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	

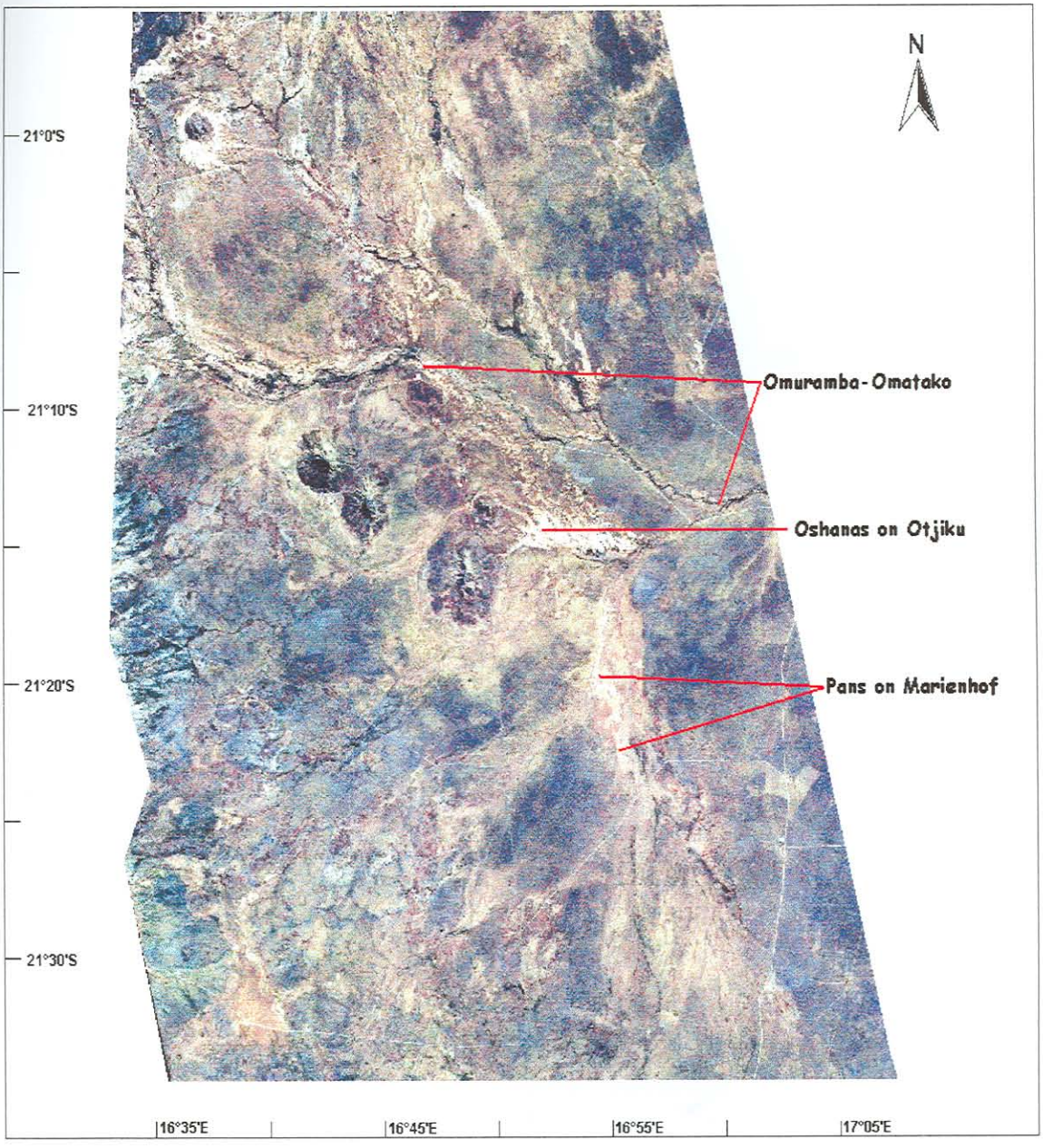

Figure 17: False-colour satellite image of the oshanas on Otjiku and Marienhof. Grootgeluk is east of Otjiku, covering about half of the oshana-system appearing white on the image. Towards the west, below the Omuramba-Omatako, the two peaks of the Omatako Mountains can be seen.

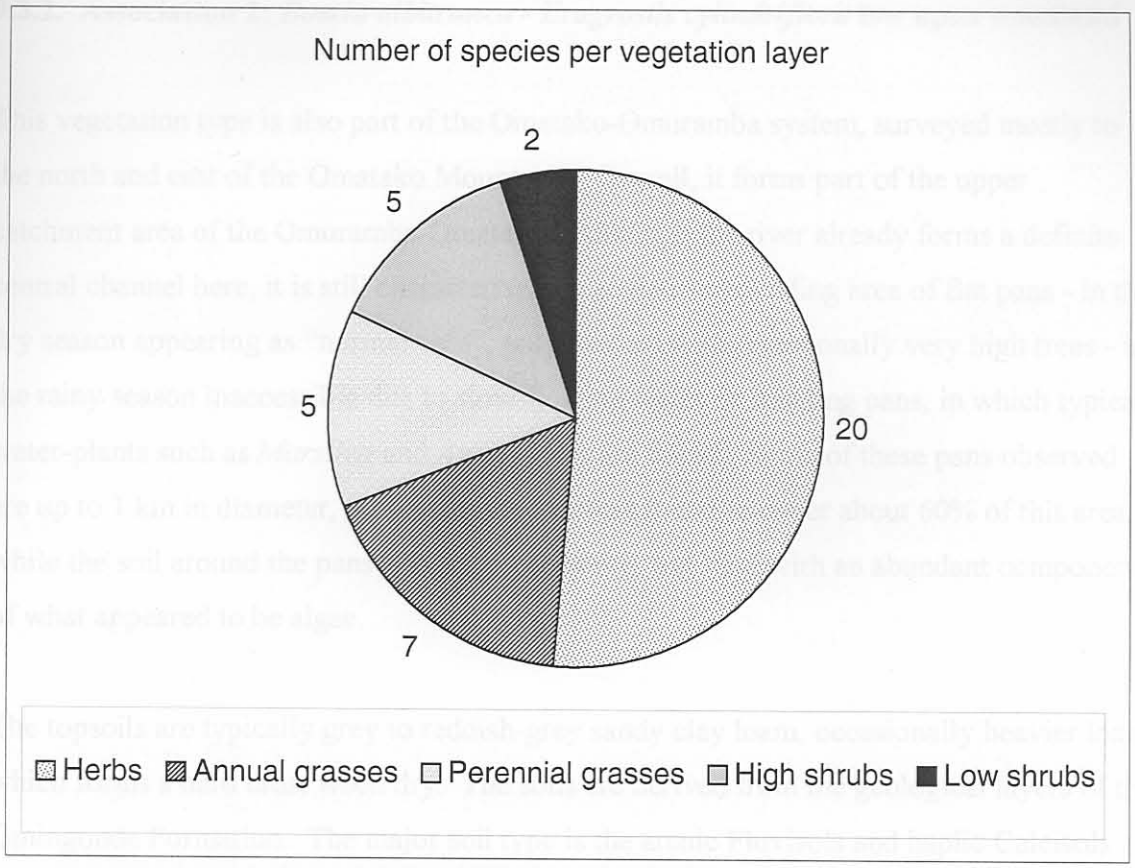

Figure 18a: Pie chart showing the total number of species recorded for each vegetation layer in association 1.

