The vegetation of Breslau Game Farm, Northern Province, South Africa

by

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SUMMARY

The study area is located along the Limpopo River in the Northern Province, in an arid region, where a major delimiting factor is the lack of sufficient, reliable rainfall. The vegetation consists of thorn savanna and broad-sclerophyll arid bushveld or woodland, which is dominated by *Colophospermum mopane*.

The aim of the study was to classify the vegetation into communities based on species composition, habitat and disturbances such as dams and contour walls, and to analyse, describe and interpret these plant communities.

The study area was stratified into three main units, namely (1) the crest and scarp, which include the koppies, rocky outcrops and ridges, (2) the valley bottom and floodplains, which include the riverine, floodplains and dams and (3) the midslope and footslope which include the plains and flatter areas. Sampling was carried out during the growing season from March 2001 to June 2001. A total of 187 plots were sampled. Species were listed according to the Braun-Blanquet cover-abundance scale.

Data were incorporated into a data base using the TURBOVEG (Hennekens 1996a) program. Two-Way Indicator Species Analysis (TWINSPAN) (Hill 1979a) was applied to the entire data set in order to identify the major plant communities. This initial classification was then refined, using the program MEGATAB (Hennekens 1996b) with Braun-Blanquet procedures (Westhoff & van der Maarel 1987; Behr & Bredenkamp 1988). The results of this classification was two distinct communities which are presented in two separate phytosociological tables. The two communities are (1) The *Colophospermum mopane – Hibiscus micranthus* Major Woodland community which is divided into two main communities, nine subcommunities and six variants and (2) The *Salvadora australis - Acacia tortilis* Major Woodland Community which is divided into three main communities, eight subcommunities and four variants. The ordination

algorithm DECORANA (Hill 1979b) was also applied to the floristic data set to illustrate relationships between the vegetation units and the environmental factors.

The soil type was a major factor influencing the vegetation. The most common type of soil is a sodic soil which is highly erodable and unstable and is dominated by the *Colophospermum mopane* veld. The *Salvadora australis* veld is found on the more brackish soils. The thornveld is found in the wetter areas around the dams and the riverine which has a more silty-clayey soil.

The effect of spreading and retaining the water by the construction of dams and contour walls can clearly be identified by the improved growth of the vegetation in these areas, resulting in increased feed for the game.

This study can be used as a basis for further studies to develop an efficient management plan with effective wildlife management programs for Breslau Game Farm.

OPSOMMING

Die studie gebied is geleë langs die Limpoporivier in die Noordelike Provinsie, in 'n droë streek, waar die hoof beperkende faktor 'n tekort aan genoegsame, betroubare reën is. Die plantegroei bestaan uit doring savanna (mikrofille) en breë blaar (sklerofille) droë bosveld of boomveld, wat gedomineer word deur *Colophospermum mopane*.

Die doel van die studie was om die plantegroei in verskillende gemeenskappe te klassifiseer, gebaseer op die spesie samestelling, habitat en versteurings soos damme en kontoerwalle, sowel as om hierdie plantgemeenskappe te analiseer, beskryf en te interpreteer.

Die studiegebied was in drie hoof eenhede gestratifiseer, naamlik: (1) die kruin en eskarp, wat bestaan uit die koppies, rotsriwwe en bergkruine, (2) die valleie (laaglande) en vloedvlaktes, wat bestaan uit die rivierkom, vloedvlaktes en damme; en (3) die middelhang en voethang wat die vlaktes en platter areas omvat. Proewe was gedurende die groeiseisoen vanaf Maart 2001 tot Junie 2001 uitgevoer. 'n Totaal van 187 persele was uitgevoer. Spesies was volgens die Braun-Blanquet bedekkingswaardes gelys.

Data was in 'n databank ingevoer deur gebruik te maak van die program TURBOVEG (Hennekens 1996a). Die hoof plantgemeenskappe is geidentifiseer met die toepassing van die program TWINSPAN ("Two-Way Indicator Species Analysis") (Hill 1979a) op die volledige datastel. Hierdie eerste klassifikasie is verfyn met die gebruik van die program MEGATAB (Hennekens 1996b) met behulp van die Braun-Blanquet prosedure (Westhoff & van der Maarel 1987; Behr & Bredenkamp 1988). The gevolg van hierdie klassifikasie was twee duidelike gemeenskappe wat in twee afsonderlike fitososiologiese tabelle voorgestel word. Die twee gemeenskappe is (1) Die *Colophospermum mopane* – *Hibiscus micranthus* Hoof Boomveld Gemeenskap wat verdeel word in twee hoof gemeenskappe, nege subgemeenskappe en ses variante, en (2) Die *Salvadora australis* - *Acacia tortilis* Hoof Boomveld Gemeenskap wat verdeel word in drie hoof

gemeenskappe, agt subgemeenskappe en vier variante. Die ordinasie algoritme DECORANA (Hill 1979b) was ook toegepas op die floristiese datastel, om die verhouding tussen die plantegroei eenhede en die omgewingfaktore te illustreer – verskeie omgewingsfaktore het 'n korrelasie getoon met die plantgemeenskappe.

Die grondtipe was 'n groot faktor wat die plantegroei beïnvloed het. Die mees algemene tipe grond is 'n natruimhoudende grond wat hoogs erodeerbaar en onstabiel is. Die grondtipe word geassosieer met die die *Colophospermum mopane* veld. Die *Salvadora australis* veld word aangetref op die brakker gronde. Die doringveld word aangetref in die natter areas rondom die damme en die rivierkom wat slik-klei grond bevat.

Die gevolg van die verspreiding en opgaar van water deur die bou van damme en kontoerwalle is duidelik sigbaar deur die verbeterde groei van die plante in hierdie gebiede, en gevolglik is daar 'n toename in weiding vir die wild.

Hierdie studie kan as 'n basis beskik vir verdere studies om 'n effektiewe bestuursplan te ontwerp met effektiewe natuurlewebestuur programme vir Breslau Wildsplaas.

CHAPTER 1

INTRODUCTION

The study area forms part of the Sudano-Zambezian Floristic Region and falls within the Savanna Biome. The Savanna Biome is the largest biome in southern Africa, occupying 46% of its area, and over one-third the area of South Africa (Low & Rebelo 1998).

A major factor delimiting this biome is the lack of sufficient rainfall which prevents the woody layer from reaching excessive heights.

The study area is located in an arid region where the average rainfall is below 400 mm per annum. One of the main problems of dry areas is that the rainfall is unreliable. However when good rains do fall in these arid areas at the right times, the response of the veld is better than would be expected. This results in a false impression that such areas are more than adequate for ranching (Bothma 1989).

The vegetation consists of thorn savanna and woodland or microphyllous thorny bushveld which occurs on fine-textured and sandy soils, as well as broad-sclerophyll arid bushveld or woodland, which is dominated by *Colophospermum mopane,* which occurs optimally on particularly dry, clayey soils.

In the past two decades there has been a considerable move, in the northern part of the Northern Province, away from cattle and goat farming to game farming. This has resulted in the erection of game fences, which may cause the potential loss of habitat for some species, the isolation of other species or the total extinction of certain plant species and overstocking of game. This has, in some areas, contributed to the deterioration of the veld on game farms as a result of mismanagement (Peel, Grossman & van Rooyen 1991). Thus it is imperative to effectively manage game farms that are fenced.

It is of primary importance in game ranch management to know that there is no such thing as a precisely repeatable pattern in nature. Each game ranch is unique in itself and contains a combination of abiotic (for example soil and climate) and biotic (for example game and plants) factors peculiar to that particular ranch. Every game ranch should therefore be treated and studied on its own merits when management measures for that specific ranch are compiled (Bothma 1989).

A management plan is the product of a management process and in broad outline consists of the following series of steps, many of which can be carried out simultaneously:

- A comprehensive description of the ecosystem/s involved.
- Determination of the available manpower, expertise and finances.
- Determination of land-use patterns in the surrounding areas.
- A definition of the permissible limits of any changes.
- Prediction of future trends and needs of the area and its users.
- The compilation of a time schedule for the management plan.
- A description of all realistic options which may help to achieve the management objectives; especially with regard to manpower, finances and the available expertise.

(Bothma 1998)

The first step of this management plan, a comprehensive description of the ecosystem, is the purpose of this study.

The vegetation analysis was carried out to produce a phytosociological inventory of Breslau Game Farm, which can be used as the initial step for further studies to lead to the development of a scientific wildlife management plan for the farm and to provide guidance towards the management of the farm's available natural resources by aiming at optimum production of game animals without causing degradation of these resources over the long term (Cauldwell 1998).

The study area selected has been run as a fully fenced private game farm since 1989. Due to the unpredictable low rainfall, great efforts have been made to spread and hold as much water as possible in order to improve the vegetation and thus the carrying capacity of the farm. The farm is not run for financial gain, however, income is generated through hunting and selling of live game to cover running expenses. The farm is thus dependent on the animals. The conservation of the animal life in an area is impossible without the conservation of the area's plant life. It is owned and run by numerous people, most of whom have no knowledge of game farm management. No formal management plan has ever been in force.

A sound knowledge of the vegetation ecology of conservation areas is essential for the establishment of efficient wildlife management programs and the compilation of conservation policies (Bredenkamp & Theron 1978, 1990). Vegetation classification and mapping are prerequisites for ecologically and economically sound land-use planning, resource management, sustainable utilisation and other conservation programs (Edwards 1972).

The aim of the study was to classify the vegetation into communities based on species composition, habitat and disturbances such as dams and contour walls, and to analyse, describe and interpret these plant communities

The necessity to identify and describe plant communities, not only for agricultural purposes, but also in conservational management, was further documented by Mentis and Huntley (1982). In order to provide an ecologically sound identification, description and interpretation of the communities on Breslau Game Farm, an extensive survey using the Zurich-Montpellier approach, was undertaken.

The Braun-Blanquet (Zurich-Montpellier) approach has been used by researchers in South Africa since 1969 (Werger 1974). This method samples selected, representative, homogeneous plots of a certain minimum size in the phytocoenoses (plant community stands) making up the vegetation of the area to be surveyed, recording all species and rating them on a cover-abundance scale. Some other analytical characteristics of the vegetation in the plot might also be recorded. The units are interpreted ecologically (Werger 1974). This method is discussed in Chapter 3.

The vegetation on Breslau is best described by Bothma (1989) as a combination of Mopaneveld, sweet bushveld and turf thornveld. The study area is discussed in Chapter 2.

The vegetation was divided into two distinct groups, namely the *Colophospermum mopane – Hibiscus micranthus* Major Woodland Community and the *Salvadora australis - Acacia tortilis* Major Woodland Community. These 2 major communities are described in Chapter 4, Sections A and B respectively, which have been written as articles for publication in scientific journals. Differences that exist in the format of these two sections and the rest of the dissertation are because these two articles have been structured to meet the requirements of the journals. References, however, appear at the end of this dissertation.

The hierarchial vegetation units are described in terms of locality, habitat, diagnostic species and the prominent species in the woody, shrub, forb and grass layers. A habitat interpretation is given for each vegetation unit.

