
Melinis repens s. repens -hl	. . 1 1 . 1 . . . 1 . 1 1 6 . 1 1 1 2 1 . 1 1 1 1 1 1 1 . . . . . . 1 . 5 1 1 1 . .	. . . . 1 . . . .
Boscia albitrunca -s1	. . . . 1 . . . . 1 . .	. . . . 1 1 1 . . 2 1 1 1 2 1 . . . . 1 1 . . . 1 . . . .
Solanum incanum -s2	1 . . . . 1 . . . 1 . . . . 1 . 1	. . . . 1 . . . 1 1 1 . . . . . 1 . . . .
Dichrostachys cinerea -s2	. . . . . 1 . . . . . 1 . . . . 1 1	. 1 . . . .
Raphionacme lanceolata -hl	. . . . . 1 . . . . 1 . . 1 . . . . 1 . 2 2 1 . . . . . . 2 . . .	. . . . . 1 . . . . 1 . . . . 1 1 .
Felicia smaragdina -hl	. . . . . 1	. 1 . 1 1 . . . . . 1 . . 1 . . 1 . . . . 1 1
Cyperus fulgens -hl	1 1 1 1 1 1 1 1 1 1 1 1 1 1 . . . . . 1 . . 1 1 1 1 . . 1 . . 1 1 1 1 1 1	. 1 1 . . 1 1 1 1 1 1 . . 1 1 1 . . 2 . . 1 1 1 1 1 . 1 . 1 1 . 1 . . 1 . 1
Hermannia modesta -hl	. . . . 1 . . . 1 1	1 . . . 1 . 1 . . . 1 . 1 . 1 . . 1 . . . . 1 1 . 1 . . . 1 1 . . 1
Geigeria acaulis -hl	. . 1 . . . . 1 . 1 . . 1 1 . 1 1 1 1 1 1 . . 1 . 1 . . . . 1 . 1 . . 1 1	1 . . . 1 . . 1 . . . . 1 1 . 1 1 1 1 . . . .
Indigofera hochstetteri -hl	. . . . 1 . . 1 1 . . . . 1 . . . . 1 . . 1 1 1	1 . 1 . 1 1 . . . 1 1 1 1 1 . 1 1 . . . . 1 . . 1 . . . .
Hermbstaedtia odorata -hl		. . . . 1 . . 1 . . . .
Limeum fenestratum -hl	. . . . 1 1 . . . 1 . . . . . . 1 . 1 . . 1 . . 1 . . 1 . 1 . 1 . 1 .	1 . 1 1 . . . . . . 1 . 1 1 . 1 3 . . 1 . . . . 1 1 . . . .
Kohautia caespitosa -hl	. . . . 1	. . . . 1 . . 1 . . . 1
Eragrostis biflora -hl	. . . . 1 . . . 1 1	1 . . . 1 . . 1 . . . 1 1 . . 1 . . . .
Acrotome fleckii -hl	. 1 . 1 1 . . . . 1 . 1	. . . . 1 1 . . 1 . . . . 1 . . . .
Ehretia rigida -s2	. 1 1 1 . . 1 1 1 . 1 1 1 1 . 1 . 1 . 1 1 1 . . 1 1 . . 1 . 1 . . 1 1 1	1 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 . . . . 1 1 1 1 1 1 . 1 . . . 1 1 .
	. . 1 1 . . . . . 1 1 1 . 1 . . . . . 1 . 1 1 1 . 1 1 . . 1 1 1 . . . . . 1 . . 1	1 . . . . 1 . . . . 1 . . 1 .

Hermannia rautanenii -s2	. . . . 1 . . . . 1 . 1 . 1 3 1 . . 1 . . 1 . .	. . . . 1 . . . .
Acalypha indica -hl	. . . . 1 . 1 1	1 . . . . 1 . 1 . . . . 1 . . . . 1 . 1 . .
Aristida effusa -hl	. . 2 1 . . . 1 . . 1 1 1 1 . 1 . . . . . 1 . . . 1 . 1 . 1 . 1 6	. . . 1 1 1 . 1 . . 1 1 . . 1 1 1 . . . . 1 . . . . . . 1 1
Setaria verticillata -hl	. . . . 1 . 1 . 1 . . . . 1 . . . . 1 1	1 . . . . 1 . . . . 1 1
Seddera suffruticosa -s2	. . . . 1 . . . . 1 . 1 1 1 1 1 1	. . . .
Lantana angolensis -s2	. . . . . . 1 1 . . . . . 1 . . . . 1 . . . . 1 1 . 1 1 .	. . 1 . . . . 1 1 . 1 . . . . 1 1 . . . .
Monelytrum luederitzianum -hl	. . . . 1 . . . 1	. . . . 1 5 . 1 1 1 . . . .
Hibiscus elliottiae -s2	. . . . 1	1 1 . 1 . . . . 1 . . . 1 . . . . 1 . 1 . . .
Jatropha erythropoda -hl		. . . .
Cyphostemma congestum -s2		. . . . 1 . . 1 1 . . 1 . . . . . . 1 . . . 1 . . . 1 .
Ruelliopsis damarensis -hl		1 . . . . 1 . . 1 1 . . . . 1 . . .
Xenostegia tridentata -hl		. . . .
Dactyloctenium aegyptium -hl		. . . . 1 1 . . . .
Hibiscus calyphyllus -s2	. . . . 5 . . 1 1 1 . . 1 . . . . 1 1	1 1 1 . . 1 . . . . 1 . 1 1 . 5 1 1 1 . . . . 1 1 . . . . 1 1 1 1 1 1 . 1
Kyllinga alba -hl		. 1 . . . . 1 . . . .
Tarchonanthus camphoratus -s2		. . . .
Petalidium ramulosum -s2		. . . .
Blepharis leendertziae -hl	. . . . 1 . 1	. . 1 . . 1 . 1 1 . . . . 1 . . 1 . . . . . 1 . 1 1 . . . 1 1 1
Tribulus terrestris -hl	. . . . 1	. . . . 1 . . . .
Lapeirousia bainesii -hl		. . . . 1 . . . .
Enneapogon scoparius -hl		. . . .
Hibiscus schinzii -hl	. . 5	. . . .
Dactyliandra welwitschii -hl	. . . . 1	. . . 1 . . . 1 . . . 1 . . . .
Citrullus lanatus -hl	. . . . 1	. . . .
Cleome hirta -hl	. . . . 1	. . . .
Boophane disticha -hl	. . . . 1	. . . .
Chamaecrista absus -hl		. . . .
Monechma divaricatum -s2		. . . .
Acacia erubescens -s1		. . . .
Heteropogon contortus -hl	. . . . 1	. . . . 1 . . . .
Grewia flavescens v. olukondae -s2		. . . . 1 .
Gossypium triphyllum -s2		. . . . 1 1 . . 1 . . . . 1 . . . .
Mollugo cerviana -hl	. . . . 1 1 . . 1 . . . . 1	1 . 1 . 1 . . . 1 1 . 1 1 1 . 1 . . . . 1 1 1
Bidens biternata -hl	. . . . 1 1 . . . . 1 . .	. . 1 . . 1 . . . . 2 . 1 . . . . 1 . . 1 1 . . . . .
Pergularia daemia -hl	. . . . 1 . . . . 1 . . . . 1	. . . .
Chamaecrista biensis -hl	. . 1 . . . . 1 1	. 1 . . . .
Indigofera charlieriana -hl	. . . . 1 . . . . 1 . . 1	. . . . 1 . . . . 1 1 1
Acrotome inflata -hl	. . . . 1 . . . . 1	1 . 1 . . . . 1 . 1 1 . 1 1 . 1 . . . . 1 . 1 1 . . . . 1 2
Albizia anthelmintica -t3	1 . . . 1 1 3 1 4 5 . 1 . . . . 1 1 2 . . 1 2 1 1 2 1	. . . . . . 5 . . . . 1 . . . . 2 . . . . . . 5 2 . 1 . . . 1 5 . . 1 . .
Erucastrum arabicum -hl	. . . . 1 . 1 1 . 1 1 . . . . 1 1 . . . . 1 1 1 1 1 1 1	. . 1 . . . 1 1 . 1 1 1 1 1 . . 1 . . . . 1 . . 1 . . . .
Acacia tortilis -s2	. . . . 1 . . . . 1	. . . . 1 . . . . 1 . . . . . .
Ornithoglossum viride -hl		. . . . 1 . . . . 1 1 .
Lycium bosciifolium -s2		. . . .
Hermannia quartiniana -hl		. . . . 1 . . . . 1 . . . .
Ophioglossum polyphyllum -hl	. . . . 1 1	. . . . 1 . .
Combretum imberbe -t3		. . . . 2 . . . .
Heliotropium marifolium -hl	 1	. . . . 1 1 . . . . 1 . .
Schmidtia kalihariensis -hl		. . . . 1 . . . . .
Pechuel-Loeschea leubnitziae -s2		. . . . 1 . . . .
Portulaca kermesina -hl	. . . . 1	. . . . 1 . . 1 . . . .
Digitaria velutina -hl		. . . . 1 1 . 1 1 1 . . . . 1 . . . 1
Sida ovata -s2	. . . . 1	. . . . 1 . . . . 1 . . . .
Eragrostis superba -hl		. . . . 1 . . . .
Merremia palmata -hl	. . . . 1 . . . 1	. . . . 1 1 . . . .
Rhus marlothii -s1		 1
Ozoroa paniculosa -s2		. . . .
Hibiscus palmatus -hl	. . . . 1 1	. . . . 1 . 1 1 . . . . 1 . . . .
Schkuhria pinnata -hl		1 . . . . 1 . . . .
Ruellia sp nova -hl		. . . . 1 . . . .
Raphionacme velutina -hl		. . . .
Corallocarpus welwitschii -hl		. . . .
Indigofera holubii -hl		. . . . 1 . . . .
Crassula rhodesica -hl		. . . .
Sporobolus festivus -hl		. . . .

Cucumis species -hl	.........1..............1..........1.....	....
Kyllingiella microcephala -hl		...................................1.
Kleinia longiflora -s2		....
Tagetes minuta -hl		.........1...........................
Pegolettia senegalensis -hl		....
Acacia species -sl	...........11.............................	......11.....1.......................
Portulaca oleracea -hl		...................1.................
Cyperus amabilis -hl		....
Justicia anselliana -hl		....
Acacia senegal -s1	................2.........................	1
Helichrysum candolleanum -hl	...1......................................	....
Heliotropium ciliatum -hl	.....................1.....1..............	....
Solanum nigrum -s2	.................1........................	..............................1......
Stipagrostis hirtigluma -hl	..............1...........................	......................1...12.........
Barleria senensis -s2	.............2............................	....
Tephrosia dregeana -hl	.................1........................	....
Aizoon virgatum -s2	.............1............................	....
Becium filamentosum -hl	............1.............................	1.....................1...1.........1
Cheilanthes viridis -hl		.....2...............................
Ozoroa insignis -t3		....
Maerua parvifolia -s2	............1.............................	........1..1.........................
Hibiscus caesius -s2	................1.........................	....
Gladiolus permeabilis -hl	................1.........................	..................................1..

Table 27

TWINSPAN TABLE

association	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	8	8	8	8	8	8	8	8	8	8	8	8
Unique relevé nr.	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	4	8	8	8	8	8	8	8	8	8	8	8	8
	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	0	5	5	5	5	5	5	5	5	5	5	5	5
	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	2	2	2	2	2	2	2	2	2
	0	0	0	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	9	9	8	8	8	8	7	7	7	7	7	7	7	7	6	6	6	6	6	5	3	2	2	1	3	5	0	0	9	9	9	9	9	8	8	7	7
	8	7	6	6	5	4	3	2	1	0	9	8	7	6	5	4	3	2	1	9	7	6	5	4	3	1	0	9	8	8	7	6	4	7	6	5	4	3	2	1	0	9	8	7	6	5	6	3	7	6	6	9	3	7	5	9	8	7	6	2	1	0	9	8
diagnostic spp association 6																																																																
Monechma genistifolium -s2	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia mellifera -s2	.	.	.	.	1	1	1	.	.	2	.	5	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	1	.	.	.	.	1	2	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.
Aptosimum lineare -hl	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Grewia flavescena v. flavescens -s2	1	.	.	.	1	.	.	.	.	1	.	.	1	.	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Lycium oxycarpum -s2	1	.	.	.	.	1	1	.	.	1	.	.	1	1	1	1	1	.	1	1	.	.	1	.	.	.	1	1	1	1	.	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Chenopodium amboanum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Albizia anthelmintica -s2	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tetragonia calycina -s2	1	.	.	1	.	.	1	1	.	1	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	1	.	1	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.
Sida cordifolia -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	5	.	.	.	.	1	.	.	.	.
Vigna species -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Commelina livingstonii -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia reficiens -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leucas martinicensis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Achyranthes aspera v. sicula -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leucas pechuelii -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis lehmanniana -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phaeoptilum spinosum -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tricholaena monachne -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.
Eragrostis annulata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Catophractes alexandri -s2	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Urginea sanguinea -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sericorema sericea -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Solanum capense -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cucumis kalahariensis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia hebeclada -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.
Enneapogon desvauxii -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Grewia schinzii -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ipomoea oblongata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
diagnostic spp association 7																																																																
Eragrostis jeffreysii -hl	2	5	1	5	6	6	6	6	.	5	1	1	1	1	1	5	1	1	1	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	6	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Aristida rhiniochloa -hl	.	.	.	.	1	1	1	1	.	.	1	1	.	.	1	1	1	1	1	.	1	.	1	1	.	.	.	.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	.	1	5	.	.	.	.	1	.	.	.	.	.	.	.	1
Cucumis anguria -hl	1	1	.	1	1	1	.	.	1	1	.	1	.	.	1	1	1	1	1	1	.	1	1	1	.	.	1	.	.	.	.	1	.	1	1	1	1	1	1	.	1	1	.	.	1	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.
Eragrostis rotifer -hl	.	.	.	.	.	2	1	1	5	.	.	.	.	.	1	6	.	.	1	.	.	.	.	1	.	1	.	.	1	1	.	.	1	1	.	1	.	1	1	1	.	1	5	.	1	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Limeum argute-carinatum -hl	.	.	.	.	.	1	1	1	1	.	.	.	.	.	.	.	.	1	.	.	.	.	1	1	1	1	1	1	1	1	.	1	1	1	1	1	.	1	.	.	1	.	.	.	.	1	1	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	1
Acacia tortilis -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	1	.	.	.	.	.	.	2	1	.	1	.	.	.	1	.	1	1	1	1	.	1	.	.	1	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Nelsia quadrangula -hl	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Achyranthes aspera v. aspera -hl	1	.	.	.	.	.	.	.	.	.	.	1	1	.	1	1	.	1	1	.	.	.	.	.	1	1	1	1	1	1	.	.	1	1	1	.	.	.	.	1	.	.	.	.	1	1	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.
Acacia tortilis -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Phaeoptilum spinosum -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Panicum coloratum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Lotononis platycarpa -hl	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	1	1	1	1	.	.	.	1	.	.	.	1	.	1	1	1	1	1	1	1	1	.	1	1	.	.	.	.	1	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis cylindriflora -hl	6	.	.	.	.	6	6	5	.	1	5	6	.	7	1	.	.	1	.	1	.	.	1	1	1	.	1	1	1	7	6	1	5	1	5	1	5	1	6	7	.	7	7	5	1	6	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.
Indigofera vicioides -hl	.	.	.	1	1	1	1	1	1	.	.	1	1	1	1	.	1	1	1	.	.	.	1	1	.	1	1	1	1	.	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Xerophyta humilis -hl	1	.	.	.	.	1	.	.	.	.	1	.	1	.	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ziziphus mucronata -s1	.	1	.	.	.	.	.	.	.	.	.	1	1	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	1	1	1	.	.	.	.	.	.	.	1	.	.	1	1	1	1	.	.	.	1
Panicum maximum -hl	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	1	.	.	1	.	1	1	.	1	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
Solanum catombelense -s2	.	.	.	.	1	1	.	.	1	1	.	.	1	.	.	.	1	1	.	.	.	.	1	.	1	.	.	1	1	.	.	.	1	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis nindensis -hl	1	1	.	.	.	.	.	.	.	.	.	1	1	1	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.
Blepharis integrifolia -hl	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	1	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Chenopodium olukondae -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Crotalaria steudneri -hl	.	.	.	.	1	.	.	.	.	.	.	1	.	1	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Blepharis mitrata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	1	.	1	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ziziphus mucronata -s2	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.

Amaranthus thunbergii -hl	. . . . . . 1 . . 1 . . . . . 1 . . . . 1 . . . . 1 . . . . . . 1 . 1	. . . .
Lotononis listii -hl	1 1 . . . . 1 . . . . . . 1 . 1	. . . .
Platycarpha carlinoides -hl	. . . . . 1 . . 1 . . . . . . 1 . . 1	. . . .
Dicoma capensis -hl	. . . . 1 . . 1 . . . . 1 . . .	. . . .
Solanum dinteri -s2	. . . . 1 . 1 1 1 . 1 . . . . 1 1 1 .	. . . .
Acacia hebeclada -s2	. . . . 1 1 .	. . . .
Panicum stapfianum -hl	. . . . 1 1 . . . . 1 1 1 1 1	. . . .
Craterostigm plantagineum -hl	. . . . 1 1 1 . . . . 1 . . . . 1	. . . .
Cymbopogon plurinodis -hl	. . . . 1 1 . . . . . 1 . . 1 1 1	 1
Cyperus cuspidatus -hl	1 1 . . . . 1 . 1 1	. . . .
Solanum supinum -s2	. 1	. . . .
Urochloa trichopus -hl	. . . . 1 . . . . 1 . 1 . . . . 1 1 1 1 1	. . . .
Andropogon chinensis -hl	. . . . 1 . . 1 . . . 1 . . . . . 1 . . 1 1 1 .	. . . .
characteristic spp ass 6 and 7		
Ondetia linearis -hl	1 . . 1 . 5 1 1 1 2 . . . 1 1 1 5 1 1 . . . . 1 1 1 1 . . 1 1 1 1 1 . 1 1 1 1 1 1 1 . 1 . .	. . . .
Blepharis obmitrata -s2	. . . . 1 1 1 . . . . 1 . .	. . . .
Eragrostis echinochloidea -hl		. . . .
Peliostomum leucorrhizum -hl	. . . . 1 . . . . . 1	. . . .
Aristida meridionalis -hl	1 1 1	. . . . . . 6 . . . . .
diagnostic spp association 8		
Acacia erioloba -t3		. 1 . 5 1 2 . 5 5 5 6 5
Asparagus africanus -s2	. . . . 1 . 1 . . . . 1 1 1 . . 1 . . . . 1 . . . . 1 . . . 1 . 1 1 . . .	. 1 . 1 . . . 1 . 1 1 1
Neoradtenenia mitis -s2	. . 1 . . . . 1	. . . 1 . . . 1 1 1 1 1
Hermannia tomentosa -hl	. . . . 1 . . . 1	1 . 1 1 . 1 . 1 . 1 . 1
Crotalaria podocarpa -hl	. 1 1 . . . . 1 . 1 . . . . . . 1 . . . . 1 . . 1	. . . 1 . . . 1 1 1 . .
Eragrostis dinteri -hl	. . . . . . 1 . . . . 1 . . 1 1	. . . . 1 . .
Harpagophytum procumbens -hl	. . . . 1 . . . . 1 1 . . 1 . 1 1 . . . . 1	. 1 1 . . . . . . 1 . .
Kohautia cynanchica -hl	. . 5 . 1 . . . . 1 1	. . . 1 5 2 . . . . . .
Ipomoea crassipes -hl	1 . . . . 1 1 . . . . . . 1 . 1 . . . . . . 1 . . . 2	. . . 5 1 . . . .
Rhigozum brevispinosum -s1	. . . . 1 . . . . . . 1 . . . . 1	. 1 1 . . . .
Helinus spartioides -s2	. . . . 1 . . . . 1	. . . .
Requienia sphaerosperma -hl		. . . . . 1 . . 1 . . .
Oxygonum alatum -hl	1 1 . . . . 1 . . 1 . . 1 1 . . 1 . 1 . . . . 1	. . . .
Sesamum capense -hl	. 1 . . 1	. . . . 1 . . 1 .
Indigofera alternans -hl	. . 1 . . . . 1 1 1	. . . 6 6 2 . 2 . . . .
Tephrosia purpurea -hl	. . . . 1 . . . . 1 . 1 . . . . 1	. . . .
Eragrostis omahekensis -hl	. . . . 1	. . . .
Terminalia sericea -t3		1 6 4 . 1 2 . . . . . .
Limeum myosotis -hl	. . . . 1 . 1 . .	. . . .
Crotalaria sphaerocarpa -hl	. . . . 1	. . . .
Terminalia sericea -s1		. . . . . 1 . . . . . .
Zornia glochidiata -hl		1 . . . .
Bothriochloa radicans -hl		. . . .
Acacia erioloba -s1		. . . .
Lycium bosciifolium -s1	. . . . 1	. . . . 2 2 . 5 2
Rhigozum brevispinosum -s2	. . . . 1	. . . .
Ipomoea hackeliana -hl	. . . . 1	. . . .
Tephrosia lupinifolia -hl	. . . . 1	. . 1 . . . .
Acacia erioloba -s2		. . . 1 . . . .
Terminalia sericea -s2		. 1 . . . 1 . . . . . .
characteristic spp ass 6, 7 and 8		
Aptosimum angustifolium -hl	. . . 1 1 1 . 1 . 1 . . . . 1 . . 1 . 1 . . . . 1 1 1 . . . 1 . . 1 1 1 . 1	. . . 1 . . 5 . 1 . . 1
Gisekia africana -hl	1 1 . 1 1 . 1 1 1 . . . . 1 . 1 1 1 1 . 1 . 1 . 1 . . . . . . 1 . . . . 1 . . .	. 1 1 . 1 1 1 1 1 1 1 1
Felicia anthemidodes -s2	. . . . 1 . 1 . 1 . . . . . 1 . . . 1 . . . . . . 1 1 1 1 . 1 1 1 . . . . 1 1 . . . . . 1 . .	. 1 1 1 . 1 1
Crotalaria pisicarpa -hl	1 1 1 1 . . . . . 1 . . . . . . 1 . 1 . 1 1 . . . . . . 1 1 . 1 . 1 1 . . . . . . 1 . . . . . . 1 . . 1	. . . .
Hibiscus fleckii -hl	1 . . . 1 1 . . . 1 1 1 . . . . 1 . . 1 . . . 1 . 1 . 1 . . . . . 1 . . . . 1 .	. . . .
Abutilon austro-africanum -s2	. . . . 1 . 1 1 . . . . 1 1 . 1 . . . . 1 . . . . . . 1 . . . . 1 . 1 . . . 1 . 1 1 .	. . . . . 1 1
Ipomoea bolusiana -hl	. . . . . 1 . 1 . 1 1 1 . . . . 1 . 1 . . . . 1 1	. . . . 1 1 .
Solanum burchellii -s2		. . . 1 . . . 1 . . . 1
Tarchonanthus camphoratus -s1	. . . . 1 1 1 1 . . . . 1 . . . . 1 1 1 . 1 1 . . 1	. 1 . . 1 1 1 . . . . .
Maerua juncea -s2		. 1 . . 1 . 1 . . 1 . 1
Waltheria indica -hl	1 1 . . 1	. 1 2 . . . .
Anthephora schinzii -hl	. . . . 1 . . . . 1 1 5 1 .	. . . .

Species	Relevés (left group)	Relevés (right group)
diagnostic spp association 9		
Grewia bicolor -s1		1 . . . .
Lonchocarpus nelsii -t3		1 . . . .
Vernonia poskeana -hl	. . . . 1 . . 1 1	. . . . 1 . . 1 1 . . .
Solanum kwebense -s2		. . . .
Combretum apiculatum -s1	1 1 . . . . 1 1 1 1	. . . .
Grewia flavescens v. olukondae -s1		. . . .
Megalochlamys marlothii -s2	. . . . 1 . . 1 1 . 1 . . . . 1 . . 1 1 . . . . 1 1 . . . 1 . .	. . . .
Ipomoea verbascoidea -s2	. . . . 1	. . . .
Albizia anthelmintica -s1	. . . . 1	. . . .
Clerodendrum ternatum -s2		. 1 . . . . . . 1 1 1 2
Eragrostis viscosa -hl	. . . . 1 . . . . 1 1 1	. . . .
Acacia fleckii -s1	. . . . 1 . . . . 1	2 6 6 1 4 1 . . . . . .
Grewia flavescens v. flavescens -s1	. 1 . 1 . . . . 1 . 1 1	. . . .
Corchorus tridens -hl	. . . . 1 . . . . 1 . .	. . . .
Asparagus cooperi -s2	. . . . 1	. 1 . . . .
Euphorbia crotonoides -hl	. . . . 1	. . . .
Aptosimum decumbens -hl		. . . .
Setaria pumila -hl	. . . . 1 . . . . 1	. . . .
Microchloa caffra -hl	1 . . . . 1 . 1 . . . . 1 1 1 . . . . 1 1	. . . .
Grewia retinervis -s1		5 . . . .
Clerodendrum uncinatum -s2		. . . .
Commiphora angolensis -s2	. . . . 1	. . . .
Momordica balsamina -hl	. . . . 1 . 1 . . . . 1	. . . .
Helinus integrifolius -s1	. . . . 1	. . . .
Oxalis purpurascens -hl	. . . . 1	. . . .
Urochloa oligotricha -hl	. . . . 1 1 . . 1 . .	. . . .
Terminalia prunioides -s1		. . . .
Boscia foetida -s1		. . . .
Commiphora glandulosa -s1		. . . .
Solanum delagoense -s2	. . . . 1 . . . . . 1	. . . .
Talinum crispatulum -hl		. . . .
Brachiaria malacodes -hl	. . . . 1 . . . 1	. . . .
Commiphora africana -s2		. . . .
Tylosema esculentum -hl		. . . .
Helinus integrifolius -s2	. . . . 1 1	. . . .
Acacia fleckii -s2		. . . .
Lonchocarpus nelsii -s1		. . . .
Grewia bicolor -s2	. . . . 1 .	. . . .
Lonchocarpus nelsii -s2		. . . .
Commiphora tenuipetiolata -s1		. . . .
Commiphora africana -s1		. . . .
Terminalia prunioides -t3		. . . .
Combretum apiculatum -s2	1 . . . . 1	. . . .
Commiphora tenuipetiolata -t3		. . . .
Aristida pilgeri -hl	. . . . 1 1 . . . . 1	. . . .
characteristic spp ass 8 and 9		
Acanthosicyos naudinianus -hl	. . . . 1 . . . . 1 . . 1 1 1 1	1 1 1 1 1 . . 1 . . . .
Commiphora pyracanthoides -s2	. . . . 1 1 . . . . . 1 1 . 1 . . . . 1	1 . 1 1
Bulbostylis hispidula -hl	1 1 1 . . 1 . . . . . . 1 . . 1 1 1	. . 1 . . . . . 1 . . .
Commiphora angolensis -s1		. . . .
Aristida stipitata -hl	. . . . 1	. . . .
Rhynchosia totta -hl		. . . .
common spp TWINSPAN group 2		
Stipagrostis uniplumis -hl	1 1 8 5 5 1 . 2 . 5 1 . 5 5 1 . 1 1 . 7 6 7 7 5 5 7 5 7 7 . . 6 1 6 6 1 1 1 . 1 5 1 . . 1 . 5 1 7 . 6 7	6 2 5 6 7 7 6 7 7 8 8 7
Acacia mellifera -s1	5 . 2 2 5 . 1 1 . . 5 1 1 2 5 1 1 5 1 5 . 5 5 5 5 1 7 5 5 5 5 2 5 1 5 3 1 1 1 5 3 5 5 7 1 1 . 1 1 2 . 5	6 5 2 6 5 5 5 5 7 7 5 6
Talinum arnotii -hl	1 . 1 1 . 1 1 . . 1 1 . . 1 . . 1 1 . . . 1 . 1 1 1 1 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 . . 1 1 1 1 1 1 1 1	. 1 1 1 1 1 1 1 1 1 1 1
Boscia albitrunca -t3	5 2 1 1 1 1 . 1 1 1 1 . . 1 1 . . . 1 . 1 1 . . 3 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 1 . 1 . 1 1 1 1 1 1 1 1	. 1 . 4 1 2 3 1 1 1 3 5
Urochloa brachyura -hl	. 1 . 1 1 . . . 1 1 1 . . 1 . . . . 1 1 . 1 1 . . . . . 1 . . 1 1 1 1 . 1 . . . . 1 1 1 1 1	1 1 2 2 1 1 1 5 2 1 1 1
Pogonarthria fleckii -hl	6 7 1 5 5 1 . 1 1 5 1 1 1 1 1 1 1 1 1 1 1 1 1 . 1 1 1 1 1 . 1 1 1 1 1 1 1 1 1 1 . 1 1 1 1 . 1 . 1 1 1 1	. 1 5 1 1 1 . 1 1 1 1 .
Eragrostis porosa -hl	1 . 1 5 1 1 1 1 . 1 1 5 1 1 1 1 1 1 1 1 1 1 1 1 5 1 . 1 1 . . . . 1 . . . . . 1 6 1 1 1 1	5 1 5 1 1 . . . 1 1 1 1
Melinis repens s. grandiflora -hl	5 5 1 1 1 1 . 1 5 1 5 5 6 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 1 . . . 1 1 1 1 1 1 1 1 . 1 1 1 . 1 . 1 1 1 6 1	. 1 1 1 5 2 1 6 5 1 1 5
Enneapogon cenchroides -hl	1 . . . 1 1 1 1 . . 1 1 1 1 1 . 1 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . 1 1 . 1 1 1 1 1 1 6 1	. 1 1 . . 1 1 1 1 . 1 1
Eragrostis rigidior -hl	. 1 1 1 1 . 1 1 6 5 . . . . 1 1 1 1 1 1 5 1 . 1 . 1 1 . 1 1 1 1 . . 1 6 1 . 1 7 . 1 . 1 . . 1	. 6 2 5 5 7 1 1 5 . . 2