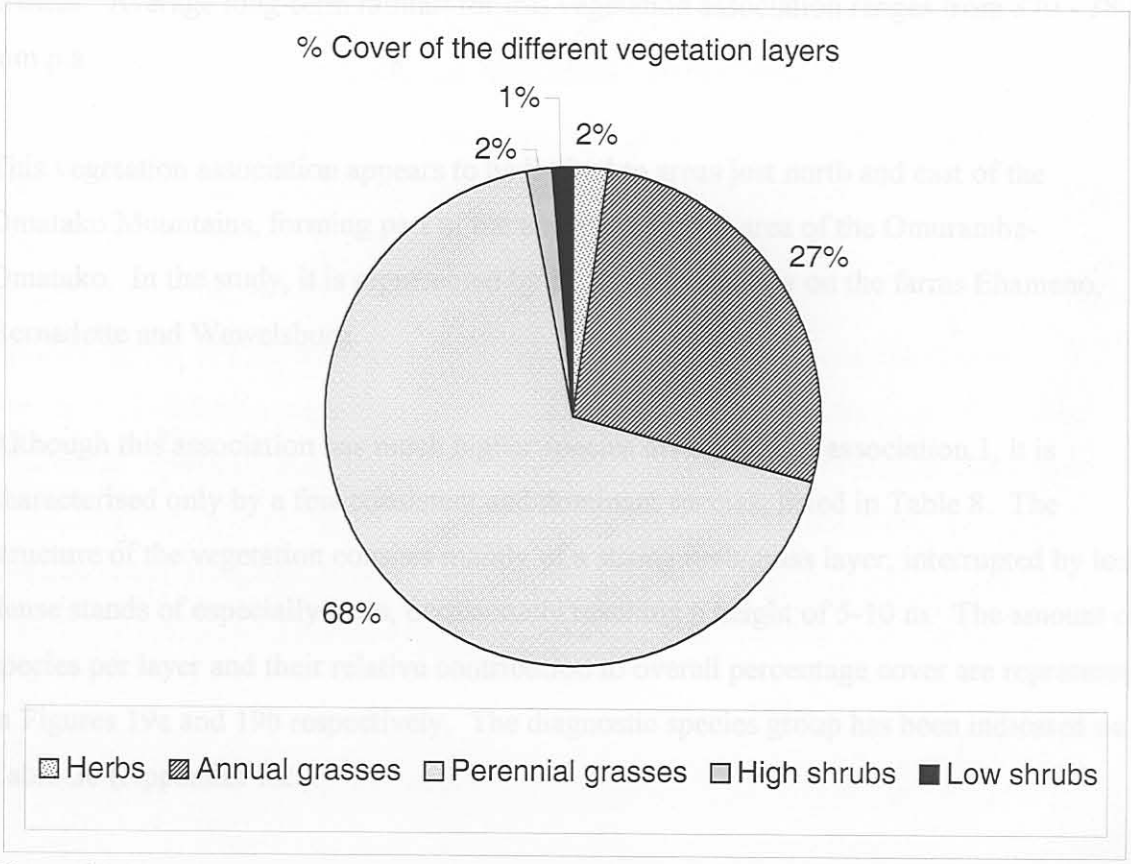

Figure 18b: Pie chart showing the average percentage cover each layer contributes to the total vegetation cover of association 1.

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*.

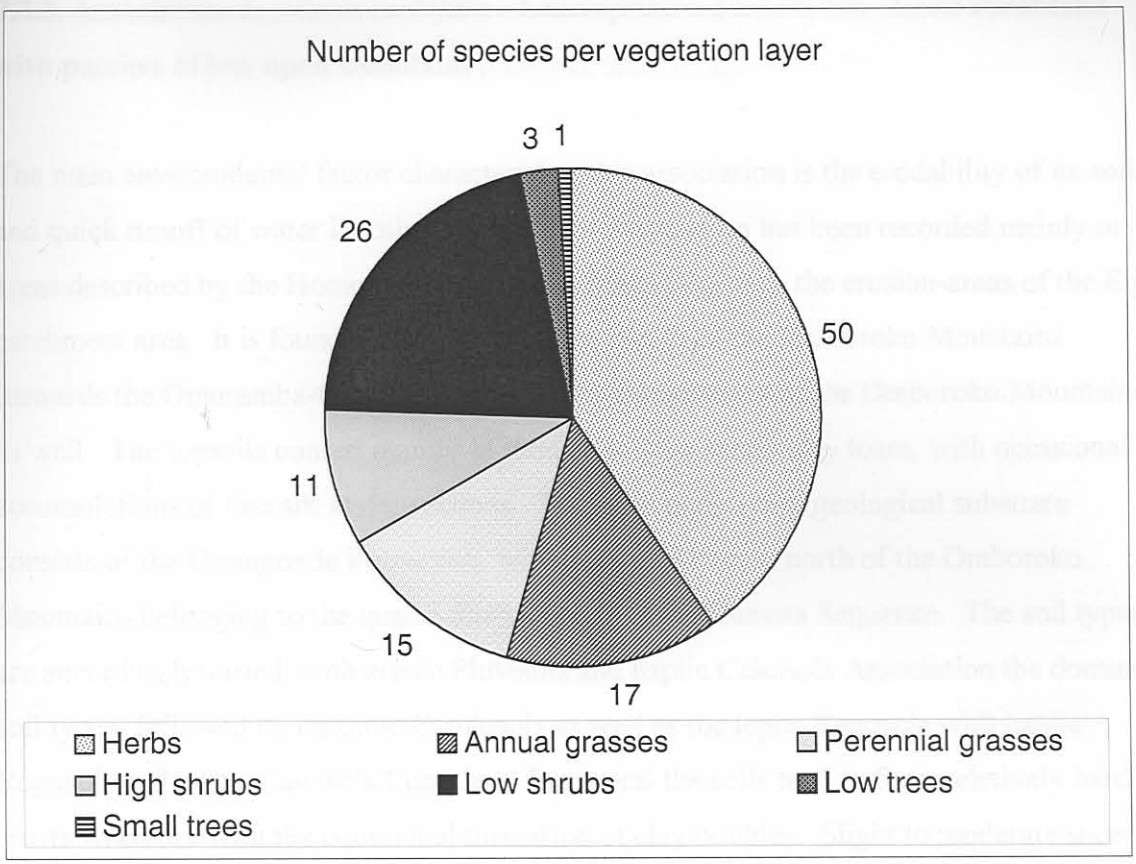

Figure 19a: Pie chart showing the total number of species recorded for each vegetation layer in association 2.