The results of this phytosociological study are discussed at the end of Sections A and B, the *Colophospermum mopane – Hibiscus micranthus* Major Woodland Community and the *Salvadora australis - Acacia tortilis* Major Woodland Community respectively, and in Chapter 5.

CHAPTER 3

METHODS

1. Introduction

The information required in this study was gathered through fieldwork and literature studies. This information was analysed by computer assisted procedures to generate tables, maps and graphs.

The two sections in Chapter 4 (Section A and B) under Results have been written as articles for publication in scientific journals. Differences that exist in the format of these two sections and the rest of the dissertation are because these two articles have been structured to meet the requirements of the journals.

A comprehensive description of all methods used is given in the present chapter. These methods are grouped under the headings Field Surveys and Data Processing and Analysis.

2. Field Surveys

2.1. Stratification

Stratification was based on the five terrain units (Land Type Survey Staff 1985), namely, 1 – crest, 2 – scarp, 3 – midslope, 4 – footslope and 5 – valley bottom or floodplain.

After intensive reconaissance of the area, Breslau was stratified into three main units, namely:

1. The koppies, rocky outcrops and ridges, which are the crest (1) and scarp (2),
2. The riverine, floodplains and dams, which are the valley bottom and floodplains (5) and

3. The remaining area which included the plains and flatter areas, which are the midslope (3) and footslope (4).

This method of stratification ensured that all areas were covered during sampling.

2.2. Sample Plots

The position of sample plots within relatively homogeneous stratification units was chosen subjectively. The number of sample plots for each stratification unit was also determined subjectively. The position and number of sample plots were chosen to provide efficient sampling to ensure adequate representation in both floristic composition and vegetation structure and to cover any variation in species abundance. Ecotones were not sampled.

The size of the sample plots was determined by the species-area curve. Sample plot sizes were determined at 30 x 30 metres for all units with the exception of the riverine woodland along the Limpopo River where plots of 50 x 50 metres were used. This is because the *Xanthocercis zambesiaca* trees are so large that they alone covered an area of 30 x 30 metres. In order to include a realistic representation of the floristic composition and vegetation in the riverine, the sample plots were made larger.

The shape of the sample plots were mostly square with the exception of some of the koppies where they were rectangular.

Sampling was carried out during the growing season from early March 2001 to early June 2001. It must be mentioned that the time of sampling was the year after the highest rainfall season recorded, so the water table was exceptionally high and the vegetation was especially dense. A number of plant species which were not seen before were also found on the farm. A total of 187 plots were sampled. These sample plots are considered to cover the floristic variation of the farm adequately.

2.3. Sampling Method

Relevés were compiled for each sample plot by recording all plant species present in a sample plot. These species were listed according to the Braun-Blanquet cover-abundance scale (Werger, 1974; Meuller-Dombois & Ellenberg, 1974):

r	one or few individuals with less than 1 % cover of total sample plot area
+	occasional and less than 1 % of total sample plot area
1	abundant and with very low cover, or less abundant but with higher cover, 1 – 5 % cover of total sample plot area
2	abundant with > 5 – 25 % cover of total sample plot area, irrespective of the number of individuals
2a	> 5 – 12,5 % cover, irrespective of the number of individuals
2b	> 12,5 – 25 % cover, irrespective of the number of individuals
3	> 25 – 50 % cover of total sample plot area, irrespective of the number of individuals
4	> 50 – 75 % cover of total sample plot area, irrespective of the number of individuals
5	> 75 % cover of total sample plot area, irrespective of the number of individuals

The Braun-Blanquet approach to vegetation classification provides a comprehensive floristic description of each relevé (Werger 1974). It is a widely used technique in southern Africa (Bezuidenhout 1982; Rogers 1993). The method forms the basis of the Zurich-Montpellier method of vegetation survey, which was developed in Europe in 1915 by J. Braun-Blanquet (Werger 1974; Allaby 1992). The method is based upon the following principles (Meuller-Dombois & Ellenberg 1974; Whittaker 1975):

1. Plant communities can be recognised from their floristic composition, which reflects the relationship between plants and their environment.
2. Certain plant species are more sensitive indicators of environmental gradients than others, and can consequently be used as diagnostic species for a given plant community.
3. Plant communities can be organised into hierarchical classes based upon their

diagnostic species.

Names of taxa conform to the list provided in the TURBOVEG database of the University of Pretoria which is an update of the list of Arnold & de Wet (1993).

2.4. Habitat analysis

There is a close relationship between environmental factors and the distribution of natural plant communities (Gauch 1982). Therefore the physical environment has to be dealt with in phytosociological studies, as it plays an important role in the ecological interpretation of the floristic data (Bezuidenhout 1982).

Latitude-longitude positions for each sample plot were obtained from a Global Positioning System in the field. Aspect, slope and surface rock size and plant cover for each sample plot were estimated in the field, as well as soil colour and type. The topography was also described.

Other information recorded were estimated height of the tree, shrub and grass layers respectively, and the % cover of each layer. The estimated height of each tree species was also recorded.

3. Data Processing and Analysis

3.1. TWINSPAN

Throughout the study the Braun-Blanquet approach (Westhoff & Van der Maarel 1978) has been adopted. The basic floristic data was subjected to Two-Way Indicator Species Analysis (TWINSPAN) (Hill 1979a), in order to derive a first approximation of the possible plant communities.

TWINSPAN uses Braun-Blanquet data that describes the percentage cover of plant species as recorded in relevés. The program groups similar relevés in a two-way phytosociological table (Hill 1979a). TWINSPAN further separates relevés in a dichotomised two-way division at multiple levels, depending on their similarity. Diagnostic plant species are then used to separate groups of relevés. The classification is based on the presence or absence of a species rather than on their abundance, and it is therefore a qualitative rather than a quantitative concept (Kent & Coker 1992), though pseudo species provide for the semi-qualitative Braun-Blanquet type data sets.

The TWINSPAN analysis generates an organised two-way phytosociological table of the original data matrix. Relevés are sorted into columns, with their numbers appearing across the top of the table above each column. Species are sorted into rows, with their names appearing down the left-hand side of the table. The main block of the table presents the sorted data. The effect of the layout is to concentrate entries down the diagonal of the table from top left to bottom right. Species that are scarce or do not fit easily into the overall diagonal trend appear at the bottom of the table. Species that are present in all or most relevés appear in a large block above those species that do not fit into the overall diagonal trend. The values r, +, a, b 3, 4 and 5 within the main body of the table correspond to the Braun-Blanquet cover abundance scale (Section 2.3). From the phytosociological table, it is possible to identify diagnostic or indicator species that are important in the differentiation of groups of relevés (plant communities, subcommunities or variations). The TWINSPAN procedure is contained in the computer program MEGATAB (Hennekens 1996b), which is a visual editor for phytosociological tables.

The TWINSPAN generated phytosociological table provided the first approximation of the vegetation units of the study area from the raw Braun-Blanquet data. This approximation was then further refined by using Braun-Blanquet procedures to obtain a final classification, which was as ecologically sound as possible (Behr & Bredenkamp 1988). This refinement involved a manual shuffling of species or relevés in MEGATAB to provide a clearer definition of the vegetation units, and identification of the diagnostic plant species.

The TWINSPAN and Braun-Blanquet procedures resulted in a hierarchial classification of the vegetation. Plant communities, subcommunities and variants are recognised, and described according to standard procedures. Although the naming of different plant communities was not formal according to the International Code for Syntaxonomy (Barkman, Moravec, & Rauschert 1986), the basic principles of naming was followed to facilitate later formalisation of the proposed syntaxon names.

The TWINSPAN classification indicated a very distinct division between two major communities, resulting in two separate tables, namely (1) The *Colophospermum mopane – Hibiscus micranthus* Major Woodland Community (Table 3), and (2) The *Salvadora australis – Acacia tortilis* Major Woodland Community (Table 4). The Braun-Blanquet refinement process was carried out separately on each of the two tables. During this refinement process, however, four relevés were transferred from the *Salvadora australis - Acacia tortilis* Major Community to the other major community, as these relevés were located on the koppies and were more suitable to the *Colophospermum mopane – Hibiscus micranthus* Major Community which contained all the other relevés on koppies and rocky outcrops and ridges.

The TWINSPAN and Braun-Blanquet procedures applied to the Major Communities resulted in these 2 communities being further divided into Main Communities. The refining process applied to the *Colophospermum mopane – Hibiscus micranthus* Major Woodland Community resulted in 2 Main Communities. These 2 Main communities were then further divided into 5 and 1 communities, 7 and 2 subcommunities and 2 and 4 variants respectively.

The refinement of the *Salvadora australis – Acacia tortilis* Major Community resulted in 3 Main communities. These 3 Main communities were further divided into 3, 4 and 3 communities, 4, 4 and 0 subcommunities and 4, 0 and 0 variants respectively. The Major communities with the respective main communities, communities, subcommunities and variants are discussed in detail in Chapter 4, Sections A and B.

3.2. Ordination

Ordination procedures were used in the present study to order vegetation relevés in relation to one another in terms of their similarity in plant species composition. One of the principal aims of ordination is to define vegetation gradients and associated underlying environmental gradients within a set of vegetation data (Kent & Coker 1992). Hypothesis concerning variation in the vegetation, and between vegetation and environmental factors then emerge, and provide direction for more specific study.

A method of indirect ordination is used in this study whereby vegetation data are analysed independently of environmental data (Kent & Coker 1992). Environmental data are introduced only after the ordination diagram has identified the major sources of variation in the vegetation data. Interpretation of environmental relationships is carried out on two-dimensional scatter diagrams of relevés. The distances between relevés on a scatter diagram demonstrate their extent of similarity. Inspection of the diagrams enables trends in the data to be recognised. When there are clear gradients across the diagram, then the environmental gradients present may be assigned to the axes (Kent & Coker 1992)

Ordinations were performed separately on the two major communities, viz. the *Colophospermum mopane – Hibiscus micranthus* Major Woodland Community (Figure 18) and the *Salvadora australis – Acacia tortilis* Major Woodland Community (Figure 23).

Ordinations were performed to illustrate floristic relationships between plant communities and to detect possible gradients in and between communities. The results were also used to confirm the order of the communities and variations in the TWINSPAN generated phytosociological tables.

Detrended Correspondence Analysis (DCA) was the ordination procedure selected for use in this study. The detrended correspondence analysis produces uncorrelated axes that overcome arch and compression effects that often distort data when other ordination procedures, for example, reciprocal averaging and principal components analysis, are used (Hill & Gauch 1980). This is achieved through detrending, in which the main axes that are presented are calculated as means of the preliminary axes. The axes of a detrended correspondence analysis are scaled in units of the mean standard deviation of species turnover (SD) (Gauch 1982). A change of approximately 50 % in the species composition of a relevé occurs at ± 1 SD. The axes of a detrended correspondence analysis can therefore be of variable length, depending upon the turnover rate of species between relevés and the extent of variation within the data. A data set that represents many diverse vegetation units with minimal species overlap between each other would therefore have long axes (Cauldwell 1998).