Lycium eenii -s2	1 . 3 1 1 1 1 1 1 1 1 . 1 1 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 . 2	. 1 5 1 1 1 2 1 1 1 2
Grewia flava -s1	. . 5 . . . . . . 1 . . 1 1 . . . . 1 2 . . 1 . 5 . . . . 1 1 . 1 . . . . 1 . . . 1	1 1 1 4 1 1 5 2 1 . 1 5
Evolvulus alsinoides -hl	1 1 1 1 1 1 1 1 . 1 1 1 1 1 . 1 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . 1 1 . 1 1 1 . . . 1 1 1 1 . 1 1 1 1 1	1 1 1 1 1 1 . . . 1 1 1
Otoptera burchellii -s2	. . . . 1 . . . . 1 1 . . . 1 . 1 . 1 .	. . . 2 . . . . . 1 1 1
Aristida congesta -hl	1 2 1 7 1 6 5 2 . 5 5 1 1 1 1 5 6 6 7 1 2 1 1 1 . 1 1 . 1 5 5 5 7 7 6 7 7 7 1 6 6 1 1 5 1 1 5 1 1 1 1 1	. . 1 5 5 2 5 5 2 1 . 5
Ptycholobium biflorum -s2	. . 1 1 1 1 . 1 . 1 1 1 1 1 1 . 1 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 1 1 1 1 . 1 1 1 1	. . . 1 . 1 1 . 1 1 1 .
Heliotropium steudneri -s2	1 1 1 . . 1 1 1 . . . . 1 . . . . . . 1 . 1 . 1 . . 1 . . 1 . . 1 . . 1 . . . . . . 1 . 1 1 1 .	. . 1 . . 1 . . . 1 1 1 1
Schmidtia pappophoroides -hl	. . 1 . . . . . 1 . . . . 1 . . 1 . . 1 . 1 1 . 1 6 1 1 5 1 1 1 1 1 1 1 1 1 1 . . . 1 1 . 1	. 1 . . . 1 1 . 1 1 . .
Cleome rubella -hl	1 1 . 1 1 . 1 1 . . . 1 1 1 . . 1 1 1 . . . . . 1 . 1 1 1 . . . 1 . . 1 1 1 . . . . 1 . 1 1 . 1	1 . 1 1 . . . . . . 1 .
Indigofera rautanenii -s2	1 . 1 1 . 1 . 1 1 1 1 1 1 . 1 . 1 1 1 . . . 1 1 1 1 1 1 . . 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . 1 1 .	. . 1 . 1 . 1 . 1 . 1 1
Aristida adscensionis -hl	2 . . 1 5 1 2 6 . 1 1 5 . 5 6 1 1 5 1 1 1 1 1 1 . . 1 1 1 1 . 1 1 1 1 1 5 6 5 1 1 5 1 1 1 1 1 1 . 1 1 1	1 . 1 . . . . . . 1 . 1
Chascanum pinnatifidum -s2	1 . 1 1 1 1 . . . 1 . . 1 1 . . . . 1 . 1 1 1 1 . . . . 1 1 1 1 . . . 1 . . . 1 . 1 . . . 1 .	. . . . 1 . 1 1
Ipomoea sinensis -hl	1 1 1 . . . 1 1 1 1 1 1 1 . 1 1 . . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . 1 1 1 1 1 . 1	. . 1 . . . . . 1 1 . 1
Chloris virgata -hl	1 . 1 . 1 . 1 . 5 1 1 1 1 1 . 1 1 1 1 1 1 1 1 1 1 . . 1 . 1 1 1 1 1 1 1 . . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 6 1	. 1 . 1 . 1 5 1
Eragrostis trichophora -hl	. . 1 5 6 5 5 5 1 5 1 1 . . 1 1 . . 1 1 1 1 5 1 5 . . . 1 5 5 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . 1 6 1 4	2 2 5 . . 1 1 . 2 . . 1
Commelina benghalensis -hl	1 1 1 . 1 . 1 1 1 1 1 . 1 1 . 1 1 1 1 1 1 . 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 1 1 1 . 1 1 . 1 1 . . . 1 . 1 1	. 1 1 . 1 . . 1 . . 1 .
Ipomoea obscura -hl	1 . . 1 1 1 1 1 1 1 1 1 . 1 1 . 1 1 . 1 . . . . 1 . . . . 1 .	. 1 1 1 1 1 1 . . . 1 1
Dichrostachys cinerea -s1	5 6 5 5 2 5 3 5 6 5 7 5 7 6 6 6 5 2 3 . . . . . 1 . . . . 1 . . . 1 . . . 1	. 2 1 . 1 . 1 1 1 . . 2
Oxygonum sinuatum -hl	1 1 . . . . 1 . . . . 1 . . 1 1 . 1 . . . 1	. . 1 1 1 1 . 2 1 1 1 .
Acacia hebeclada -s1	. 2 . 1 . . . . . 2 . . . . . . 1 1 1 . . . . 1 1 . . 1 . . . . 1 1 1 . . . 1 1 . 1 1 1 1	2 . . 5 5 1 5 2 3 . . 1
Lindneria clavata -hl		. 1 . 1 . 1 . . . . . .
Ocimum americanum -hl	1 . 1 1 . 1 1 1 1 1 1 . 1 . . . 1 1 1 1 1 1 . 1 1 . 1 . 1 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . . 1 1 1	1 . 5 1 . . 1 . . . . .
Catophractes alexandri -s1	5 5 . 1 . . . . 1 . . 1 . 1 . 1 1 1 3 . . 1 . 1 . 1 . 1 . . . . 1 1 . . . . . . 1 . . . 2 4	. . . . 1 . 1 . .
Phyllanthus maderaspatensis -hl	. 1 . . . . 1 . . 1 1 . . . . 1 . . 1 . . . . 1 . 1 . . . 1 . . 1 1 . 1 . . . 1 .	1 . . 1 1
Boscia albitrunca -s2	. . 1 . . 1 1 1 . . . . 1 1 . . 1 . . 1 . . . . . . 1 1 1 . . . . . . 1 . . . 1 . 1 . . 1 . 1 . 1 1 1 . 1	. 1 . 1 1 1 . . 1 . . 1 1
Pupalia lappacea -s2	. . 1 1 . . 1 . 1 1 . 1 1 1 1 . 1 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 1 . 1 1 1 1	1 . . 1 . 1 1 . 1 . . 1
Kyphocarpa angustifolia -hl	. 1 . 1 1 1 1 1 . 1 1 1 1 1 1 1 1 1 1 . 1 1 1 . 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . . 1 1	. . . . . 1 1 1 1 . . .
Tragus berteronianus -hl	. . . . . 1 . . . . . 1 . . 1 1 . . 1 . . 1 . . 1 . . 1 1 . . . 1 . . . 1 1 1 . . . . 1 1 . . 1	. . . . . 1 . . . 1 1 .
Nidorella resedifolia -hl	. . . . 1 . 1 . 1 1 1 1 . . . . . . 1 . . . . 1 . 1 1 . . . 1 .	. 1 . . . 1 1 . 1 1 1 1
Barleria lanceolata -s2	1 . . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . 1 1 . 1 1 . . 1 1 1 1 . . 1 1 1 1 1 1 . . 1 1 1 1 1 1 1 . 1 1 . 1 .	. 1 1 . . 1 1 . 1 . . .
Hirpicium gorterioides -hl	. 1 . . 1 . . . . 1 . . . . 1 . 1 1 1 . . . 1 . . 1 1 . . 1 1 1 . 1	. . 1 . 1 1 . 1 1 . . .
Geigeria ornativa -hl	. . . 1 1 . 1 . 1 1 . . . . 1 1 1 1 1 1 1 . 1 1 . 1 1 . 1 1 1 . . . 1 1 1 1 1 . 1 1 . 1 . . .	. . 1 . . 1 . . 1 . . 1
Pollichia campestris -s2	. . . . 1 . . . . 1 . . . . 1 . . 1 1 . . . . 1	. . . 1 1 . 1 1
Ehretia rigida -s1	. . . . 1 . 1 1 . 1 . . . . 1 . 1 1 1 . . . . 1 . . . . 1 . . 1 . 1 . . . 1 . 1 . 1 . . 1 . . .	. . 1 1 1 1 . 1 . . 1 .
Dicoma tomentosa -hl	1 1 1 . . . . 1 . . . . 1 1 . . . . 1 1 1 1 1 . . . . . 1 . . 1 . . . 1 1 1 1 1	. . 1 . . . . . 1 . 1 .
Leucosphaera bainesii -s2	. . 1 . . 1 1 . 1 1 . 1 . 1 . . . . 1 . 1 1 . . 1 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 . 1 . 1 1 1 1 1	. 1 1 1
Grewia flava -s2	. . . 1 1 1 . 1 . 1 1 . . 1 . . . . 1 1 . . 1 1 . 1 . 1 1 1 1 . 1 1 . . . . 1 . 1 . 1 1 1 . 1 1 1 1	. . . . 1 1 .
Lycium oxycarpum -s1	. . . . . . 1 1 . . . 1 . . . . . 1 . . . . . 1 1 1 . . . 1 . 1 1 . . 1 1 1 1 1 1 1 1 . 1 1 . 1	. . 5 . 1 1 1 . . . . .
Chamaesyce inaequilatera -hl	. . . . . 1 . . . . . 1 . 1 . 1 . . . . 1	. . . . 1 1 1 . 1
Pavonia burchellii -s2	. . 1 . . . . . . 1 . . . . . . 1 . . . . 1 . 1 1 1 1 . 1 . . . 1 1 . 1 . . 1 . . 1 1 . . . . 1 .	. 1 . 1 1 1 . . . 1 . 1
Cleome monophylla -hl	. 1 . . . 1 . . 1 . 1 1 1 . 1 1 . 1 1 1 . 1 1 1 . . 1 1 . 1 . 1 . 1 . . . 1 1 . 1 1 1 1 . . 1 1	. 1 1 . . . . . 1 . . .
Phyllanthus pentandrus -hl	. 1 . . 1 . . . 1 1 . 1 . 1 . . . 1 1 1 1 1 1 1 . . 1 . 1 . . . . 1 1 1 .	. 1 . . . .
Crotalaria heidmannii -hl	1 . . . . 1 . . . . 1 . 1 1 . . . . . 1 . . 1 . . . . 1 1	 1
Acacia reficiens -s1	6 1 2 . . 1 . . . 2 . . 2 1 1 1 1 1 1 1 1 1 1 1 . . . . . 1 . 1 2 1 1 . . . 1 . . 1 1 1 2 1 1 2 . . 1 . . .	1 . . . 5 5 2 . . . 1 .
Acacia reficiens -t3	. . . . . . 5 . 1 1 1 . 1 1 . . . 1 . 1 1 . 1 . . . . 1	. 1 . 4 . 4 1 5 . . . .
Brachiaria deflexa -hl	. . . 1 . . . . . 1 . . . . . . 1 . . . . 1 . . . 1 . . 1 . . . . . 1 . . . 1 . . . . 1 1 1 1 .	. . . . 1 . 1 . 1 .
Limeum sulcatum -hl	1 . . . . 1 . 1	. . . . 1 . . . 1 1
Cenchrus ciliaris -hl	. . . . 1 1 . . . . 1 1 . 1 . . . . . 1 . . . . . . 1 1 1 . . . . 1 . . 1 . . . . 1 . 1 . . 1 . . 1 .	. . . .
Melinis repens s. repens -hl	1 1 . . . . . 1 . 1 1 . . . . 1 . . . . 1 . . 1 2 . .	. . . . 1 . . . .
Boscia albitrunca -s1	. 1 . . 1 . . . . . . 1 . . . . . . 1 . 1 1 1 1 1 1 . . 1 1 1 1 1 1 1 1 1 1 1 . . 1 1 1 1 . . . 1 1 . .	. . 1 1 . . . .
Solanum incanum -s2	. . . . 1 . . . . 1 1 . 1 1 . . . 1 . 1 1 . . . . 1 . . . . 1 . 1 . 1 . . . 1 . .	. . . . 1 . 1 .
Dichrostachys cinerea -s2	. . . . 1 1 . . . . 1 1	. . . . 2 1 .
Raphionacme lanceolata -hl	. . . . 1 . . . . . . 1 1 . . 1 . . 1 . . . . 1 . 1 . . 1 . . . . 1	. . . .
Felicia smaragdina -hl	. 1 1 1 1 . . 1 . 1 1 . 1 . . . . 1 1 1 1 . 1 1 1 1 1 1 . 1 1 . . . . 1 . 1 1 . . 1 . . 1	. 1 . 1 . 1 1
Cyperus fulgens -hl	1 1 1	. . . . 1 . 1 1
Hermannia modesta -hl	1 1 . . . . 1 1 1 1 1 1 1 1 1 1 1 1 . . . . . . 1 . . . . 1 . 1 1 . 1 . . . . 1 1 . . . . 1 . . 1 1 . 1 . 1	. . . .
Geigeria acaulis -hl	1 . . 1 . . . 1 . 1 1 1 1 1 1 1 . 1 1 1 . . 1 . 1 . . . . 1 1 1 1 1 1 . . . . 1 1 . . 1 . . 1 1	1 . . . . 1 . . .
Indigofera hochstetteri -hl	. . . . 6 . . . . 1 . . 1 1 1 1 1 . . . . 1 1 . . . . 1 . 1 1 1 . .	. . . .
Hermbstaedtia odorata -hl	. . . . 1 . . . . 1 . 1 1 . . . . . 1 . . . 1 . . . 1 . .	. . 1 . . . . . 1 . . .
Limeum fenestratum -hl	1 1	. . . .
Kohautia caespitosa -hl	. 1 . . . . . 1 . 1 1 . 1 1 . 1 1 1 . . 1 . . . . 1 . 1 . . . . 1	1 . . . .
Eragrostis biflora -hl	. 1 . 1 . . . . 1 1 . 1 . . . 1 1 1 . 1 . 1 1 . 1 1 . . . . 1 . . .	. . . . 1 . . . .
Acrotome fleckii -hl	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . 1 . 1 1 . . . . 1 . . 1	. . . . 1 . . . .
Ehretia rigida -s2	1 . 1 . . 1 . . . 1 . . . . 1 . . . . . 1 1 1 . 1 1 1 1 . 1 . . . . . . 1 . 1 . 1 . . . 2 1 1	. . . .

Hermannia rautanenii -s2		....
Acalypha indica -hl	..........11......1.....................1..........	........1...
Aristida effusa -hl	...15...1111111.1111.1111.11....111.1111.....1....11	....
Setaria verticillata -hl	...........1...1..........1......1..1..........1..1.	......1.....
Seddera suffruticosa -s2	....1.	1..........1
Lantana angolensis -s2	.1.....1.1.....11.1................1...1.1........1.	....
Monelytrum luederitzianum -hl	............1................15.1......1..1......5..	....
Hibiscus elliottiae -s2	..11...1..1.111.1111.......111111..1...1111.11..11..	....
Jatropha erythropoda -hl	.............................1......................	....
Cyphostemma congestum -s2	.......1.1..1...1.1.....1.11.11...........1.........	..11........
Ruelliopsis damarensis -hl	...........1...1....................................	...1.1..1..1
Xenostegia tridentata -hl		.11.........
Dactyloctenium aegyptium -hl	......1.............1...............1...........11..	....
Hibiscus calyphyllus -s2	......1.1.11.111..11111....1.11.1..1....11111.......	........1.11
Kyllinga alba -hl	.................11.....................1.11........	....
Tarchonanthus camphoratus -s2	...........1.............11..1.1.1......1.1.........	.........1..
Petalidium ramulosum -s2		....
Blepharis leendertziae -hl		....
Tribulus terrestris -hl	1.....1.....................1.1.....11..............	....
Lapeirousia bainesii -hl		....
Enneapogon scoparius -hl	....1........	....
Hibiscus schinzii -hl	..........11.....1..................................	....
Dactyliandra welwitschii -hl	....1.........1.	....
Citrullus lanatus -hl	....1.................................1.............	....
Cleome hirta -hl		....
Boophane disticha -hl	...............................1...................1	....
Chamaecrista absus -hl		.11.........
Monechma divaricatum -s2	..........................1.......................1.	....
Acacia erubescens -s1	....1..1.......	....
Heteropogon contortus -hl	........1...................1.......................	....
Grewia flavescens v. olukondae -s2		2.........1.
Gossypium triphyllum -s2	....11....	....
Mollugo cerviana -hl	....1..1..1.11.1.1.....1..11..................11....	....
Bidens biternata -hl	....1.....1	....
Pergularia daemia -hl		....
Chamaecrista biensis -hl	....1...	..1.........
Indigofera charlieriana -hl	........1.1..1......................1..1.....11..1..	....
Acrotome inflata -hl	11..1...11.1...11.1......11......1.......1.111..111.	........1...
Albizia anthelmintica -t3	..11.111..1.111..11.................................	....
Erucastrum arabicum -hl	.....11.111...11.1.............1....1.1.1....1.1.1.1	....
Acacia tortilis -s2	..1......1......................1......1.....1......	....
Ornithoglossum viride -hl		....
Lycium bosciifolium -s2	..1................1............................111.	....
Hermannia quartiniana -hl	...........1.1......................................	....
Ophioglossum polyphyllum -hl	.......1..1...	...1........
Combretum imberbe -t3		6...........
Heliotropium marifolium -hl		....
Schmidtia kalihariensis -hl	.....................................1..............	....
Pechuel-Loeschea leubnitziae -s2	.....................1..........................1...	....
Portulaca kermesina -hl	...1..1...1...	....
Digitaria velutina -hl	....1...11....1....1....1..1..1.......1..1..1.......	..1.........
Sida ovata -s2		....
Eragrostis superba -hl	....1........	....
Merremia palmata -hl		...1........
Rhus marlothii -s1		....1.......
Ozoroa paniculosa -s2	11..	....
Hibiscus palmatus -hl	..1...	........1...
Schkuhria pinnata -hl	...............1....................................	....
Ruellia sp nova -hl		....
Raphionacme velutina -hl	....................................1........1......	....
Corallocarpus welwitschii -hl		....
Indigofera holubii -hl		....
Crassula rhodesica -hl	............1..1....................................	....
Sporobolus festivus -hl	.....1...........1.........................1........	....

Cucumis species -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kyllingiella microcephala -hl	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kleinia longiflora -s2	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tagetes minuta -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pegolettia senegalensis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia species -sl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Portulaca oleracea -hl	1	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyperus amabilis -hl	.	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Justicia anselliana -hl	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia senegal -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helichrysum candolleanum -hl	.	.	.	.	.	.	.	1	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Heliotropium ciliatum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Solanum nigrum -s2	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stipagrostis hirtigluma -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Barleria senensis -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tephrosia dregeana -hl	1	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aizoon virgatum -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Becium filamentosum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cheilanthes viridis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ozoroa insignis -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Maerua parvifolia -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hibiscus caesius -s2	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gladiolus permeabilis -hl	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 27
TWINSPAN TABLE

association	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Unique relevé nr.	85277	85276	85275	85274	85273	85272	85271	85270	85268	85265	85264	85263	85262	85261	85260	85259	85258	85257	85256	85255	85254	85235	85232	85231	85230	85229	85228	85227	85110	85108	85102	85057	85045	85039	85038	85037	85036	85023	85022	85021	85020	85047	85043	85041
diagnostic spp association 6																																												
Monechma genistifolium -s2	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia mellifera -s2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	1	.	.	.	1	.	1	.	1	.	.	.
Aptosimum lineare -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Grewia flavescens v. flavescens -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lycium oxycarpum -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	1	.	1	1	.	.	.	1	.	.	.	.	.	.	.	.
Chenopodium amboanum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Albizia anthelmintica -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tetragonia calycina -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sida cordifolia -hl	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vigna species -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Commelina livingstonii -hl	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Acacia reficiens -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leucas martinicensis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Achyranthes aspera v. sicula -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leucas pechuelii -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis lehmanniana -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phaeoptilum spinosum -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tricholaena monachne -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis annulata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Catophractes alexandri -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Urginea sanguinea -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sericorema sericea -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Solanum capense -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cucumis kalahariensis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia hebeclada -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Enneapogon desvauxii -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Grewia schinzii -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ipomoea oblongata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	1	.	.	.	.
diagnostic spp association 7																																												
Eragrostis jeffreysii -hl	.	.	.	.	.	.	1	1	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	1	5
Aristida rhiniochloa -hl	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	1	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cucumis anguria -hl	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	.	1	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Eragrostis rotifer -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Limeum argute-carinatum -hl	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	1	1	1	.	.	.	.	.	.	.	.
Acacia tortilis -s1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	1	.	.	.	.	.	.
Nelsia quadrangula -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Achyranthes aspera v. aspera -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.
Acacia tortilis -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phaeoptilum spinosum -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Panicum coloratum -hl	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lotononis platycarpa -hl	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	1	.	.	.	.	.	.	.	.
Eragrostis cylindriflora -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	1	1	.	.	.	.	.	.	.	5	.
Indigofera vicioides -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	1	.	.	.	1	1	.	.	.	.	.	.
Xerophyta humilis -hl	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ziziphus mucronata -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Panicum maximum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	1	.
Solanum catombelense -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.
Eragrostis nindensis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Blepharis integrifolia -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Chenopodium olukondae -hl	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	1	.
Crotalaria steudneri -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Blepharis mitrata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ziziphus mucronata -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

association	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Unique relevé nr.	85417	85377	85303	85427	85366	85365	85364	85363	85362	85361	85360	85359	85358	85357	85355	85354	85351	85421	85419	85418	85356	85422	85015	85014	85013	85012	85009	85006	85005	85003	85200	85304
diagnostic spp association 6																																
Monechma genistifolium -s2	.	.	.	.	.	.	.	.	.	1	.	.	5	.	2	1	1	1	.	.	1	6	1	.	.	1	.	1	.	1	.	.
Acacia mellifera -s2	.	.	.	1	.	.	.	.	.	.	.	1	1	.	.	1	.	.	.	.	.	2	.	.	.	1	.	.	.	.	.	.
Aptosimum lineare -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Grewia flavescens v. flavescens -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	1	.	.	5	.
Lycium oxycarpum -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
Chenopodium amboanum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Albizia anthelmintica -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tetragonia calycina -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sida cordifolia -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Vigna species -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Commelina livingstonii -hl	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Acacia reficiens -s2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.
Leucas martinicensis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Achyranthes aspera v. sicula -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leucas pechuelii -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.
Eragrostis lehmanniana -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phaeoptilum spinosum -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tricholaena monachne -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Eragrostis annulata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Catophractes alexandri -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Urginea sanguinea -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sericorema sericea -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Solanum capense -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cucumis kalahariensis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia hebeclada -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Enneapogon desvauxii -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Grewia schinzii -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ipomoea oblongata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.
diagnostic spp association 7																																
Eragrostis jeffreysii -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	1	.	.	5	.	.	.	.	.	.	.	1	2	.
Aristida rhiniochloa -hl	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	1	1	1	1	1	.	.	1	.	.
Cucumis anguria -hl	.	1	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis rotifer -hl	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	6	.	.	.	.	.	.	1	.	1	.	.
Limeum argute-carinatum -hl	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	1	.	.	1	.	.
Acacia tortilis -s1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Nelsia quadrangula -hl	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Achyranthes aspera v. aspera -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	1	1	1	.	.
Acacia tortilis -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phaeoptilum spinosum -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Panicum coloratum -hl	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Lotononis platycarpa -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis cylindriflora -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera vicioides -hl	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.
Xerophyta humilis -hl	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ziziphus mucronata -s1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Panicum maximum -hl	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Solanum catombelense -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis nindensis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Blepharis integrifolia -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chenopodium olukondae -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crotalaria steudneri -hl	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.
Blepharis mitrata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Ziziphus mucronata -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Amaranthus thunbergii -hl	. . . . 1	. . . .
Lotononis listii -hl		. . 1 . . . .
Platycarpha carlinoides -hl		. . . .
Dicoma capensis -hl	. . . . 1	. . . . 1 . . . .
Solanum dinteri -s2		. . . .
Acacia hebeclada -s2	. . . . 1	. . . .
Panicum stapfianum -hl		. . . .
Craterostigm plantagineum -hl		. . . . 1 .
Cymbopogon plurinodis -hl	. . . . 1	. . . .
Cyperus cuspidatus -hl		. . . .
Solanum supinum -s2	. . . . 1	. . . .
Urochloa trichopus -hl		. . . .
Andropogon chinensis -hl		. . . .
characteristic spp ass 6 and 7		
Ondetia linearis -hl	. . . . . . 1 . . . . 1 . . . . 1	. . . .
Blepharis obmitrata -s2		. . . . 1 . . . .
Eragrostis echinochloidea -hl		1 . . . . 2 . . . 1 . . . . 1 . . . . .
Peliostomum leucorrhizum -hl	. . . . 1 . . . 1 . . . . 1 1 . . 1	. . . .
Aristida meridionalis -hl		5 . . . .
diagnostic spp association 8		
Acacia erioloba -t3	6 5 5 5 2 2 . . 2 . 5 5 1 . . . 1 1 . . . 1 . . 1 1 1 1 . . . . 1 1 . . 1 . 1 1 1	. . . . 1 . 1 . . . .
Asparagus africanus -s2	1 1 1 1 1 1 . 1 1 1 . . . 1 1 . 1 . . 1 . 1 . 1 . 1 . 1 . 1 1 . 1 . . . . 1 . 1 .	1 . . . . . 1 . . . . 1 1 . . . .
Neorautanenia mitis -s2	1 2 1 1 . . . . . . 1 1 1 1 1 . . . 1 . . 1 5 2 . 1 1 1 . . . . 1 1 1 1 . . .	. . . . . 1 . . . 1 1 1 . 1 . 2 1 . . . . . 1 . . 1 1 . . . . .
Hermannia tomentosa -hl	1 1 1 1 2 . . . . 1 . . 1 . 1 1 1 1 . 1 1 . . . . . . 1 1 1 . 1 1 . . .	. . . . 1 . . 1 1
Crotalaria podocarpa -hl	1 . 1 . 1 . . . . . 1 1 1 1 1 . . 1 1 1 . . . . 1 . . 1 . . 1 . . . 1 1 1 . . .	. . . . 1 .
Eragrostis dinteri -hl	1 1 1 1 . . . . 1 . . . . 1 . . . 1 1 . . . . 1 . 1 . 1 1 1 1 1 . 1 .	. . . .
Harpagophytum procumbens -hl	. 1 . 1 1 . . . . . 1 1 . . . . . . 1 . . . . 1 . . . 1 . . 1 . . 1 1 1	1 . . . . 1 . . . . 1 . 1 . . . . . .
Kohautia cynanchica -hl	. 1 . . . . 1 . 1 . . . . . 1 1 1 1 . 2 . 1 . 1 . . . . 1 . . 1 . . .	. . 1 . . . . 1 1
Ipomoea crassipes -hl	. . . 2 . . . . . . 1 1 1 1 1 . . . 1 . . . . . . 1 . . . . 5 . . . 1 1 1	1 . . . . 1 1 . 1 . . . . . .
Rhigozum brevispinosum -s1	. . . . 5 1 1 . 1 . . . 1 . 1 . . . . 1 . . . . . 1 1 1 1 . . .	. . . . 1 . . . . 1 . 1 1
Helinus spartioides -s2	. . . . 1 . . . . 1 2 . 1 1 1 . . 1 1 . . . 1 . 1 . . . . . 1 .	. . . .
Requienia sphaerosperma -hl	1 . 1 . . . . 1 . . . . 1 . . . . 1 . 1 . 1 1 .	. . . .
Oxygonum alatum -hl	. . . . 1 1 1 1 1 . 1 1 . 1 . . 1 . . . 1 . . .	. . . . 1 .
Sesamum capense -hl	1 . . 1 1 . . 1 . . . . 1 1 . 1 . 1	. . . . 1 .
Indigofera alternans -hl	. . . . 1 1 1 . . . . . 2 . . . . 1 1	. . 1 . . . .
Tephrosia purpurea -hl	. . . . 1 1 1 . . . 1 1 1 1 1 1 . . .	. 1 . . . . 1 . . . . . .
Eragrostis omahekensis -hl	. . . . 1 . . . 1 1 1 1 1 . . . . 1 1 1	. . . .
Terminalia sericea -t3	. . . . 1 . 1	. . 5 5
Limeum myosotis -hl	. . . . 1 1 . . . . 1 1 . 1	. . . . 1 .
Crotalaria sphaerocarpa -hl	. . 1 . . . . 1 . . 1 1 . . . . . 1 .	. . . .
Terminalia sericea -s1	. . . . 1 5 5	. . . .
Zornia glochidiata -hl	. . . . 1 . . . . 1 1	. . . . 1 . . .
Bothriochloa radicans -hl	. . . . . . 1 1 . . . . 1 . 1	. . . .
Acacia erioloba -s1	. . . 1 . . . . 1 1 . . . . 1 . .	. . . .
Lycium bosciifolium -s1	1 1 2 2 1 2 1 1 5 1 . . . . . 1 1 . . 1 1 . 1 1 2 . 1 . . 1 . . . 1 1 1 1 1 1 . 1 1 . 1	. . . .
Rhigozum brevispinosum -s2	. . . . 1 . . . . . . 1 1 1 . . .	. . . . 1 . . . . . .
Ipomoea hackeliana -hl	. . . . 1 1 1	. . . .
Tephrosia lupinifolia -hl	. . . . 1 1 .	. . . .
Acacia erioloba -s2	. . . . 1	. . . .
Terminalia sericea -s2		 1
characteristic spp ass 6, 7 and 8		
Aptosimum angustifolium -hl	1 1 . . 1 . . . 1 . 1 1 1 . 1 1 1 1 . 1 1 . 1 1 1 1 1 1 1 . . 1	. 1 1 1 . . . . 1 1 1 . . . .
Gisekia africana -hl	1 1 1 1 1 . . . 1 1 1 1 . 1 . 1 1 1 2 1 . . . . 1 1 1 1 1 1 1 1 . . . . 1 1	. . . . 1 . . . . 1 1 . . . . 1 .
Felicia anthemidodes -s2	. . 1 . 1 . . . . . . 1 1 1 1 1 . 1 . 1 . . 1 . 1 . . . 1 . 1 1 . . . 1	. . . .
Crotalaria pisicarpa -hl	. . . . 1 . . . . . . 1 1 1 1 . . . . 1 . . . . . . 1	1 . 1 . . . .
Hibiscus fleckii -hl	. . . . 1 . . 1 . 1 . 1 . 1 . . . . 1 1 . . . . 1 . . . . 1 . .	. . . . 1 . . 1 . . . 1 . . . .
Abutilon austro-africanum -s2	. 1 . . . . 1 . . . . 1 . . . 1 . . 1	. . 1 . . . .
Ipomoea bolusiana -hl	1 1 1 1 1 1 . . 1 . . . . . . 1 . . . . 1 . 1 1 1 1 1 . . 1	. 1 . . . . . . 1 . 1 . . . . . 1 . . . . 1 . . . .
Solanum burchellii -s2	. 1 1 . . . . 1 1 1 1 1 1 1 1 1 1 1 . 1 1 . 1 1	. 1 . . . . 1 1
Tarchonanthus camphoratus -s1	1 1 . . 1 1 . . . . . 1 . . . . 1 . . . . 1 1 . . . . 1	. 1 . . . . . 1 1
Maerua juncea -s2	. . . 1 1 . 1 1 . . . . 1 . . . . 1 . . . . . . 1 1	. . . .
Waltheria indica -hl	. . . . 1 1 1	. . 1 5
Anthephora schinzii -hl	. . . . 1 . . . . 1 . . . . 1 1 . . . . 1 1 1 . . .	1 . . . . 1 . . . .