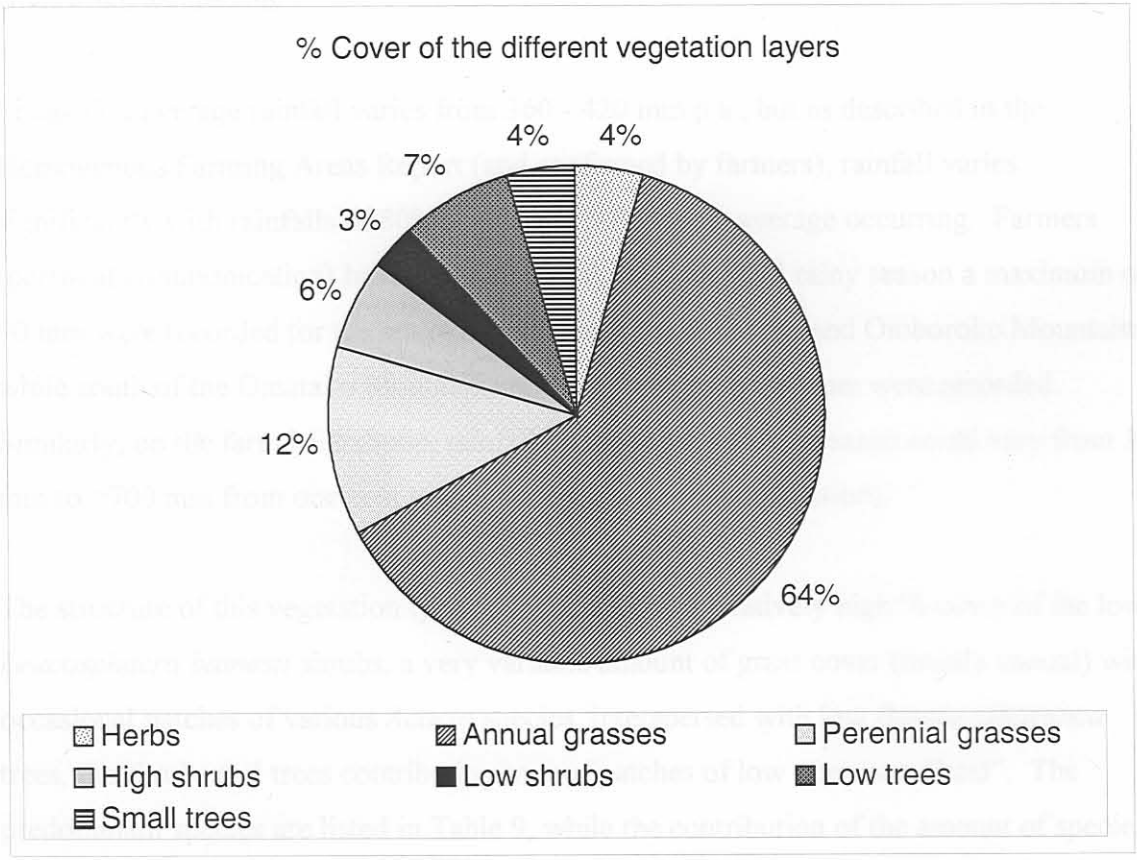

Figure 19b: Pie chart showing the average percentage cover each layer contributes to the total vegetation cover of association 2.

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.

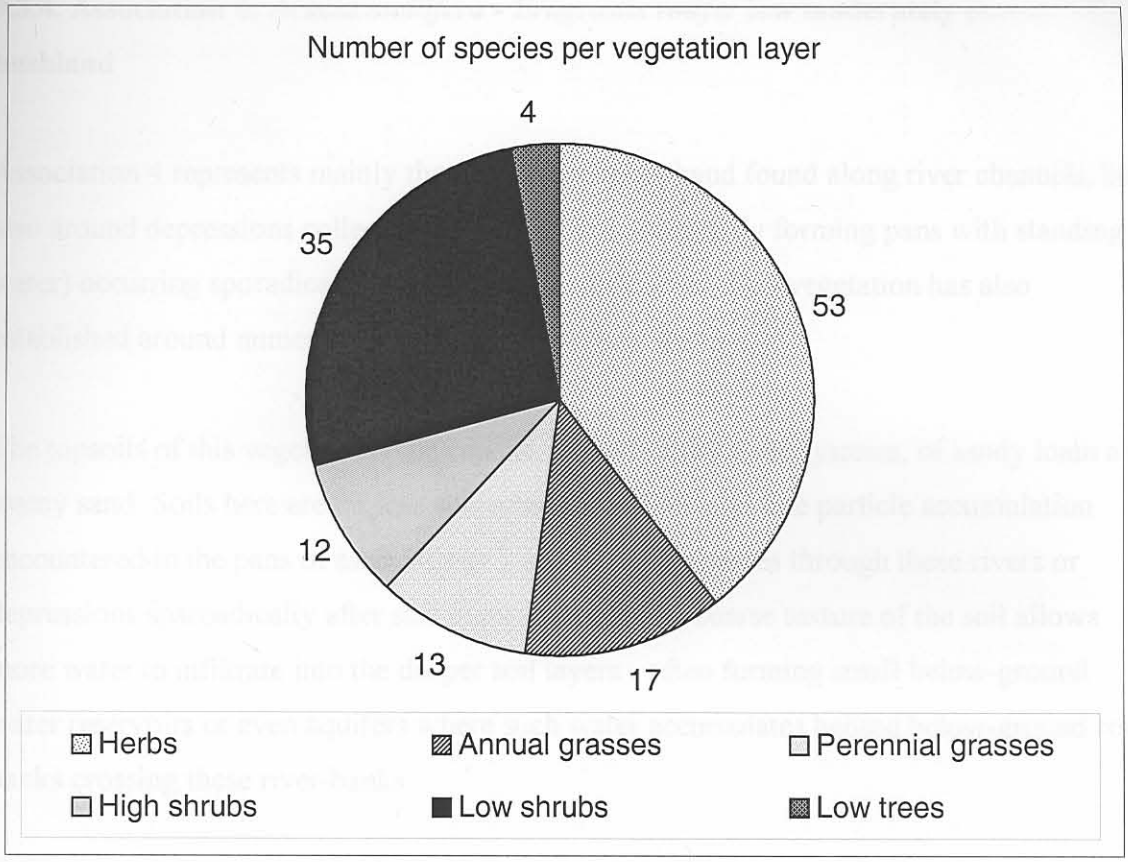

Figure 20a: Pie chart showing the total number of species recorded for each vegetation layer in association 3.