The computer program DECORANA was used to conduct a detrended correspondence analysis on the Braun-Blanquet data of the present study (Hill 1979b; Hill & Gauch 1980). DECORANA has become one of the most widely used ordination procedures in vegetation science since 1980 when it was introduced (Kent & Coker 1992).

The distribution of the relevés along the first and second axis of a DECORANA ordination is given in Chapter 4, Section A for the *Colphospermum mopane – Hibiscus micranthus* Major Woodland Community, and Chapter 4, Section B for the *Salvadora australis - Acacia tortilis* Major Woodland Community.

No distinct discontinuities are observed among the identified plant communities though the communities are restricted to particular areas in the graph.

The distribution of the relevés along the axes is related to particular environmental factors.

CHAPTER 4

SECTION A

A FLORISTIC DESCRIPTION OF THE PLANT COMMUNITIES ON BRESLAU GAME FARM IN THE NORTHERN PROVINCE, SOUTH AFRICA.

THE *COLOPHOSPERMUM MOPANE* – *HIBISCUS MICRANTHUS* MAJOR COMMUNITIES:

ABSTRACT

The study was conducted on Breslau Game Farm (Pty) Ltd, in the Evangelina District in the Northern Province of South Africa. The farm covers 2 920 ha and borders on the Limpopo River opposite Botswana.

The floristic classification of the vegetation was done by means of TWINSPAN and refined by the Braun-Blanquet method. The vegetation was divided into two distinct groups, namely the *Colophospermum mopane* – *Hibiscus micranthus* Major Woodland Community and the *Salvadora australis* - *Acacia tortilis* Major Woodland Community. A floristic description of the *Colophospermum mopane* – *Hibiscus micranthus* Major Woodland Community is included in this paper. It is divided into 2 main communities, 6 communities, 9 subcommunities and 6 variants, collectively named vegetation units.

INTRODUCTION

On the South African nature conservation front the establishment of numerous new game ranches over the past twenty-five years stands out as an important landmark. (Bothma 1989). This is particularly noticeable in the northern part of the Northern Province where there has been a drastic change away from cattle and goat farming to game farming. If these game ranches are planned and managed on a healthy ecological basis, they will increasingly form an essential cornerstone of nature conservation in South Africa, and they are being increasingly recognised as such.

The study area is located in an arid region where the average rainfall is below 400 mm per annum. One of the main problems of dry areas is that the rainfall is unreliable. However, when good rains do fall in the arid areas at the right times, the response of the veld is better than would be expected. This results in a false impression that such areas are more than adequate for ranching (Bothma 1989).

According to Bothma (1989), the study area forms part of the mopaneveld and the sweet bushveld. According to Acocks (1988), there are two blocks of this distinct mopaneveld. The first, in the wide, gently undulating valley of the Limpopo north of the Soutpansberg with altitudes ranging from 400 – 750 m above sea level and the rainfall from 250 – 400 mm per annum, strictly confined to the summer months. The climate is very hot. The second, a broad belt running south from the eastern part of the Soutpansberg and including the northern part of the Kruger National Park. This latter block is wetter, rainfall being over 400 mm per annum and the altitude from under 300 – 459 m above sea level. The vegetation is taller and more mixed (Acocks 1988).

The dominant tree in the study area discussed in this paper is the mopane, *Colophospermum mopane*, which is indigenous to southern central Africa. Where the species occurs it is always the sole dominant of a woodland community (broad sclerophyll arid bushveld) or, in some cases, a tree savanna, and usually makes up about 90 % or more of the total phytomass of the community. However, in the main valleys the bush is more mixed. Mopane woodland grows on fine grained, sandy to loamy and clayey, usually deep soils, though sometimes calcrete layers occur near the surface. Soils under mopane tend to develop a high exchangeable sodium content, which inevitably results in reduced permeability and increased susceptibility to erosion (Werger 1978).

Mopane vegetation occurs from fairly dense to open woodland or, in some cases to tree savanna from 5 to 7 m tall. A shrubby growth form up to 6 m in height is also common, and on heavy, impervious soils, a low scrub mopane can dominate the countryside (Werger 1978).

The study area selected has been run as a fully fenced private game farm since 1989. Due to the unpredictable low rainfall, great efforts have been made to spread and hold as much water as possible in order to improve the vegetation cover and thus the carrying capacity of the farm. The farm is not run for financial gain, but income is generated through trophy hunting and the sale of live game to cover running expenses. The farm is thus dependent on the animals. No formal management plan has ever been in force.

The conservation of the animal life in an area is impossible without the conservation of the area's plant life. To achieve this aim, sound conservation and management policies are essential (Edwards 1972). These policies must be based on a thorough knowledge of the ecosystem which should include a detailed classification of the vegetation of the area.

The vegetation analysis was done to produce a phytosociological inventory of the farm which can be used as the initial step for further studies to lead to the development of a scientific wildlife management plan for the farm and to provide guidance towards the management of the farm's available natural resources by aiming at optimum production of game animals without causing degradation of these resources over the long term (Cauldwell 1998).

The aim of the study was to classify the vegetation into communities based on species composition, habitat and disturbances such as dams, and to analyse, describe and interpret these plant communities

The vegetation was divided into two distinct groups, namely the *Colophospermum mopane – Hibiscus micranthus* Major Woodland Community and the *Salvadora australis - Acacia tortilis* Major Woodland Community. The vegetation units for thr entire sudy are shown in Figure 12(a) and 12(b). A floristic description of the *Colophospermum mopane – Hibiscus micranthus* Major Woodland Community is included in this paper. This

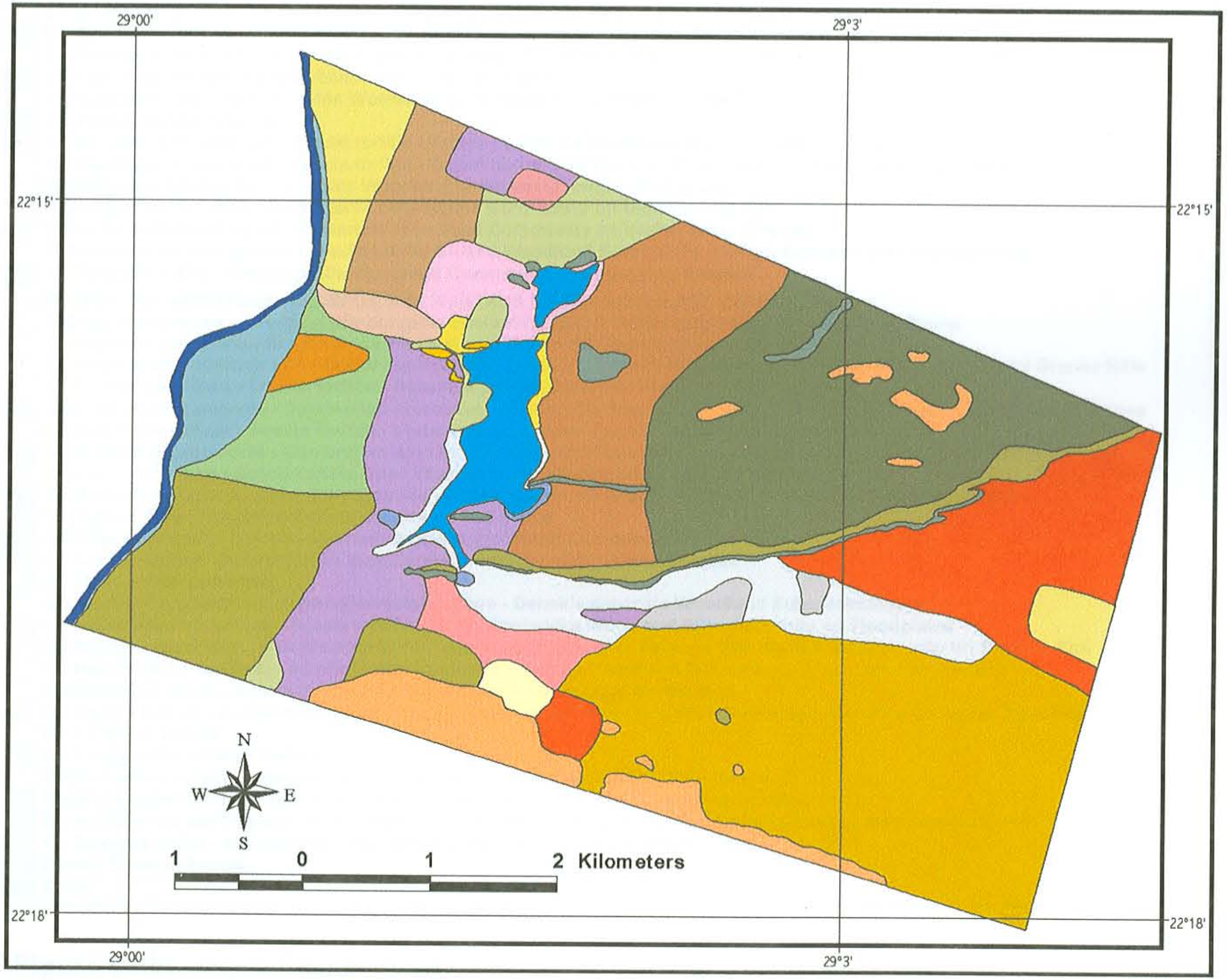
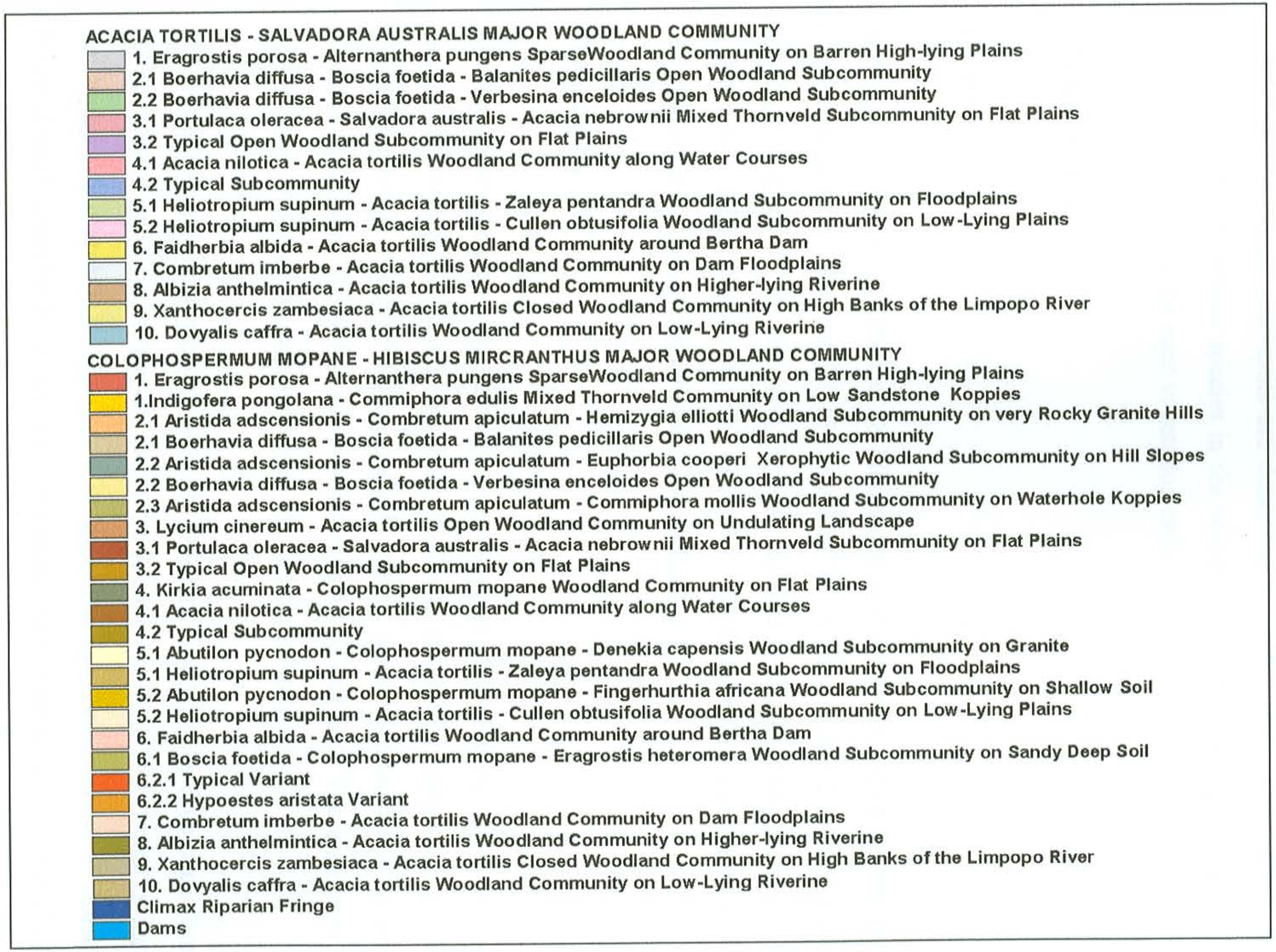