diagnostic spp association 9		
Grewia bicolor -s1		2 1 . 2 5 2 3 5 2 6 1 1 1 2 5 1 5 5 . . 5 1 . . . . 5 . 1 1 . .
Lonchocarpus nelsii -t3		. . . 1 5 5 5 4 5 . 5 2 5 5 1 1 . . . 5 . 2 1 1 2 1 . 1 1 . 5 .
Vernonia poskeana -hl	. . . . 1 . . . 1 . . . . 1 . . . . 1	1 1 . . 1 1 1 . 1 1 1 1 . 1 . 1 1 . . . . . 1 1 1 1 . 1 1 1 . .
Solanum kwebense -s2		1 . . 1 1 1 . 1 . . . . . 1 . 1 1 . . . . 1 1 . 1 1 1 1 1 1 1 .
Combretum apiculatum -s1		1 . . . 6 6 . . . . 6 7 . . . . . . 5 6 . . . . 1 . . .
Grewia flavescens v. olukondae -s1	. . . 1 . . 1 1 . . . . . . 1 . . 1 1 . . . . 1 . . . . 1 1 .	. . 2 . . . . . 7 5 2 1 . 1 1 1 5 . . . 1 5
Megalochlamys marlothii -s2	. . . . 1	. . . 1 1 . . . . 1 . 1 . 1 1 1 1 . 1 . . 1 1 1 . 1 .
Ipomoea verbascoidea -s2		. . . . . . 1 2 2 . . 1 1 . . . 1 . . . . . 1 . 1 1 1 . 1 . 1 .
Albizia anthelmintica -s1		1 1 . 1 5 . 2 . 2 2 . . . . 1 . 1 . 1 . . 2 . . . .
Clerodendrum ternatum -s2	. 1 1 . . . . . 1	5 . . . . . 1 . . . 2 . . . . . . 5 . 2 . . 1 1 1 1 . . 1 1 1 .
Eragrostis viscosa -hl		. . . 1 1 1 1 1 1 . . . . 1 . . 1 1 .
Acacia fleckii -s1	. . . . 1	2 1 5 . . . . 1 . . . . . . 5 2 1 1 . . 1 . 5 5
Grewia flavescens v. flavescens -s1	. . . . 1 1 . . .	. . . . 2 1 6 . . . . 5 . . . . 1 . . 1 . . 1 1 . .
Corchorus tridens -hl		. . . . 1 1 . . . . 1 . 1 1 1 1 1 . . 1 . .
Asparagus cooperi -s2	. . . . 1 . . . . 1 . 1 . . . . 1 . . . . 1	. . 1 . . . . 1 . . . 1 1 . 1 1 1 1
Euphorbia crotonoides -hl		. 1 . 1 . 1 . . . . . . 1 . . . . . 1 . . . . . 1 . . . . . 1 .
Aptosimum decumbens -hl		1 . . . . 1 . . 1 . 1 1 1 . 1 . . .
Setaria pumila -hl		1 . . . . 1 . 1 . . . . . . 1 1 1 . 1 .
Microchloa caffra -hl		3 1 . 1 . 1 . . . . 2 1 . . . . . 1 . . . . . .
Grewia retinervis -s1		1 . 5 . . . . 2 1 . 1 1
Clerodendrum uncinatum -s2	. . . . 1	. . . . 1 . 1 . . . . 1 1 1 1 . . . . . .
Commiphora angolensis -s2	. . . . 1	. . . . 1 1 . . . . . 1 . 1 1 . . 1 . . .
Momordica balsamina -hl	. . . . 1 . 1	. . . . . 1 . . 1 . . . 1 1 . . 1 . . . .
Helinus integrifolius -s1		. . . . 1 . . . 2 . . . . . 1 . . . . . 1 . . . . . . 1 . . . .
Oxalis purpurascens -hl		. . 1 1 . . 1 . . . . 1 . 1 . .
Urochloa oligotricha -hl		. . . 1 . . . . 2 5 . . . . . 1 . . . .
Terminalia prunioides -s1		. . . . 5 . . 5 . . . . . . 1 . 1 .
Boscia foetida -s1		. . . . 3 5 5 . . . . 1 . . . .
Commiphora glandulosa -s1	. . . . 1	. . . . . . 1 . . . . 2 . . . . 1 . 1 . . .
Solanum delagoense -s2		. . . . 1 . . . 1 1 1 . . .
Talinum crispatulum -hl		. . . . 1 1 1 1 . . . . . .
Brachiaria malacodes -hl		. . . . 5 . . . . 1 1 . . 1 .
Commiphora africana -s2	. . . . 1	. . . . 1 . . 1 . . . . 1 1 . . . .
Tylosema esculentum -hl		. . . . 2 . . . . 1 . . 1 . . . . . .
Helinus integrifolius -s2	. . . . 1	. . . . 1 . . . . 1 . . 1 . .
Acacia fleckii -s2		. . . . 1 . 1 . . . . 1 .
Lonchocarpus nelsii -s1		. . . . . . 5 1 5 . . . .
Grewia bicolor -s2		. . . . 1 . . . 1 . . 2 .
Lonchocarpus nelsii -s2		. . . . 1 1
Commiphora tenuipetiolata -s1		. . . . 5 1 . . . .
Commiphora africana -s1	. . . . 1	. 1 . . . . 1 . . . .
Terminalia prunioides -t3		. . . . 2 . . 5 . . . .
Combretum apiculatum -s2		. . . 1 . . . . 5 . . . .
Commiphora tenuipetiolata -t3		. . . . 6 . 1 . . . .
Aristida pilgeri -hl	. . . . 1 1	. . 5 5
characteristic spp ass 8 and 9		
Acanthosicyos naudinianus -hl	. 1 1 1 . . . . . . 1 . . . . 1 1 . . . 1 1 1 . 1 1 . . .	1 . . . 1 1 . . . . 1 1 . . . . 1 1 1 1 1
Commiphora pyracanthoides -s2	. . . . 1 . . 1 . 1 . 1 . . 1 1 . . . . . 1 1 . . . . 1 1 . . .	1 . . . 1 1 . 1 . 1 . . . 1 1 . 1 1 . . 1 1 . 1 . 1 . . . . 1 .
Bulbostylis hispidula -hl	. 1 . 1 . . . . 1 . . . . 1	1 . . 1 . . 1 . . 1 . . . 1 . . . 1 1 . . . .
Commiphora angolensis -s1	. . . . 1 2 . . . . . . 1 . 5 . . . . 1	1 . . . . 2 . . 1 . . . . 1 . . . . 1 . 1 . . 1 . . .
Aristida stipitata -hl	. . . . 5 1 1	. . . . 5 . . . . 1 . .
Rhynchosia totta -hl	. . . . 1 . . . . 1 . 1	. . . . 1 . . . . 1 . . . .
common spp TWINSPAN group 2		
Stipagrostis uniplumis -hl	7 7 7 6 8 7 7 8 6 6 7 6 5 5 1 6 5 6 5 7 5 6 6 6 6 7 7 7 6 7 7 7 5 7 8 7 8 7 7 7 7 . 1 .	2 1 1 . 2 1 1 . . . 2 1 . . . . . 5 5 . . 5 1 5 1 1 . . 1 . . 5
Acacia mellifera -s1	6 5 . 5 6 1 5 1 6 6 5 5 7 6 7 6 5 5 1 . 2 5 6 7 6 7 . 5 5 5 1 . 1 2 1 1 1 1 5 1 1 1 1 .	2 2 5 2 2 1 . 1 2 5 1 . . . . 5 6 1 5 . . 2 5 2 1 6 1 1 5 6 6 5
Talinum arnotii -hl	1 1 1 1 . 1 . 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . 1 1 1 1 . 1 . 1 . . .	. 1 1 . 1 1 1 1 1 1 1 2 1 . 1 1 . . . . 1 1 . . 1 . 1 1 . 1 . 1
Boscia albitrunca -t3	. 5 5 . 2 2 2 5 3 5 5 2 5 3 1 1 2 5 5 5 5 3 5 1 1 1 2 2 1 1 1 1 1 . . . . 5 3 1 . . 1 .	. 1 2 2 . . . . 3 . . . . 1 . . 1 . 1 1 . . . 1
Urochloa brachyura -hl	2 1 1 1 1 1 . 1 1 5 1 1 . . 1 1 1 1 . 1 1 1 1 1 . 1 1 1 . . . . 1 . 1 1 1 1 1 1 1 . 1 .	1 . . . 1 1 . 1 . . 1 1 . . 2 2 . 1 1 . . 1 . 1 1 . 1 1 1 1 1 1
Pogonarthria fleckii -hl	1 1 1 1 1 . . . . . 3 5 2 1 1 2 1 1 2 1 2 . 1 1 1 1 2 1 1 1 1 5 1 1 1 1 1 6 1 1 1 . . .	5 2 . 1 1 1 1 1 1 1 1 2 1 1 1 2 5 5 5 5 . 1 1 1 1 1 1 . 5 1 5 1
Eragrostis porosa -hl	1 1 1 2 1 2 . 1 . 5 6 5 1 2 . 6 5 5 7 6 5 1 1 . 1 . 1 1 1 1 . 1 1 1 1 1 . . 1 . 1 1 1 1	. 2 . 1 1 . 1 . . 1 1 1 1 1 2 5 2 5 2 5 5 5 . . 1 . 1 1 . 1 5 .
Melinis repens s. grandiflora -hl	5 2 1 3 1 1 5 2 1 2 . 1 . . . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . 1 . . . . 1 1 1 1 . 1 .	2 2 . 1 . 1 . 1 . . 1 . 1 . 1 5 1 1 1 1 . . 1 1 1 1 1 1 5 1 2 1
Enneapogon cenchroides -hl	. 1 . 1 1 1 1 1 1 . 1 1 2 1 2 1 1 1 . 3 . 1 . 1 . 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 . 1 .	. . . 1 . . . . 1 . 2 1 5 6 2 1 1 5 1 . . 1 1 1 1 1 2 .
Eragrostis rigidior -hl	6 6 6 7 1 . . . 2 5 5 7 7 8 6 5 6 6 5 5 5 . 1 1 1 1 1 . 5 1 . 1 . 1 1 . 1 . . 1 1 . . .	6 7 5 6 5 6 5 5 5 7 7 6 5 7 5 6 1 2 2 . . . 1 1 1 1 1 . 1 . . 6

Lycium eenii -s2	1 1 . 1 . 1 1 1 . 1 . 1 1 1 1 1 1 1 1 1 1 1 1 . 1 . . . 1 1 1 1 1 1 . . . . 1 . . . 1 .	. 1 1 . . . . . . 1 . . . . 1 1 . . . . 2 . 1 . . 1 . . . 1 . .
Grewia flava -s1	1 1 1 1 1 . 1 1 1 1 . 1 1 1 1 1 . 1 1 1 1 5 5 1 . . . . . 1 . . 1 1 1 1 . 1 . 1	. 1 5 . 5 5 5 6 5 . . 1 . 1 1 . 2 5 5 5 1 5 1 2 1 1 1
Evolvulus alsinoides -hl	1 1 1 1 . . . 1 1 . . . 1 1 1 . . . 1 1 1 . 1 1 1 1 1 1 1 1 1 1 . 1 1 1 1 . 1 1 1 . . .	1 1 1 1 . . 1 . . . 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 1 1
Otoptera burchellii -s2	1 1 1 1 1 1 . . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . . . . 1 . 1 1 . . 1 1 1 1 . . .	1 . . . . 1 1 . 1 1 1 1 1 .
Aristida congesta -hl	1 2 . 1 . 5 5 . 6 . . 1 1 1 2 5 5 1 . . 5 . 5 6 5 2 5 . 6 1 . 6 . . 1 . . 1 . 1 1 . . .	7 5 1 2 . 5 6 1 2 2 . . 5 2 . 5 2 . 5 1 5 . 1 1 1 1 1
Ptycholobium biflorum -s2	. . 1 1 1 . 1 1 . . 1 1 1 1 1 . . 1 1 1 1 . 1 1 1 1 . 1 1 1 1 1 . . . . 1 . . .	. 1 . . 1 1 1 1 1 1 1 1 1 . . 1 . . 1 . . 1 . . 1 . 1 . . . 1 1
Heliotropium steudneri -s2	. 1 1 1 1 1 . . . 1 . 1 1 1 1 1 1 1 1 . 1 . . . . 1 . . . . . 1 1 1 1 1 1 . . 1 1 . . .	. . . . . 1 . 1 . . . . . 1 1 . 1 . . . . 1 1 . . . .
Schmidtia pappophoroides -hl	1 1 1 2 . 1 2 2 1 5 . . 1 . . 1 1 . . 1 1 1 . 1 . . . . 1 1 1 1 1 1 1 1	. . . 1 . . 1 . . . 1 . . . . . 1 . 1 1 . . . . 1 . . . .
Cleome rubella -hl	. . 1 1 1 . . . . 1 1 1 1 1 1 1 . . . . 1 1 1 1 1 . 1 1 1 1 1 . . 1 1 1	1 1 . 1 . . . . . . 1 1 . . . . 1 . . . . . .
Indigofera rautanenii -s2	1 . . . . 1 1 1 1 1 . 1 . 1 1 1 1 . 1 1 1 . 1 1 1 . . . . . 1 1 . . . . . . 1 . 1 . . .	. . 1 1 . . . . 2 2 . . . .
Aristida adscensionis -hl	. 1 1 1 1 . 1 1 . . 1 2 1 1 2 5 5 1 1 1 1 . . . . 1 1 1 1 1 . . . . . 1	2 2 . 1 . . . . 1 1 . 5 2 5 5 1 5 5 1 1 1 1 1 1 . 1 . 1
Chascanum pinnatifidum -s2	. 1 1 . 1 . 1 . . . . 1 1 1 1 1 . 1 1 1 1 1 1 1 2 1 . 1 . 1 . 1 . 1 . . . . 1	. 1 1 . . . . . . 1 . . . . 1 . . . . 1 1 1 . . . .
Ipomoea sinensis -hl	1 1 . 1 . . . . 1 1 . . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . 1 1 1 . . .	. 1 . . . 1 . . . 1 . . . . 1 . 1 1 1 1 1
Chloris virgata -hl	. 1 1 . . 1 1 . 1 . . 1 . 5 . 1 1 1 1 1 1 . . . . . 1 . 1 1 1 1 1 . . . . . 1 . . . 1 .	. . . 1 . 1 . . . . . . 5 . 1 1 . 1 . . 1 1 . . . . 1 1 . 1 . .
Eragrostis trichophora -hl	. . 1 . . . 1 . 5 . . 1 1 1 3 2 2 1 1 1 1 . . . . . 1 . 1 1 . 1 . 1	5 5 6 5 2 1 5 6 . 5 . . 6 2 1 1 5 2 5 2 2 . 1 1 1 1 1 . . 1 . 5
Commelina benghalensis -hl	1 1 . . 1 . . . . 1 . . . . . 1 1 . . 1 1 1 1 . . . . . . 1 1 . . 1 1 1 1 . 1 . 1 . . .	. 1 . . 1 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 . . 1 1 . 1 1 1 1 . 1 .
Ipomoea obscura -hl	. 1 1 1 . . . . 1 . 1 1 1 1 1 . 1 1 1 . . . . 1 . . 1	1 1 . . 1 1 1 1 1 1 1 1 . 1 1 2 2 1 1 . 1 1 . 1 1 1 1 1 . 1 . .
Dichrostachys cinerea -s1	1 1 . 1 . . 1 1 . 1 1 . 1 . 1 1 . 1 1 1 1 . . . . 1	5 6 5 6 5 5 6 6 . 2 6 5 7 6 6 6 5 7 6 6 5 6 5 5 6 5 6 5 6 7 5 1
Oxygonum sinuatum -hl	1 1 1 1 1 . . . . . 1 1 . 1 1 . . . 1 1 . . 1 1 1	. 1 1 . . 1 1 . . . 1 1 1 . 1 . . 1 . . . 1 1 . 1 1 1 1 . . . 1
Acacia hebeclada -s1	. . . 1 . . . . 2 . 5 5 1 5 . . . . 1 . . . . 1 . . . . 1 1 1 . . . 1 1 . . .	. . . . 1 . 1 1 . . . . 1 2 1 2 . . . .
Lindneria clavata -hl	1 1 1 1 1 . . . . . 1 1 1 1 1 . . 1 1 1 . 1 1 . 1 1 1	1 . . . 1 . . . 1 . 1 1 . 1 1 . 1 . . . 1 . . . .
Ocimum americanum -hl	. . . . 1 . . 1 . . 1 1 1 . 1 . 2 1 . . 1 . 1 1 1 . . 1 . 1 1 . . . . . 1 . . .	. . 1 1 . . . . 1 1 1 1 1 1 1 . . .
Catophractes alexandri -s1	. . . . 5 . 2 6 . . 1 2 1 . 1 . . . 1 1 6 5 . 1 5 . . . . . 5 1 . . . . . . 5 1 5 . . .	. . . . 2 . . 1 . . . .
Phyllanthus maderaspatensis -hl	. . . . 1 1 1 . 1 . . 1 1 . 1 . 1 1 . . 1 . 1 . 1 1 1 1 . . . . . 1 1	. 1 . . . . 1 . . . 1 1
Boscia albitrunca -s2	. 1 . 1 . . 1 . . . . . . 1 1 . . . 1 . 1 1 . . . . 1 1 . . . 1 1 . . .	. 1 . . . . 1 . 1 . 1 1 . . . 1 . 1 . 1 1 1 1 . . . .
Pupalia lappacea -s2	. 1 . . . . 1 . . . . 1 . 1 . . . . 1 . . . 1 . . 1 1 . . 1 1 1 1 . 1	. 1 . . 1 1 1 1 . 1 1 . . . 1 . 1 1 1 1 . 1 . 1 1 1 1 1 1 1 . 1
Kyphocarpa angustifolia -hl	1 . . 1 . . . . 1 . 1 . . . . . 1 1 1 1 . . . . 1 1 . 1 1 1 . . . . . 1 1 . . .	1 . . . . 1 . 1 . . 1 . 1 1 . 1 . . . . . . 1 1 1 1 1 1 1 1 . 1
Tragus berteronianus -hl	. . 1 1 . 1 1 1 . . 1 . 1 . . 1 1 1 . . 1 . . . . . 1 . 1 1 . 1	. . . . . 1 . . . . 1 1 1 . . . 1 1 . . 1 . 1 . . 1 1 .
Nidorella resedifolia -hl	. 1 1 . . . . 1 1 . . . . . . 1 . . . . . 2 . 1 . 1 1 . 1 1	. 1 . . . .
Barleria lanceolata -s2	. . . 1 . 1 . . . . . . 1 1 1 1 1 . . . . 1 . . 1 . . . . 1 . . . 1 . . . . 1 . 1 . . .	. 1 1 . . . 1 . . . . . 1 1 . 1 1 . . . . 1 1 . . 1 1 . . 1 . 1
Hirpicium gorterioides -hl	1 . . 1 . . . . 1 . 1 . 1 1 . 1 1 1 . . . . 1 . . 1 . . . . 1 . . .	1 1 . . . . 1 . . . 1 . . 1 . . . . . .
Geigeria ornativa -hl	. 1 . . . . . . 1 . . . . 1 1 1 1 . . 1 1 . . . . 1 . . 1 1 1 1 . . .	. . . . 1 . . . .
Pollichia campestris -s2	. 1 . 1 . 1 . . . . 1 1 1 1 . . . . . . 1 . . 1 . 1 . . . . . . 1 . . 1 . . . 1 .	. . 1 . . . . 1 . . . . 1 . 1 1
Ehretia rigida -s1	. . . . . . 1 1 . . 1 . 1 1 1 . . . . 1 1 . . . . 1 . . . . . 1	. . . 1 . . . . 1 . . . . 1 . . 1 . . . . . . 1 . . 1 . . . . .
Dicoma tomentosa -hl	. . . 1 . 1 . . . . 1 1 . 1 . . . . 1 1 1 1 . . . 1 . . . . 1 . 1 . 1 . . .	. 1 . . . . 1 . 1 1 . . . . 1 1 1 1 1 1 1 1 1 .
Leucosphaera bainesii -s2	. . . . 1 1 1 1 1 3 . . . . . 1 1 . . . . 1 . . 1 . . . . . . 1 . . 1	. 1 . . . 1 . . . . 1 1 . . 2 6 . . . . . 1 . 1 . .
Grewia flava -s2	. . . . . 1 . . . . 1 . . . . . 1 . . . . 1 5 1 1 . . 1 . . . . . 1 . 1 1 1 . . .	. . . . 1 . . . . .
Lycium oxycarpum -s1	. . . . 1 1 . . . 1 . 2 . 1 . 1 1 . . . . . 1 . 1 . . . . 1 .	. 1 . . . . 1 1
Chamaesyce inaequilatera -hl	1 1 1 1 1 1 . . . . 1 . . . . . 1 . . . 1 . . . . 1 . . .	. . . . 1 . . . . 1 1 1 1 1 1 . 1 1 1 . .
Pavonia burchellii -s2	. 1 1 . . 1 . . . . 1 . . . 1 . . . . 1 . . . . 1 1	. 1 . . . . 1 . . . . . 1 . 1 . 1 1 . . . . . 1 1
Cleome monophylla -hl	. . . . 1 . . . . 1 . . . . 1 1 1 . . . 1 1 . . 1 1 1 . . .	. . . . 1 . . . . . . 1 . 1 1 . . . 1 . . . . . 1 . 1 . . 1 . .
Phyllanthus pentandrus -hl	. . . . 1 . . . . 1 1 . . . 1 1 1 . 1 1 1 1 1 1 .	. . . . 1 . . . 1 . . . . . . 1 . . 1 1 .
Crotalaria heidmannii -hl	. . . . 1 . 1 . . 1 1 . . 1 1 1 1 . 1 . . . 1 . . . 1	. . . . 1 1 . . . 1 . . .
Acacia reficiens -s1	. . 5 . . 1 1 1 . . . . 1 . . . . 1 . . . . . . 1 . . .	. 5 6 1 1 5 . 2 2 6 . . . 1 . 5 5 . . . 1 2 1 1 . 2 1 1 . . 5 2
Acacia reficiens -t3	. . 6 . . . . 5 . . . . 6 1 . . . 1 . 1 . . 5 .	. 5 5 . . . 5 . . . 5 1 . . 5 5 2 5 5 . . . . . . 2 1 5 1 . . .
Brachiaria deflexa -hl	. 1 . . . 1 1 . . . . 1 . . . . 1 1 . . 1 . . . . . . 1 . 1 . .	. . . . 1 . 1 1 . . . 1 1 . 1 . .
Limeum sulcatum -hl	1 . . . . 1 . . . . 1 . 1 . . . 1 . 1 . . . . 1 . . . . 1 . . . 1	. . . . 1 . . . . 1 .
Cenchrus ciliaris -hl	. . . . . . 2 2 1 1 . . . . 1 . . . . 1 . 1 1 . . . . . 1 . . . . . 1 . . 1 1	. . . . 1 . . 1 . . . 1 . . . 5 . 1 1 . 1 . . 1 1 .
Melinis repens s. repens -hl	. . . . 1 1 . 1 . 1 1 1 1 1 . 1 . 1 . .	1 1 . . . . . 1 . . . . 1 1 1 1
Boscia albitrunca -s1	1 . . . . 1 . . . . . 1 . . . 1 1 1 . . 1 . 1	. . . 1 1 1 1 1 1 1 1 . 1 1 1 2 . . . .
Solanum incanum -s2	. . . . 1 1 . . . 1 . . . 1 1 . . . . 1 1 1	. . . . 1 . . . . . 1 . . . . . 1 . . . .
Dichrostachys cinerea -s2	. . 1 . . . . 1 . . 1 . . . . 1 1 . . 1 . . . 1 . 1 . . .	. 1 . . . . . . 5 . . . . . . 2 . . 1 . . 2 . . . . . 6 . . . .
Raphionacme lanceolata -hl	. . . 1 . . . . 1 1 1 . . . 1 . 1 . . 1 1 . 1 . . . . 1	. . . . . 1 . . . . 1 . . 1 . . . . 1 . . . . . .
Felicia smaragdina -hl	. . . . 1 . . . . 1 . 1 1 . 1 . . . 1	. . . . 1 1 1 . . 1 . 1 1 . 1 1 . . . . . . 1 1 1 1 . . . . . .
Cyperus fulgens -hl	. . . . . . 1 1 1 1 . . . . . 1 . . . . . 1	. . 1 . 1 . . 1 . 1 . . . . 1 1 . . 1 . 1 . . . .
Hermannia modesta -hl	. . . . . 1 1 1 . . . . 1 1 1 . 1 . . 1 . . . . 1	. . . . 1 1 1 . 1 . 1 . 1 . 1 1 1 . . 1 1 .
Geigeria acaulis -hl	. . . . . . 1 1 . . . . 1 . 1 . 1 1	. 1 . . 1 . 1 . . 1 . . . . . 1 1 . . . . . 1 1 1 1 1 1 . 1 . .
Indigofera hochstetteri -hl	. . . . 1 . . 1 1 . 1 . . . . 1 1 1	. . . . 1 1 . . 1 . . . . 1 . . . .
Hermbstaedtia odorata -hl	. . . . 1 . . . . . 1 . . . . 1 . . . 1 1	. . . . 1 . . . .
Limeum fenestratum -hl	. . . . 1 . . . . 1 . . . . 1 . . 1 1 1 . 1	. . . .
Kohautia caespitosa -hl	1 1 . 1 . . . . 1 . . . 1 1	1 . 1 1 . . . . 1 . . . . 1 . . . 1 1 1 1 1 . . 1 . .
Eragrostis biflora -hl	. . . . 1 . . . . . . 1 . . . 1 . . . . . 1 1 1 . . . 1	. 1 . . . . 1 . . . . 1 1 . . . . . 1 . . . . . .
Acrotome fleckii -hl	. . . . 1 . . . . 1 . . . . . 1 1 1 . . . 1	. . . . 1 .
Ehretia rigida -s2	. . 1 . 1 . . . . 1 . . . . 1 . . . . 1 . 1 . 1 .	. . . . . . 1 . . . . 1 1 . 1 1 . 1 1 . . .