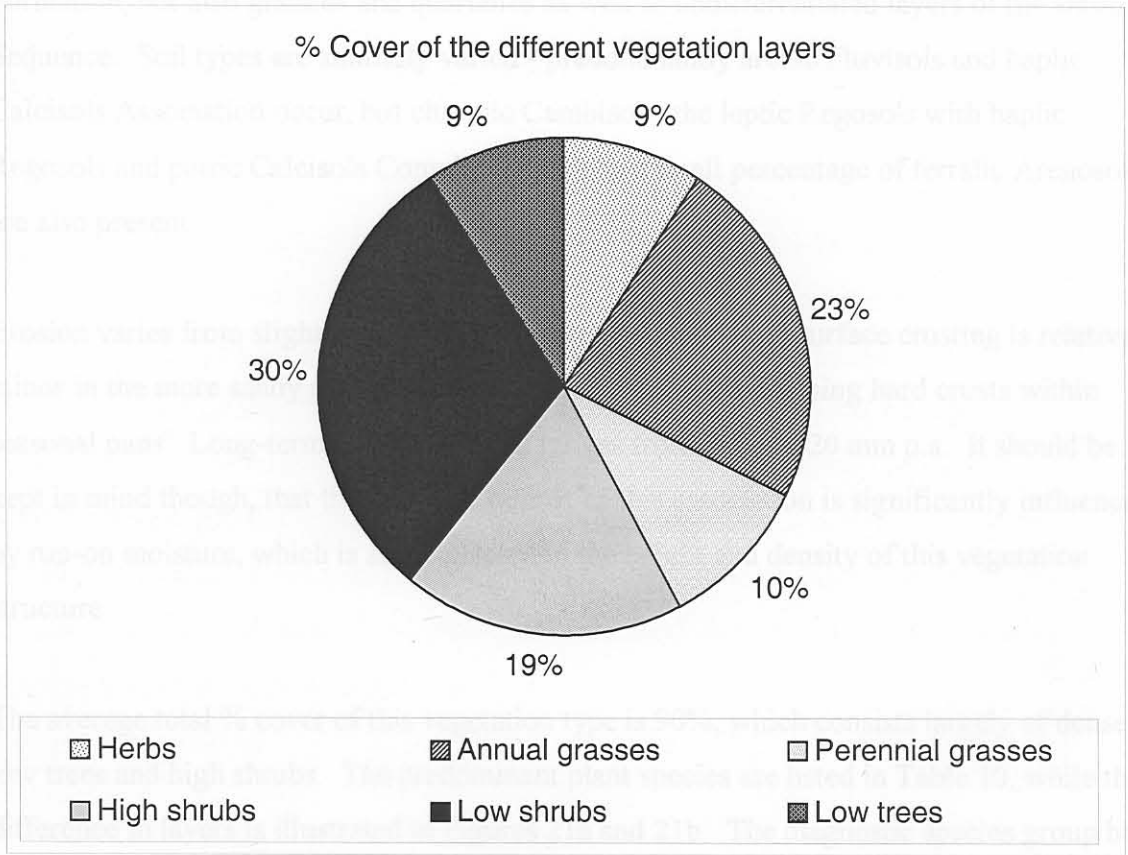

Figure 20b: Pie chart showing the average percentage cover each layer contributes to the total vegetation cover of association 3.

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.

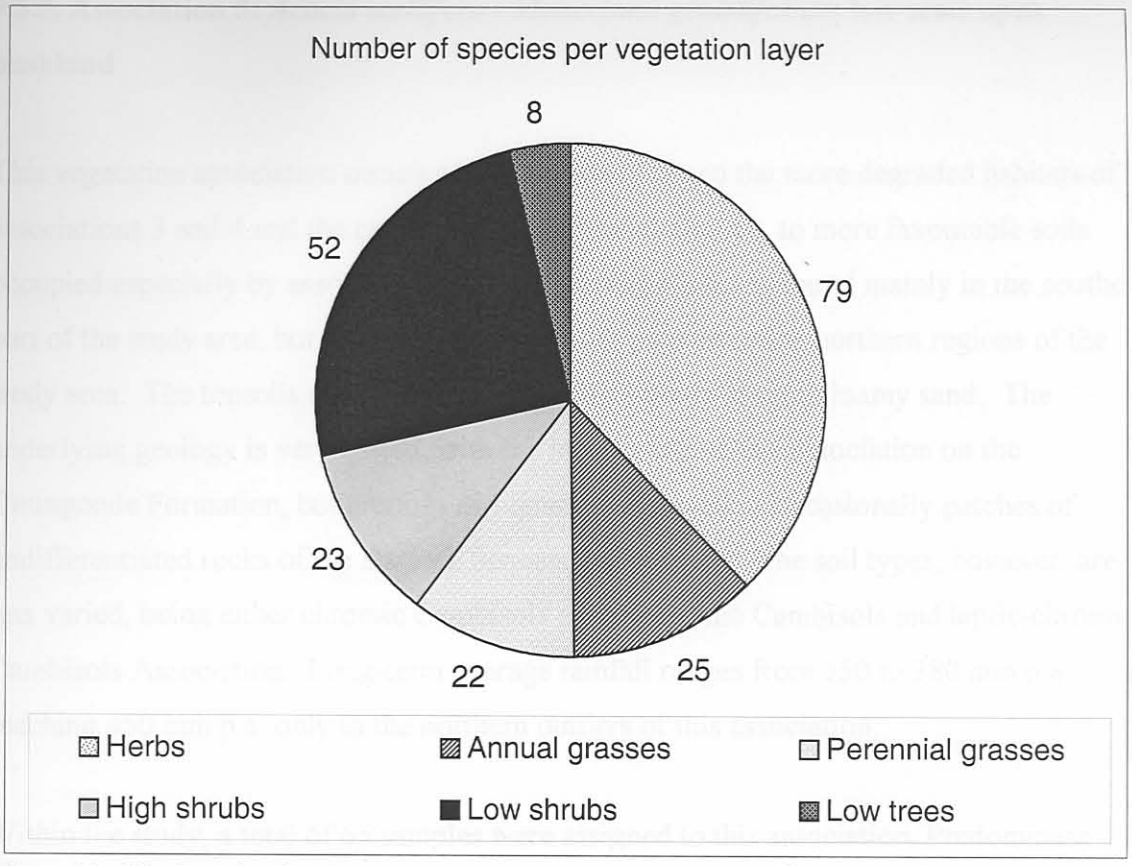

Figure 21a: Pie chart showing the total number of species recorded for each vegetation layer in association 4.