Figure 12(a) Vegetation units of Breslau Game Farm as derived from Phytosociological Tables 3 and 4



ACACIA TORTILIS - SALVADORA AUSTRALIS MAJOR WOODLAND COMMUNITY

⬜ 1. Eragrostis porosa - Alternanthera pungens SparseWoodland Community on Barren High-lying Plains
🟧 2.1 Boerhavia diffusa - Boscia foetida - Balanites pedicillaris Open Woodland Subcommunity
🟩 2.2 Boerhavia diffusa - Boscia foetida - Verbesina enceloides Open Woodland Subcommunity
🟥 3.1 Portulaca oleracea - Salvadora australis - Acacia nebrownii Mixed Thornveld Subcommunity on Flat Plains
🟪 3.2 Typical Open Woodland Subcommunity on Flat Plains
🟥 4.1 Acacia nilotica - Acacia tortilis Woodland Community along Water Courses
🟦 4.2 Typical Subcommunity
🟩 5.1 Heliotropium supinum - Acacia tortilis - Zaleya pentandra Woodland Subcommunity on Floodplains
🟪 5.2 Heliotropium supinum - Acacia tortilis - Cullen obtusifolia Woodland Subcommunity on Low-Lying Plains
🟨 6. Faidherbia albida - Acacia tortilis Woodland Community around Bertha Dam
⬜ 7. Combretum imberbe - Acacia tortilis Woodland Community on Dam Floodplains
🟫 8. Albizia anthelmintica - Acacia tortilis Woodland Community on Higher-lying Riverine
🟨 9. Xanthocercis zambesiaca - Acacia tortilis Closed Woodland Community on High Banks of the Limpopo River
🟦 10. Dovyalis caffra - Acacia tortilis Woodland Community on Low-Lying Riverine

COLOPHOSPERMUM MOPANE - HIBISCUS MIRCRANTHUS MAJOR WOODLAND COMMUNITY

🟥 1. Eragrostis porosa - Alternanthera pungens SparseWoodland Community on Barren High-lying Plains
🟨 1.Indigofera pongolana - Commiphora edulis Mixed Thornveld Community on Low Sandstone Koppies
🟧 2.1 Aristida adscensionis - Combretum apiculatum - Hemizygia elliotti Woodland Subcommunity on very Rocky Granite Hills
🟫 2.1 Boerhavia diffusa - Boscia foetida - Balanites pedicillaris Open Woodland Subcommunity
🟩 2.2 Aristida adscensionis - Combretum apiculatum - Euphorbia cooperi Xerophytic Woodland Subcommunity on Hill Slopes
🟨 2.2 Boerhavia diffusa - Boscia foetida - Verbesina enceloides Open Woodland Subcommunity
🟩 2.3 Aristida adscensionis - Combretum apiculatum - Commiphora mollis Woodland Subcommunity on Waterhole Koppies
🟧 3. Lycium cinereum - Acacia tortilis Open Woodland Community on Undulating Landscape
🟥 3.1 Portulaca oleracea - Salvadora australis - Acacia nebrownii Mixed Thornveld Subcommunity on Flat Plains
🟨 3.2 Typical Open Woodland Subcommunity on Flat Plains
🟩 4. Kirkia acuminata - Colophospermum mopane Woodland Community on Flat Plains
🟫 4.1 Acacia nilotica - Acacia tortilis Woodland Community along Water Courses
🟨 4.2 Typical Subcommunity
⬜ 5.1 Abutilon pycnodon - Colophospermum mopane - Denekia capensis Woodland Subcommunity on Granite
🟫 5.1 Heliotropium supinum - Acacia tortilis - Zaleya pentandra Woodland Subcommunity on Floodplains
🟨 5.2 Abutilon pycnodon - Colophospermum mopane - Fingerhurthia africana Woodland Subcommunity on Shallow Soil
⬜ 5.2 Heliotropium supinum - Acacia tortilis - Cullen obtusifolia Woodland Subcommunity on Low-Lying Plains
🟥 6. Faidherbia albida - Acacia tortilis Woodland Community around Bertha Dam
🟩 6.1 Boscia foetida - Colophospermum mopane - Eragrostis heteromera Woodland Subcommunity on Sandy Deep Soil
🟥 6.2.1 Typical Variant
🟧 6.2.2 Hypoestes aristata Variant
⬜ 7. Combretum imberbe - Acacia tortilis Woodland Community on Dam Floodplains
🟩 8. Albizia anthelmintica - Acacia tortilis Woodland Community on Higher-lying Riverine
🟫 9. Xanthocercis zambesiaca - Acacia tortilis Closed Woodland Community on High Banks of the Limpopo River
🟫 10. Dovyalis caffra - Acacia tortilis Woodland Community on Low-Lying Riverine
🟦 Climax Riparian Fringe
🟦 Dams

Figure 12(b): Key to Figure 12 (a)

community occurs on the eastern half of the study area away from the Limpopo River and along the south to the Limpopo River. It is divided into two main communities, six communities, nine subcommunities and six variants, collectively named vegetation units (Figure 13).

The hierarchial vegetation units are described in terms of locality, habitat, diagnostic species and the prominent species in the woody, shrub, forb and grass layers. A habitat interpretation is given for each vegetation unit.

STUDY AREA

Location

Breslau Game Farm is situated 18 kilometres east of the Pontdrift border post, in the Evangelina district, between 22°15' S and 22°18' S latitude and 29°00' E and 29°04' E longitude (Figure 1). On the west, Breslau borders with Botswana along the Limpopo River, which flows south – north at this point. The farm covers approximately 3 000 ha and is situated in the Savanna biome (Low & Rebelo 1998).

Topography

The landscape is reasonably flat with a few koppies. The altitude varies from 535 m in the Limpopo valley to 560 m in the south-east, with the highest koppie being 630 m.
The largest water course, the Matlamakadi stream, enters Breslau from the east, and is joined by a number of smaller streams from the south and east. These streams flow into Bertha Dam, which is the largest dam on the farm (Figure 5).

According to the Land Type Survey Staff (1989) the following landtypes are found;
Fc 622 (found on the granite areas along the south border), Ib 395 (found on the koppies and higher lying areas), Ia 155 (found in lower riverine, below Show of Roads towards Pyramid and Euphorbia Kop) and Db 218 (found in all other areas of Breslau) (Figure 6).

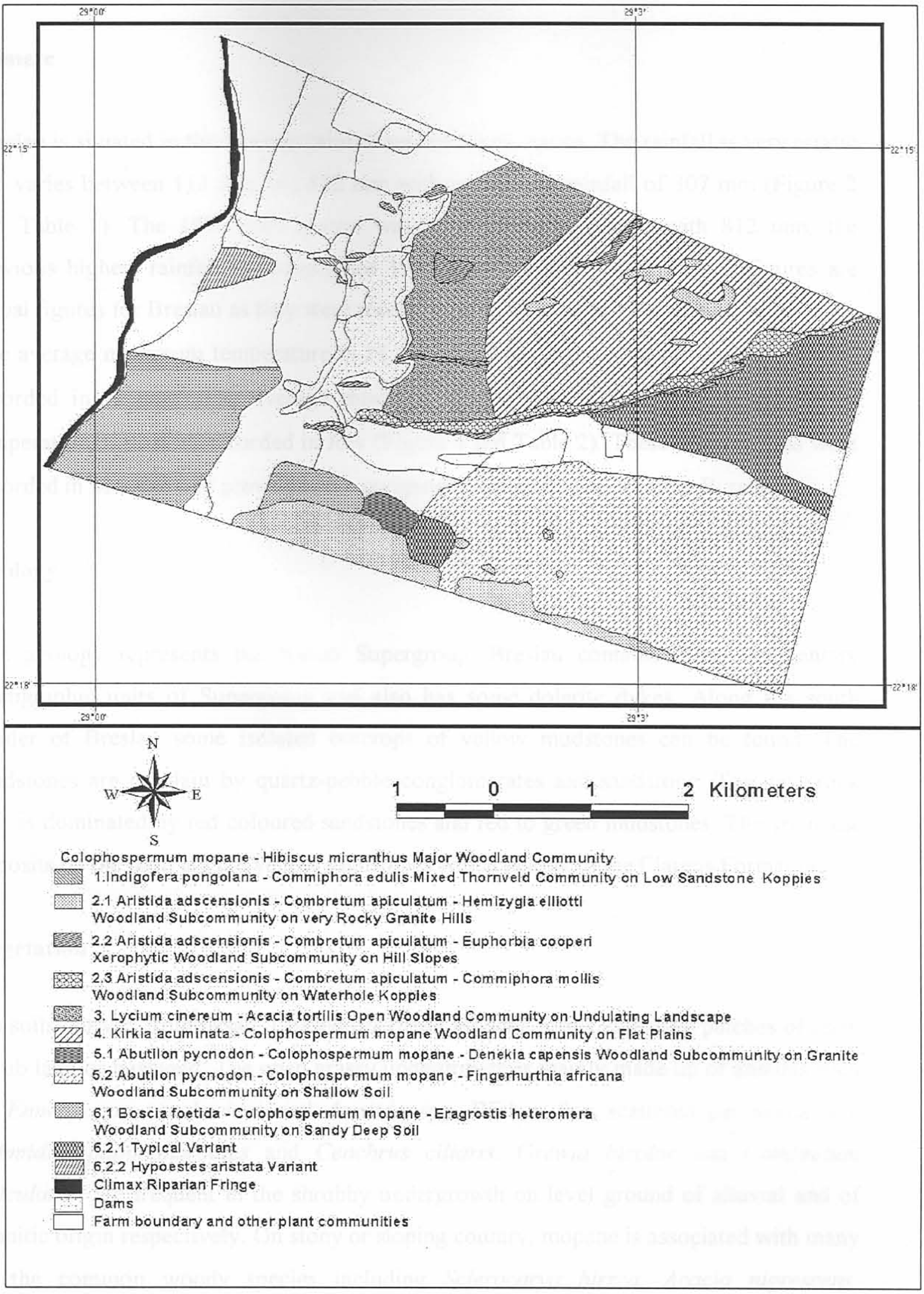


Figure 13: Map of the *Colophospermum mopane – Hibiscus micranthus* Major Woodland Community