Hermannia rautanenii -s2	1 . . . . 1 1 . 1 . . . . 1 . . 1	. . . . 1 . . . .
Acalypha indica -hl	. . . . 1 . 1 1 . . . . 1 1	. . . . 1 . . 1 . .
Aristida effusa -hl	. . . 1 . . . . 1 . . . . 1 . . . . . . 1 . . 1 . . . 1	. 1 . 1 . . 1 . . . . 1 . . 5 1 1 . 1 . 1 . . . 1 . . 2 .
Setaria verticillata -hl	. . . . 1 . . 1 . . . . 1 1 . . 1 .	. . . . 1 . . . . . 1 . . . .
Seddera suffruticosa -s2	. . . 1 1 . 1 . 1	. . . . 1 1 . . . . 1 1 . . 1 . .
Lantana angolensis -s2	. . . . 1 . . 1 . 1 . 1 . . . 1 . . . . . 1	. . . . . 1 1 . . . . 1 . . . . . . 1 . 1 1 . . . . . .
Monelytrum luederitzianum -hl	. . 1 . . 2 . 1 1 . . . . 1 . . . . 1	. . . . 1 . . . 2 . . . .
Hibiscus elliottiae -s2	. . . . 1 . . . . . . 1 . . . . 1 . . . . . . 1 1 . . .	2 1 . . 1 1 1 . 1 1 . 1 . . 1 1 . 1 1 2 1 . . 1 1 1 1 1 1 . . .
Jatropha erythropoda -hl	. . . . 1 1 . . . . 1 . . . . 1 . 1	. . . . 1 . . . . 1 . . . 1 . . . . .
Cyphostemma congestum -s2	. . . . 1 . . 1 . . . . 1	. 1 . . . . . 1 . . 1 . . . 1 . 1 . . . 1 . 1 1 1 . 1 . . . . .
Ruelliopsis damarensis -hl	. . . . 1	. . . . 1 . . . .
Xenostegia tridentata -hl	. . . . 1 . . . 1 . 1	 1
Dactyloctenium aegyptium -hl	. . 1 . . 1 . . . . 1 . . . . 1 . . . . 1 .	. . . .
Hibiscus calyphyllus -s2	. . . . 1 1	. . 1 1 1 . 1 1 . 1 . . 1 . 1 . 1 . . . . 5 . . . . . 1 . . 1 1
Kyllinga alba -hl	. . . 1 1 . . . . 1 . . . . . . 1	. . . . 1 . . . . . 1 1 . 1 . . . . . .
Tarchonanthus camphoratus -s2	. . 1 . . . . 1 . . . . 1	. . . . 1 . . . . 1 . 1 . . . .
Petalidium ramulosum -s2	. . . . 1 1 1 1	. . . .
Blepharis leendertziae -hl	. . . . . 1 . . . . 1 . . . 1	1 . . . . 1 . . . . 1 . . . . .
Tribulus terrestris -hl	. . . . 1 . . . . 1 . 1	. . . . 1 .
Lapeirousia bainesii -hl	. . . . 1 1 . 1	. . . .
Enneapogon scoparius -hl	. . . . 6 . . . . 1 . 1	. . . . 1 . . . . .
Hibiscus schinzii -hl	. . . . 1 1 1	. . . .
Dactyliandra welwitschii -hl	. . . . 1 . . . . . . 1 . . .	. . . . 1 . .
Citrullus lanatus -hl	. . . . . 1 . . . . 1	. . . .
Cleome hirta -hl	. . . . 1 . . . . 1 .	. . . . 1 . . . . . 1 . . . . .
Boophane disticha -hl	. . . . 1 . . . . 1	. . . .
Chamaecrista absus -hl		. . . . 1 . . .
Monechma divaricatum -s2	. . 1 . . . . 1	. . . . 1 . . .
Acacia erubescens -s1	. . . . 1 1	. . . .
Heteropogon contortus -hl	. . . . 1 . . . . . 1	. . . . 2 1
Grewia flavescens v. olukondae -s2		. . . .
Gossypium triphyllum -s2	. . . . . . 1 . . . . 1	. . . . 1 . . . .
Mollugo cerviana -hl	. . . . 1 . . . . . 1	. . . 1 . . 1 . . . . . . 1 . 1 . . 1 1 . . . . . 1 1 . . 1 . .
Bidens biternata -hl	. . . . 1 . . . . 1	. . . . 1 . . . . 1 . 1 .
Pergularia daemia -hl	. . . . 1 1 . . .	. . . . 1 . . . . 1 . . .
Chamaecrista biensis -hl	. 1	. . 1 . . . .
Indigofera charlieriana -hl	. . . . 1 . . . . 1	. . . . 1 . . . .
Acrotome inflata -hl	. . . . 1	. . . . 1 . 1 . . . . . . 1 1 1 1 1 1 1 . 1 . 1 1 1 1 1 1 1 . .
Albizia anthelmintica -t3	. . . . 1 1	. . . 1 6 2 5 2 5 5 . . 2 5 5 . 5 2 2 2 5 3 . . . .
Erucastrum arabicum -hl	. . . . 1 . 1	. . . . . . 1 . . . . 1 . . . . 1 . 1 . .
Acacia tortilis -s2	. . . . 1 . . . . 1	. . . .
Ornithoglossum viride -hl	. . . . 1	. . . .
Lycium boscifolium -s2	. . . . 1	. . . .
Hermannia quartiniana -hl	. . . . 1	. . . . 1 . . . .
Ophioglossum polyphyllum -hl		. . 1 . . . .
Combretum imberbe -t3		. . . .
Heliotropium marifolium -hl	. . . . 1	. . . .
Schmidtia kalihariensis -hl	. . . . . 1	. . . .
Pechuel-Loeschea leubnitziae -s2	. . . . 1	. . . .
Portulaca kermesina -hl	 1	. . . . 1 .
Digitaria velutina -hl		. . . . 1 . . . . 1 . 1 . . 1 . . . 1 . . 1 1 1 1 1 .
Sida ovata -s2	. . . . 1	. . . .
Eragrostis superba -hl	. . . . 1	. . . .
Merremia palmata -hl		. . . . 1 . . . .
Rhus marlothii -s1		. 1 . . . .
Ozoroa paniculosa -s2	. . . . 1	. . . .
Hibiscus palmatus -hl		. . . . . . 1 . . 1 . . . . 1 1 . . . .
Schkuhria pinnata -hl		. . . .
Ruellia sp nova -hl		. . . . 1 . . . . 1 .
Raphionacme velutina -hl		. . . . 1 . 1 . . . .
Corallocarpus welwitschii -hl		. . . . 1 1 1 . . . .
Indigofera holubii -hl		1 . . . . 1 . . .
Crassula rhodesica -hl		. . . . . . 1 . . . . 1 . . . . . .
Sporobolus festivus -hl		. . . .

Cucumis species -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kyllingiella microcephala -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kleinia longiflora -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tagetes minuta -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pegolettia senegalensis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Acacia species -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Portulaca oleracea -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyperus amabilis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Justicia anselliana -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia senegal -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helichrysum candolleanum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Heliotropium ciliatum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Solanum nigrum -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stipagrostis hirtigluma -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Barleria senensis -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Tephrosia dregeana -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Aizoon virgatum -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.
Becium filamentosum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Cheilanthes viridis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ozoroa insignis -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Maerua parvifolia -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Hibiscus caesius -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gladiolus permeabilis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 28

TWINSPAN TABLE

diagnostic spp association 10 and *diagnostic spp association 11* — association 10:

association	10	10	10	10	10	10	10	10	10	10
Unique relevé nr.	85096	85247	85236	85237	85253	85212	85213	85214	85215	85216
diagnostic spp association 10										
Barleria lanceolata -s2	.	1	.	.	1	1	1	1	1	1
Lycium eenii -s2	1	1	1	1	1	1	1	.	.	.
Boscia foetida -s1	1	1	.	.	.	1	1	1	1	1
Eragrostis annulata -hl	.	1	.	1	1	.	.	1	.	1
Hermannia damarana -s2	.	.	.	.	.	1	1	2	1	1
Erucastrum arabicum -hl	.	.	.	.	.	.	1	.	1	1
Lindneria clavata -hl	.	.	.	1	.	.	.	1	.	1
Catophractes alexandri -s2	.	.	.	.	.	.	.	1	2	.
Lycium oxycarpum -s1	.	.	.	.	.	1	1	.	.	.
Calostephane divaricata -hl	.	1	.	1	.	.	.	.	.	.
Indigofera rautanenii -s2	.	1	.	.	1	.	.	.	.	.
Pegolettia pinnatiloba -hl	.	.	.	1	1	.	.	.	.	.
diagnostic spp association 11										
Clerodendrum ternatum -s2	.	.	.	.	.	.	.	.	.	.
Hibiscus caesius -s2	.	.	.	.	.	.	.	1	.	.
Combretum hereroense -s2	.	.	.	.	.	.	.	.	.	.
Heteropogon contortus -hl	.	.	.	.	.	.	.	.	.	.
Eragrostis nindensis -hl	1	.	.	.	.	.	.	.	.	.
Monechma divaricatum -s2	.	.	.	.	1	.	.	.	.	.
Phyllanthus pentandrus -hl	.	.	.	.	.	.	.	.	.	.
Anthephora pubescens -hl	.	.	.	.	.	.	.	.	.	1
Barleria senensis -s2	.	.	.	.	.	.	.	.	.	.
Rhus ciliata -s2	.	.	.	.	.	.	.	.	.	.
Tinnea rhodesiana -s2	.	.	.	.	.	.	.	.	.	.
Raphionacme lanceolata -hl	.	.	.	.	.	.	.	.	.	.
Rhynchosia totta -hl	.	.	.	.	.	.	.	.	.	.
Hermannia quartiniana -hl	.	.	.	1	.	.	.	.	.	1
Croton gratissimus -s2	.	.	.	.	.	.	.	.	.	.
Hiernia angolensis -s2	.	.	.	.	.	.	.	.	.	.
Commiphora angolensis -s2	.	.	.	.	.	.	.	.	.	.
Ipomoea obscura -hl	.	.	.	.	.	.	.	.	.	.
Heliotropium ovalifolium -s2	.	.	.	.	.	.	.	.	.	.
Schmidtia pappophoroides -hl	.	.	.	.	.	.	.	.	.	.
Lantana dinteri -s2	.	.	.	.	.	.	.	.	.	.
Eragrostis viscosa -hl	.	.	.	.	.	.	.	.	.	.
Solanum supinum -s2	.	.	.	.	.	.	.	.	.	.
Croton gratissimus -s1	.	.	.	.	.	.	.	.	.	.
Helinus integrifolius -s2	.	.	.	.	.	.	.	.	.	.
Blepharis mitrata -hl	.	.	.	.	.	.	.	.	.	.
Sporobolus paniculoides -hl	.	.	.	.	.	.	.	.	.	.
Cephalocroton mollis -s2	.	.	.	.	.	.	.	.	.	.
Aloe zebrina -s2	.	.	.	.	.	.	.	.	.	.
Asparagus africanus -s2	.	.	.	.	.	.	.	.	.	.
Petalidium englerianum -s2	.	.	.	.	.	.	.	.	.	.
Ozoroa paniculosa -s2	.	.	.	.	.	.	.	.	.	.
Peltophorum africanum -t3	.	.	.	.	.	.	.	.	.	.
Commiphora africana -s2	.	.	.	.	.	.	.	.	.	.
Peltophorum africanum -s1	.	.	.	.	.	.	.	.	.	.
Helichrysum cerastioides -s2	.	.	.	.	.	.	.	.	.	.

Association 11:

association	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Unique relevé nr.	85180	85181	85189	85190	85191	85192	85193	85194	85195	85196	85197	85128	85144	85157	85158	85159	85160	85186	85187	85198	85324	85325	85327	85334	85335	85336	85179	85182
diagnostic spp association 10																												
Barleria lanceolata -s2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Lycium eenii -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Boscia foetida -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	1	.	.
Eragrostis annulata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hermannia damarana -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Erucastrum arabicum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Lindneria clavata -hl	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Catophractes alexandri -s2	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lycium oxycarpum -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Calostephane divaricata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera rautanenii -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pegolettia pinnatiloba -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
diagnostic spp association 11																												
Clerodendrum ternatum -s2	1	1	1	.	1	2	1	1	1	.	.	.	.	1	1	1	1	.	1	1	.	.	.	1	1	1	1	1
Hibiscus caesius -s2	1	1	.	.	.	1	.	1	1	.	1	1	.	1	1	1	1	.	1	1	.	.	.	.	.	.	1	1
Combretum hereroense -s2	.	.	1	1	1	1	1	.	1	1	1	1	.	1	.	1	1	.	.	.	.	1	.	1	.	.	.	.
Heteropogon contortus -hl	.	.	1	1	.	.	1	.	1	1	.	1	5	1	2	1	.	.	.	.	.	.	1	1	1	.	.	.
Eragrostis nindensis -hl	1	1	.	1	1	1	1	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1
Monechma divaricatum -s2	.	.	1	1	.	1	1	.	1	1	1	.	.	.	1	1	1	.	.	1	.	2	.	1	.	.	.	.
Phyllanthus pentandrus -hl	.	1	.	.	1	.	1	1	.	1	1	.	1	.	1	1	.	.	1	1	.	.	.	.	.	.	.	.
Anthephora pubescens -hl	.	1	1	.	1	1	1	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	.
Barleria senensis -s2	.	.	.	.	.	1	.	1	1	1	.	1	.	1	1	.	1	.	.	1	.	1	.	.	.	.	.	.
Rhus ciliata -s2	.	1	.	.	.	.	1	1	1	.	1	1	.	.	.	1	.	.	1	1	.	.	.	.	.	.	.	1
Tinnea rhodesiana -s2	.	.	1	.	1	1	1	2	1	1	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.
Raphionacme lanceolata -hl	1	.	.	.	1	1	.	1	.	1	1	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	1
Rhynchosia totta -hl	.	.	1	1	1	1	.	.	.	1	1	.	1	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.
Hermannia quartiniana -hl	1	.	.	1	1	.	1	1	.	1	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Croton gratissimus -s2	.	.	.	.	.	.	.	.	.	5	1	1	2	.	1	.	.	1	5	6	.	.	.	.	.	.	.	1
Hiernia angolensis -s2	.	.	.	.	1	1	.	1	1	1	1	.	.	.	1	.	.	.	.	.	.	5	.	.	.	.	.	.
Commiphora angolensis -s2	.	.	.	.	.	.	.	1	2	1	.	.	.	1	.	.	1	.	1	.	.	.	.	.	.	.	1	1
Ipomoea obscura -hl	1	.	.	.	.	1	.	1	1	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
Heliotropium ovalifolium -s2	.	.	.	.	1	1	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Schmidtia pappophoroides -hl	.	.	.	1	.	.	1	.	1	1	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.
Lantana dinteri -s2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	1	1	.	1
Eragrostis viscosa -hl	1	1	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Solanum supinum -s2	.	1	.	.	.	1	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Croton gratissimus -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	5	2	2	1	.
Helinus integrifolius -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	1	.	.	1	1
Blepharis mitrata -hl	.	.	.	.	1	.	.	.	.	.	.	1	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.
Sporobolus paniculoides -hl	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	1	1	.	.	.	.	1	.	.
Cephalocroton mollis -s2	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Aloe zebrina -s2	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.
Asparagus africanus -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	1	.	.
Petalidium englerianum -s2	.	.	.	.	.	.	.	.	5	5	2	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Ozoroa paniculosa -s2	.	.	.	.	.	.	1	1	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Peltophorum africanum -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	2	.	.	.	1	.	.	.	.	.	.	.	.
Commiphora africana -s2	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Peltophorum africanum -s1	.	.	.	.	.	.	.	.	.	.	.	1	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Helichrysum cerastioides -s2	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.

Association 12:

association	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Unique relevé nr.	85177	85178	85183	85184	85185	85199	85326	85328	85340	85127	85132	85145	85146	85147	85148	85149	85150	85151	85152	85188	85337	85344	85346	85347	85348	85350	85368	85011	85173	85345
diagnostic spp association 10																														
Barleria lanceolata -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.
Lycium eenii -s2	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.
Boscia foetida -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis annulata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hermannia damarana -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Erucastrum arabicum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	1	.	.	.	.
Lindneria clavata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Catophractes alexandri -s2	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Lycium oxycarpum -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Calostephane divaricata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Indigofera rautanenii -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Pegolettia pinnatiloba -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
diagnostic spp association 11																														
Clerodendrum ternatum -s2	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Hibiscus caesius -s2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Combretum hereroense -s2	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
Heteropogon contortus -hl	.	1	.	.	.	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Eragrostis nindensis -hl	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.
Monechma divaricatum -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.
Phyllanthus pentandrus -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	1	.	.
Anthephora pubescens -hl	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Barleria senensis -s2	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Rhus ciliata -s2	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Tinnea rhodesiana -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Raphionacme lanceolata -hl	1	1	.	.	.	.	.	.	.	.	.	1	.	1	1	.	.	.	.	.	.	1	1	.	1	.	.	1	1	.
Rhynchosia totta -hl	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	1	1	.
Hermannia quartiniana -hl	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Croton gratissimus -s2	.	.	.	1	1	1	.	.	.	.	.	.	1	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.
Hiernia angolensis -s2	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Commiphora angolensis -s2	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Ipomoea obscura -hl	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.
Heliotropium ovalifolium -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Schmidtia pappophoroides -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lantana dinteri -s2	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis viscosa -hl	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Solanum supinum -s2	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Croton gratissimus -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helinus integrifolius -s2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
Blepharis mitrata -hl	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sporobolus paniculoides -hl	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Cephalocroton mollis -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aloe zebrina -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Asparagus africanus -s2	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Petalidium englerianum -s2	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ozoroa paniculosa -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Peltophorum africanum -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Commiphora africana -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Peltophorum africanum -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helichrysum cerastioides -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

characteristic spp ass 10 and 11			
Stipagrostis uniplumis -hl	6 1 7 6 1 5 6 6 5 2	1 . 1 1 2 . . . 5 2 1 . . . . . . 5 1 . . . . 1 1	. . . . 1 . . . 5 1 1 . . . . 1 5 6 1 1 1 . . 1 1 2
Enneapogon desvauxii -hl	5 6 1 5 5 5 5 5 5 5	. . . . 2 1 1 1 . 1 1 6 . . . . 1 1 1 1	. . . . 1 . . . . 6 . 1 2 . . 1 . . .
Eriocephalus pubescens -s2	1 . 1 1 2 1 1 2 2 3	. . 1 1 5 5 1 1 1 1 1 . 1 1 4 1 1 . . . . 1 5 3 2 1 . 1	1 . . 1 1 . 1 1 1 . . . . 1 . . . .
Sericorema sericea -hl	. . 1 1 1 1 1 1 1 2	. . 1 . 1 1 . 1 1 1 1 . 1 1 . . . 1 . 1 . 1 . . . 1 . .	1 . . . . 1 . . . . 1 . . . .
Catophractes alexandri -s1	6 6 5 6 7 . . 5 6 1	2 2 5 5 5 5 2 5 5 . . . 1 1 1 . . . 3 . 2 . 5 5 5 . 2 2	. 1 . . . . 1 1 . . . . . 1 . . .
Fingerhuthia africana -hl	1 . . 1 1 1 . 1 1 1	. . . 1 1 1 1 1 1 1 1 1 2 . 1 1 1 . . . . . 1 1 1 1 . .	. . . . 1 . . . 1 . . . . . 1 . . . .
Aristida adscensionis -hl	. 5 1 5 . . 1 1 1 .	. . . . 1 . . . . 1 . .	. . . . . 1 . . 1 . . . . 1 . . 1 . . 2 2 . 2 . 1 . 1
Eragrostis jeffreysii -hl	. . . 1 . 1 1 1 1 1	. 1 . . 1 . 1 1 . 1 5 . . 1 . . . 1 . 1	1 . . . . 2 . . . . 1 . 1 6 . . .
Sida ovata -s2	. . . 1 . 1 1 2 1 1	1 . 1 . . . . . . 1 1 1 . . 1 1	1 1 1 . . . . 1 . . . . 1 . .
Achyranthes aspera v. aspera -hl	1 . . 1 . 1 . 1 . .		. . . . . 1 . . 1 . . . . 1 1 . . . . 1 . .
Cucumis anguria -hl	1 . 1 . . . . 1 . 1		. . . . 1 1 1 1 1 1 1 . . . .
Setaria verticillata -hl	. . . . . . 1 . 1 1		1 . . . . 1 . . . . . . 1 . . 1 1
diagnostic spp association 12			
Grewia flavescens v. flavescens -s1		. . . . 1 . . . . 1	1 . . . . . 1 . . 1 1 1 1 1 1 1 . 1 . . 1 . . . .
Pavonia burchellii -s2		. . . . 1 . . 1 . . . . 1 .	1 1 . . . . 1 . . 1 1 1 . . . 1 . . . 1 . . . . 1 1 . . 1 .
Urochloa oligotricha -hl		. . . . 1 . . 1 1	. . . 1 . . . . . 1 . 2 . 1 2 1 5 1 1 . . . . 1 .
Acacia hebeclada -s1		. . . . 5	. . . . . 2 3 . . . . . . 1 . . . 1 1 . . 1 . . 5 5 . 1 . 5
Brachiaria deflexa -hl	. . 1		. . . . . 1 . . . . 1 1 1 1 1 1 . . 1 . . . . 1 .
Ipomoea sinensis -hl		. . . . 1 .	1 1 . . . 1 . . . . . 1 . 1 . 1 1 . . . . . . 1 1
Acalypha indica -hl	. . . . . 1		. . . . 1 . 1 . . 1 1 . 1 . 1 . 1 . . . 1 . . . .
Rhynchosia minima -hl		. . . . 1 1	. 1 . . . . 1 . . . . 1 . 1 1 . 1 1 . . . . 1 . . . .
Solanum kwebense -s2		. . . . 1	. . . . 1 1 1 . 1 1 1 . 2
Commelina benghalensis -hl			. . . . 1 1 . 1 . . 1 . . . . 1 1 . .
Boscia albitrunca -s2	. 1	. . . . 1	. . . . 1 . . . . 1 1 . . 1 . . . . 1 . 1 .
Monelytrum luederitzianum -hl	. . . . 1		. . . . . . 1 . . . . 2 2 1 2 5 . . .
Hermannia modesta -hl		. . . . 1	. . . . . 1 . . . . . 1 . . . 1 . 1 . . . . . 1 . 1 . . . .
Albizia anthelmintica -s2		. . . . 1 . . .	. . . . 1 . . 1 . 1 1 . . 1 1
Sporobolus fimbriatus -hl			. . . . . . 6 1 . . 1 . 1 1 . 1 . . . .
Terminalia prunioides -s2		. . . . 1 . . 1 1 . . .	. . . . 1 . . . 1 1 . . 1 . 1 1 . . . .
Pechuel-Loeschea leubnitziae -s2			. . . . 1 . . 1 1 1 1 . 1 . . . .
Albizia anthelmintica -t3	. 1	. . . . 1	. . . . 5 . . . 1 5 . . . 1 1 . . . . 5 . . .
Pollichia campestris -s2	 1		1 . . . . 1 1 1 . . . . 1 . . 1 . . . . .
Ipomoea crassipes -hl			. . . . 1 1 . . . . 1 . . . . 1 . 1
Commicarpus pentandrus -hl			. . . . 1 . 1 . 1 1 . 1 . . . .
Setaria pumila -hl		. . . . 1	. . . . . 1 . . . . . 1 1 . 1 1 . . . .
Digitaria velutina -hl		. . . . 1	. . . . . 1 . . . . 1 . 1 . . 1 . . . . 1 . .
Dichrostachys cinerea -s2		. . . . 1 1	. . 1 1 1 . . . . 1 1 . . . .
Aristida congesta -hl			. 1 . . . . 1 . . 1 . . 1 2
Terminalia prunioides -s1		. . . . 1 . . . . 1 .	. 1 . . . 1 . . . . 1 . . . . . . 2 . . . .
Lonchocarpus nelsii -t3		. . . . 2	. . . . . 1 . . . . 2 . . . . 1 5
Grewia flavescens v. olukondae -s2			. . . . 1 1 . 1 2
Hibiscus discophorus -s2			. . . . 1 . . 1 . 1 . . 1
Chloris virgata -hl			. . . . . 2 . . . . 1 . . 1 . .
Grewia bicolor -s1			. . . . 5 1 . 5 .
Aloe littoralis -s2		. . . . 1 .	. 1 . . . . 1 1
Aloe littoralis -s1		. . . . 1	. . . . 1 . . . . 1 . . . .
Grewia flavescens v. olukondae -s1			. . . . 1 . . . 5
characteristic spp ass 11 and 12			
Eragrostis trichophora -hl		1 1 . 1 1 1 1 . 1 1 . 5 . 1 1 2 1 1 5 1 . 2 5 . 5 1 . 2	1 6 5 5 2 . 5 6 6 1 5 6 6 7 6 6 6 6 5 6 1 . 5 . 5 5 5 1 5 5
Dichrostachys cinerea -s1		1 . . . . 1 2 1 . . . 6 1 2 1 1 1 . . 1 6 1 1 2 5 5 2 .	5 5 . . . 5 1 5 5 6 6 1 5 5 1 1 . 2 5 . 5 . . . 1 . 1 6 5 1
Stipagrostis hirtigluma -hl	. 5 1 2	5 5 1 6 5 6 6 5 2 5 1 6 2 5 2 1 5 . . 1 2 5 1 5 6 5 1 1	1 . 1 1 . . . 5 1 1 1 . 5 . . . . . 5 . . . 1 . 5 . . 1 . .
Enneapogon scoparius -hl		. . 1 . . 1 1 . 5 . 1 . 2 1 1 1 1 1 5 . . 1 6 2 1 . 1 2	1 . 2 2 1 . 2 5 5 1 6 . . . . 1 . . 1 1 . . . 1 . . . . 1 .
Acacia reficiens -t3	. . . 1 5	1 . . . . 1 . 2 . 2 2 6 6 5 5 .	5 5 2 . . . . 5 . . . . 1 . . . . 5 5 . . . 6 6 1 5 5
Tarchonanthus camphoratus -s1		1 . 6 1 5 3 5 1 . . 1 . 1 1 . . . . 1 . . 1 . .	. . . . . . 1 1 1 . . 1 . . . . 6 . . . . . . 1 . . .
Tarchonanthus camphoratus -s2		. 1 . . . . 1 . 1 . . 1 1 1 1 1 1 . . . . . . 1 1	. 1 1 . . 1 . . . . 1 . . . . 1 . . . . . 1 . 5
Geigeria ornativa -hl	. 1	1 . . 1 . 1 1 1 1 1 1 . 1 . 1 1 1 1 . . 1 . . 1 1 1 1 .	1 1 . 1 . . . . 1 . . . . 1 . . . 1 . . 1 . . 1 1 .
Corchorus tridens -hl		1 1 . . . . 1 1 . . . . 1 . . 1 1	1 1 1 1 1 . . . . . . 1 1 1 1 1 1 1 1 1 . 1 1 1 1 1 . . 1 1
Becium filamentosum -hl		1 . 1 . 1 1 1 1 1 1 1 . 1 . 1 . 1 . 1 1 . . . 1 . . 1 1	1 1 1 1 1 . 1 . . 1 1 1 1 1 1 1 1 1 1 1 . . . . 1 1 .
Heliotropium steudneri -s2	. 1	1 1 1 1 . . . . 1 . . . . 1 1 . . . 1 1 . 1 1	1 . . 1 1 . . . . . . 1 1 1 . 1 1 1 1 1 . . . 1 1 1 . 1 1 1
Hibiscus calyphyllus -s2		. . . . 1 . . 1 . . 1 . 1 1 . 1 . 1 . . . 1	. . 1 1 1 1 . 1 . . . 1 . 1 . 1 1 1 1 . 1 . . . . 1 1 1 1 .
Ruellia sp nova -hl		1 1 1 . 1 1 1 1 . . 1 . . . 1 1 1 1 1 1 . . . 1 . 1 1 1	1 1 1 1 1 1 . 1 . . . . . 1 1 1 1 1 . . 1 . . . . 1 .
Eragrostis porosa -hl	. . 1 1 1 1 1 1 1 1		. . . . . 1 . . . 2 . . 1 . . . 1 1 . 5 . 1 2 5 1 5 . . 2 6
Solanum incanum -s2		. . . . 1 . 1 . . 1 . . . . 1	. . . . 1 . . . . . 1 1 1 1 1 1 1 1 . 1 . . . . . 1 . . 1 .