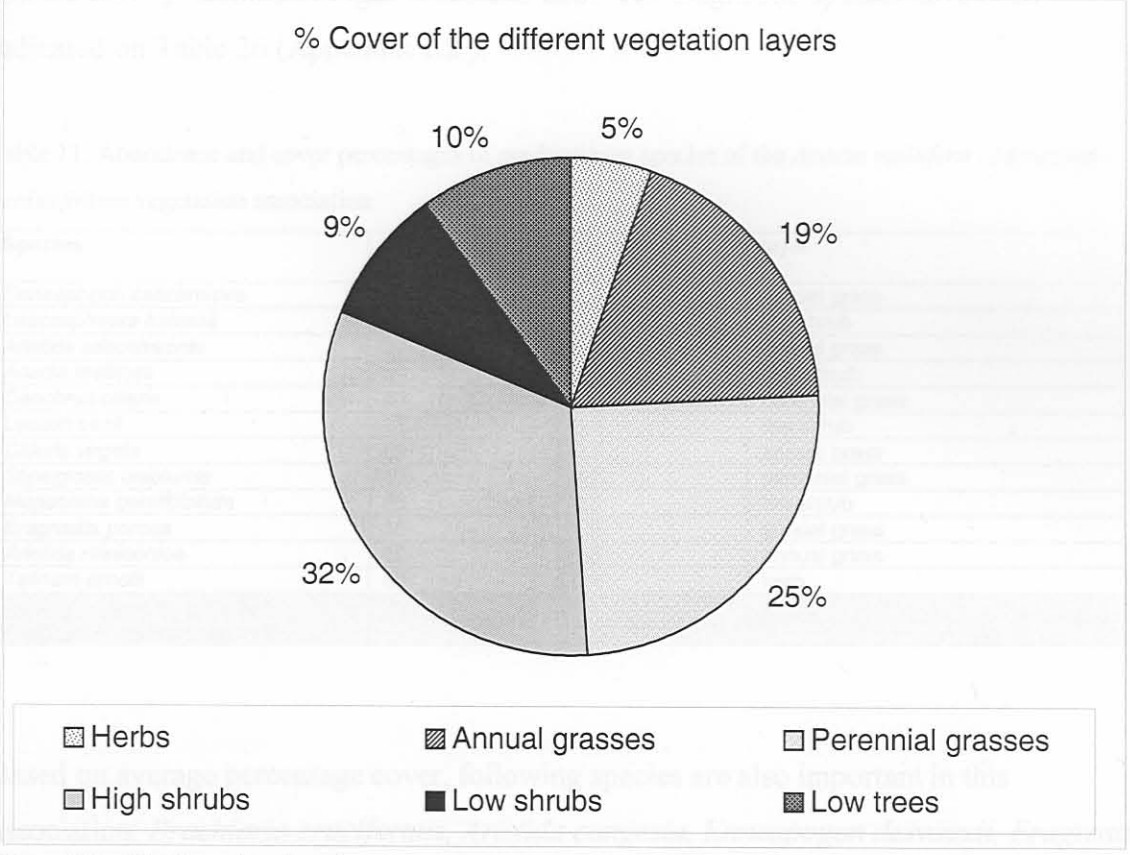

Figure 21b: Pie chart showing the average percentage cover each layer contributes to the total vegetation cover of association 4.

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.

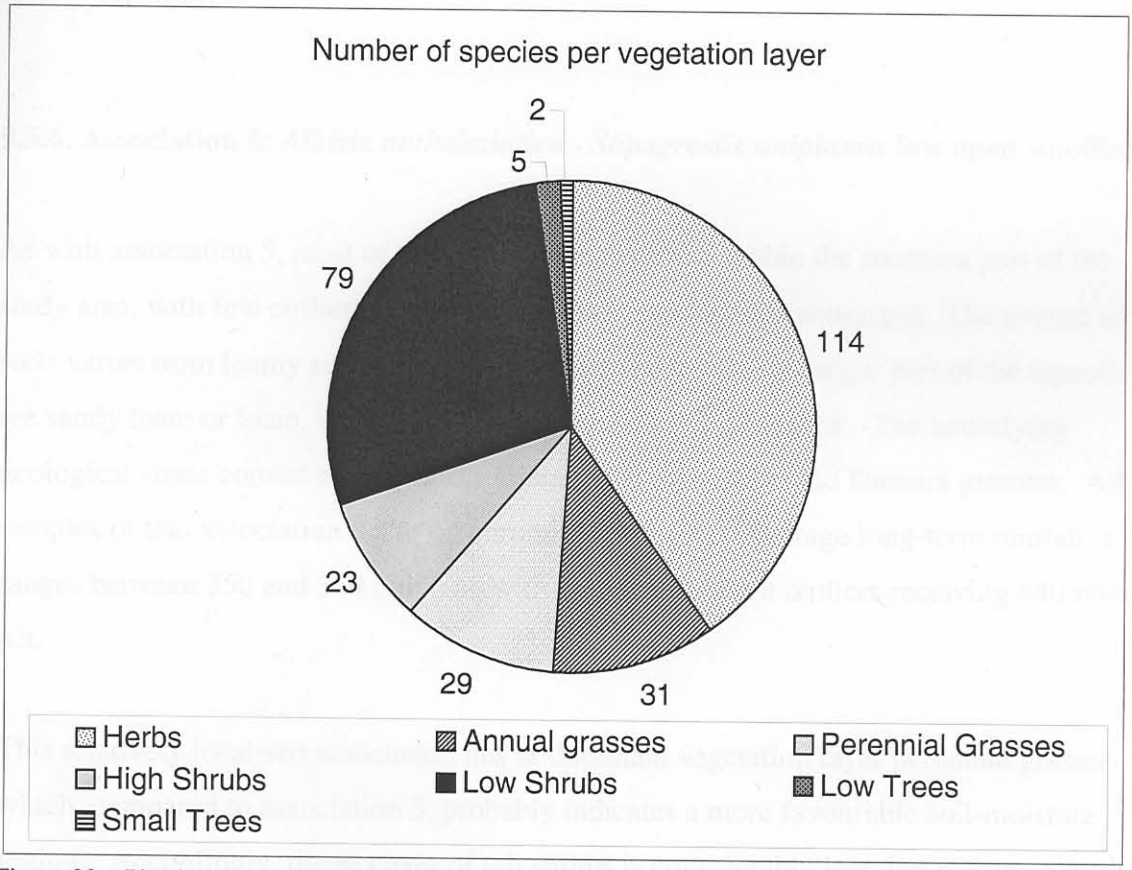

Figure 22a: Pie chart showing the total number of species recorded for each vegetation layer in association 5.