Climate

Breslau is situated in the summer rainfall area of South Africa. The rainfall is very erratic and varies between 113 mm and 812 mm with an average rainfall of 307 mm (Figure 2 and Table 1). The 1999/2000 season was an exceptional season with 812 mm, the previous highest rainfall recorded since 1982 was 576 mm. These rainfall figures are actual figures for Breslau as they were recorded on Breslau from 1982 to June 2001. The average maximum temperature is 29,8° C, with the highest temperature of 44,4° C recorded in January. The average minimum temperature is 15,2°C with the lowest temperature of –3,6° C recorded in July (Figure 4 and Table 2). These temperatures were recorded in Messina and provided on a computer printout by the Weather Bureau.

Geology

The geology represents the Karoo Supergroup. Breslau contains three sedimentary stratigraphic units of Supergroup and also has some dolerite dykes. Along the south border of Breslau some isolated outcrops of yellow mudstones can be found. The mudstones are overlain by quartz-pebble conglomerates and sandstone. The next rock unit is dominated by red coloured sandstones and red to green mudstones. The youngest deposits on the farm are the yellow sandstones which belong to the Clarens Formation.

Vegetation

On soils derived from basalt, *Colophospermum mopane* forms extensive patches of open shrub land or bushveld. The open grassy undergrowth is mainly made up of annuals such as *Enneapogon cenchroides* and *Aristida* spp. With a few scattered perennials like *Schmidtia pappophoroides* and *Cenchrus ciliaris*. *Grewia bicolor* and *Combretum apiculatum* are frequent in the shrubby undergrowth on level ground of alluvial and of granitic origin respectively. On stony or sloping country, mopane is associated with many of the common woody species including *Sclerocarya birrea, Acacia nigrescens, Combretum apiculatum, Kirkia acuminata, Terminalia prunoides, Adansonia digitata* and species of *Grewia* and *Commiphora*. On basalt soils *Acacia* and *Commiphora* species become important, on shallow basalt-sandstone contact soils *Boscia foetida and Boscia albitrunca* appear and on sandstone *Sesamothamnus lugardii* (Werger 1978).

History of Land-Use and Management

The information provided under this heading was kindly provided by Corrie Straub, a co-owner of Breslau, who has been actively involved with the farm since 1948.

Since the 1940's huge numbers of cattle, goats and donkeys were kept on Breslau. As there were no fences, hundreds of cattle from neighbouring farms also grazed on Breslau as there was a permanent waterhole. These cattle stayed until there was no more grazing. A direct result of this overgrazing was the elimination of the grasses and forbs and erosion which is still present today.

Water entered Breslau from the east via two shallow watercourses, known as the Matlamakadi Stream. Due to the overgrazing, the northernmost watercourse gradually became deeper and deeper until no water could escape to flood the surrounding veld which was relatively flat, resulting in many huge trees dying.

In 1972 a decision was made to run Breslau as a game farm only. Further dams were built along the main watercourse as well as other areas on the farm.

The underground water on Breslau is plentiful but very salty. Two boreholes measured 16 and 18 grams of salt per litre, respectively. The building of dams has increased the water-table with fresh water to the extent that the trees now benefit. There is considerable photographic evidence on record showing the improvement to the landscape as a result of the dam-building program (Figures 8, 9, 10 and 11).

In 1989 Breslau was fully game fenced and acquired an exemption certificate, which means the game within the fences belong to Breslau and hunting may be carried out on the farm for 12 months a year. Feed has been brought in during the very dry winter months to feed the game.

METHODS

In a comprehensive study over the entire study area, relevés were compiled in 187 stratified, random sample plots. Stratification was based on three terrain units, namely, (1) – crest and scarp, which included all the koppies, rocky outcrops and ridges, (2) – valley bottom or floodplain, which included the riverine, dams, watercourses and floodplains and (3) – footslope and midslope, which covered the plains and other remaining areas. The position and number of sample plots within these stratified areas were chosen subjectively to ensure adequate representation in floristic composition and vegetation structure. The size of the plots were 30 x 30 m with the exception of the riverine area, where the plots were 50 x 50 m due to the very large size of some trees.

The total floristic composition, and cover-abundance values for each species, were recorded in each sample plot using the Braun-Blanquet cover-abundance scale (Meuller-Dombois & Ellenberg 1974). Environmental data recorded included topography, slope, aspect, geology, rockiness of soil surface, soil colour and type, and any disturbances.

Data were incorporated into a data base using the TURBOVEG program (Hennekens 1996a). Two-Way Indicator Species Analysis (TWINSPAN) (Hill 1979a) was applied to the entire data set in order to identify the major plant communities. This initial classification was then refined, using the program MEGATAB (Hennekens 1996b) with Braun-Blanquet procedures (Westhoff & van der Maarel 1978; Behr & Bredenkamp 1988). The results of this classification was two distinct communities which are presented in two separate phytosociological tables. The two communities are:

1. *Colophospermum mopane* – *Hibiscus micranthus* Major Woodland Community, and
2. *Salvadora australis* – *Acacia tortilis* Major Woodland Community

In this paper only the *Colophospermum mopane – Hibiscus micranthus* Major Woodland Community is discussed (Table 3 and Figure 13).

The ordination algorithm DECORANA (Hill 1979b) was also applied to the floristic data set to illustrate relationships between the vegetation units and the environmental factors. (Figure 18).

RESULTS

The *Colophospermum mopane – Hibiscus micranthus* Major Woodland Community is divided into two main communities, six communities, nine subcommunities and six variants. These communities are listed below:

Classification

The *Colophospermum mopane - Hibiscus micranthus* Major Woodland Community

A. *Terminalia prunoides - Colophospermum mopane* Main Woodland Community

1. *Indigofera pongolana - Commiphora edulis* Mixed Thornveld Community on Low Sandstone Koppies

2. *Aristida adscensionis - Combretum apiculatum* Woodland Community on Steep Koppies

    2.1. *Aristida adscensionis - Combretum apiculatum - Hemizygia elliotti* Woodland Subcommunity on very Rocky Granite Hills

    2.2. *Aristida adscensionis - Combretum apiculatum - Euphorbia cooperi* Xerophytic Woodland Subcommunity on Hill Slopes

2.2.1. *Croton gratissimus* Xerophytic Woodland Variant on Slopes of Koppies

2.2.2. *Acacia senegal* var. *leiorachus* Xerophytic Woodland Variant on Pyramid Koppie

2.3. *Aristida adscencionis* - *Combretum apiculatum* - *Commiphora mollis* Woodland Subcommunity on Waterhole Koppies

3. *Lycium cinereum* - *Acacia tortilis* Open Woodland Community on Undulating Landscape

4. *Kirkia acuminata* - *Colophospermum mopane* Woodland Community on Flat Plains

4.1. *Kirkia acuminata* - *Colophospermum mopane* Typical Subcommunity

4.2. *Kirkia acuminata* - *Colophospermum mopane* - *Endostemon tenuiflorus* Subcommunity on Flat Area and Deeper Soil

5. *Abutilon pycnodon* - *Colophospermum mopane* Woodland Community on Sandy Plains

5.1. *Abutilon pycnodon* - *Colophospermum mopane* - *Denekia capensis* Woodland Subcommunity on Granite

5.2. *Abutilon pycnodon* - *Colophospermum mopane* - *Fingerhurthia africana* Woodland Subcommunity on Shallow Soil

B. *Salvadora australis* - *Colophospermum mopane* Main Woodland Community on Sandy Deep Soil

6. *Boscia foetida* – *Colophospermum mopane* Woodland Community on Sandy Soil

6.1. *Boscia foetida - Colophospermum mopane - Eragrostis heteromera* Woodland Subcommunity on Sandy Deep Soil

6.1.1. *Ximenia americana* Variant

6.1.2. *Salvadora australis* Variant

6.2. *Boscia foetida - Colophospermum mopane - Abutilon grandiflorum* Woodland Subcommunity on Sandy Plains

6.2.1. Typical Variant

6.2.2. *Hypoestes aristata* Variant

Description of the Plant Communities

The floristic composition of the *Colophospermum mopane - Hibiscus micranthus* Major Woodland Community is given in Table 3. The plant communities are shown in Figure 13. The description of the plant communities is given below.

A. *Terminalia prunoides - Colophospermum mopane* Main Woodland Community

This main community includes all the koppies, rocky outcrops and ridges on Breslau, as well as the eastern part of Breslau mostly north of the Waterhole Koppies. The soil is silty though shallow.

The dominant tree is *Colophospermum mopane*, except in areas where it was removed in the early 1940's. The tree *Salvadora australis* is characteristically absent.

The characteristic species for this main community are shown in Species Group P (Table 3). These include the trees *Terminalia prunoides, Dichrostachys cinerea* and

Commiphora glandulosa, the forbs *Blepharis aspera* and *Waltheria indica*, the shrubs *Asparagus suaveolens* and *Asparagus nelsii* and the grass *Melinis repens* subsp *repens*.

This main community can be subdivided into five communities, seven subcommunities and two variants described below.

1. *Indigofera pongolana - Commiphora edulis* Mixed Thornveld Community on Low Sandstone Koppies

This community is found on the crest and on the northern slopes of Overflow Koppie and Dam Wall Koppie (Figures 5 & 13), which are very rocky and stony. A dolorite ridge runs through both of these koppies. The crests of the koppies consist of large sandstone boulders with many smaller dolorite rocks scattered along the dolorite ridge on the crest and down the sides of the koppies. The soil is silty-clayey and brownish-grey in colour.

The surrounding area consists mostly of the *Acacia tortilis - Salvadora australis* Major Woodland Community.