Asparagus cooperi -s2		. . . . 1 . . . . . . 1 . . 1 . 1 1	. . . 1 1 . 1 . . . . 1 . 1 1 . 1 . . 1 . 1 . . . 1 1 . . 1
Hibiscus palmatus -hl		. . . . 1 . . . 1 1 . . 1	. . 1 1 1 . . . . 1 1 1 1 1 . . . . 1 1 . . 1
Ziziphus mucronata -s2		. . . . 1 . . . . . 1 . 1 . . . . . . 1 1	. 1 . . . 1 . . 1 1 . . . . 1 . 1 . . . . 1 1 . . . . 1 1 .
Aptosimum decumbens -hl		1 . 1 1 1 1 1 1 . 1 1 . 1 1 . . . 2 . . . . 1 .	1 1 . . . . 1 . . . . 1 . 1 1 . 1 . . 2 . 1
Bothriochloa radicans -hl		. . . . 1 1 . . 5	. 1 2 1 . . 1 . 2 . . . . 1 . . . . 1 . . 2 .
Grewia flavescens v. flavescens-s2		. . . . 1 . . . . 1 1 . 1	. . 1 . . 1 . 1 1 . . . . 1 . . . . 1 1 . .
Grewia bicolor -s2		. . . . 1 2	. . 1 1 1 1 . . . . 1 . .
Indigastrum costatum -hl		1 1 . 1 1 1 . . 1 1	. . 1 . . . . 1 1 1 . 1 . 1 1 . . . .
Rhus marlothii -s1		. . . . 1 1 1 . 1 . . . . 1 . 4 1 1 1 .	1 . . . . . 1 . 1 . . . 1 1 . . . . . . 1 . . . . . 1 . . .
Helinus spartioides -s2	1	1 1 1 . . . . 1 1 . 1 1 . . 1 . . 1 . . . 1 . . . . 1 .	. . . . 1 . . 1 . . . . 1 . . 1 . . 1 . .
Hypoestes forskaolii -s2		. . . . 1 . . 1 . 1 1 . . 1	. . . . . . 2 1 . . . . 1 1 . . . .
Lycium oxycarpum -s2	. . 1		. . 1 2 1 . 1 . . . .
Commelina livingstonii -hl		. . . . 1 1 . . 1 . . . . 1 1 1 1	. 1 . . . 1 . . . 1 1 1 . . . . . 1 . . . . 1 . . .
Brachiaria malacodes -hl		. . . . 1 1 . . 1 . . . . . . 1	. . . . 1 . . . . . 1 . . . . 1 . . . .
Kalanchoe lanceolata -hl		. . . . . 1 . . . . . 1 . . . . 1 .	. 1 . . . 1 . . . 1 . . . .
Microchloa caffra -hl		. . . . 1 . 1 . 2	. . . . 1 1 . . . . 1 . . . .
Hermannia tomentosa -hl		. . 1 . . . 1 . . . . . 1 1	. . . . 1 . . . . 1 1
Helichrysum tomentosulum -s2		. 1 1 . . . . 1 . . . . 1 .	. . . 1 . . . . 1 . . . . 1 . .
Combretum hereroense -s1		. . . . 1 1	. 1 . . . . . . 1 . . . .
common spp TWINSPAN group 3			
Melharia virescens -s2	. 1 1 1 2 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 1 1	1 1 1 1 1 . 2 1 1 1 . 1 1 1 1 . . 1 1 1 . 1 1 1 1 . 1 1 1 .
Acacia mellifera -s1	. 1 . 5 6 5 3 2 3 5	7 8 1 6 5 6 7 7 7 7 6 5 6 6 7 7 7 5 6 7 5 7 7 6 6 7 7 7	8 7 7 7 7 7 6 6 7 2 . 1 . 2 5 5 5 1 3 5 5 7 5 5 5 1 2 3 5 5
Eragrostis echinochloidea -hl	. 1 1 1 1 1 2 1 1 1	2 5 1 2 2 1 1 1 2 2 2 2 1 1 . 1 1 . . 1 . 1 2 5 6 1 1 5	1 5 . 5 2 . 5 5 5 1 2 1 5 5 5 1 1 5 6 1 1 5 5 5 1 2 2 . . 2
Acacia reficiens -s1	. . 2 1 1 2 . 1 1 1	5 2 . 2 . . 1 . 2 1 2 5 4 2 2 1 2 3 5 5 5 6 5 6 5 5 7 2	5 5 5 5 5 5 6 7 5 . 6 1 2 5 5 . 5 2 3 . 7 2 2 5 6 5 6 2 5 6
Seddera suffruticosa -s2	1 . 1 1 1 . 1 1 1 1	. 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . 1 1 . . .	1 1 1 . . . 1 1 1 . . . 1 . . . . . 1 . 1 1 . 1 1 1 . 1 1 1
Cenchrus ciliaris -hl	1 1 1 1 5 5 1 5 5 5	2 1 . . . . 1 . 1 . 1 2 2 1 1 . 1 5 5 1 . 1 1 2 1 5 2 6	1 5 1 6 6 . 5 2 5 7 2 7 5 5 6 5 6 7 1 1 1 5 5 6 7 7 6 1 1 5
Otoptera burchellii -s2	1 . 1 1 2 1 . 1 1 1	1 . 1 1 1 1 1 . 1 1 1 1 1 1 1 . . 1 1 1 1 . 1 . . 1 . 1	1 1 . . . . . 1 1 . . . 1 1 1 1 . 1 1 1 1 1 1 . 1 1 . 1 1 1
Lantana angolensis -s2	. . . . 1 1 .	1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 1 . . 1 1 . . 1	. 1 . 1 1 . . . 1 1 1 1 1 1 1 . . 1 . 1 . 1 1 . . . . 1 . .
Leucas pechuelii -s2	. . 1 1 1 1 1 . 1 .	1 1 . 1 . . . 1 1 1 1 2 . . . . . 1 1 1 1 1 1 2 1 1 1 .	1 1 1 . 1 1 . 1 1 1 1 1 1 . 1 . . 1 1 . 1 . . 1 1 1 1 1 . .
Ptycholobium biflorum -s2	1 . . 1 1 . . 1 . 1	1 . . 1 1 1 1 1 . 1 1 . . 1 1 1 1 1 1 . . 1 . 1 . 1 1 .	. . . 1 . . . 1 . . . 1 1 1 . 1 1 1 1 . . . . 1 1 . . . 1 .
Phyllanthus maderaspatensis -hl	. . . . . 1 . 1 1 1	1 1 1 1 1 1 . 1 1 1 1 1 . 1 1 . . 1 1 . . 1 . . . . 1 .	1 . . . 1 . . . . . . 1 1 1 1 1 1 . . . 1 . . 1 . 1 1 . 1 1
Enneapogon cenchroides -hl	5 6 2 2 1 1 2 1 1 1	. 1 . 1 1 . 1 . . . . 2 1 1 . . 1 5 5 1 6 1 . 1 . 1 . .	. . 5 . . . 1 1 1 1 . . 1 1 . 1 . . 2 . 1 1 1 1 1 1 1 1 . 1
Nidorella resedifolia -hl	. . . . . . 1 . . .	1 1 1 . 1 1 1 1 1 . 1 . 1 . . . . 1 . 1 . . . 1 . . 1 1	1 1 . 1 . . 1 . 1 . 1 1 . . 1 . 1 1 . 2 . . . . . . 1 . 1 .
Aristida effusa -hl	1 . 1 . . . 1 . . 1	1 . 1 . . . . 1 . 1 1 . . . . 1 1 2 . 1 1 1 1 1 .	. . 1 . . . . 1 1 1 1 1 1 . . . 1 1 . 1 1 2 2 2 1 1 1 1 . 1
Grewia flava -s1	. 1 . 1 . 2 . 1 1 1	1 1 . . . 2 2 2 1 . . . . 1 . . . . 1 1 5 2 2 1 .	1 1 . . . . 5 . . . . 1 . 1 . 1 1 . . . 1 . . . . 1 1 . . 2
Ehretia rigida -s2	. . 1 . . 1 1 . . .	. . . . 1 . . . 1 1 1 . . 1 . 1 1 . 1 1 . . . 1 1 . . 1	1 1 1 1 1 1 . 1 . . . 1 . . 1 . 1 1 1 . . . . 1 1 .
Grewia flava -s2	1 . 1 . . . 1 . . .	. . 5 1 3 . . . . 1 1 . 1 . 1 1 1 . 1 1 5	. . 1 1 1 . . 2 1 . . . 1 . . . . 1 1 1 . 1 1 1 . . . 1 1 .
Aristida rhiniochloa -hl	. . 1 . . . 1 . . 1	. 1 1 . 1 . 1 1 1 . . . . 1 1 . 1 . 1 . . 1 1 .	1 . . . . 1 . . 1 . . . 1 1 1
Leucosphaera bainesii -s2	1 3 1 1 3 5 3 5 2 5	1 . . . . 1 1 1 1 . . . . 1 . 1 2 . 1 1 . 1 1	1 . 2 1 3 . . 1 . . . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 5 . . .
Peliostomum leucorrhizum -hl	. 1 . 1 1 2 1 2 5 1	. 1 . . 1 . . 1 1 1 . 1 . 1 . . . . . . 1 . . 1 1 . . 1	1 . 1 1 1 . . 1 . 1 1 1 1 1 . 1 . 1 1 . . 1 1 . 1 . 1 . . .
Tephrosia dregeana -hl	. . . . 1 1 .	. . 1 . 1 1 . 1 1 1 1 1 1 . . . . 1	. . . . 1 . . . . 1 . . . .
Commiphora pyracanthoides -s2	1 . . . . . 1 . . .	. . . . . 1 1 1 . . . . . 1 . 1 . 1 1 1 . . . 1 . . . 1	. . 1 . . 1 . . . . 1 . . . . .
Felicia anthemidodes -s2	. . . 1 . . . 1 . .	. 1 . . . . . . 1 . . . . 1 . 1 1 1 . . . 1 . . 1 . 1 1	1 . 1 . 1 1 1 . . . . . . 1 1 . . . 1 . 1 . . . . 1 . 1 . .
Ocimum americanum -hl	1 . . 1 . 1 1 1 1 1	. . 1 1 1 1 . . . 1 . 1 1 . . . . 1 1	. 1 . . . . 1 1 1 1 . 1 . . . . . 1 1 1 . .
Aizoon virgatum -s2	1 1 . 1 1 . . 1 . 1	. 1 . . 1 . . . . . . 1 . 1 1 . . . 1 . . 1 . . . . 1 1	. . 1 1 . 1 . 1 . 1 1 1 1 1 1 . 1 1 1 . . 1 . 1 1 . 1 . . .
Kleinia longiflora -s2	1 . 1	1 . . 1 . . . . 1 . . . . 1 1 1 . . 1 . . . . 1 .	1 1 1 . . . . . . 1 . . . .
Melinis repens s. grandiflora -hl	. . . . 1 1 1 . . .	. . 1 1 1 . 1 . . . . 1 . 1 . . . 1	. . . . 1 1 1 . 1 . 1 1 . . 1 . 1 . . 1 . . 1 . 1
Chascanum pinnatifidum -s2	. 1 1 1 . . . 1 . .	. . 1 . . . . . 1 . . . . 1 . 1 1 . . . 1 . 1 .	1 . . 1 1 . . . . 1 1 . . 1 1 1 . 1 . . . 1 . 1 . 1
Ruelliopsis damarensis -hl		1 . . . . . 1 . . . . 1 . . . . . 1 . 1 1 1 .	1 . . . . . 1 . 1 . . . . 1 . . 1 1 . . 1 1
Tragus berteronianus -hl	. . . 1	1 . . . 1 . . . 1 . 1 . 1 . . . . 1	. . 1 . . 1 . . . 1 1 1 1 . . . 1 1 . 1 . 1 . 1 1 1 . . 1 .
Urochloa brachyura -hl	 1	. . 5 1 . . 1 . 1 . . 1 . 1	. 1 . . . 1 . . . 1 . 1 1 1 1 1 . . . 1 . . . . 1 . . 1 . 1
Monechma genistifolium -s2	1 5 1 5 . 6 5 6 6 6	. . . . 2 6 5 5 6 . 2	1 . 1 2 5 . 5 5 . . . . 6 5 6 6 5 5 6 . . 1
Ziziphus mucronata -s1	. . 1 1	. . . . 1 . . . 1 1 . . . . 1 1 .	1 . . . . . 2 . . . 2 1 1 1 . 1 1 1 1 . 1 . . . 1 . . . . .
Acacia erioloba -t3	. . 1	. . . 3 2 5 5 1	. . . . 1 . . . . 5 . . 2 . . . 2 5
Hirpicium gorterioides -hl	. . . . 1 . .	. . . . 1 . . 1 . . . . 1 . . . . 1 . .	 1
Evolvulus alsinoides -hl	. . . . . 1	. 1 . . . . 1 . 1 . 1	. . . . . 1 . . . 1 . . . . . 1 . . . 1 . . . . 1 1 . 1 1 1
Polygala leptophylla -hl		. . . 1 . . 1 . . 1 1	. . . .
Limeum sulcatum -hl		. . 1 . . . . 1 . . . . 1 . 1	. . . .
Acacia mellifera -s2	. . 1 . . 1 1 . . 1	. . 1 . . . . 1 . . 5 . . . . . 5	. 5 2 . . . . . . 1 . . . . 1 1 1 . . . . . 1 . .
Megalochlamys marlothii -s2	1	. . . . . . 1 . . . . 1 1 1 .	1 . 1 1 . 1 . . . . . . 1 . . . . 1 . . . . . 1 . 1 .
Andropogon chinensis -hl		. . . . 1 . . . 1 1	. . . .
Kohautia caespitosa -hl	. . 1 . . 1 . 1 . .	. . . 1 . . . . 1 . . . . 1	. . . . 1 . . 1 . 1 . 1
Oropetium capense -hl	. 1 . . . . . 1 . .	. . . . 1 . 1 . 1	. . . . . 1 . . . .
Aerva leucura -s2		. . . . 1 1 . . . . . 1	. . . . 1 . . . .

Species	Group 1	Group 2	Group 3
Cyperus fulgens -hl		1 1 1	1 1
Talinum arnotii -hl	1 1 1 1	1 1 1	1 1 1 1 1 1 2 1
Portulaca kermesina -hl		1 1 1	1 1 1
Tribulus terrestris -hl	1	1 1 1	1 1 1 1 1 1 1 1 1 1
Acacia tortilis -s1	1 1 1	2 1 1	6 5 2 1 1 1
Ipomoea bolusiana -hl		1 1	1 1 1 1
Maytenus senegalensis -s2		1 1	1 1 1 1
Talinum tenuissimum -hl		1 1	1 1
Gnidia polycephala -s2		1 1	1 1
Aptosimum lineare -hl		1 1	1 1 1 1 1
Euclea undulata -s2		2 1	1
Boscia albitrunca -t3	2	1 3	1 1 2 2 2
Commiphora glandulosa -s1	1	1 1	1 1
Pegolettia senegalensis -hl		1 1	1 1
Ipomoea verbascoidea -s2		1 1	1 1 1 1
Pogonarthria fleckii -hl		1 1	1 1 1 5
Ehretia rigida -s1	1 1 1	1 1	1 1 1 1 1 1 1
Indigofera charlieriana -hl	1	1 1	1 1 1
Merremia palmata -hl		1 1	1 1 1 1
Acacia tortilis -s2	1	1 1	1 1
Pupalia lappacea -s2	1 1 1	1 1	1 1 1 1 1 1 1 1 1 1 1 1
Acacia tortilis -t3	2	1 1	1
Blepharis leendertziae -hl	1	1 1	1 1 1 1 1
Neorautanenia mitis -s2		1	1 1
Acacia erubescens -s1		2	
Boscia foetida -s2	1	1	1 1 1 1
Hermbstaedtia odorata -hl	1	1	1 1
Solanum burchellii -s2	1 1 1 1	1	1 1 1 1
Terminalia prunioides -t3		2	
Ximenia caffra -s1		2	1
Blepharis obmitrata -s2		1	1 1 1
Acacia reficiens -s2	1 1	1	1 1
Commiphora angolensis -s1		1	1 1
Melinis repens s. repens -hl		1	1 1
Momordica balsamina -hl		1	1 1 1 1
Euclea undulata -s1			5
Eragrostis rigidior -hl			5
Crotalaria heidmannii -hl	1		1 1
Kyphocarpa angustifolia -hl			1 1 1
Ximenia americana -s1			1 1 1
Cyphostemma hereroense -hl			1 1 1
Nelsia quadrangula -hl			1 1 1
Pergularia daemia -hl	1		1 1
Acrotome inflata -hl			1 1 1 1 1
Boscia albitrunca -s1			1 1 1
Panicum maximum -hl			1 1 1
Gomphocarpus fruticosus -s2			1 1 1 1
Eragrostis rotifer -hl			1 1 1 1 1
Geigeria acaulis -hl			1 1 1 1 1
Harpagophytum procumbens -hl			1 1 1
Combretum imberbe -t3			5
Chamaesyce inaequilatera -hl	1 1		1 1 1 1 1 1 1

Table 29

TWINSPAN TABLE

associations	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
Unique relevé nr.	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	3	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	6	6	6	6	6	2	3	3	3	3	3	0	0	1	7	7	7	7	5	1	3	4	4	4	4	5	5	5	5	6	6	6	7	7	6
	1	5	2	3	4	9	0	1	3	4	6	4	7	0	2	4	5	6	2	6	9	0	1	2	3	4	6	3	5	6	8	9	0	1	7
diagnostic spp association 13																																			
Evolvulus alsinoides -hl	1	.	1	1	1	1	1	.	.	.	1	1	1	1	1	1	1	1	1	1	.	1	.	1	.	1	1	1	1	.	.	.	.	1	.
Eragrostis trichophora -hl	1	2	1	1	6	.	6	2	.	1	1	1	1	.	.	5	1	1	.	1	.	.	.	.	2	5	5	5	5	1	.	.	.	1	5
Urochloa brachyura -hl	1	1	1	1	.	5	1	1	6	.	.	.	1	1	.	1	1	1	1	1	2	1	.	1	1	.	1	.	1	.	.	.	.	.	.
Limeum sulcatum -hl	1	1	.	1	.	.	.	.	.	.	.	1	.	.	1	.	1	1	.	.	1	1	1	1	1	1	1	1	1	1	1	.	1	1	.
Aptosimum decumbens -hl	.	1	.	1	1	.	.	.	1	1	.	1	.	1	1	5	5	2	1	1	.	.	.	1	.	.	.	.	1	1	.	.	.	1	.
Commelina benghalensis -hl	1	.	.	.	.	.	.	.	.	1	.	.	1	1	1	.	.	1	1	.	.	.	1	.	.	1	1	1	1	1	.	.	1	.	.
Bidens biternata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	1	.	1	.	1	.	1	1	.	1	1	1	.	1	1
Brachiaria deflexa -hl	.	.	.	.	.	.	.	.	5	5	.	.	1	.	1	.	.	1	.	1	1	.	1	.	.	1	1	1	1	.	.	.	.	.	1
Hibiscus calyphyllus -s2	.	.	.	.	.	.	.	1	1	1	1	.	1	.	.	.	.	.	.	.	1	.	.	.	.	1	.	1	1	1	1	1	.	.	2
Solanum incanum -s2	.	.	.	.	1	.	1	.	.	2	.	.	.	.	.	1	1	.	.	.	.	.	1	.	1	1	.	1	1	.	.	1	.	1	1
Eragrostis jeffreysii -hl	.	.	.	.	.	.	5	.	.	.	1	.	.	.	.	.	.	.	.	.	1	5	2	2	1	.	.	1	5	1	.	.	.	1	.
Eragrostis rigidior -hl	1	1	1	5	1	.	1	.	.	.	.	1	.	.	.	1	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Digitaria velutina -hl	.	1	.	.	1	.	.	.	1	.	.	.	1	1	1	.	.	1	.	.	.	.	.	.	.	1	.	1	1	.	.	.	.	.	.
Setaria verticillata -hl	.	.	.	.	.	.	.	.	1	.	.	.	1	1	.	.	.	.	.	.	1	.	.	.	.	1	.	1	1	.	1	1	.	.	5
Acrotome fleckii -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	1	.	1	.	.	1	1	.	.	1	1	.	1	1
Urochloa oligotricha -hl	1	.	5	1	5	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	1	.	.	1	1	.	.	1	.	.	.	.	.	.	.
Gisekia africana -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	1	1	1	.	1	1	.	1	1	.
Hermannia tomentosa -hl	1	.	1	1	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.
Setaria pumila -hl	.	.	.	.	.	.	.	.	1	1	1	.	.	1	.	.	.	.	.	.	1	.	.	.	1	.	.	1	1	.	.	1	.	.	.
Acacia fleckii -s1	.	.	1	.	.	1	1	1	.	.	.	.	.	1	.	.	.	1	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Kohautia caespitosa -hl	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	1	1	.	.	.	.	1	1	.	.	.	.	1	.	.	.	.	1	.
Heliotropium steudneri -s2	.	.	.	.	.	.	.	.	1	.	.	1	1	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.
Leucas pechuelii -s2	.	1	.	.	.	1	.	1	.	.	.	1	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.
Digitaria seriata -hl	5	.	5	5	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	1	1	2	.	.	.	.	.	.
Heliotropium ovalifolium -s2	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	1	1	.	.	.	.	1	1	5	1	.	1
Oxygonum alatum -hl	.	1	.	1	.	.	.	.	.	.	.	1	.	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Talinum arnotii -hl	.	.	.	.	.	.	.	.	.	1	.	.	1	1	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	1	1	.	.	1	.
Pentarrhinum insipidum -hl	.	.	1	.	.	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	1	.
Rhus ciliata -s2	.	.	.	.	.	1	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	1	1	.	1	.	1	.
Grewia flavescens v. flavescens -s2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	1	.	.	1	.	.	.	1
Hermannia quartiniana -hl	1	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	.	.	.	.	.	1	.	.	.	.	1
Ruellia sp nova -hl	1	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	1	.	1	.	.	.
Tephrosia purpurea -hl	.	1	.	1	1	.	.	.	.	.	.	.	.	1	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Panicum maximum -hl	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	1	.	1	.	1	1	.	.	.	1
Monechma debile -hl	.	.	.	.	.	.	1	1	1	5	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	1
Commiphora angolensis -s2	.	1	.	1	.	.	.	.	.	.	.	1	.	1	1	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.
Corchorus tridens -hl	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	1	1	1	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.
Melinis repens s. repens -hl	2	1	1	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Waltheria indica -hl	1	1	.	.	1	.	.	.	.	.	.	1	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Felicia anthemidodes -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	1	.
Acalypha indica -hl	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	1	1	1	.	.	.	.	.	.	1
Schmidtia pappophoroides -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kyllinga alba -hl	1	1	.	1	1	.	.	.	.	.	.	.	.	1	.	.	1	1	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.
Tarchonanthus camphoratus -s2	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	.	.	.	.	1	.	.	.	.	.
Ipomoea sinensis -hl	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	1	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.
Combretum imberbe -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	.	5	5
Neorautanenia mitis -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	1	.	1	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.
Eragrostis rotifer -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1

associations	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Unique relevé nr.	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	3	3	3	3	3	3	4	4	4	3	3	3	1	1	1	3	3	3	3	3	3	3	3
	3	3	2	3	4	4	1	2	2	2	3	4	3	3	3	1	3	3	1	2	2	2	1
	8	9	3	3	2	3	5	0	4	9	0	1	5	7	8	8	1	2	9	0	1	2	7
diagnostic spp association 13																							
Evolvulus alsinoides -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Eragrostis trichophora -hl	.	.	.	.	.	2	1	.	5	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Urochloa brachyura -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	1	1
Limeum sulcatum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aptosimum decumbens -hl	.	.	.	.	.	.	1	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Commelina benghalensis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bidens biternata -hl	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachiaria deflexa -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hibiscus calyphyllus -s2	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	1
Solanum incanum -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis jeffreysii -hl	.	.	.	.	1	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis rigidior -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Digitaria velutina -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Setaria verticillata -hl	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Acrotome fleckii -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Urochloa oligotricha -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Gisekia africana -hl	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hermannia tomentosa -hl	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Setaria pumila -hl	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Acacia fleckii -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Kohautia caespitosa -hl	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Heliotropium steudneri -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
Leucas pechuelii -s2	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.
Digitaria seriata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Heliotropium ovalifolium -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oxygonum alatum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Talinum arnotii -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pentarrhinum insipidum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhus ciliata -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Grewia flavescens v. flavescens -s2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Hermannia quartiniana -hl	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ruellia sp nova -hl	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tephrosia purpurea -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Panicum maximum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Monechma debile -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Commiphora angolensis -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.
Corchorus tridens -hl	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melinis repens s. repens -hl	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.
Waltheria indica -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Felicia anthemidodes -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acalypha indica -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Schmidtia pappophoroides -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kyllinga alba -hl	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tarchonanthus camphoratus -s2	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Ipomoea sinensis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Combretum imberbe -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.
Neorautanenia mitis -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Eragrostis rotifer -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Acacia erioloba -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	2	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Boerhavia diffusa -hl	.	.	.	.	.	1	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Combretum apiculatum -s2	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pogonarthria squarrosa -hl	1	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aristida congesta -hl	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyphostemma congestum -s2	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia tortilis -s1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Peltophorum africanum -s1	.	1	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aloe littoralis -s1	.	.	.	.	.	1	1	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kirkia acuminata -t3	.	.	.	.	.	.	.	.	2	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Grewia bicolor -s2	.	.	.	.	.	.	.	.	1	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia tortilis -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia karroo -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ziziphus mucronata -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Olea europaea -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ozoroa paniculosa -s2	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
diagnostic spp association 14																																																											
Terminalia prunioides -s1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	5	1	.	.	.	.	5	5	6	5	.	.	1	.	.	.	5	.	.	2	5	1	.	2	5	5	7	2	.	.	.	6	7	6	7	6	6	6	6
Combretum apiculatum -s1	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	1	6	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	2	.	.	.	.	1	1	1	.	1	.	5	1	1	5	1	1	2	5	2	2	6
Stipagrostis hirtigluma -hl	1	1	.	1	.	2	.	2	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	1	.	.	1	.	1	1	1	1	.	.	2	.	5	5	5	5	2	2	1	6	5	6	1	6	5	1	1	.	.	5	1	.	.
Catophractes alexandri -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	2	1	.	.	2	1	.	.	1	.	.	.	.	2	5	.	2	2	1	6	.	6	5	5	2	2	1	1	.	.	.	.	.	1	.	.	1	2	.
Enneapogon desvauxii -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	2	2	.	1	.	5	1	1	2	.	.	1	.	.	5	.	.	.	.	1	1	.
Fingerhuthia africana -hl	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	1	.	.	.	.	.	.	1	.	.	.	1	1	1	.	.	2	1	.	2	5	1	.	5	.	1	.	.	.	.	1	.	.
Dombeya rotundifolia -s1	.	.	.	.	.	1	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	.	.	1	.	1	1	2	.	1	1	.	.	.
Blepharis obmitrata -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	3	1	1	.	.	.	.	1	.	.	.	1	2	.	1
Acacia mellifera -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	1	.	.	1	.	.	.	.	1	1	.	.	.	1	.	.
Helichrysum tomentosulum -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	.	1	.	.	.	1	.	.	.	.	.	.	1
Terminalia prunioides -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2	.	5	1	5	.
Eriocephalus pubescens -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	1	.	.	.	2	.	.	1	.	.	.	1	.	.
Aristida rhiniochloa -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	5	1
Calostephane divaricata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	1	.	.	.	1	.	.	.
Commiphora africana -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	2	.	.	.	1
Triaspis hypericoides -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.
Hiernia angolensis -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	1	.	.	.	.	1	.	5	.	.	.	.	.	.	.
Dichrostachys cinerea -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.
Dombeya rotundifolia -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	1	.
Combretum apiculatum -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	5	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Commiphora angolensis -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	2
Ozoroa insignis -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	1	.	.	.	1
Lannea discolor -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	5	.	.	.	.	.	.	.	.
Acacia hebeclada -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	5
Albizia anthelmintica -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Boscia foetida -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Commiphora tenuipetiolata -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
common spp TWINSPAN group 4																																																										
Dichrostachys cinerea -s1	6	1	5	5	5	7	7	7	8	6	2	6	6	5	.	5	5	5	2	6	1	1	.	.	.	5	1	1	2	1	1	1	.	1	.	1	.	6	5	5	5	2	6	6	2	5	5	1	1	5	5	5	3	5	6	7	7	5
Acacia mellifera -s1	5	2	2	1	6	6	5	1	1	.	1	5	6	3	6	6	6	6	5	5	1	5	5	6	6	5	6	6	2	2	5	5	6	.	.	5	6	7	5	6	6	5	6	5	6	6	7	1	1	1	1	5	5	.	.	5	.	.
Cenchrus ciliaris -hl	1	1	1	1	1	6	5	7	2	1	.	1	1	1	1	1	1	1	1	5	5	6	5	6	1	5	1	.	2	1	1	5	1	1	1	1	1	.	6	1	5	2	5	2	.	1	1	.	.	1	.	5	.	.	.	.	.	.
Acacia reficiens -s1	1	5	2	6	.	.	2	1	2	6	.	.	.	2	1	6	5	1	1	.	2	5	1	5	1	5	.	.	.	5	.	2	.	.	.	.	.	5	5	6	5	2	.	2	1	2	5	2	.	1	.	2	.	.	.	.	1	.
Grewia flavescens v. flavescens -s1	.	5	1	5	1	1	5	1	2	1	1	1	2	1	1	1	1	1	.	.	1	1	.	.	.	.	1	.	5	1	.	1	1	1	1	2	2	.	1	.	.	3	2	5	.	.	.	2	.	1	.	1	.	.	1	.	.	1
Enneapogon cenchroides -hl	.	.	.	.	.	1	1	1	1	1	1	1	1	1	.	1	.	.	1	2	1	1	1	1	1	1	5	1	1	1	2	5	1	1	.	2	2	6	1	.	1	1	1	5	.	.	.	1	.	1	.	6	5	5	2	6	5	6
Eragrostis echinochloidea -hl	1	1	1	.	.	1	.	1	.	1	.	1	.	1	1	.	1	1	1	1	1	2	5	5	5	5	1	.	1	1	5	5	1	1	2	2	6	.	2	5	2	2	.	5	2	2	5	.	.	1	1	1	5	1	1	.	.	.
Melhania virescens -s2	1	1	1	.	1	2	.	1	.	.	1	1	.	1	1	1	2	1	.	1	5	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5	5	3	1	1	1	1	2	2	1	1	1	.	1	.	.	.
Melinis repens s. grandiflora -hl	.	1	.	1	.	.	1	1	1	1	5	2	2	1	1	1	.	1	1	1	5	1	5	1	1	.	5	1	1	.	1	1	.	1	.	5	2	.	1	.	1	1	1	1	.	1	.	2	.	1	1	1	5	1	.	.	1	5
Becium filamentosum -hl	1	1	1	1	.	1	1	1	1	.	1	.	1	.	1	.	1	.	.	.	1	1	1	1	1	1	.	1	.	1	1	1	1	1	1	1	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	1
Tragus berteronianus -hl	.	.	.	.	.	1	1	1	.	.	1	.	.	1	1	1	1	1	.	.	1	1	1	1	1	1	1	1	1	1	1	1	1	.	.	1	1	.	.	1	.	1	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.
Lantana angolensis -s2	.	1	1	1	1	1	1	1	1	.	.	1	1	1	1	1	1	.	.	.	.	1	1	.	.	1	.	1	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	.	1	.	.	.	1	.	.	1	.
Aristida effusa -hl	1	1	.	1	.	1	1	1	1	.	1	1	1	.	.	1	1	.	.	1	1	1	.	.	.	.	1	1	1	1	.	1	.	1	.	1	1	2	1	1	1	2	1	.	.	.	.	1	.	1	5	2	1	6	.	5	.	.