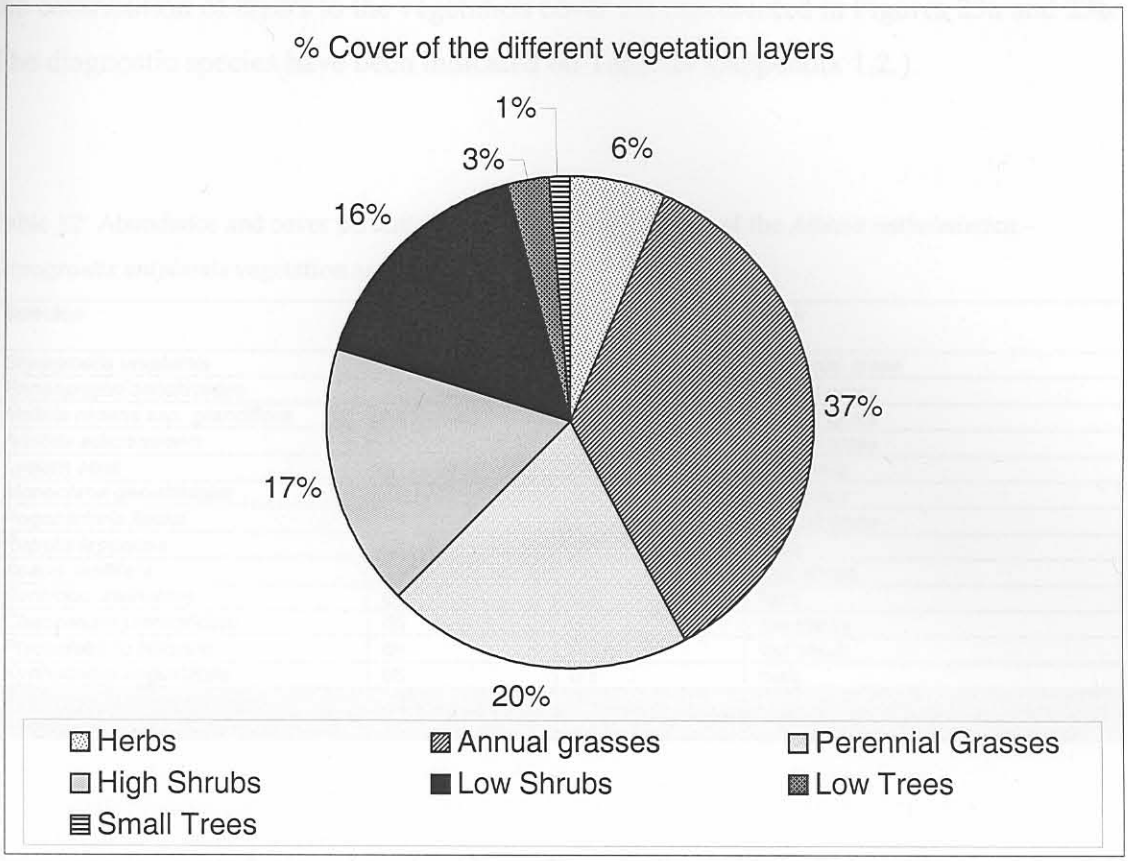

Figure 22b: Pie chart showing the average percentage cover each layer contributes to the total vegetation cover of association 5.

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.

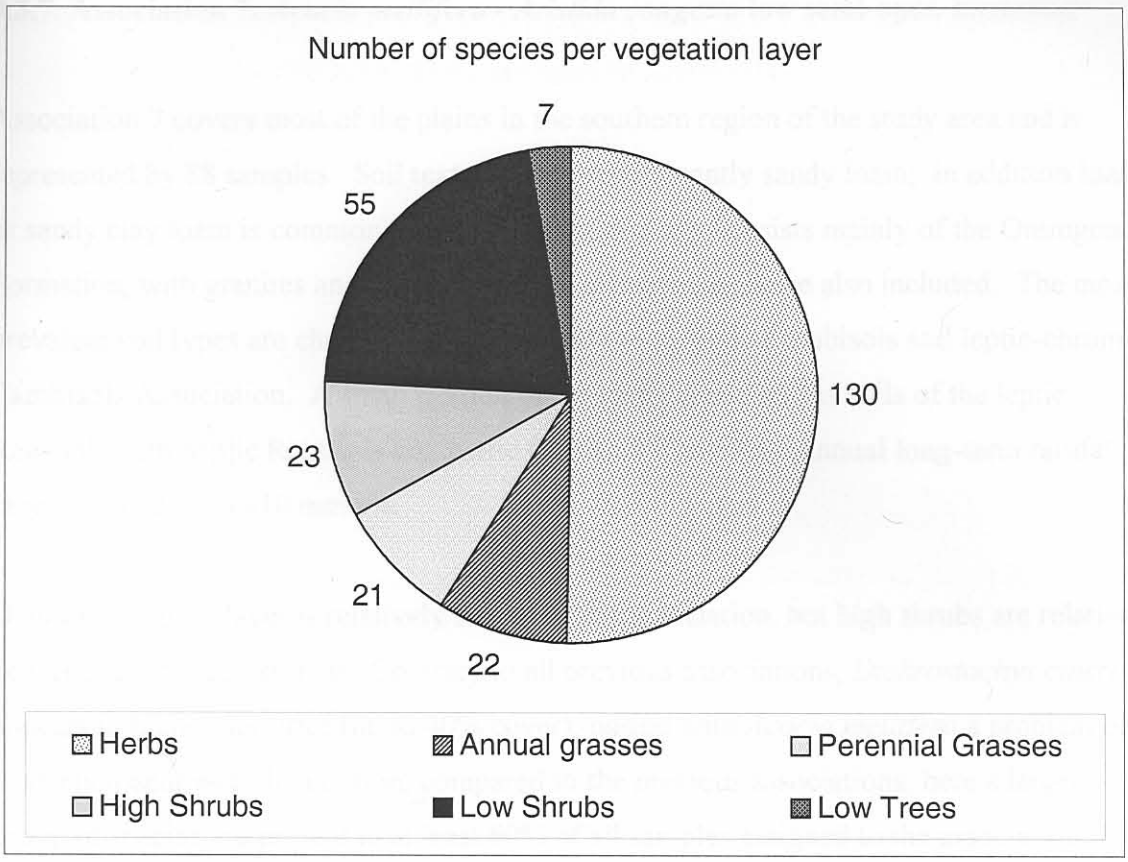

Figure 23a: Pie chart showing the total number of species recorded for each vegetation layer in association 6.

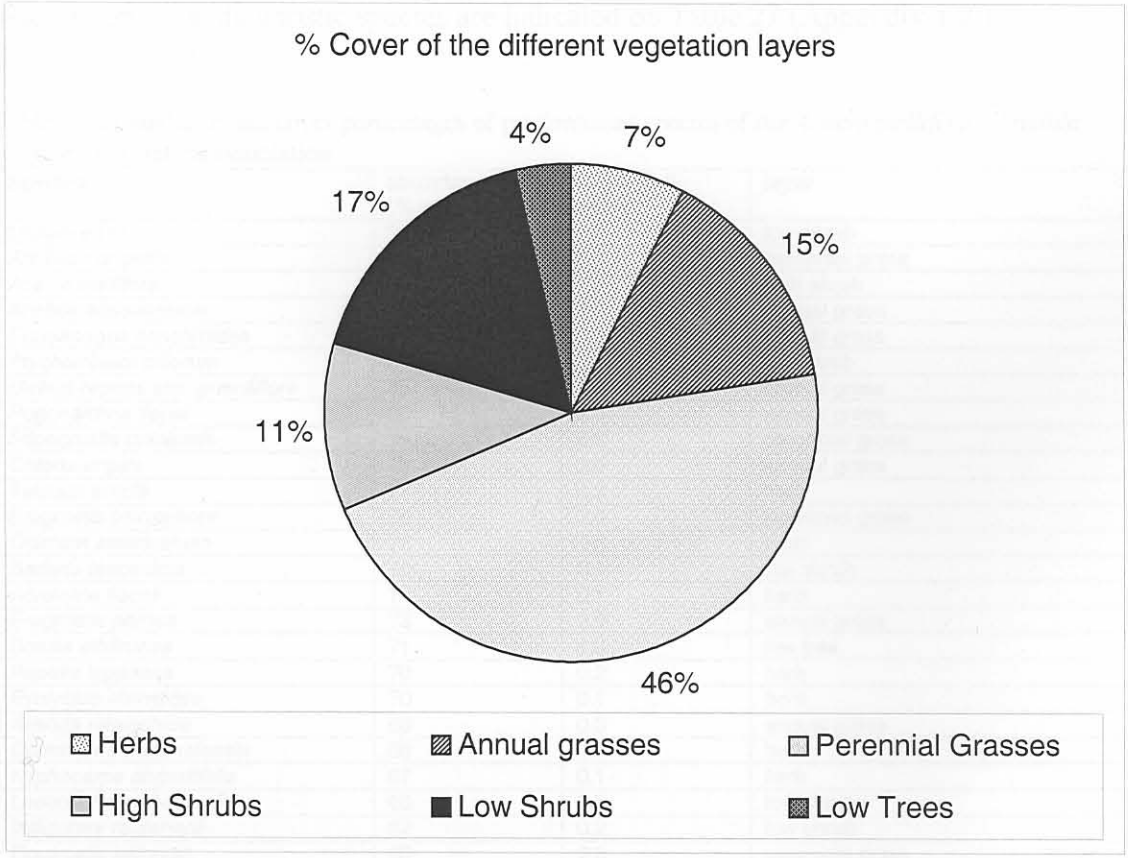

Figure 23b: Pie chart showing the average percentage cover each layer contributes to the total vegetation cover of association 6.