The herbaceous stratum and the tree stratum each have canopy covers of about 50 %. The herbaceous layer is sparse due to the large number of rocks and stones. The shrub layer is open with a canopy cover of only about 5 %.

This community is represented by 2 relevés in which an average number of 49 species were recorded.

The diagnostic species are those listed in Species Group A (Table 3) and include the legume, *Indigofera pongolana*, which is the most abundant of the diagnostic species, the forb *Rhinacanthus xerophilus* and the aloe *Aloe globuligemma*.

The diagnostic trees are *Commiphora edulis, Acacia mellifera, Balanites pedicellaris* and the scrambling *Combretum mosambicensis*.

The tree stratum has relatively high species diversity and the more common trees include *Commiphora tenuipetiolata, Cordia monoica, Acacia senegal* var. *rostrata, Acacia tortilis, Flueggia virosa, Dichrostachys cinerea* and *Terminalia prunoides.*

The shrubs include *Grewia villosa, Grewia subspathulata, Abutilon grandiflorum* which is found in patches on the koppies and reach over 1 metre tall, and *Solanum panduriforme*.

Other species in this community include the grasses *Aristida adscensionis, Melinis repens* subsp. *repens, Cenchrus ciliaris* and *Enneapogon cenchroides* and the forbs *Ceratotheca triloba, Vernonia cinerascens, Endostemon tenuiflorus, Hermannia glanduligera, Indigofera sordida* which is a common woody legume and *Hibiscus micranthus*.

2. *Aristida adscensionis - Combretum apiculatum* Woodland Community on Steep-Sloped Koppies

This community covers all the koppies and ridges that were sampled. It includes slope aspects of north, south, east and west, as well as the crests of koppies. All areas are rocky, from large boulders to smaller stones and rocks. It includes both the granite ridges and koppies in the south of Breslau as well as the sandstone koppies which make up the majority of the area. The soil is shallow and is sandy to silty to silty-clayey and in many cases leached due to the water running down the slope of the koppies.

The diagnostic species are those listed in Species Group B (Table 3). These include the trees *Hexalobus monopetalus, Tricalysia junodii, Albizia brevifolia, Ehretia rigida* and *Acacia nigrescens* which are all characteristic of the koppies and ridges, and *Commiphora merkeri* which also occur in the flatter habitats.

The diagnostic species in the herbaceous layer include the grasses *Aristida adscensionis, Brachiaria deflexa* and *Acrachne racemosa*, while the only diagnostic forb is the leguminous creeper *Rhyncosia totta*.

Some other species common to this community include the trees *Colophospermum mopane, Combretum apiculatum* and *Terminalia prunoides*, the grasses *Melinis repens* subs *repens,* and *Digitaria eriantha* and the shrub *Asparagus suaveolens* which is not very abundant. Other species common to this community are shown in Species Group V (Table 3).

This community is subdivided into three subcommunities and two variants described below.

2.1. *Aristida adscensionis - Combretum apiculatum - Hemizygia elliotti* Woodland Subcommunity on very Rocky Granite Hills

This subcommunity is in the *Colophospermum mopane* woodland and is located in the south of the study area on the granite koppies and ridges and rocky outcrops (Figures 5 & 13). The terrain consists of large granite slabs and boulders many of which are embedded with small pebbles, and loose granite rocks and stones. The soil is shallow and sandy with some clay.

The diagnostic species are those listed in Species Group C (Table 3), and include the forbs *Hemizygia elliotti* and *Hemizygia petrensis* which are both characteristic of the granite areas. Other diagnostic forbs include *Sida dregei, Chamaesyce neopolycnemoides, Teramnus labialis* and the legumes *Tephrosia zoutpansbergensis* and *Indigofera viciodes* which are only found on rocky ridges, the shrub *Hibiscus calyphyllus* and the tree *Flueggea virosa*.

The most conspicuous tree is *Colophospermum mopane* with *Combretum apiculatum* having the next highest cover value. Other common species are those listed in Species Group P, R and V (Table 3).

2.2. *Aristida adscensionis – Combretum apiculatum – Euphorbia cooperi* Xerophytic Woodland Subcommunity on Hill Slopes

This subcommunity includes the slopes of Euphorbia Kop, Pyramid Koppie and the southern slopes of the Waterhole Koppies (Figures 5 & 13). These areas are all underlain by sandstone. The sides of the koppies consist mostly of loose rocks and stones with some larger boulders. The angle of the slopes vary from 45 to 75 degrees. The soil is silty-sandy with a pinkish tinge.

The canopy cover of the tree stratum is equal to that of the herbaceous stratum which is around 55 %.

The diagnostic species are those listed in Species Group D (Table 3) which are the trees *Euphorbia cooperi, Commiphora tenuipetiolata* and *Cordia monoica*, the shrub *Cadaba aphylla,* the grass *Enneapogon scoparius* and the forb *Corbichonia decumbens*.

Other common woody species are *Acacia tortilis* which reach no more than 2 metres high, *Terminalia prunoides* and *Colophospermum mopane*.

A few other species which also have high cover values include the grasses *Enneapogon cenchroides, Digitaria eriantha*, *Cenchrus ciliaris* and *Panicum maximum* and the forbs *Acalypha indica* and *Hibiscus micranthus*.

This subcommmunity is subdivided into two variants described below.

2.2.1. *Croton gratissimus* Xerophytic Woodland Variant on Slopes of Koppies

This variant is located on the south and north slopes of Euphorbia Kop and on the southern slopes of the Waterhole Koppies (Figure 5). The slopes of this variation consist of large boulders, whereas the variation mentioned in 2.2.2. below has loose rocks and stones. The soil is silty-sandy but with a clay component and is more brownish-pink in colour. The angle of the slopes is about 35 degrees.

The species diversity of the vegetation is not as great as in the variation in 2.2.2. below. The shrub layer is poorly developed. A large number of dassies are present and forage on the trees and forbs.

The diagnostic species are those listed in Species Group E (Table 3). They are the trees *Croton gratissimus* and *Pappea capensis*, both of which have a reasonably high cover value, and the forbs *Philyrophyll schinzii* and *Tragia rupestris* and the shrubs *Solanum lichtensteinii* and *Antherothamnus pearsonii* which are concentrated on the Waterhole Koppies.

Some other common species include the grasses *Urochloa mosambicensis* and *Schmidtia pappophoroides* and the shrub *Abutilon grandiflorum.*

2.2.2. *Acacia senegal* var *leiorachus* Xerophytic Woodland Variant on Pyramid Koppie

This variation is located on the north, south, east and west slope of Pyramid Koppie and on the southern slope of the more eastern Waterhole koppies (Figure 5). The slopes are steeper than the previous variation, 2.2.1. above, and are greater than 45 degrees. The soil is silty-sandy with more of a pinkish colour. The slopes are very rocky with no large boulders.

The diversity of species is far greater than the variation 2.2.1. above, although the shrub layer is also poorly developed.

The diagnostic species are those listed in Species Group F (Table 3). They include the conspicuous tree *Acacia senegal var. leiorachus*, and the forbs *Barleria senensis*, *Ceratotheca triloba, Barleria lugardii, Otoptera* species, *Commelina erecta* and *Xerophyta retinervis* and the creeper *Cardiospermum corindum*.

Other species with a high cover value include the trees *Sterculia rogersii, Combretum apiculatum* and *Terminalia prunoides*, and the forbs *Justicia protracta* subsp. *rhodesica, Hibiscus micranthus, Seddera suffruticosa* and *Melhania acuminata*.

The shrubs with a high cover value include *Solanum coccineum, Grewia bicolor* and *Abutilon pycnodon*. The grasses include *Digitaria eriantha, Enneapogon cenchroides, Cenchrus ciliaris* and *Panicum maximum.*

2.3. *Aristida adscensionis - Combretum apiculatum - Commiphora mollis* Woodland Subcommunity on Waterhole Koppies

This subcommunity is located on the northern slopes of the Waterhole Koppies and on the crest where it is flat. It also includes the south-western slope of a rocky outcrop below Leopard Dam (Figures 5 & 13). The slopes are no more than 30 degrees. The soil is silty-sandy and brown in colour. The terrain consists of large rounded and flat boulders as well as loose rocks and stones.

The shrub layer is poorly developed with the canopy cover of the tree stratum and herbaceous stratum being about equal at 50 % cover.

The diagnostic species are the trees *Sclerocarya birrea* and *Commiphora mollis*, the grasses *Pogonarthria squarrosa, Pogonarthria fleckii* and *Melinis repens* subsp. *grandiflora* and the forb *Ammannia baccifera* (Species Group G, Table 3).

Other common species include the shrubs *Grewia flavescens* and *Grewia villosa* and the legume *Tephrosia rhodesica* and the grasses *Eragrostis lehmanniana* and *Melinis repens* subsp. *repens* and species as shown in Species Group V (Table 3).

3. *Lyceum cinereum - Acacia tortilis* Open Woodland Community on Undulating Landscape (Figure 14)

This community is located to the east and north of Pyramid Koppie to the northern border, between Pyramid Koppie and Ruins Koppie, around Ruins Koppie and towards the Waterhole Koppies (Figures 5 & 13). The landscape is undulating and includes some *Terminalia prunoides* ridges that are reasonably rocky, and open thornveld plains that are sandy. The few ridges are sandstone, while the soil is silty-sandy and pinkish-reddish-brown in colour.

The *Colophospermum mopane* trees are very scarce although this was originally all *Colophospermum mopane* woodland. In the 1940's all the *Colophospermum mopane* trees were removed from this area by the families living on Breslau to make way for agricultural fields. The *Colophospermum mopane* has never recovered but the result is *Acacia* thornveld and grassland, which is very valuable food for both the grazers and the browsers (Figure 14).

The herbaceous stratum is well developed and has a canopy cover of from 75 to 95 %, with the grasses being the more dominant species and making up 80 to 100 % of the herbaceous layer. The tree stratum has a canopy cover of from 15 to 45 %, while the shrub layer is poorly developed with a canopy cover of about 5 %.

The diagnostic species are those listed in Species Group H (Table 3) and include the trees *Acacia senegal* var. *rostrata,* the shrub *Lycium cinereum* and the forbs *Tribulus zeyheri, Hermbstaedtia linearis, Commicarpus plumbagineus, Phyllanthus parvulus, Kohautia cynanchica, Gisekia africana, Acanthospermum hispidum, Mormordica balsamina, Acrotome inflata* and *Laggera decurrens*. The forbs are all associated with disturbed areas. The diagnostic grass is *Chloris virgata*.

Other common trees include *Acacia tortilis*, which is the most conspicuous tree and has a high cover value (Species Group I, Table 3), *Terminalia prunoides* which are

Figure 14: *Lyceum cinereum – Acacia tortilis* Open Woodland Community east of Pyramid Koppie. The *Colophospermum mopane* trees were removed in the 1940s.

concentrated on the rocky sandstone ridges and *Boscia foetida* which are found throughout this community.