Phyllanthus pentandrus -hl	1	1	.	.	.	.	.	.	.	.	.	1	1	1	1	1	1	.	.	.	1	1	1	1	1	1	.	1	1	1	1	1	1	.	.	.	1	.	.	.	.	1	.	1	.	.	.	.	1	.	1	.	1	.	1	.	.	1
Otoptera burchellii -s2	.	.	.	1	1	.	.	.	1	.	1	1	1	1	1	1	1	1	.	1	1	.	.	1	1	1	1	.	.	.	1	.	1	.	.	1	1	1	.	1	1	1	.	1	1	1	.	1	.	1	.	.	.	.	.	1	.	.
Clerodendrum ternatum -s2	1	1	.	.	1	1	1	1	.	.	1	1	1	.	1	.	1	1	.	1	1	1	1	.	.	1	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	5	5	1	.	.	1	.	.	.	1
Seddera suffruticosa -s2	.	.	.	.	1	1	.	1	.	.	1	1	.	1	.	1	1	1	.	1	1	1	1	1	1	.	.	.	.	1	.	1	1	.	.	1	1	1	1	1	.	1	1	1	1	2	1	1	.	1	.	2	1	.	1	1	.	.
Grewia bicolor -s1	.	.	.	.	.	.	.	.	.	1	1	.	2	.	1	2	5	1	2	1	.	.	.	.	.	2	.	1	2	6	2	5	3	2	1	1	.	.	.	.	.	5	.	.	.	.	.	2	.	.	.	.	.	1	.	.	.	.
Ocimum americanum -hl	.	.	.	1	.	1	.	.	.	.	.	1	1	1	.	1	1	1	1	1	1	.	.	1	.	.	1	1	.	1	1	1	.	1	.	.	1	.	.	1	1	.	.	1	.	.	1	.	.	.	.	.	1	1	1	.	1	1
Eragrostis porosa -hl	.	1	.	.	.	1	1	.	.	.	1	.	.	.	.	1	5	5	6	2	1	1	1	.	1	.	1	1	1	.	.	.	1	6	.	2	1	1	1	1	.	6	5	1	.	.	.	.	.	.	.	.	.	.	1	.	.	5
Acacia reficiens -t3	2	2	6	.	5	.	.	.	.	.	.	1	5	2	.	.	5	.	.	1	.	5	1	.	2	.	.	.	.	6	.	5	5	5	4	6	6	5	5	.	.	5	4	5	2	3	.	.	.	.	5	2	5	1	5	5	5	.
Solanum kwebense -s2	.	.	1	1	.	1	1	1	1	1	.	1	1	1	.	.	1	1	1	.	.	1	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	1	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	1
Achyranthes aspera v. aspera -hl	.	.	.	.	.	1	1	.	1	1	.	1	1	1	1	.	.	.	1	.	.	.	.	.	.	1	1	1	1	1	.	.	.	1	1	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	1
Pavonia burchellii -s2	.	.	.	.	1	1	1	.	1	.	.	.	1	1	.	.	1	.	.	1	1	.	1	1	.	1	1	1	.	1	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	1	1	.	.	1	1
Pupalia lappacea -s2	.	.	.	1	.	1	1	1	5	2	1	1	1	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	1	1	.	1	.	.	.	.	.	.	1	.	1	1	.	.	.	.	.	.	.	1	.	.	.	.	1
Rhynchosia totta -hl	1	.	1	1	1	.	.	.	.	.	.	1	.	1	1	.	1	.	1	1	.	1	.	1	.	1	.	.	.	1	.	.	1	.	.	1	.	.	.	.	1	.	1	1	.	.	.	.	.	1	1	1	.	.	.	.	.	.
Aizoon virgatum -s2	.	.	.	.	.	1	1	1	.	1	.	1	1	1	.	.	.	.	.	1	.	1	.	1	.	1	.	1	.	1	1	.	.	.	1	.	.	.	1	1	1	.	1	1	.	1	1	.	.	1	.	1	.	.	.	.	.	.
Stipagrostis uniplumis -hl	3	1	.	.	1	5	.	.	.	.	.	1	.	1	2	1	1	.	6	2	1	.	.	.	.	.	.	.	.	.	1	.	1	1	.	1	2	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	5	.	.	.	.	.
Hibiscus caesius -s2	1	1	1	1	1	.	.	.	.	.	1	1	.	.	1	.	.	.	.	1	.	1	1	1	1	.	.	.	.	1	.	.	1	.	.	.	.	.	1	.	1	1	1	.	.	1	1	1	1	1	1	1	.	.	.	.	.	1
Pogonarthria fleckii -hl	1	1	.	1	1	1	.	.	.	.	.	2	1	1	1	1	1	.	2	5	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	1	.	.	.	.	.	2	1	.	1	1
Abutilon austro-africanum -s2	.	.	1	.	.	.	.	.	1	.	1	.	.	.	1	.	.	.	.	.	1	1	1	.	.	1	1	.	1	1	1	1	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	1
Sericorema sericea -hl	.	1	.	1	1	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	1	1	.	1	1	.	.	.	.	.	1	1	1	1	.	1	1	1	.	.	.	1	1	1	1	1	1	.	.	.	1	1	1	.	.	.	.	.
Combretum imberbe -t3	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	6	4	.	.	.	.	.	1	1	5	5	6	6	5	2	2	5	.	.	.	.	.	.	2	5	5	.	.	.	.	.	.	5	5	5	.	.	.	.	.
Rhus marlothii -s1	1	.	5	1	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	2	1	2	1	.	1	.	.	.	.	.	1	.	5	1	1	.	2	1	2	2	1	1	1	1	1	1	.	1	.	1	1	.	.	1	.	.
Eragrostis nindensis -hl	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	1	5	5	5	2	.	.	1	.	.	.	1	.	1	.	2	5	.	.	1	2	.	.	3	1	.	.	.	5	1	1	.	1	.	.	.	1	.
Tarchonanthus camphoratus -s1	5	1	5	5	2	.	.	1	.	.	.	.	.	.	1	1	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	1	1	1	.	.	.	.	.	2	.	1	1	.	.	.	.	.	.	.	.
Combretum hereroehse -s1	4	1	2	2	1	1	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	1	.	5	5	1	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Grewia flava -s1	5	1	.	.	1	.	.	.	.	.	.	.	.	.	1	1	.	.	2	.	.	.	.	1	.	.	.	1	.	1	2	1	.	.	1	.	1	.	1	5	.	2	5	5	.	.	2	1	.	.	1	1	.	.	1	1	.	.
Heteropogon contortus -hl	.	1	1	1	1	1	.	.	.	.	2	.	.	.	.	.	.	.	.	1	6	2	5	5	6	.	.	.	.	.	.	.	.	.	.	.	2	.	.	1	1	.	2	.	5	2	2	5	5	1	1	2	2	.	1	.	.	.
Grewia flava -s2	.	.	1	1	.	1	1	1	1	.	.	.	.	1	.	.	.	.	.	.	1	1	1	.	.	.	1	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	1	1	.	.	.	.	.	.	1	.	.	.	.	.
Croton gratissimus -s1	4	7	.	2	.	.	.	.	2	.	6	1	.	.	.	.	.	.	.	.	1	.	.	.	.	1	1	.	.	.	1	.	2	.	.	2	.	5	5	5	5	.	.	.	.	5	5	6	7	7	5	2	5	1	6	3	2	2
Monechma divaricatum -s2	5	1	2	.	.	.	.	.	.	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	1	.	.	1	.	1	.	1	.	1	.	.	.	.	.	.	1	.	1	.	.	1	.	.	.	.	.	.	.
Phyllanthus maderaspatensis -hl	1	1	.	.	.	1	1	.	.	.	.	1	1	1	.	.	.	.	1	.	.	1	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	1	1	1	1	.	.	.	1	1	1	.	.	.	.	1	.	.	.
Tribulus terrestris -hl	.	.	.	.	.	1	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	1	.	1	1	.	1	1	.	.	1	.	.	.	.	.	1	.	.	.	.	.	1	.	1	.	.	1	.	.	.	.	.
Rhynchosia minima -hl	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	1	.	1	1	1	1	1	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	1	1	1	1	.	.	.	1	.	.	.
Aerva leucura -s2	.	1	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	1	.	.	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	1
Ziziphus mucronata -s1	.	.	1	.	1	.	.	1	.	.	.	.	.	.	1	.	1	1	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	1	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Enneapogon scoparius -hl	5	.	1	1	5	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	1	.	.	.	.	.	1	.	5	6	.	.	.	.	1	5	5	.	1	.	.	.	.	.	.	.	.	.
Sida ovata -s2	.	1	.	1	1	.	.	.	.	.	1	.	.	1	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Tephrosia dregeana -hl	.	.	.	.	.	1	.	1	.	.	1	.	.	.	.	.	.	.	.	.	1	1	1	.	1	.	1	.	.	.	.	.	.	.	.	1	.	1	.	1	.	.	.	.	.	.	.	1	.	1	1	1	1	.	1	.	.	.
Nidorella resedifolia -hl	1	.	.	.	.	.	1	1	.	.	.	.	1	.	1	1	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Chenopodium olukondae -hl	.	.	.	.	.	1	.	.	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Raphionacme lanceolata -hl	.	.	.	.	1	1	.	1	.	1	.	.	.	.	1	1	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.
Maytenus senegalensis -s1	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2	.	.	.	.	1	2	.	.	.	5	5	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.
Boscia albitrunca -t3	.	.	.	1	.	.	.	.	.	.	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	1	.	.	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ptycholobium biflorum -s2	.	.	.	.	.	.	.	1	.	.	.	1	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	1	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Euclea undulata -s1	1	1	5	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	2	1	.	2	1	1	.	1	.	.	.	.	.
Mundulea sericea -s1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	1	1	.	3	.	.	1	1	.	.	1	.	.	.	.	.	1	.	.	.	.	.	1	3	.	.	1	.	.
Hypoestes forskaolii -s2	.	1	5	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	1	.	.	.	.	1	.	.	.	.	1	.	1	.	.	.	2	6	5	.	.	.	.	.
Commiphora pyracanthoides -s2	1	.	.	.	.	1	.	.	.	.	.	.	1	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	1	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.
Commiphora glandulosa -s1	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	1	.	.	.	1	.	.	.	.	.	1	.	.	.	1	.	1	.	.	.	1	.	.	.	.	.	4	.	.	1	2
Peltophorum africanum -t3	3	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	.	.	5	.	5	.	.	.	.	2	1	.	.	.	.	.
Chascanum pinnatifidum -s2	1	.	.	.	.	1	.	.	.	.	1	1	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	1	.	.	.	.	1	1	1	.	.
Acrotome inflata -hl	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	1	1	.	.	.	1	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
Croton gratissimus -s2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	5	1	5	.	.	.	.	.	.	1	.	.	.	.	5	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.
Mundulea sericea -s2	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.
Commiphora africana -s2	.	.	.	.	.	1	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Maytenus senegalensis -s2	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.
Mollugo cerviana -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chamaesyce inaequilatera -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	1	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hibiscus elliottiae -s2	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Geigeria ornativa -hl	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melhania acuminata -s2	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.		.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Erucastrum arabicum -hl	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	1	.	.	1	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ehretia rigida -s1	1	1	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Blepharis leendertziae -hl	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.		.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anthephora pubescens -hl	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	.	.	.	.	.	.	.	.	1	.	.		.	.	.	.	.	.	1	1	.	.	1	.	.	.	2	.	.	.	.	.	1	.	.	.
Helinus spartioides -s2	1	.	.	.	.	1	.	1	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Aristida adscensionis -hl	.	.	1	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.		.	.	.	.	.	.	.	5	.	1	.	.	.	.	.	.	.	.	.	.	.	.	6	.
Indigofera charlieriana -hl	.	.	.	.	.	1	.	1	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	1	.	.	1	1	.	.	.	1	.	1	1	.	.	.	.	.	1	.	1
Euclea undulata -s2	.	.	.	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Cyperus margaritaceus -hl	1	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vernonia poskeana -hl	.	.	.	.	1	.	.	.	.	.	.	1	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sida cordifolia -hl	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Indigofera vicioides -hl	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
Gomphocarpus fruticosus -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Combretum hereroense -s2	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.		.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Monechma spartioides -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	5	.	.	.	.	.	.	.
Asparagus cooperi -s2	.	1	1	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Barleria senensis -s2	1	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.		.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ehretia rigida -s2	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.		.	.	.	1	.	.	.	.	.	.	1	.	1	.	.	.	.	1	.	.	.	.	.	.
Pollichia campestris -s2	.	.	.	1	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Microchloa caffra -hl	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia ataxacantha -s1	2	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.
Lantana dinteri -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	1	.	.	1	.	1		.	.	.	.	1	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ipomoea obscura -hl	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Petalidium engleranum -s2	1	.	.	.	1	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pergularia daemia -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Panicum coloratum -hl	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chloris virgata -hl	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Bulbostylis hispidula -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Commelina livingstonii -hl	.	.	.	1	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oxalis purpurascens -hl	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kyphocarpa angustifolia -hl	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Helinus integrifolius -s1	.	.	.	.	.	.	.	.	.	1	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	2	2	.	1
Solanum burchellii -s2	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Marsdenia sylvestris -hl	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Ziziphus mucronata -s2	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	1	.	.	.	.	.	.
Peliostomum leucorrhizum -hl	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.		.	.	.	.	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
Sporobolus panicoides -hl	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.		.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	1	.
Pegolettia senegalensis -hl	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	1	1	.	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	1	.	.
Lonchocarpus nelsii -t3	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.
Dicoma tomentosa -hl	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Cyperus fulgens -hl	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis superba -hl	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indigastrum costatum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	1	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis biflora -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ximenia caffra -s1	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Schkuhria pinnata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ipomoea verbascoidea -s2	.	.	.	.	.	.	.	.	.	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Clerodendrum uncinatum -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera rautanenii -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Asparagus africanus -s2	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cymbopogon plurinodis -hl	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis viscosa -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Megalochlamys marlothii -s2	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachiaria malacodes -hl	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	1	.
Ximenia americana -s2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Commiphora glaucescens -t3	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.

Ximenia americana -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hermbstaedtia fleckii -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sporobolus fimbriatus -hl	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Terminalia prunioides -t3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	5	.	.	.	.	.	.
Grewia retinervis -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
Bothriochloa radicans -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.
Urochloa trichopus -hl	.	.	.	.	.	.	5	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tagetes minuta -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Talinum tenuissimum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oropetium capense -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Blepharis mitrata -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Triraphis schinzii -hl	5	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kigelia africana -t3	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tinnea rhodesiana -s1	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Craterostigm plantagineum -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia karroo -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1
Anthephora schinzii -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tinnea rhodesiana -s2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.
Xerophyta humilis -hl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.
Phaeoptilum spinosum -s1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

APPENDIX 2: TABLE 30: FULL ANNOTATED SPECIES LIST

SPECIES NAME AND TAXONOMIC GROUPING	ABUN-DANCE	LIFE-FORM	PERIODICITY
PTERIDOPHYTA			
Ophioglossaceae			
Ophioglossum polyphyllum A.Braun	16	geophyte	perennial
Pteridaceae			
Cheilanthes viridis (Forssk.) Sw.	1	hemicryptophyte	perennial herb
Marsileaceae			
Marsilea aegyptiaca Willd.	1	helophyte	perennial
ANGIOSPERMAE			
Monocotyledonae			
Poaceae			
Sorghum versicolor Andersson	1	hemicryptophyte	biennial grass
Bothriochloa radicans (Lehm.) A.Camus	43	hemicryptophyte	perennial grass
Dichanthium annulatum (Forssk.) Stapf var. *papillosum* (A.Rich.) de Wet & Harlan	8	hemicryptophyte	perennial grass
Andropogon chinensis (Nees) Merr.	24	hemicryptophyte	perennial grass
Andropogon gayanus Kunth var. *polycladus* (Hack.) Clayton	1	hemicryptophyte	perennial grass
Cymbopogon plurinodis (Stapf) Stapf ex Burtt Davy = *Cymbopogon pospischilii* (K. Schum.) Hubb.	16	hemicryptophyte	perennial grass
Heteropogon contortus (L.) Roem. & Schult.	53	hemicryptophyte	perennial grass
Heteropogon melanocarpus (Elliott) Benth.	2	therophyte	annual grass
Digitaria eriantha Steud.	1	hemicryptophyte	perennial grass
Digitaria seriata Stapf	11	hemicryptophyte	perennial grass
Digitaria velutina (Forssk.) P.Beauv.	56	therophyte	annual grass
Brachiaria deflexa (Schumach.) C.E.Hubb. ex Robyns	79	therophyte	annual grass
Brachiaria eruciformis (Sm.) Griseb.	8	therophyte	annual grass
Brachiaria malacodes (Mez & K.Schum.) Scholz	48	therophyte	annual grass
Brachiaria nigropedata (Ficalho & Hiern) Stapf	1	hemicryptophyte	perennial grass
Brachiaria schoenfelderi C.E.Hubb. & Schweick.	10	hemicryptophyte	biennial grass
Brachiaria xantholeuca (Schinz) Stapf	2	therophyte	annual grass
Urochloa brachyura (Hack.) Stapf	215	therophyte	annual grass
Urochloa oligotricha (Fig. & De Not.) Henrard	36	hemicryptophyte	perennial grass
Urochloa trichopus (Hochst.) Stapf	18	therophyte	annual grass
Panicum coloratum L. var. *coloratum*	44	hemicryptophyte	perennial grass
Panicum maximum Jacq.	47	hemicryptophyte	perennial grass
Panicum stapfianum Fourc.	32	hemicryptophyte	perennial grass
Setaria pumila (Poir.) Roem. & Schult.	46	therophyte	annual grass
Setaria verticillata (L.) P.Beauv.	94	therophyte	annual grass
Tricholaena monachne (Trin.) Stapf & C.E.Hubb.	7	hemicryptophyte	biennial grass
Melinis kallimorpha (Clayton) Zizka	1	therophyte	annual grass
Melinis repens (Willd.) Zizka ssp. *grandiflora* (Hochst.) Zizka	286	therophyte	annual grass
Melinis repens (Willd.) Zizka ssp. *repens*	50	hemicryptophyte	perennial grass
Anthephora pubescens Nees	25	hemicryptophyte	perennial grass
Anthephora schinzii Hack.	35	therophyte	annual grass
Cenchrus ciliaris L.	236	hemicryptophyte	perennial grass
Stipagrostis hirtigluma (Trin. & Rupr.) De Winter	77	hemicryptophyte	perennial grass
Stipagrostis uniplumis (Licht.) De Winter var. *uniplumis*	290	hemicryptophyte	perennial grass
Aristida adscensionis L.	279	therophyte	annual grass
Aristida congesta Roem. & Schult. ssp. *congesta*	213	hemicryptophyte	perennial grass
Aristida effusa Henrard	166	therophyte	annual grass
Aristida hordeacea Kunth	27	therophyte	annual grass
Aristida meridionalis Henrard	14	hemicryptophyte	perennial grass
Aristida pilgeri Henrard	8	hemicryptophyte	perennial grass
Aristida rhiniochloa Hochst.	174	therophyte	annual grass
Aristida stipitata Hack. ssp. *stipitata*	10	hemicryptophyte	perennial grass
Tragus berteronianus Schult.	138	therophyte	annual grass
Tragus racemosus (L.) All.	2	therophyte	annual grass
Monelytrum luederitzianum Hack.	64	hemicryptophyte	perennial grass
Sporobolus festivus A.Rich.	6	hemicryptophyte	perennial grass
Sporobolus fimbriatus (Trin.) Nees	13	hemicryptophyte	perennial grass
Sporobolus panicoides A.Rich.	15	therophyte	annual grass

SPECIES NAME AND TAXONOMIC GROUPING	ABUN-DANCE	LIFE-FORM	PERIODICITY
Eragrostis annulata Rendle ex Scott-Elliot	17	therophyte	annual grass
Eragrostis biflora Hack. ex Schinz	44	therophyte	annual grass
Eragrostis cylindriflora Hochst.	68	therophyte	annual grass
Eragrostis dinteri Stapf	30	therophyte	annual grass
Eragrostis echinochloidea Stapf	152	hemicryptophyte	perennial grass
Eragrostis jeffreysii Hack.	153	hemicryptophyte	perennial grass
Eragrostis lehmanniana Nees var. *lehmanniana*	9	hemicryptophyte	perennial grass
Eragrostis nindensis Ficalho & Hiern	62	hemicryptophyte	perennial grass
Eragrostis omahekensis De Winter	18	therophyte	annual grass
Eragrostis pilgeriana Dinter ex Pilg.	2	therophyte	annual grass
Eragrostis porosa Nees	269	therophyte	annual grass
Eragrostis rigidior Pilg.	132	hemicryptophyte	perennial grass
Eragrostis rotifer Rendle	135	hemicryptophyte	perennial grass
Eragrostis superba Peyr.	10	hemicryptophyte	perennial grass
Eragrostis trichophora Coss. & Durieu	287	hemicryptophyte	perennial grass
Eragrostis viscosa (Retz.) Trin.	26	therophyte	annual grass
Microchloa caffra Nees	31	hemicryptophyte	perennial grass
Cynodon dactylon (L.) Pers.	1	hemicryptophyte	perennial grass
Chloris virgata Sw.	237	therophyte	annual grass
Craspedorhachis rhodesiana Rendle	1	hemicryptophyte	perennial grass
Willkommia sarmentosa Hack.	4	hemicryptophyte	perennial grass
Oropetium capense Stapf	11	hemicryptophyte	perennial grass
Eleusine indica (L.) Gaertn. ssp. *indica*	9	therophyte	annual grass
Dactyloctenium aegyptium (L.) Willd.	22	therophyte	annual grass
Dactyloctenium giganteum Fisher & Schweick.	1	therophyte	annual grass
Diplachne fusca (L.) P.Beauv. ex Roem. & Schult. = *Leptochloa fusca* (L.) Kunth ssp. *fusca*	1	hemicryptophyte	perennial grass
Pogonarthria fleckii (Hack.) Hack.	217	therophyte	annual grass
Pogonarthria squarrosa (Roem. & Schult.) Pilg.	5	hemicryptophyte	perennial grass
Coelachyrum yemenicum (Schweinf.) S.M.Phillips	2	hemicryptophyte	perennial grass
Triraphis ramosissima Hack.	2	hemicryptophyte	perennial grass
Triraphis schinzii Hack.	2	hemicryptophyte	perennial grass
Enneapogon cenchroides (Roem. & Schult.) C.E.Hubb.	345	hemicryptophyte	biennial grass
Enneapogon desvauxii P.Beauv.	63	hemicryptophyte	biennial grass
Enneapogon scoparius Stapf	56	hemicryptophyte	perennial grass
Schmidtia kalihariensis Stent	3	therophyte	annual grass
Schmidtia pappophoroides Steud.	105	hemicryptophyte	perennial grass
Fingerhuthia africana Lehm.	49	hemicryptophyte	perennial grass
Cyperaceae			
Cyperus amabilis Vahl	3	therophyte	annual herb
Cyperus cuspidatus Kunth	5	therophyte	annual herb
Cyperus fulgens C.B.Clarke	87	geophyte	perennial
Cyperus margaritaceus Vahl	5	geophyte	perennial
Mariscus chersinus N.E.Br.	1	hemicryptophyte	perennial herb
Monandrus squarrosus (L.) Vorster ined.	5	therophyte	annual herb
Kyllinga alba Nees	26	hemicryptophyte	biennial herb
Kyllingiella microcephala (Steud.) R.W.Haines & Lye	3	hemicryptophyte	perennial herb
Bulbostylis hispidula (Vahl) R.W.Haines	38	therophyte	annual herb
Commelinaceae			
Commelina benghalensis L.	162	hemicryptophyte	biennial herb
Commelina livingstonii C.B.Clarke	37	hemicryptophyte	biennial herb
Commelina subulata Roth	7	therophyte	annual herb
Colchicaceae			
Gloriosa superba L.	3	geophyte	perennial
Ornithoglossum viride (L.f.) Aiton	4	geophyte	perennial
Asphodelaceae			
Aloe littoralis Baker	10	nano-phanerophyte	perennial succulent
Aloe zebrina Baker	4	chamaephyte	perennial succulent
Hyacinthaceae			
Urginea sanguinea Schinz = *Drima sanguinea* (Schinz) Jessop	5	geophyte	perennial

SPECIES NAME AND TAXONOMIC GROUPING	ABUN-DANCE	LIFE-FORM	PERIODICITY
Lindneria clavata (Mast.) Speta = *Pseudogaltonia clavata* (Mast.) Speta	46	geophyte	perennial
Asparagaceae			
Asparagus africanus Lam.	68	hemicryptophyte	perennial subshrub
Asparagus cooperi Baker	57	hemicryptophyte	perennial subshrub
Asparagus exuvialis Burch.	1	hemicryptophyte	perennial subshrub
Amaryllidaceae			
Boophane disticha (L.f.) Herb.	6	geophyte	perennial
Nerine laticoma (Ker Gawl.) T.Durand & Schinz	1	geophyte	perennial
Velloziaceae			
Xerophyta humilis (Baker) T.Durand & Schinz	37	geophyte	perennial
Iridaceae			
Gladiolus permeabilis D.Delaroche ssp. *edulis* (Burch. ex Ker Gawl.) Oberm.	4	geophyte	perennial
Lapeirousia bainesii Baker	6	geophyte	perennial
Lapeirousia coerulea Schinz	3	geophyte	perennial
ANGIOSPERMAE			
Dicotyledonae			
Santalaceae			
Thesium xerophyticum A.W.Hill	1	chamaephyte	perennial subshrub
Olacaceae			
Ximenia americana L.	9	nano-phanerophyte	perennial
Ximenia caffra Sond.	5	nano-phanerophyte	perennial
Polygonaceae			
Oxygonum alatum Burch.	32	therophyte	annual succulent
Oxygonum sinuatum (Hochst. & Steud. ex Meisn.) Dammer	69	therophyte	annual succulent
Chenopodiaceae			
Chenopodium amboanum (Murr) Aellen	23	therophyte	annual herb
Chenopodium olukondae (Murr) Murr	55	therophyte	annual herb
Amaranthaceae			
Hermbstaedtia fleckii (Schinz) Baker & C.B.Clarke	4	therophyte	annual herb
Hermbstaedtia odorata (Burch.) T.Cooke	63	chamaephyte	biennial herb
Amaranthus thunbergii Moq.	22	therophyte	annual herb
Sericorema sericea (Schinz) Lopr.	61	therophyte	annual herb
Kyphocarpa angustifolia (Moq.) Lopr.	161	hemicryptophyte	biennial herb
Nelsia quadrangula (Engl.) Schinz	72	therophyte	annual herb
Leucosphaera bainesii (Hook.f.) Gilg	260	chamaephyte	perennial subshrub
Pupalia lappacea (L.) A.Juss.	232	chamaephyte	perennial subshrub
Aerva leucura Moq.	16	hemicryptophyte	biennial herb
Achyranthes aspera L. var. *aspera*	120	chamaephyte	perennial subshrub
Achyranthes aspera L. var. *sicula* L.	8	therophyte	annual herb
Alternanthera nodiflora R.Br.	1	therophyte	annual herb
Nyctaginaceae			
Commicarpus pentandrus (Burch.) Heimerl	7		
Boerhavia coccinea Mill.	1	therophyte	annual herb
Boerhavia diffusa L.	7	hemicryptophyte	biennial herb
Phaeoptilum spinosum Radlk.	23	nano-phanerophyte	perennial
Gisekiaceae			
Gisekia africana (Lour.) Kuntze var. *africana*	80	therophyte	annual succulent
Gisekia pharnacioides L. var. *pharnacioides*	1	therophyte	annual succulent

SPECIES NAME AND TAXONOMIC GROUPING	ABUN-DANCE	LIFE-FORM	PERIODICITY
Molluginaceae			
Limeum argute-carinatum Wawra & Peyr.	80	therophyte	annual succulent
Limeum fenestratum (Fenzl) Heimerl var. *fenestratum*	10	therophyte	annual herb
Limeum myosotis H.Walter	13	therophyte	annual herb
Limeum sulcatum (Klotzsch) Hutch.	52	therophyte	annual herb
Mollugo cerviana (L.) Ser. ex DC.	50	therophyte	annual succulent
Aizoaceae			
Trianthema triquetra Rottler ex Willd.	2	therophyte	annual succulent
Aizoon virgatum Welw. ex Oliv.	70	chamaephyte	perennial subshrub
Tetragonia calycina Fenzl	61	chamaephyte	perennial succulent
Portulacaceae			
Talinum arnotii Hook.f.	240	geophyte	perennial
Talinum caffrum (Thunb.) Eckl. & Zeyh.	1	geophyte	perennial
Talinum crispatulum Dinter ex Poelln.	4	geophyte	perennial
Talinum tenuissimum Dinter	8	geophyte	perennial
Portulaca kermesina N.E.Br.	23	therophyte	annual succulent
Portulaca oleracea L.	7	therophyte	annual succulent
Caryophyllaceae			
Polycarpaea corymbosa (L.) Lam.	2	therophyte	annual herb
Illecebraceae			
Pollichia campestris Aiton	71	chamaephyte	perennial subshrub
Brassicaceae			
Lepidium africanum (Burm.f.) DC. ssp. *divaricatum* (Aiton) Jonsell	5	therophyte	annual herb
Erucastrum arabicum Fisch. & C.A.Mey.	92	therophyte	annual herb
Capparaceae			
Cleome angustifolia Forssk. ssp. *diandra* (Burch.) Kers	4	therophyte	annual herb
Cleome elegantissima Briq.	1	therophyte	annual herb
Cleome gynandra L.	2	therophyte	annual herb
Cleome hirta (Klotzsch) Oliv.	6	therophyte	annual herb
Cleome monophylla L.	79	therophyte	annual herb
Cleome rubella Burch.	88	therophyte	annual herb
Boscia albitrunca (Burch.) Gilg & Gilg-Ben.	308	nano-phanerophyte	perennial
Boscia foetida Schinz ssp. *foetida*	34	nano-phanerophyte	perennial
Maerua juncea Pax ssp. *juncea*	21	nano-phanerophyte	perennial
Maerua parvifolia Pax	6	nano-phanerophyte	perennial
Maerua schinzii Pax	2	micro-phanerophyte	perennial
Crassulaceae			
Kalanchoe lanceolata (Forssk.) Pers.	11	therophyte	annual succulent
Kalanchoe rotundifolia (Haw.) Haw.	3	chamaephyte	biennial succulent
Crassula rhodesica (Merxm.) Wickens & M.Bywater	6	therophyte	annual succulent
Vahliaceae			
Vahlia capensis (L.f.) Thunb.	2	hemicryptophyte	biennial herb
Fabaceae subfamily Mimosoideae			
Albizia anthelmintica (A.Rich.) Brongn.	107	micro-phanerophyte	perennial
Acacia ataxacantha DC.	7	nano-phanerophyte	perennial
Acacia erioloba E.Mey.	58	micro-phanerophyte	perennial
Acacia erubescens Welw. ex Oliv.	10	nano-phanerophyte	perennial
Acacia fleckii Schinz	37	nano-phanerophyte	perennial
Acacia hebeclada DC. ssp. *hebeclada*	120	nano-phanerophyte	perennial
Acacia hereroensis Engl.	2	nano-phanerophyte	perennial
Acacia karroo Hayne	7	micro-phanerophyte	perennial
Acacia mellifera (Vahl) Benth. ssp. *detinens* (Burch.) Brenan	430	nano-phanerophyte	perennial
Acacia nilotica (L.) Willd. ex Delile ssp. *kraussiana* (Benth.) Brenan	1	micro-phanerophyte	perennial
Acacia reficiens Wawra including *Acacia luederitzii* Engl. [1]	304	nano-phanerophyte	perennial
Acacia senegal (L.) Willd. var. *rostrata* Brenan	1	micro-phanerophyte	perennial