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
Evolvolus 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.

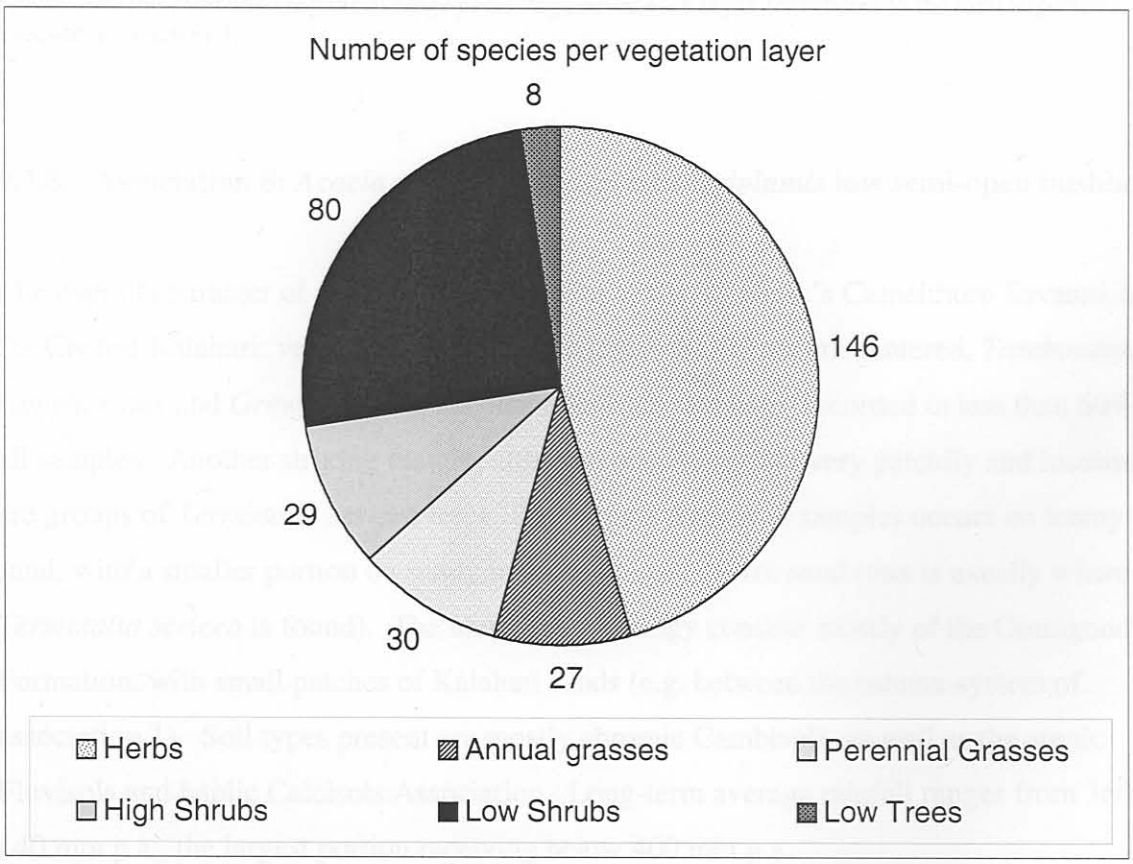

Figure 24a: Pie chart showing the total number of species recorded for each vegetation layer in association 7.

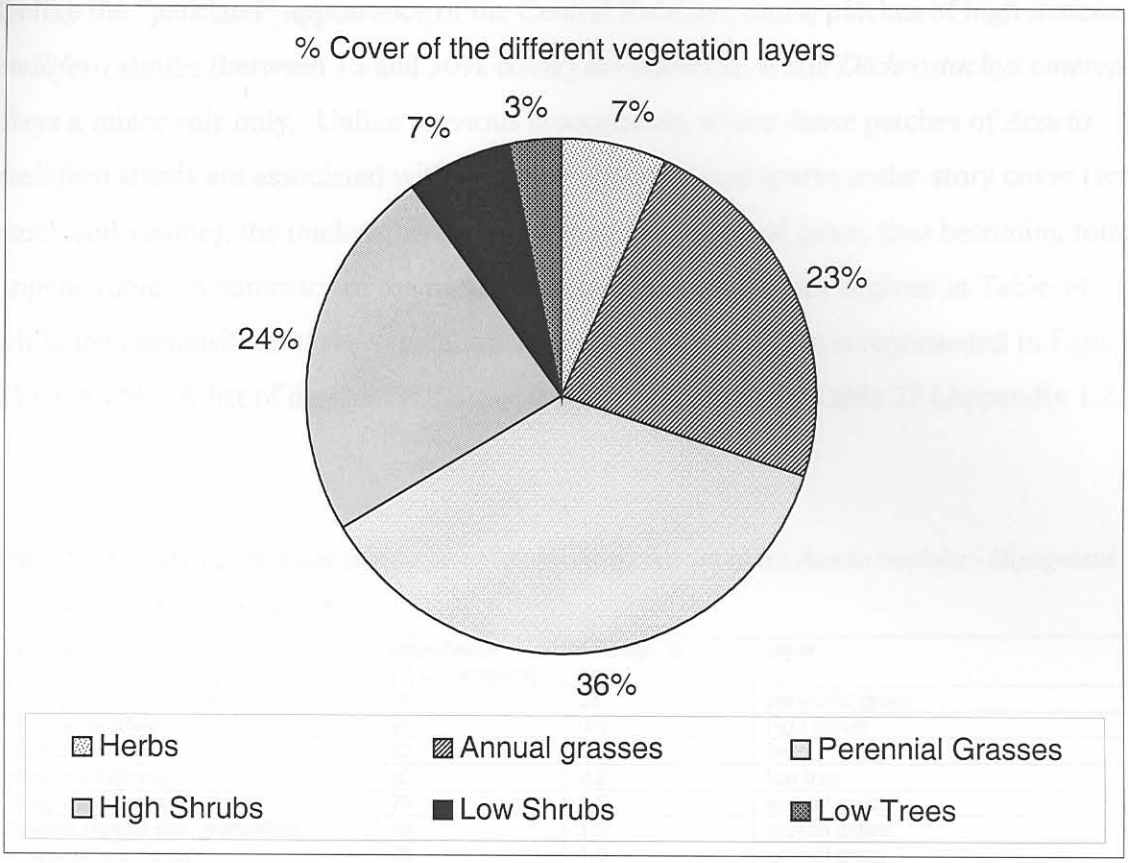

Figure 24b: Pie chart showing the average percentage cover each layer contributes to the total vegetation cover of association 7.