The most abundant grasses are *Eragrostis lehmanniana* and *Aristida congesta* subsp. *congesta*, while *Enneapogon cenchroides* and *Urochloa mosambicensis* are common grasses but not as abundant as the beforementioned species.

Species Group V and Species Group L (Table 3) list other common species.

4. *Kirkia acuminata – Colophospermum mopane* Woodland Community on Flat Plains (Figure 15)

This community is located in the *Colophospermum mopane* veld around Show of Roads towards the northern border and towards Beacon Kop, including the north eastern corner of Breslau (Figures 5 & 13). Degradation in this area is noticeable by the large number of dongas causing erosion, some of which are up to 3 metres deep. The sodic nature of the soil makes it vulnerable to erosion. The rocky outcrops, which are made up of large rock slabs, and koppies, are sandstone. The terrain is reasonably flat except for the koppies, rocky outcrops and dongas. The soil is deep, silty-sandy, loose under foot and has a colouration of different shades of brown.

The most conspicuous trees are *Colophospermum mopane* which are 3 to 4 metres tall and the *Kirkia acuminata* which tower above the other trees at heights of 8 metres (Figure 15). The canopy cover of the tree stratum varies from 30 to 70 % and that of the herbaceous layer from 30 to 80 %. The shrub layer is poorly developed.

The diagnostic species of this community are those listed in Species Group J (Table 3). These include the trees *Kirkia acuminata*, the more shrubby trees *Rhigozum zambesiacum* and *Commiphora africana*, the shrub *Cadaba termitaria* and the forbs *Sida chrysantha*, *Pseudognaphalum luteo-album*, *Leucas glabrata*, *Oxygonum delagoense*, *Vernonia*

Figure 15: *Kirkia acuminata – Colophospermum mopane* Woodland Community showing the *Kirkia acuminata* towering above the other trees which are mostly *Colophospermum mopane*

cinerascens, Ipomoea bolusiana, Clerodendrum ternatum and *Commelina benghalensis* The diagnostic grass is *Aristida canescens*.

The most common species include the grasses *Eragrostis lehmanniana, Aristida congesta* subsp. *congesta* and *Urochloa mosambicensis,* the forbs *Tephrosia rhodesica, Geigeria burkei, Hermannia glanduligera, Hibiscus micranthus, Evolvulus alsinoides* and *Melhania acuminata,* the shrubs *Solanum coccineum, Asparagus suaveolens* and *Grewia bicolor* and the trees *Dichrostachys cinerea* and *Terminalia prunoides*.

This community is subdivided into two subcommunities described below.

4.1 *Kirkia acuminata – Colophospermum mopane* Typical Subcommunity (Figure 16)

This subcommuity is located to the north and east of Show of Roads, around Bushman Paintings Rock, Fishpond Rock and Ficus Rock (Figure 5). The degradation is greater in this subcommunity than the subcommunity described in 4.2. below, and has a greater number of larger dongas. The soil is sandier and deeper, sandy-silty and reddish-brown in colour

The canopy cover of the tree stratum and the herbaceous stratum are both higher than the subcommunity described in 4.2. below, averaging 55 % and 65 % respectively.

This subcommunity has no diagnostic species but can be identified by the absence of species listed in Species Group K (Table 3), which are the diagnostic species for the *Kirkia acuminata - Colophospermum mopane - Endostemon tenuiflorus* Subcommunity in 4.2. below.

Some characteristic species include the forbs *Justicea protracta* subsp *rhodesica*, the shrubs *Ximenia americana*, the trees *Combretum apiculatum* and the grass *Schmidtia pappophoroides*.

Figure 16: Typical Mopaneveld in the *Kirkia acuminata – Colophospermum mopane* Typical Subcommunity

Common species are those mentioned in the *Kirkia acuminata – Colophospermum mopane* Woodland Community in 4 above and those listed in Species Group L and V (Table 3).

4.2. *Kirkia acuminata - Colophospermum mopane - Endostemon tenuiflorus* Subcommunity on Flat Area and Deeper Soil

This subcommunity is located to the south and west of Show of Roads, south of Ruins Koppie and between Fishpond Rock and Beacon Kop (Figure 5). The soils are shallower than the typical subcommunity described in 4.1. above. The soil is silty-sandy and more greyish-brown in colour.

The tree layer and the herbaceous layer have lower canopy covers than the variation in 4.1. above, averaging 40 % and 55 % respectively.

The diagnostic species are those listed in Species Group K (Table 3) and include the forbs *Endostemon tenuiflorus, Litogyne gariepina, Leucas sexdentata* and *Pavonia burchellii,* and the sedge *Mariscus rehmannianus* which grows in the shade.

Some other species associated with this subcommunity are the forbs *Ptycholobium contortum, Kyllinga alba* and *Barleria bremekampii* and the shrub *Abutilon pycnodon.*

5. *Abutilon pycnodon – Colophospermum mopane* Woodland Community on Sandy Plains

This community is located along the south border of Breslau up to the east border and includes some sandier areas north and east of Leopard Dam. The terrain is gently undulating and includes many sandy gulleys and dongas (Figure 13, Communities 5.1. and 5.2.).

There are no diagnostic species for this community, but it can be distinguished from the other communities in the *Terminalia prunoides – Colophospermum mopane* Main Community by the absence of those species listed in Species Groups L and N (Table 3). These absent species include the forbs *Hermannia glanduligera, Justicia protracta* subsp. *rhodesica, Leonotis nepetifolia, Tephrosia rhodesica* and *Geigeria burkei.* The grasses *Eragrostis lehmanniana* and *Aristida stipitata* are also absent and *Urochloa mosambicensis* is very scarce.

Some common species are shown in Species Group V (Table 3). These include the forbs *Hibiscus micranthus, Evolvulus alsinoides, Melhania acuminata* and *Barleria bremekampii* and the grasses *Aristida congesta* subsp. *congesta* and *Enneapogon cenchroides*. The common shrubs include *Grewia bicolor* and *Abutilon pycnodon.*

This community is subdivided into two subcommunities described below.

5.1. *Abutilon pycnodon - Colophospermum mopane - Denekia capensis* Woodland Subcommunity on Granite

This is a very small subcommunity represented by only 2 relevés. It is located along the south border of Breslau in a sandy area (Figure 13). The sand is a result of deposits from flooding, as it is close to a watercourse running onto Breslau from the south. Dead grass and washed *Colophospermum mopane* leaves are also evidence of flooding.

The area is flattish, with a few gulleys running from the south towards Bertha Dam. There is a small rocky outcrop in the centre of the one sample plot, in between the sand, which consists of a few granite boulders embedded with small pebbles. The soil is silty-sandy and greyish-brown in colour.

The tree stratum, which consists mostly of *Colophospermum mopane*, reaches a height of 4 metres and has a canopy cover of 30 % and a very low species diversity - 4 species in total. The herbaceous layer has a low canopy cover of 10 to 25 %, and a high species diversity compared with other subcommunities on Breslau – an average of 29 forb species and 9 grass species per relevé.

The diagnostic species is the forb *Denekia capensis* in Species Group M (Table 3).

The most abundant tree is *Colophospermum mopane*, with the odd *Boscia foetida Terminalia prunoides* and *Combretum apiculatum* scattered amongst them.

The species with the highest cover value, besides *Colophospermum mopane*, is the grass *Aristida congesta* subsp. *congesta*. The other species in this subcommunity are shown in Table 3, mainly in Species Group V.

5.2. *Abutilon pycnodon - Colophospermum mopane - Fingerhurtia africana* Woodland Subcommunity on Shallow Soil

This subcommunity is located to the north and east of Leopard Dam, along the southern border and up to the eastern border (Figures 5 & 13). The terrain is gently undulating with granite rocks and stones scattered throughout. The gulleys have coarser sand. The soil is sandy-silty and of different shades of brown. The soil is not very deep due to the gentle slopes not having dense vegetation cover and thus the sand being washed away by the rainwater.

The canopy cover for the tree stratum is greater than that of the herbaceous layer, averaging 60 % and 25 % respectively. The canopy cover of the shrub layer is about 5 %.

Colophospermum mopane is the most conspicuous tree and in some areas it is quite stunted while in other areas it reaches heights of 5 metres, however, the average height is 3 metres.

The diagnostic species for this subcommunity are those listed in Species Group O (Table 3) which are the shrub *Maerua parvifolia*, the grass *Fingerhurthia africana* and the legume *Tephrosia villosa*.

Species with high cover values are *Colophospermum mopane* which is the most abundant tree and *Aristida congesta* subsp. *congesta*, which is the most abundant grass.

Other common species are shown in Species Group V (Table 3), and include the forbs *Hibiscus micranthus, Evolvulus alsinoides* and *Barleria bremekampii*, the tree *Boscia foetida* and the grass *Enneapogon cenchroides*.

B. *Salvadora australis – Colophospermum mopane* Main Woodland Community on Deep Sandy Soil (Figure 17)

This main community is found mostly on the southern side of Breslau from the western border along the Limpopo River up to the eastern border. The soil is sandy and deeper than the *Terminalia prunoides – Colophospermum mopane* Main Woodland Community in A above.

The dominant tree in this main community is the *Colophospermum mopane*.

This main community is also distinguished from the main woodland community in A above by the presence of the tree *Salvadora australis*, which is absent in A above. The presence of *Salvadora australis* is also an indication of a higher salt content in the soil (Figure 17).

This main community has one community, which is the same as this main community, two subcommunities and four variants described below.

Figure 17: The *Salvadora australis* – *Colophospermum mopane* Main Woodland Community showing *Salvadora australis* amongst the *Colophospermum mopane* on sandy deep soil

CHAPTER 4b

6. *Boscia foetida – Colophospermum mopane* Woodland Community on Deep Sandy Soil

This community is situated in the south-west corner of Breslau, the sandy areas around Pebble Pool, south of Pluchea Kop and the Waterhole Koppies towards the eastern border.

The diagnostic species for this community are those listed in Species Group U (Table 3) which are the tree *Salvadora australis* and the forb *Heliotropium steudneri,* although *Heliotropium steudneri* also has a noticeable presence in the *Lycium cinereum – Acacia tortilis* Open Woodland Community (Community 3 above).

Colophospermum mopane is the most conspicuous tree with cover values of over 50 %. Other species with high cover values are shown in Species Group V (Table 3) and include the tree *Boscia foetida*, the grasses *Aristida congesta* subsp. *congesta* and *Enneapogon cenchroides* and the forb *Barleria bremekampii*.

6.1. *Boscia foetida – Colophospermum mopane – Eragrostis heteromera* Woodland Subcommunity on Deep Sandy Soil

This subcommunity is located in the south-west corner of Breslau, adjacent to the Limpopo River and along the lower south border (Figure 15). The terrain is flat with deep sandy-silty soil which is brown in colour. The most conspicuous tree is *Colophospermum mopane*. This area has a low concentration of game which includes impala, kudu and occasionally eland.