SPECIES NAME AND TAXONOMIC GROUPING	ABUN-DANCE	LIFE-FORM	PERIODICITY
Acacia tortilis (Forssk.) Hayne ssp. *heteracantha* (Burch.) Brenan	175	meso-phanerophyte	perennial
Dichrostachys cinerea (L.) Wight & Arn. ssp. *africana* Brenan & Brummit	263	nano-phanerophyte	perennial
Elephantorrhiza elephantina (Burch.) Skeels	1	hemicryptophyte	perennial subshrub
Fabaceae subfamily Ceasalpinioideaea			
Tylosema esculentum (Burch.) A.Schreib.	5	geophyte	perennial creeper
Chamaecrista absus (L.) Irwin & Barneby	4	chamaephyte	perennial subshrub
Chamaecrista biensis (Steyaert) Lock	11	therophyte	annual herb
Senna italica Mill.	5	chamaephyte	perennial subshrub
Peltophorum africanum Sond.	19	meso-phanerophyte	perennial
Fabaceae subfamily Papilionoideae			
Lotononis listii Polhill	8	therophyte	annual creeper
Lotononis platycarpa (Viv.) Pic.Serm.	61	therophyte	annual creeper
Rothia hirsuta (Guill. & Perr.) Baker	1	therophyte	annual herb
Crotalaria argyraea Welw. ex Baker	1	chamaephyte	perennial subshrub
Crotalaria heidmannii Schinz	37	therophyte	annual herb
Crotalaria pisicarpa Welw. ex Baker	37	hemicryptophyte	biennial herb
Crotalaria podocarpa DC.	46	therophyte	annual herb
Crotalaria sphaerocarpa Perr. ex DC. ssp. *sphaerocarpa*	7	therophyte	annual herb
Crotalaria steudneri Schweinf.	21	therophyte	annual herb
Indigastrum costatum (Guill. & Perr.) Schrire ssp. macrum (E. Mey.) Schrire	18	hemicryptophyte	biennial herb
Indigofera alternans DC.	15	therophyte	annual creeper
Indigofera charlieriana Schinz	49	therophyte	annual herb
Indigofera daleoides Benth. ex Harv.	2	hemicryptophyte	biennial creeper
Indigofera hochstetteri Baker ssp. *streyana* (Merxm.) A. Schreib.	42	therophyte	annual herb
Indigofera holubii N.E.Br.	8	therophyte	annual creeper
Indigofera rautanenii Baker f.	131	chamaephyte	perennial subshrub
Indigofera vicioides Jaub. & Spach	55	hemicryptophyte	biennial herb
Cullen obtusifolia (DC.) C.H.Stirt.	2	hemicryptophyte	biennial herb
Ptycholobium biflorum (E.Mey.) Brummitt ssp. *biflorum*	219	chamaephyte	perennial subshrub
Requienia sphaerosperma DC.	14	hemicryptophyte	perennial herb
Tephrosia burchellii Burtt Davy	1	hemicryptophyte	biennial herb
Tephrosia dregeana E.Mey. var. *dregeana*	37	chamaephyte	biennial herb
Tephrosia lupinifolia DC.	4	chamaephyte	perennial creeper
Tephrosia purpurea (L.) Pers. ssp. *leptostachya* (DC.) Brummit	27	hemicryptophyte	biennial herb
Mundulea sericea (Willd.) A.Chev.	27	nano-phanerophyte	perennial
Sesbania macowaniana Schinz	2	therophyte	annual herb
Lessertia benguellensis Baker f.	1	therophyte	annual herb
Zornia glochidiata Rchb. ex DC.	7	therophyte	annual herb
Lonchocarpus nelsii (Schinz) Heering & Grimme ssp. *nelsii*	37	micro-phanerophyte	perennial
Neorautanenia mitis (A.Rich.) Verdc.	53	geophyte	perennial
Rhynchosia minima (L.) DC.	29	chamaephyte	perennial creeper
Rhynchosia totta (Thunb.) DC.	43	chamaephyte	perennial climber
Rhynchosia venulosa (Hiern) K.Schum.	2	chamaephyte	perennial climber
Otoptera burchellii DC.	196	chamaephyte	perennial subshrub
Lablab purpureus (L.) Sweet ssp. *uncinatus* Verdc.	1	chamaephyte	perennial climber
Dolichos linearis E.Mey.	1	therophyte	annual herb
Macrotyloma axillare (E.Mey.) Verdc.	1	therophyte	annual herb
Geraniaceae			
Monsonia umbellata Harv.	2	hemicryptophyte	biennial herb
Oxalidaceae			
Oxalis purpurascens Salter	13	geophyte	perennial
Zygophyllaceae			
Tribulus terrestris L.	47	therophyte	annual herb
Simaroubaceae			

SPECIES NAME AND TAXONOMIC GROUPING	ABUN-DANCE	LIFE-FORM	PERIODICITY
Kirkia acuminata Oliv.	2	micro-phanerophyte	perennial
Burseraceae			
Commiphora africana (A.Rich.) Engl.	26	nano-phanerophyte	perennial
Commiphora angolensis Engl.	46	nano-phanerophyte	perennial
Commiphora glandulosa Schinz	28	nano-phanerophyte	perennial
Commiphora glaucescens Engl.	4	nano-phanerophyte	perennial
Commiphora pyracanthoides Engl.	84	nano-phanerophyte	perennial
Commiphora tenuipetiolata Engl.	4	nano-phanerophyte	perennial
Malpighiaceae			
Triaspis hypericoides (DC.) Burch. ssp. *nelsonii* (Oliv.) Immelman	8	nano-phanerophyte	perennial
Polygalaceae			
Polygala leptophylla Burch.	5	chamaephyte	perennial subshrub
Euphorbiaceae			
Phyllanthus maderaspatensis L.	177	chamaephyte	perennial herb
Phyllanthus pentandrus Schumach. & Thonn.	86	therophyte	annual herb
Croton gratissimus Burch. var. *gratissimus*	57	nano-phanerophyte	perennial
Acalypha indica L.	57	therophyte	annual herb
Acalypha segetalis Müll.Arg.	3	therophyte	annual herb
Jatropha erythropoda Pax & K.Hoffm.	10	geophyte	perennial
Cephalocroton mollis Klotzsch	4	chamaephyte	perennial subshrub
Chamaesyce glanduligera (Pax) Koutnik = *Euphorbia glanduligera* Pax	1	therophyte	annual herb
Chamaesyce inaequilatera (Sond.) Soják = *Euphorbia inaequilatera* Sond.	62	therophyte	annual herb
Euphorbia crotonoides Boiss.	11	therophyte	annual herb
Anacardiaceae			
Lannea discolor (Sond.) Engl.	2	micro-phanerophyte	perennial
Ozoroa insignis Delile	4	micro-phanerophyte	perennial
Ozoroa paniculosa (Sond.) R.& A.Fern.	10	nano-phanerophyte	perennial
Rhus ciliata Licht. ex Roem & Schult.	26	nano-phanerophyte	perennial
Rhus marlothii Engl.	58	nano-phanerophyte	perennial
Celastraceae			
Maytenus senegalensis (Lam.) Exell = *Gymnosporia senegalensis* (Lam.) Loes.	33	nano-phanerophyte	perennial
Rhamnaceae			
Ziziphus mucronata Willd.	127	micro-phanerophyte	perennial
Helinus integrifolius (Lam.) Kuntze	29	chamaephyte	perennial subshrub
Helinus spartioides (Engl.) Schinz ex Engl.	45	chamaephyte	perennial subshrub
Vitaceae			
Cyphostemma cirrhosum (Thunb.) Desc. ex Wild & R.B.Drumm. ssp. *transvaalense* (Szyszyl.) C.A. Sm.	1	geophyte	perennial succulent
Cyphostemma congestum (Baker) Desc. ex Wild & R.B.Drumm.	40	geophyte	perennial succulent
Cyphostemma hereroense (Schinz) Desc. ex Wild & R.B.Drumm.	6	geophyte	perennial succulent
Cyphostemma omburense (Gilg & M.Brandt) Desc.	2	geophyte	perennial succulent
Tiliaceae			
Corchorus tridens L.	61	therophyte	annual herb
Grewia bicolor Juss.	75	nano-phanerophyte	perennial
Grewia flava DC.	315	nano-phanerophyte	perennial
Grewia flavescens Juss. var. *flavescens*	134	nano-phanerophyte	perennial
Grewia flavescens Juss. var. *olukondae* (Schinz) Wild	33	nano-phanerophyte	perennial
Grewia retinervis Burret	11	nano-phanerophyte	perennial
Grewia schinzii K.Schum.	3	nano-phanerophyte	perennial

SPECIES NAME AND TAXONOMIC GROUPING	ABUN-DANCE	LIFE-FORM	PERIODICITY
Malvaceae			
Abutilon austro-africanum Hochr.	60	chamaephyte	perennial subshrub
Sida cordifolia L.	25	hemicryptophyte	biennial herb
Sida ovata Forssk.	36	chamaephyte	perennial subshrub
Pavonia burchellii (DC.) R.A.Dyer	124	chamaephyte	perennial subshrub
Hibiscus caesius Garcke	50	chamaephyte	perennial subshrub
Hibiscus calyphyllus Cav.	145	chamaephyte	perennial subshrub
Hibiscus discophorus Hochr.	5	chamaephyte	perennial subshrub
Hibiscus elliottiae Harv.	74	chamaephyte	perennial subshrub
Hibiscus fleckii Gürke	36	therophyte	annual herb
Hibiscus palmatus Forssk.	34	hemicryptophyte	biennial herb
Hibiscus schinzii Gürke	8	hemicryptophyte	biennial creeper
Gossypium triphyllum (Harv.) Hochr.	16	chamaephyte	perennial subshrub
Sterculiaceae			
Melhania acuminata Mast.	11	chamaephyte	perennial subshrub
Melhania virescens (K.Schum.) K.Schum.	114	chamaephyte	perennial subshrub
Dombeya rotundifolia (Hochst.) Planch. var. *rotundifolia*	18	nano-phanerophyte	perennial
Hermannia damarana Baker f.	7	chamaephyte	perennial subshrub
Hermannia modesta (Ehrenb.) Mast.	116	therophyte	annual herb
Hermannia quartiniana A.Rich. ssp. stellulata (K.Schum.) De Winter	34	chamaephyte	perennial subshrub
Hermannia rautanenii Schinz ex K.Schum.	21	chamaephyte	perennial subshrub
Hermannia tomentosa (Turcz.) Schinz ex Engl.	57	chamaephyte	perennial creeper
Waltheria indica L.	22	hemicryptophyte	biennial herb
Cactaceae (alien invasive family)			
Opuntia species	4	nano-phanerophyte	perennial
Thymelaeaceae			
Gnidia polycephala (C.A.Mey.) Gilg	5	chamaephyte	perennial subshrub
Combretaceae			
Combretum apiculatum Sond.	44	micro-phanerophyte	perennial
Combretum hereroense Schinz ssp. *hereroense*	43	nano-phanerophyte	perennial
Combretum imberbe Wawra	23	micro-phanerophyte	perennial
Terminalia prunioides M.A.Lawson	46	nano-phanerophyte	perennial
Terminalia sericea Burch. ex DC.	10	micro-phanerophyte	perennial
Ebenaceae			
Euclea undulata Thunb.	25	nano-phanerophyte	perennial
Oleaceae			
Olea europaea L. ssp. *africana* (Mill.) P.S.Green	4	micro-phanerophyte	perennial
Periplocaceae			
Raphionacme lanceolata Schinz	59	geophyte	perennial
Raphionacme velutina Schltr.	6	geophyte	perennial
Asclepiadaceae			
Gomphocarpus fruticosus (L.) Aiton f.	13	chamaephyte	perennial subshrub
Pentarrhinum abyssinicum Decne.	1	chamaephyte	perennial climber
Pentarrhinum insipidum E.Mey.	9	chamaephyte	perennial climber
Sarcostemma viminale (L.) R.Br.	1	chamaephyte	perennial succulent

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Stapelia kwebensis N.E.Br.	2	hemicryptophyte	perennial succulent
Stapelia schinzii A.Berger & Schltr.	1	hemicryptophyte	perennial succulent
Marsdenia macrantha (Klotzsch) Schltr.	1	chamaephyte	perennial climber
Marsdenia sylvestris (Retz.) P.I.Forst.	5	chamaephyte	perennial climber
Pergularia daemia (Forssk.) Chiov.	15	chamaephyte	perennial climber
Convolvulaceae			
Evolvulus alsinoides (L.) L. var. *linifolius* (L.) Baker	208	hemicryptophyte	perennial herb
Seddera suffruticosa (Schinz) Hallier f.	105	chamaephyte	perennial subshrub
Jacquemontia tamnifolia (L.) Griseb.	2	therophyte	annual herb
Convolvulus ocellatus Hook.f.	1	chamaephyte	perennial creeper
Merremia palmata Hallier f.	15	geophyte	perennial creeper
Xenostegia tridentata (L.) D.F.Austin & Staples ssp. *angustifolia* (Jacq.) A. Meeuse	6	therophyte	annual herb
Ipomoea bolusiana Schinz ssp. *bolusiana*	60	geophyte	perennial creeper
Ipomoea coptica (L.) Roth ex Roem. & Schult.	7	geophyte	perennial creeper
Ipomoea coscinosperma Hochst. ex Choisy	6	therophyte	annual creeper
Ipomoea crassipes Hook.	32	geophyte	perennial creeper
Ipomoea hackeliana (Schinz) Hallier f.	6	therophyte	annual creeper
Ipomoea hochstetteri House	6	therophyte	annual creeper
Ipomoea holubii Baker	1	chamaephyte	perennial subshrub
Ipomoea magnusiana Schinz	1	geophyte	perennial creeper
Ipomoea oblongata E.Mey. ex Choisy	9	chamaephyte	perennial subshrub
Ipomoea obscura (L.) Ker Gawl.	119	therophyte	annual creeper
Ipomoea sinensis (Desr.) Choisy	134	therophyte	annual creeper
Ipomoea verbascoidea Choisy	23	geophyte	perennial climber
Boraginaceae			
Cordia sinensis Lam.	3	nano-phanerophyte	perennial
Ehretia rigida (Thunb.) Druce	208	nano-phanerophyte	perennial
Heliotropium ciliatum Kaplan	3	therophyte	annual herb
Heliotropium lineare (A.DC.) Gürke	2	chamaephyte	perennial subshrub
Heliotropium marifolium Retz.	5	therophyte	annual herb
Heliotropium ovalifolium Forssk.	20	hemicryptophyte	biennial herb
Heliotropium steudneri Vatke	154	chamaephyte	perennial subshrub
Verbeneceae			
Lantana angolensis Moldenke	120	chamaephyte	perennial subshrub
Lantana camara L.	2	nano-phanerophyte	perennial
Lantana dinteri Moldenke	17	chamaephyte	perennial subshrub
Chascanum pinnatifidum (L.f.) E.Mey.	182	chamaephyte	perennial herb
Priva auricoccea A.Meeuse	2	hemicryptophyte	perennial herb
Lamiaceae			
Clerodendrum ternatum Schinz	68	chamaephyte	perennial subshrub
Clerodendrum uncinatum Schinz	11	hemicryptophyte	perennial subshrub
Tinnea rhodesiana S.Moore	12	nano-phanerophyte	perennial
Acrotome fleckii (Gürke) Launert	121	therophyte	annual herb
Acrotome inflata Benth.	104	therophyte	annual herb
Leucas martinicensis (Jacq.) R.Br.	12	therophyte	annual herb
Leucas pechuelii (Kuntze) Gürke	89	chamaephyte	perennial subshrub
Plectranthus neochilus Schltr.	5	therophyte	annual succulent
Hemizygia petrensis (Hiern) M.Ashby	3	hemicryptophyte	perennial herb
Becium filamentosum (Forssk.) Chiov. = *Ocimum filamentosum* (Forssk.) Chiov.	92	chamaephyte	perennial subshrub
Ocimum americanum L. var. *americanum*	227	therophyte	annual herb

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Solanaceae			
Lycium bosciifolium Schinz	74	nano-phanerophyte	perennial
Lycium eenii S.Moore	268	nano-phanerophyte	perennial
Lycium oxycarpum Dunal	178	nano-phanerophyte	perennial
Withania somnifera (L.) Dunal	2	hemicryptophyte	biennial herb
Solanum burchellii Dunal	68	chamaephyte	perennial subshrub
Solanum capense L.	5	chamaephyte	perennial subshrub
Solanum catombelense Peyr.	17	chamaephyte	perennial subshrub
Solanum delagoense Dunal	8	chamaephyte	perennial subshrub
Solanum dinteri Bitter	23	chamaephyte	perennial subshrub
Solanum incanum L.	80	chamaephyte	perennial subshrub
Solanum kwebense N.E.Br. = *Solanum tettense* Klotzsch var. *renschii* (Vatke) Gonç.	55	nano-phanerophyte	perennial
Solanum nigrum L.	6	therophyte	annual herb
Solanum supinum Dunal	18	chamaephyte	perennial subshrub
Scrophulariaceae			
Aptosimum angustifolium E.Weber & Schinz	92	chamaephyte	perennial creeper
Aptosimum decumbens Schinz	49	chamaephyte	perennial creeper
Aptosimum lineare Marloth & Engl.	72	hemicryptophyte	biennial herb
Peliostomum leucorrhizum E.Mey. ex Benth.	91	chamaephyte	perennial subshrub
Craterostigma plantagineum Hochst.	8	geophyte	perennial
Lindernia nana (Engl.) Roessler	2	therophyte	annual herb
Hebenstretia integrifolia L.	1	therophyte	biennial herb
Selago lepida Hilliard	1	chamaephyte	perennial subshrub
Hiernia angolensis S.Moore	15	chamaephyte	perennial subshrub
Striga gesnerioides (Willd.) Vatke ex Engl.	1	Para	HrA
Bignoniaceae			
Rhigozum brevispinosum Kuntze	27	nano-phanerophyte	perennial
Catophractes alexandri D.Don	153	nano-phanerophyte	perennial
Kigelia africana (Lam.) Benth.	1	micro-phanerophyte	perennial
Pedaliaceae			
Pterodiscus aurantiacus Welw.	4	geophyte	perennial
Harpagophytum procumbens (Burch.) DC. ex Meisn. ssp. *procumbens*	32	geophyte	perennial creeper
Sesamum capense Burm.f.	19	therophyte	annual herb
Sesamum triphyllum Welw. ex Asch. var. *triphyllum*	1	therophyte	annual herb
Acanthaceae			
Petalidium engleranum (Schinz) C.B.Clarke	11	chamaephyte	perennial subshrub
Petalidium ramulosum Schinz	10	chamaephyte	perennial subshrub
Ruelliopsis damarensis S.Moore	44	chamaephyte	biennial herb
Ruellia sp. nov.1 M.-J. Cadman	50	chamaephyte	perennial subshrub
Barleria lanceolata (Schinz) Oberm.	177	chamaephyte	perennial subshrub
Barleria rigida Willd. ex Nees	1	chamaephyte	perennial subshrub
Barleria senensis Klotzsch	25	chamaephyte	perennial subshrub
Blepharis integrifolia (L.f.) E.Mey. ex Schinz	20	hemicryptophyte	biennial herb
Blepharis leendertziae Oberm.	62	therophyte	annual herb
Blepharis mitrata C.B.Clarke	32	chamaephyte	biennial herb
Blepharis obmitrata C.B.Clarke	34	chamaephyte	biennial herb
Peristrophe hereroensis (Schinz) K.Balkwill	2	chamaephyte	perennial herb
Dicliptera eenii S.Moore	3	chamaephyte	perennial herb

SPECIES NAME AND TAXONOMIC GROUPING	ABUN-DANCE	LIFE-FORM	PERIODICITY
Hypoestes forskaolii (Vahl) R.Br.	29	chamaephyte	perennial subshrub
Megalochlamys marlothii (Engl.) Lindau	60	chamaephyte	perennial subshrub
Justicia anselliana (Nees) T.Anderson	20	therophyte	annual herb
Monechma debile (Forssk.) Nees	7	therophyte	annual herb
Monechma divaricatum (Nees) C.B.Clarke	43	chamaephyte	perennial subshrub
Monechma genistifolium (Engl.) C.B.Clarke	149	chamaephyte	perennial subshrub
Monechma spartioides (T.Anderson) C.B.Clarke	8	chamaephyte	perennial subshrub
Rubiaceae			
Kohautia azurea (Dinter & K.Krause) Bremek.	1	therophyte	annual herb
Kohautia caespitosa Schnizl. ssp. *brachyloba* (Sond.) D.Mantell	74	therophyte	annual herb
Kohautia cynanchica DC.	31	therophyte	annual herb
Oldenlandia herbacea (L.) Roxb.	6	therophyte	annual herb
Ancylanthos bainesii Hiern = *Ancylanthos rubiginosus* Desf.	2	nano-phanerophyte	perennial
Cucurbitaceae			
Dactyliandra welwitschii Hook.f.	14	therophyte	annual climber
Zehneria marlothii (Cogn.) R.& A.Fern.	3	therophyte	annual climber
Corallocarpus welwitschii (Naudin) Hook.f. ex Welw.	6	geophyte	perennial climber
Acanthosicyos naudinianus (Sond.) C.Jeffrey	44	geophyte	perennial creeper
Momordica balsamina L.	24	therophyte	annual climber
Citrullus lanatus (Thunb.) Matsum. & Nakai	5	therophyte	annual creeper
Cucumis africanus L.f.	1	hemicryptophyte	biennial creeper
Cucumis anguria L.	106	hemicryptophyte	biennial creeper
Cucumis kalahariensis A.Meeuse	4	geophyte	perennial creeper
Cucumis sagittatus Peyr.	2	therophyte	annual creeper
Trochomeria debilis (Sond.) Hook.f.	2	geophyte	perennial climber
Asteraceae			
Vernonia fastigiata Oliv. & Hiern	8	hemicryptophyte	biennial herb
Vernonia poskeana Vatke & Hildebr. ssp. *botswanica* G.V. Pope	46	therophyte	annual herb
Felicia anthemidodes (Hiern) Mendorça	100	chamaephyte	perennial subshrub
Felicia clavipilosa Grau ssp. *clavipilosa*	3	chamaephyte	perennial subshrub
Felicia smaragdina (S.Moore) Merxm.	84	therophyte	annual herb
Nidorella resedifolia DC.	159	therophyte	annual herb
Tarchonanthus camphoratus L.	128	nano-phanerophyte	perennial
Laggera decurrens (Vahl) Hepper & J.R.I.Wood	3	hemicryptophyte	biennial herb
Pechuel-Loeschea leubnitziae (Kuntze) O.Hoffm.	23	chamaephyte	perennial subshrub
Helichrysum candolleanum H.Buek	4	hemicryptophyte	biennial herb
Helichrysum cerastioides DC.	3	chamaephyte	perennial subshrub
Helichrysum tomentosulum (Klatt) Merxm. ssp. *tomentosulum*	16	chamaephyte	perennial subshrub
Calostephane divaricata Benth.	10	therophyte	annual herb
Pegolettia pinnatilobata (Klatt) O.Hoffm. ex Dinter	2	chamaephyte	perennial creeper
Pegolettia senegalensis Cass.	19	therophyte	annual herb
Ondetia linearis Benth.	109	therophyte	annual herb
Geigeria acaulis (Sch.Bip.) Benth. & Hook.f. ex Oliv. & Hiern	95	therophyte	annual herb
Geigeria ornativa O.Hoffm.	155	therophyte	annual herb
Geigeria schinzii O.Hoffm.	3	therophyte	annual herb
Xanthium spinosum L.	2	therophyte	annual herb
Xanthium strumarium L.	1	therophyte	annual herb
Melanthera triternata (Klatt) Wild = *Melanthera marlothiana* (Klatt) Wild	2	therophyte	annual herb
Bidens biternata (Lour.) Merr. & Sherff	69	therophyte	annual herb
Flaveria bidentis (L.) Kuntze	3	therophyte	annual herb
Schkuhria pinnata (Lam.) Cabrera	13	therophyte	annual herb
Tagetes minuta L.	8	therophyte	annual herb
Eriocephalus pubescens DC. = *Eriocephalus luederitzianus* O. Hoffm.	51	chamaephyte	perennial subshrub

SPECIES NAME AND TAXONOMIC GROUPING	ABUN-DANCE	LIFE-FORM	PERIODICITY
Artemisia afra Jacq. ex Willd.	1	chamaephyte	perennial subshrub
Kleinia longiflora DC.	23	chamaephyte	perennial succulent
Senecio eenii (S.Moore) Merxm.	1	therophyte	annual herb
Osteospermum muricatum E.Mey. ex DC. ssp. *muricatum*	12	therophyte	annual herb
Ursinia nana DC. ssp. *nana*	1	therophyte	annual herb
Hirpicium gorterioides (Oliv. & Hiern) Roessler ssp. *gorterioides*	65	therophyte	annual herb
Platycarpha carlinoides Oliv. & Hiern	16	therophyte	annual herb
Dicoma capensis Less.	13	hemicryptophyte	biennial herb
Dicoma schinzii O.Hoffm.	5	hemicryptophyte	perennial herb
Dicoma tomentosa Cass.	83	therophyte	annual herb
Launaea intybacea (Jacq.) P.Beauv.	1	hemicryptophyte	biennial herb

Species are listed according to the TURBOVEG species list - the latest synonyms according to Craven and Kolberg (1999) have been indicated where applicable.

APPENDIX 3: STANDARD SURVEY FORMS OF THE VEGETATION SURVEY OF NAMIBIA

Habitat Description

Observer:	Number:	Computer No:	
Landscape:	Date:	Altitude:	
Locality:	Region:	GPS reading: ° ' " S ° ' " E	
	District:		
	Owner:	Accuracy of GPS: (Schwarzeneck)	
		Estimate from 1:50 000 map	General estimate

Landscape: / **Local Topography:**

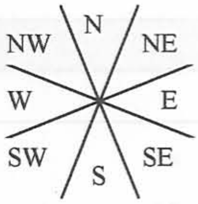
Code	Landscape	Slope	Relief	Code	Local Topography	Description
Level land						
LP	Plain	<8%	<100m/km	LPP	Plain	
				LPS	Sand drift plain	Covered by >50 % sand (unconsolidated)
				LPI	Interdunal street	
				LPD	Low dunefield	Plains with low dunes like hummock dunes
				LPF	Flood plain	Temporarry water logged, especially along river systems
				LPO	Oshana	Shallow channels of the Cuvelai delta
				LPM	Omuramba	Shallow, broad drainage lines of the erosion plains
LL	Plateau	<8%	<100m/km	LLP	Plateau	
LD	Depression	<8%	<100m/km	LDP	Pan	Seasonally water filled
LF	Low gradient footslope	<8%	<100m/km	LFF	Low gradient footslope	
LV	Valley floor	<8%	<100m/km	LVR	Dry river bed	
				LVBD	Dry river embankment	
				LVB	Perennial river embankment	
Sloping land						
SM	Medium gradient mountain	15-30 %	>600m/2km	SMM	Medium gradient mountain	
				SMF	Medium gradient footslope	
				SML	Medium gradient plateau	
SH	Medium gradient hill	8-30 %	>50 m/slope unit	SHH	Medium gradient hill	
SE	Medium gradient escarpment zone	15-30 %	<600m/2km	SER	River terrace	Especially along the Okavango and Omurambas in the Kalahari sand plateau
				SDP	Pan terrace / rim	
SR	Ridges	8-30 %	>50 m/slope unit	SRR	Rocky ridges	
				SRDF	Fossil dunes: foot	
				SRDS	Fossil dunes: slope	
				SRDC	Fossil dunes: crest	
				SRAS	Active dunes: slip face	
				SRAW	Active dunes: windward face	
SU	Mountainous highland	8-30 %	>600m/2km	SUU	Mountainous highland	
SP	Dissected plain	8-30 %	Variable	SPP	Dissected plain	
				SPA	Alluvial fan	
				SWC	Water courses and small rivers	
Steep land						
TM	High gradient mountain	>30 %	>600m/2km	TMM	High gradient mountain	
				TMF	High gradient footslope	
				TMB	Inselbergs, bornhardts	
TH	High gradient hill	>30 %	<600m/2km	THH	High gradient hill	
				THR	Rocky outcrops like dolerite koppies	
TE	High gradient escarpment zone	>30 %	>600m/2km	TEE	Escarpment	
				TET	Tallus slope	
TV	High gradient valleys	>30 %	Variable	TVC	Canyon slope	
				TWC	Steep water courses and ravines	
Land with composite landforms						
CV	Valley	>8 %	Variable	Other:		
CL	Narrow plateau	>8 %	Variable			
CD	Major depression	>8 %	Variable			

Slope:

Flat	Gently undulating	Undulating	Rolling	Moderately steep	Steep	Very steep
0 - 1°	1 - 3°	3 - 6°	6 - 9°	9 - 17°	17 - 30°	> 30°
(0-2%)	(2-5%)	(5-10%)	(10-15%)	(15-30%)	(30-60%)	(>60 %)

Stoniness: Cover & Size:

Aspect:



None	Gravel 0.2-2 cm	Pebbles 2-6 cm	Medium 6-20 cm	Large 20-60 cm	Rock >60 cm
0-2 %					
2-5 %					
5-15 %					
15-40 %					
40-80 %					
>80 %					

Lithology:

Acidic igneous rock	IA1	Granite	Clastic sediments	SC1	Conglomerate, Breccia
	IA2	Grano-diorite		SC2	Sandstone, greywacke, arkose
	IA3	Quartz-doprite		SC3	Siltstone, mudstone, claystone
	IA4	Rhyolite		SC4	Shale
Intermediate igneous rock	II1	Andesite, trachyte, phonolite	Organic sediments	SO1	Limestone and other carbonate rocks
	II2	Diorite-syenite		SO2	Marl and other mixtures
Basic igneous rock	IB1	Gabbro		SO3	Coals, bitumen and related rocks
	IB2	Basalt	Evaporites	SE1	Anhydrite, gypsum
	IB3	Dolerite		SE2	Halite
Ultrabasic igneous rock	IU1	Peridotite	Unconsolidated material	UF	Fluvial
	IU2	Pyroxenite		UL	Lacustrine
	IU3	Ilmenite, magnetite, ironstone, serpentine		UM UC	Marine Colluvial
Acidic metamorphic rock	MA1	Quartzite		UE	Eolian
	MA2	Gneiss, magmatite		UG	Glacial
Basic metamorphic rock	MB1	Slate, phylite (peltic rocks)		UP UO	Pyroclastic Organic
	MB2	Schist		UCa	Calcrete
	MB3	Gneiss rich in ferro-magnesian minerals	Other:		
	MB4	Metamorphic limestone (marble)			

Erosion:

none	Wind erosion	Wind deposition	Shifting sand	Sheet erosion	Rill erosion	Gully erosion	Deposition by water
slight							
moderate							
severe							
extreme							

Surface Crusting:

None	Weak (soft or slightly hard, <0.5 cm thick)	Moderate (soft or slightly hard, >0.5 cm thick, or hard <0.5 cm)	Strong (hard crust >0.5 cm)	Clay bubbles (Schaumböden) present

Soil Texture

Sand	Sandy Loam	Sandy Clay	Silty Clay Loam	Loam	
Loamy Sand	Sandy Clay Loam	Silt Loam	Silty Clay	Clay Loam	Clay

Disturbances:

None	Herbicides	Selective clearing	Mechanical clearing
Fire	Bush encroachment	Severe overgrazing	Deforestation
Other:			

Stratigraphy (Geology):

AEZ:

Growing Period Zone:

Soil Type:

Notes:

Photos:

Vegetation Data

Observer:	Number:	Computer No:	
Landscape:	Date:	Altitude:	
Locality:	Region:	GPS reading: ° ' " S	
	District:	° ' " E	
	Owner:	Accuracy of GPS: (Schwarzeneck)	
		Estimate from 1:50 000 map	General estimate

Vegetation structure:

	Total	Trees	Shrubs >1m	Trees and shrubs	Shrubs <1m	Grasses	Herbs
Average height							
Total cover							
Vegetation structure:							
Th: High tree >20m Tt: Tall tree 10 – 20m Ts: Small tree 5 –1 0m Tl: Low tree 2- 5m Sh: High shrub 2 –5 m St: Tall shrub 1 – 2m Ss: Small shrub 0.5 – 1 m Sl: Low shrub <50cm							

Species composition:

Coll. No	Species	Abundance by growth form									
		T1		T2	T3	S1		S2		Hl	
		Th	Tt	Ts	Tl	Sh	St	Ss	Sl	G	H
	Total cover:										

APPENDIX 4: SATELLITE MAPS

MAP 1: false colour composite satellite image of the southern part of the study area

MAP 2: false colour composite satellite image of the northern part of the study area

MAP 3: supervised classification of vegetation associations of the southern part of the study area, part 1

MAP 4: supervised classification of vegetation associations of the southern part of the study area, part 2

MAP 5: first approximation of major vegetation types of the southern part of the study area

MAP 6: first approximation of major vegetation types of the northern part of the study area

Notes to the legend on Maps 5 and 6:

Vegetation Type A: combination of associations 1-4:
Association 1: *Catophractes alexandri - Willkommia sarmentosa* tall sparse shrubland
Association 2: *Boscia albitrunca - Eragrostis cylindriflora* low open woodland
Association 3: *Acacia mellifera - Leucosphaera bainesii* low closed shrubland with patches of low open woodland
Association 4: *Acacia mellifera - Eragrostis rotifer* low moderately closed bushland

Vegetation Type B:
Association 5: *Acacia mellifera - Monechma genistifolium* low semi-open bushland

Vegetation Type C: combination of associations 6 and 7:
Association 6: *Albizia anthelmintica - Stipagrostis uniplumis* low open woodland
Association 7: *Acacia mellifera - Aristida congesta* low semi-open bushland

Vegetation Type D:
Association 8: *Acacia erioloba - Stipagrostis uniplumis* low semi-open bushland

Vegetation Type E:

Association 9: *Lonchocarpus nelsii - Eragrostis rigidior* low moderately closed bushland

Vegetation Type F:

Association 10: *Boscia foetida - Leucosphaera bainesii* low semi-open bushland

Vegetation Type G: combination of associations 11 and 12

Association 11: *Acacia mellifera - Stipagrostis hirtigluma* low moderately closed bushland

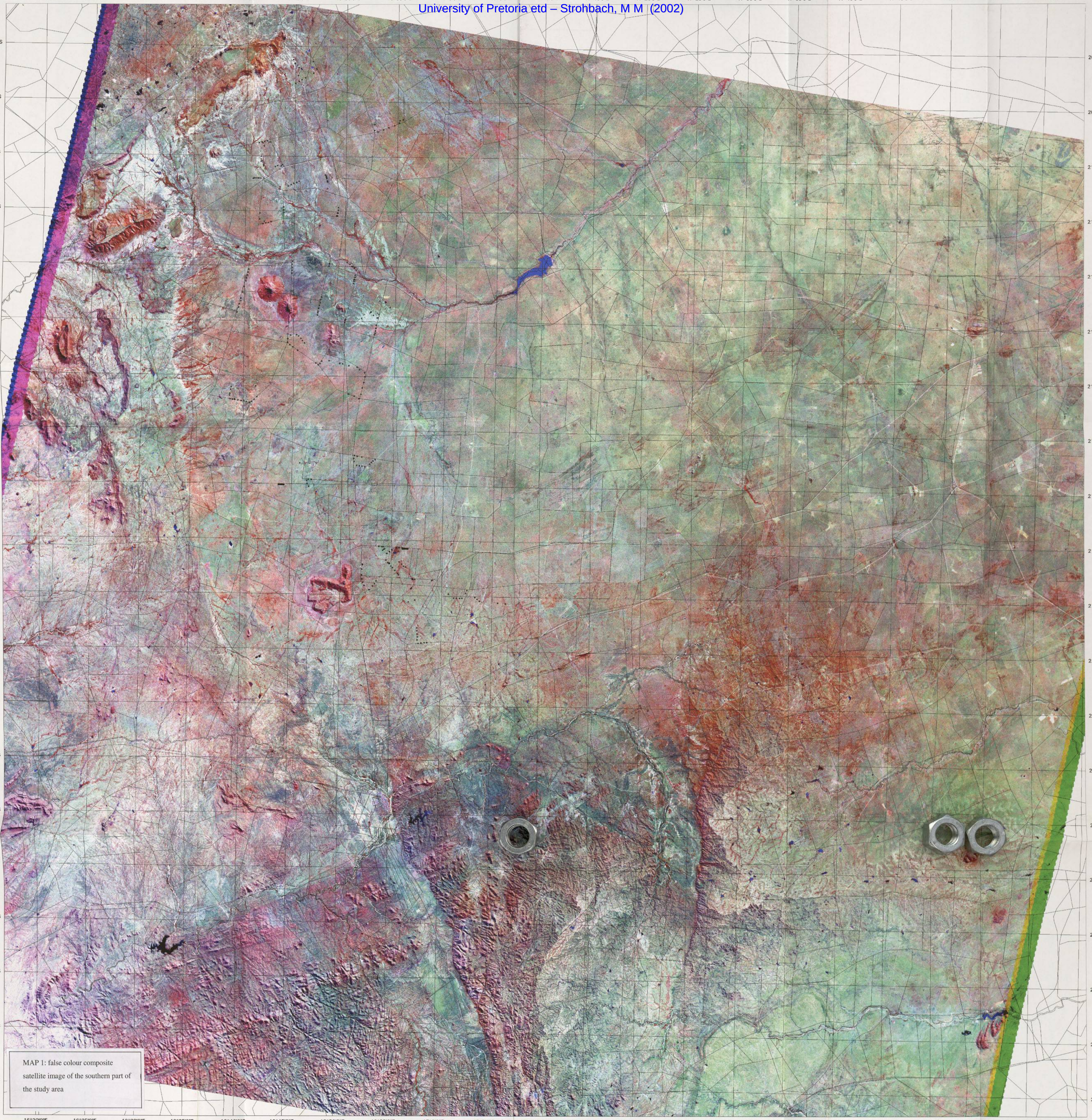
Association 12: *Acacia mellifera - Cenchrus ciliaris* low moderately closed bushland

Vegetation Type H:

Association 13: *Dichrostachys cinerea - Cenchrus ciliaris* low moderately closed bushland

Vegetation Type I:

Association 14: *Terminalia prunioides - Croton gratissimus* low closed bushland



MAP 1: false colour composite satellite image of the southern part of the study area

BIOTA

DLR

Scale

10 0 10 Kilometers

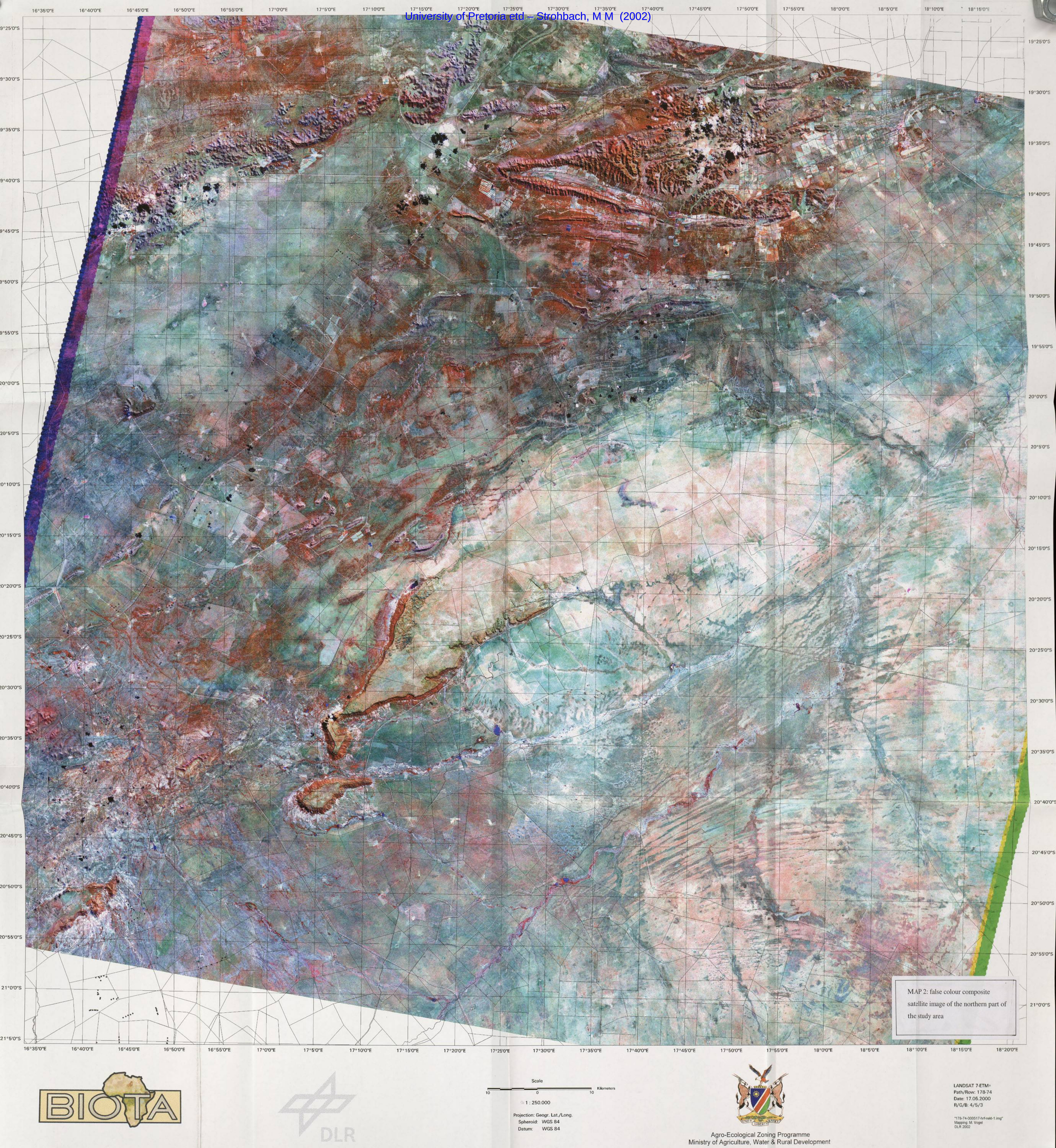
1 : 250.000

Projection: Geogr. Lat./Long.
Spheroid: WGS 84
Datum: WGS 84

Agro-Ecological Zoning Programme
Ministry of Agriculture, Water & Rural Development

LANDSAT 7-ETM+
Path/Row: 178-75
Date: 17.05.2000
R/G/B: 4/5/3

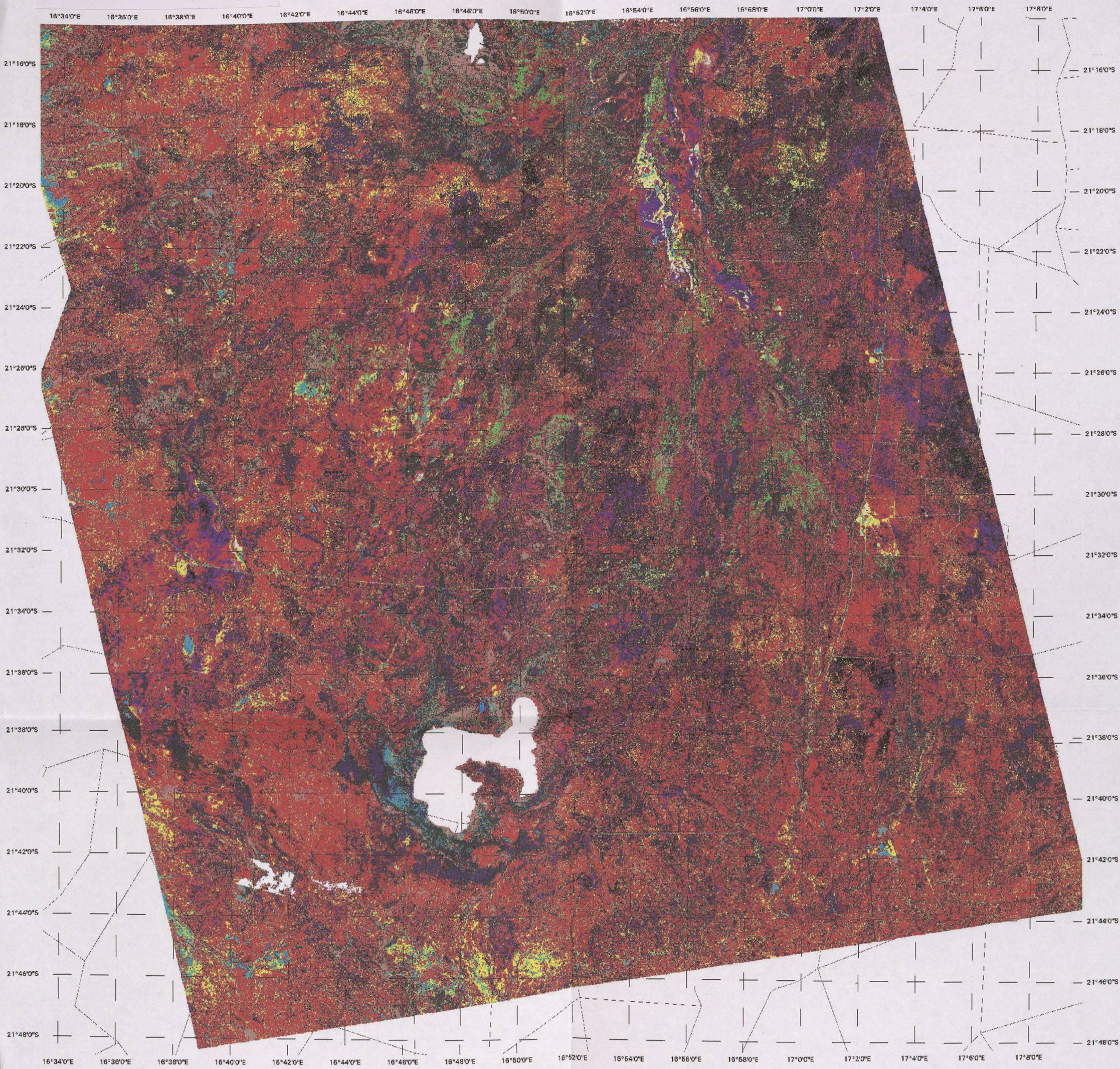
"178-75-000517-hrf-rekt-1.img"
Mapping: M. Vogel
DLR 2002



MAP 2: false colour composite satellite image of the northern part of the study area

MAP 3:

Supervised classification of vegetation associations of the southern part of the study area, part 1



Legend: Vegetation Associations

association		association		association		association	
	1		6		2		3
	5		7		9		4
	5		8		10		

Scale

5 0 5 Kilometers

Projection: Geographic
Ref. Ellipsoid: WGS 84
Geodetic Dat. WGS 84

Distribution of Vegetation Associations

Part 1

Classification with TWINSPAN

Image Base LANDSAT ETM 178-75

Image Date 17.05.2000

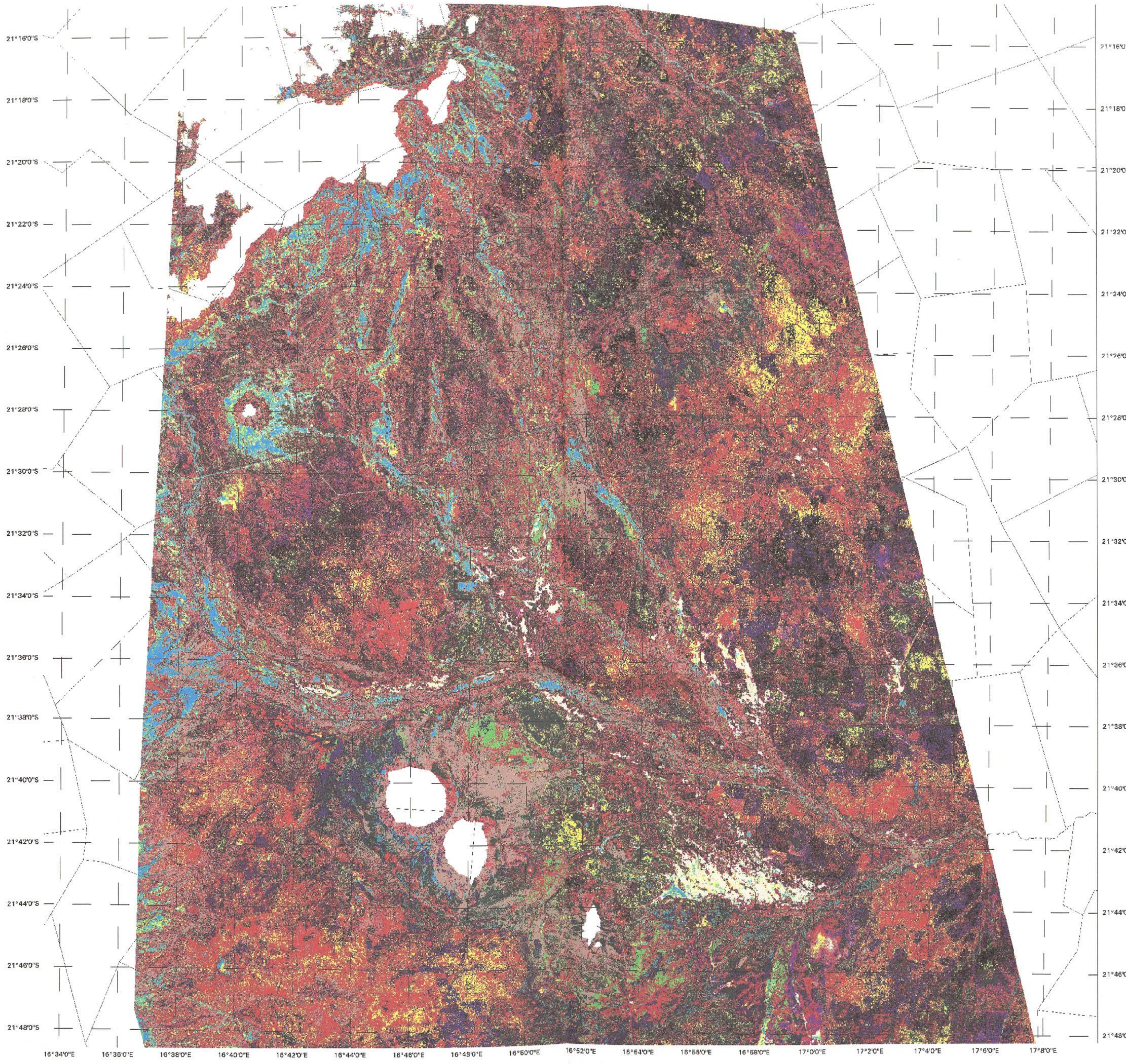
Image processing by:

Melanie Vogel & Marianne Strohbach

September 2002

MAP 4:

Supervised classification of vegetation associations of the southern part of the study area, part 2



Scale

5 0 5 Kilometers

Projection: Geographic
Ref. Elipsoid: WGS 84
Geodetic Dat. WGS 84

Legend: Vegetation Associations

association	association	association	association
1	6	2	3
5	7	9	4
5	8	10	

Distribution of Vegetation Associations

Part 2

Classification with TWINSPAN

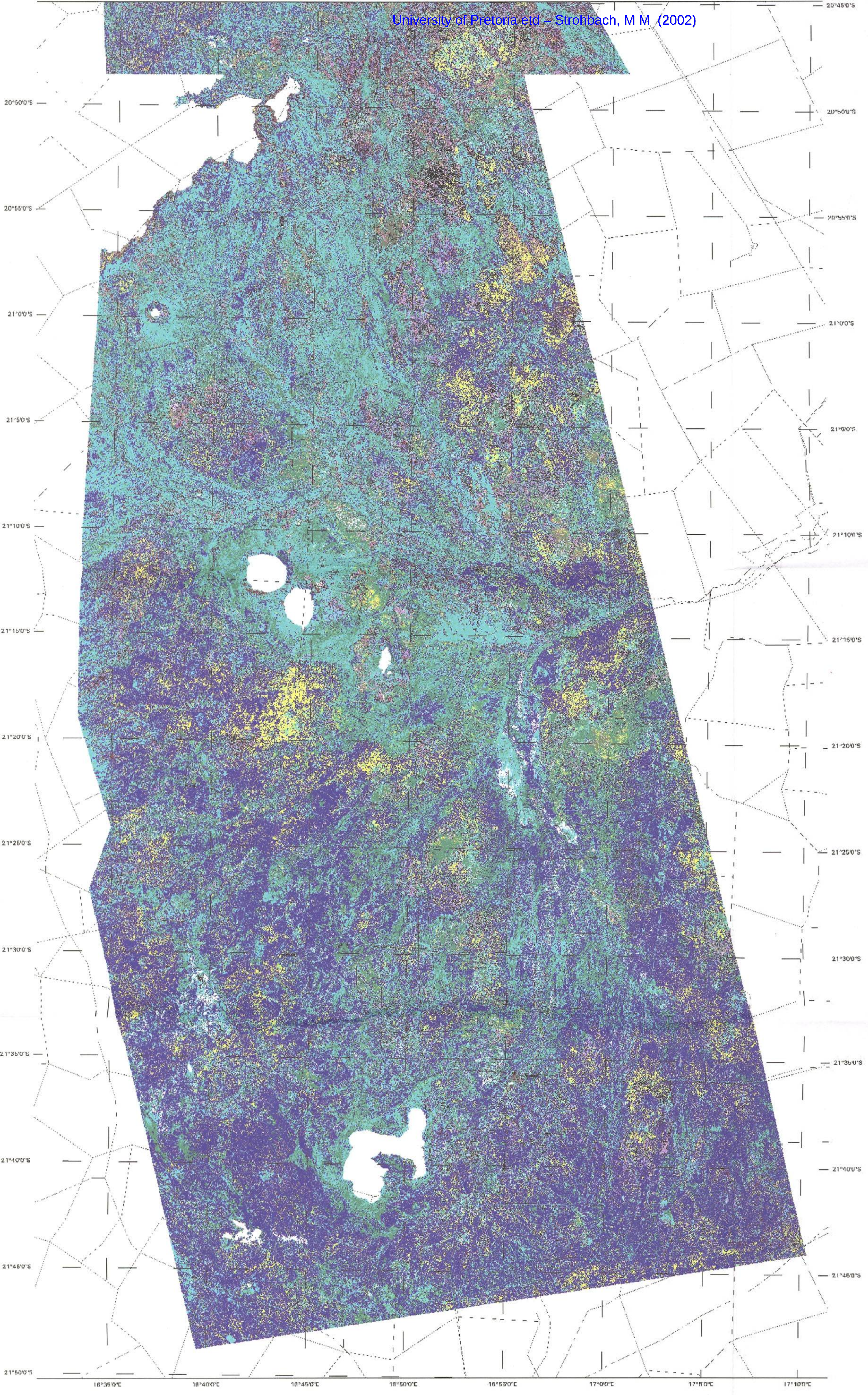
Image Base LANDSAT ETM 178-75

Image Date 17.05.2000

Image processing by:

Melanie Vogel & Marianne Strohbach

September 2002



MAP 5:

First approximation of major vegetation types of the southern part of the study area

Scale

10 0 10 Kilometers

Projection: Geographic lat./long.

Spheroid: WGS 84

Datum: WGS 84

Legend:
Vegetation Types

- A
- B
- C
- D
- H
- I
- E
- F
- G

Landsat-7-ETM

Path/Row 178-75

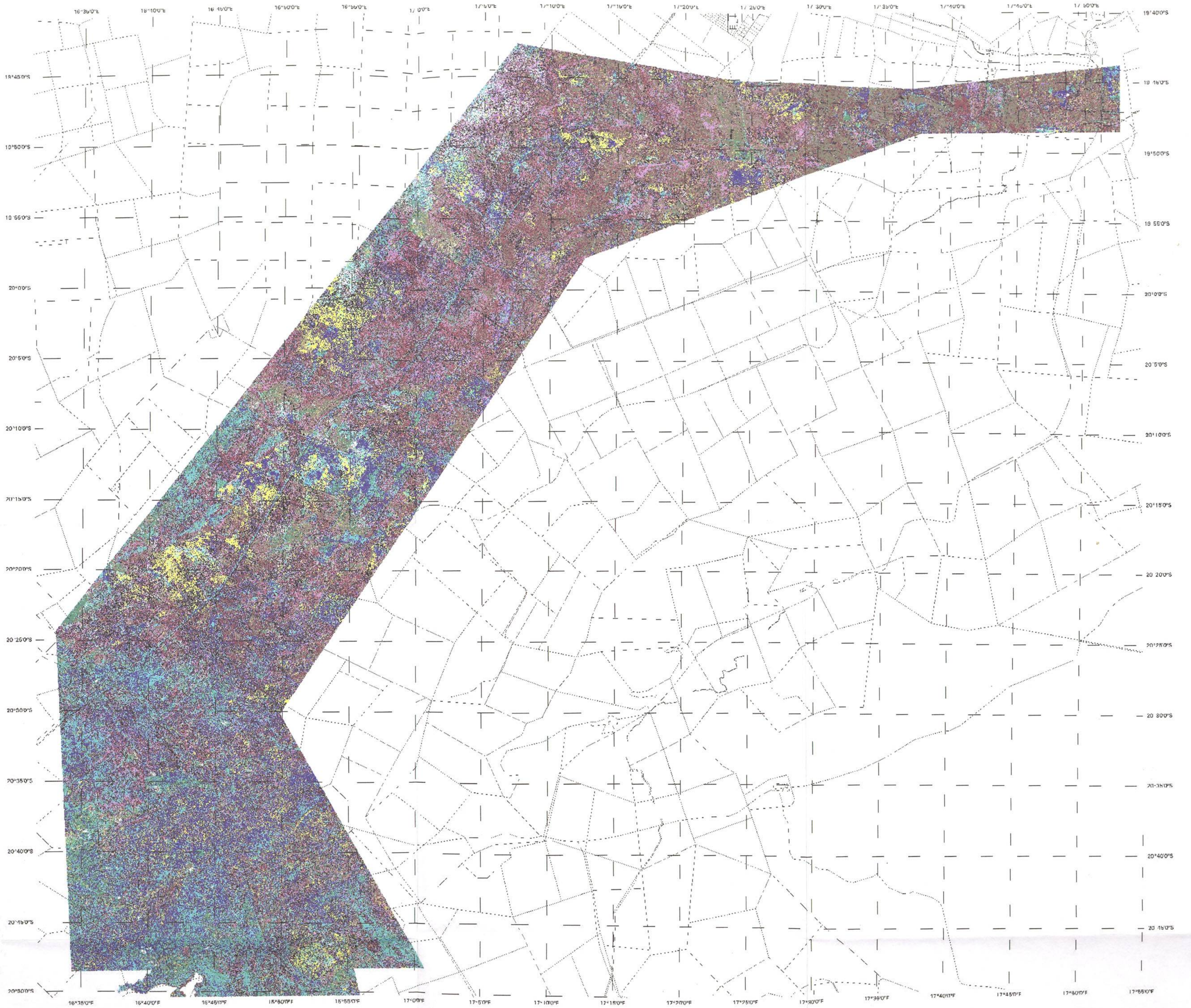
Vegetation data: M. Strohbach

Mapping: M. Vogel

DLR October 2002

MAP 6:

First approximation of major vegetation types of the northern part of the study area



Scale
10 0 10 Kilometers

Projection: Geographic lat./long.

Spheroid: WGS 84

Datum: WGS 84

Legend:
Vegetation Types

- A
- B
- C
- D
- H
- I
- E
- F
- G

Landsat-7-ETM

Path/Row 178-74

Vegetation data: M. Strohbach

Mapping: M. Vogel

DLR October 2002