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.

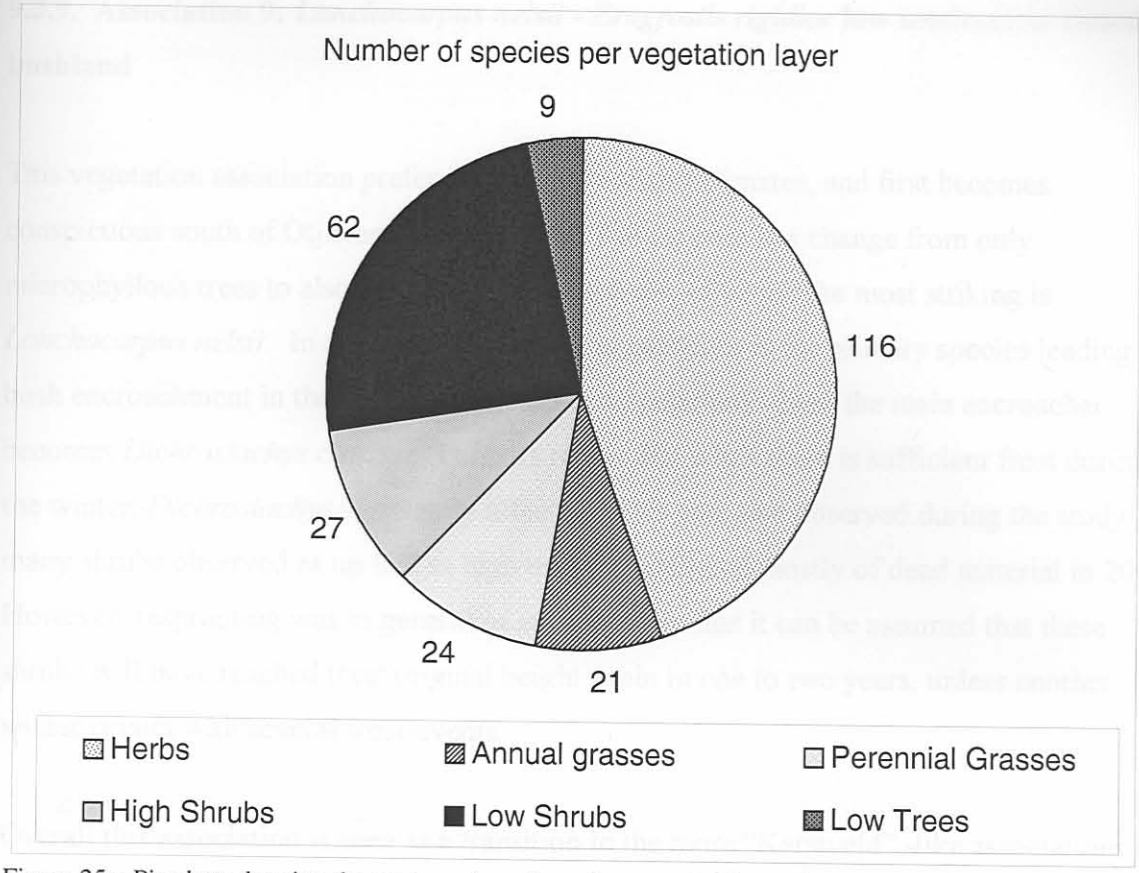

Figure 25a: Pie chart showing the total number of species recorded for each vegetation layer in association 8.

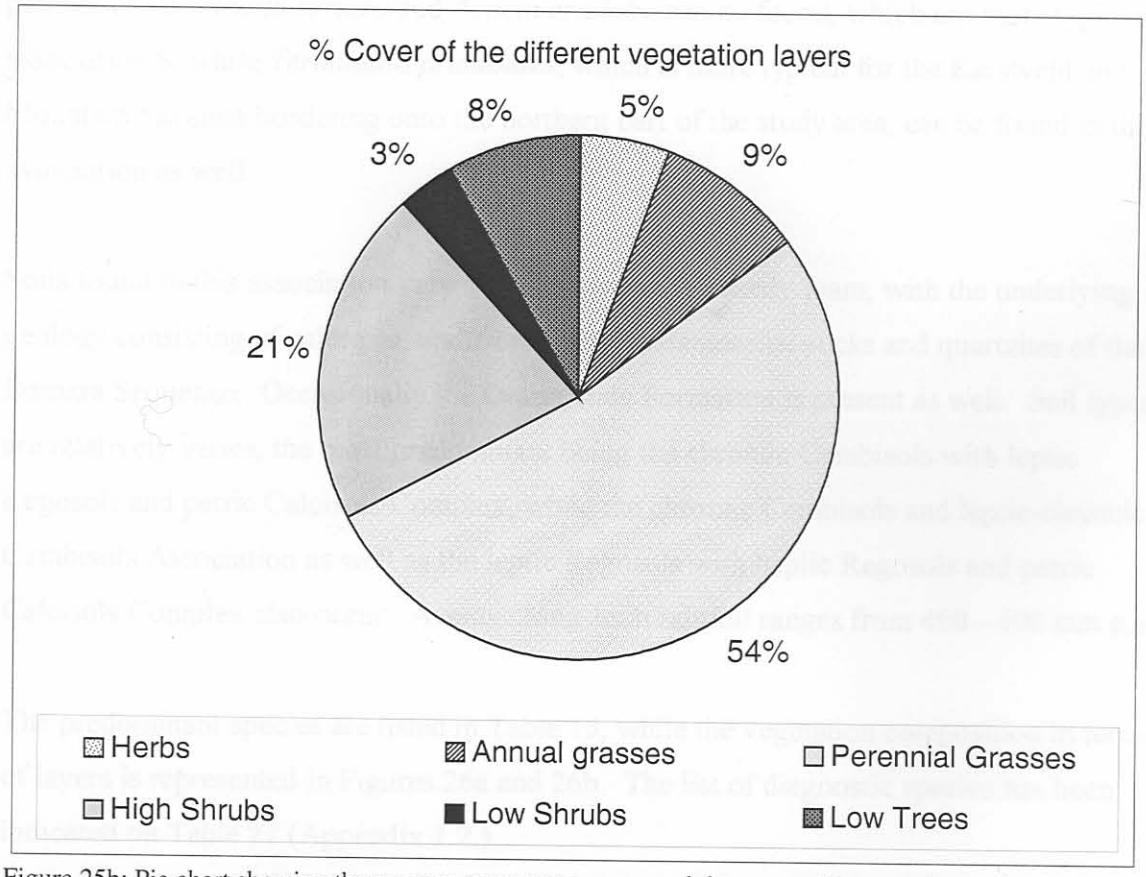

Figure 25b: Pie chart showing the average percentage cover each layer contributes to the total vegetation cover of association 8.