The diagnostic species are those listed in Species Group Q (Table 3) which are the grass *Eragrostis heteromera*, the tree *Boscia albitrunca* and the forbs *Ocimum americanum, Melhania burchelli* and *Seddera suffruticosa.*

Species with high cover values are *Colophospermum mopane*, which is the dominant tree and the grass *Aristida congesta* subsp. *congesta*.

Other common species are those listed in Species Group V (Table 3) and include the tree *Boscia foetida*, the grass *Enneapogon cenchroides* and the forb *Indigofera sordida* in Species Group R (Table 3).

Two variants, described below, occur in this subcommunity.

6.1.1. *Ximenia americana* Variant

There are no diagnostic species in this variant. However, this variant can be distinguished from the variant in 6.1.2. below, by the presence of the shrub *Ximenia americana* and the absence of, or very rare presence of the scrambling tree *Salvadora australis*. In the majority of relevés sampled, *Colophospermum mopane* was the only tree present.

Other species more common to this variant include the grasses *Schmidtia pappophoroides* and *Digitaria eriantha* and the forbs *Melhania burchelli* and *Kyllinga alba*.

6.1.2. *Salvadora australis* Variant

Species Group U (Table 3) is differential for this variant. This variant is distinguished from the variant in 6.1.1. above by the presence of *Salvadora australis* and the absence of *Ximenia americana*.

The trees *Boscia albitrunca* and *Boscia foetida* are also common, however, *Boscia foetida* is found in the *Ximenia americana* variant but only as very small shrubs, reaching no higher than 700 mm.

Other species associated with this variant include the shrub *Abutilon pycnodon* and the forbs *Heliotropium steudneri*, *Acalypha indica* and *Sida cordifolia*.

6.2. *Boscia foetida - Colophospermum mopane - Abutilon grandiflorum* Woodland Subcommunity on Sandy Plains

This subcommunity is located south of the Waterhole Koppies towards the east of the study area, in the sandier areas around Pebble Pool and south of Pluchea Kop and in an isolated area in the west above the upper river bush (Figure 5 and Figure 15 - Communities 6.2.1 and 6.2.2). The terrain is flat with numerous very sandy, shallow dongas which only hold water when heavy rains fall within the vicinity. The soil is sandy-silty and of different shades of brown. The ground is covered by fallen *Colophospermum mopane* leaves, dead twigs and dead grass.

The dominant tree is *Colophospermum mopane* which grows an average of 3 metres tall, but along the watercourses it reaches heights of 8 metres. *Salvadora australis* is also common in this subcommunity.

The diagnostic species are those listed in Species group S (Table 3), which are the shrubs *Abutilon grandiflorum*, also strongly associated with the *Aristida adscensionis – Combretum apiculatum – Euphorbia cooperi* Woodland Subcommunity (2.2. above), and *Solanum panduriforme*, the forbs *Hypertelis salsoloides, Psiadia punctulata, Trianthema salsoloides* and the creeper *Cucumis zeyheri*.

The diagnostic grasses are *Eragrostis tricophora* and *Sporobolus ioclados. Acacia grandicornuta* is the diagnostic tree and is associated with deeper, wetter soils.

Other species associated with this subcommunity are the tree *Acacia tortilis* (Species Group I, Table 3), and the grasses *Eragrostis lehmanniana* and *Urochloa mosambicensis* (Species Group L and N respectively, Table 3). Other common species are shown in Species Group U (Table 3).

Two variants occur, described below.

6.2.1. Typical Variant

This variant contains a greater number, and larger, sandy dongas and the soil is generally more sandy than the *Hypoestes aristata* Variant in 6.2.2 below. It is located in the south and east of the study area (Figure 13).

There are no diagnostic species in this variant, but it can be distinguished by the absence of the diagnostic species for the *Hypoestes aristata* Variant in 6.2.2. below, Species Group T (Table 3).

The canopy cover of the tree stratum is much greater than that of the variant below, reaching 95 % in some areas. The canopy cover of the herbaceous layer varies from 30 % to 75 %.

6.2.2. *Hypoestes aristata* Variant

This variant is located in an isolated area of *Colophospermum mopane* located in the west of the study area, near the Limpopo River, just above the upper river bush (Figure 15). The terrain is flat, sandy-silty with very few sandy dongas. Animal activity is obvious, not only by the presence of the animals, but also by evidence of the trampling, and impala and kudu middens. The grass is sparse and the forbs *Hypoestes aristata* and the young *Cyathula orthacantha* have been eaten by the game.

The canopy cover of the tree stratum and the herbaceous stratum are each about 40 %. The shrub layer is very sparse.

The dominant tree is *Colophospermum mopane*, with *Salvadora australis* being the only other conspicuous tree.

The diagnostic species are those listed in Species Group T (Table 3) and include the legume *Hypoestes aristata*, the forbs *Boerhavia diffusa, Ruellia patula, Hermannia modesta* and *Chenopodium album* which is found mostly in the shade of the *Salvadora australis* and the shrub *Abutilon angulatum*.

The forbs *Heliotropium steudneri* and *Geigeria burkei* are also associated with this variant. Other common species are those in Species Group U and V (Table 3).

ORDINATION

An ordination algorithm, DECORANA (Hill 1979b) was also applied to the floristic data to determine possible environmental and disturbance gradients. The results were also used to confirm the order of the communities and variations in the TWINSPAN generated phytosociological tables. These results are shown in Figure 18.

In Figure 18, the first axis describes a gradient displaying the dolorite content of the rocks and soil, with the vegetation units associated with the dolorite rocks and ridges occurring to the right, and those with no dolorite present occurring to the left.

To the right of the diagram the relevés on the koppies and rocky outcrops and ridges can be distinguished. These indicate Community 1 (the *Indigofera pongolana – Commiphora edulis* Mixed Thornveld Community) and Community 2 (the *Aristida adscensionis – Combretum apiculatum* Woodland Community). Both these communities occur on dolorite ridges. Community 3 (*Lycium cinereum – Acacia tortilis* Open Woodland Community) is distinguished to the lower left of the diagram, which is found on the lower footslopes of some rocky ridges and on flat sandy areas with no rocks whatsoever. The soil in this community is reasonably deep and permeable to water. Communities 4 (*Kirkia acuminata – Colophospermum mopane* Woodland Community), 5 (*Abutilon pycnodon – Colophospermum mopane* Woodland Community) and 6 (*Boscia foetida – Colophospermum mopane* Woodland Community) are not as distinguishable from one another as the other communities above but are indicated in the centre left of the diagram.

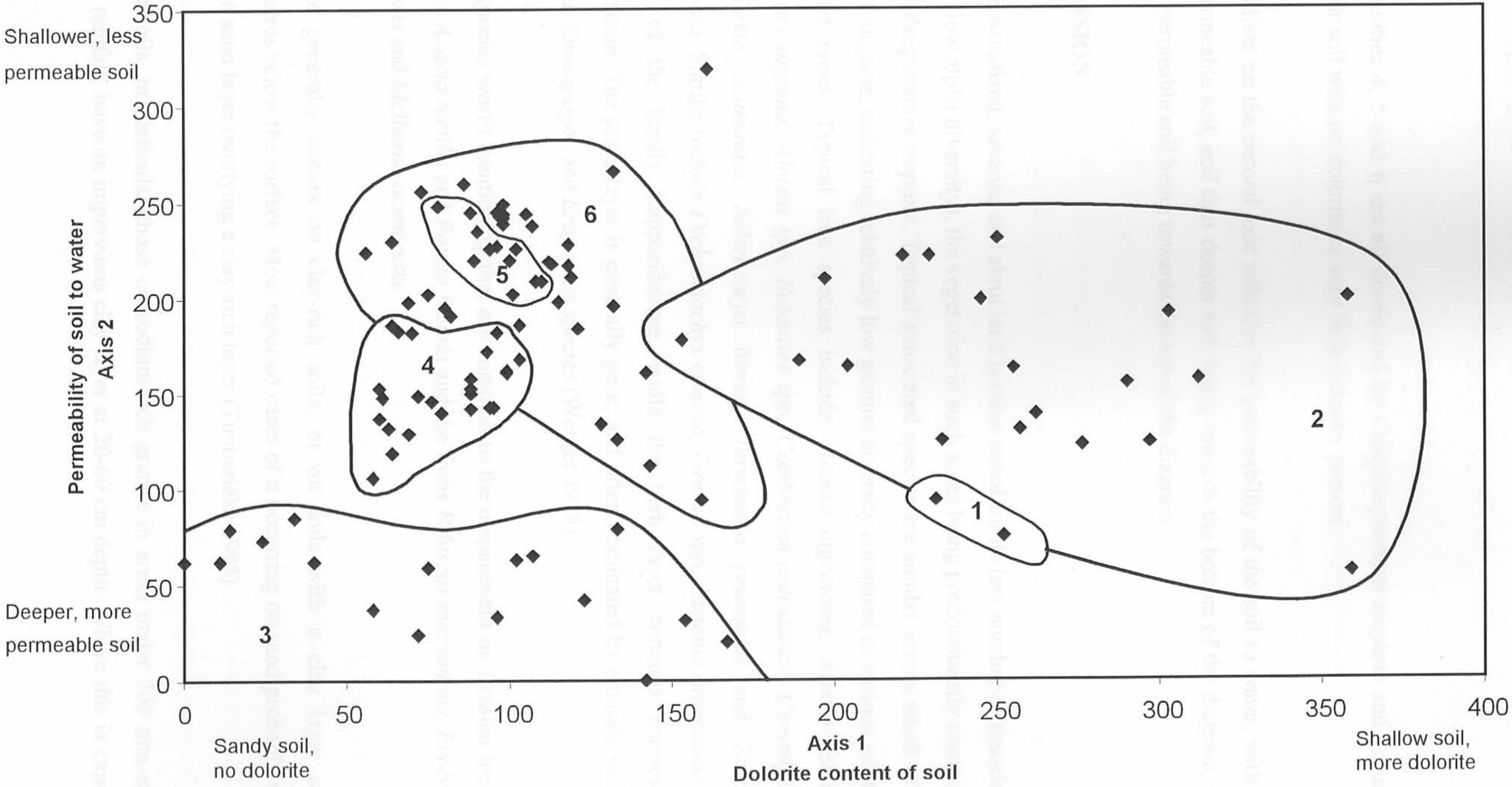


Figure 18: Scatter diagram of the relevés along the first and second axis of a DECORANA ordination for the *Colophospermum mopane - Hibiscus micranthus* major woodland community showing the vegetation

Communities 4, 5 and 6 are all dominated by *Colophospermum mopane* and occur in shallower soil with no dolorite or very little dolorite present.

The gradient on the second axis indicates the permeability of the soil to water, with the more permeable soil, and thus deeper soil, being towards the bottom of the diagram, and the less permeable soil being towards the top of the diagram.

DISCUSSION

Mopane woodland, savanna and shrubland is often noted for its low number of associated species (low alpha diversity), the vegetation in such areas being predominantly composed of *Colophospermum mopane*. Typical associated species are similar across much of the range of mopane, indicating relatively low gamma diversity compared to various miombo woodland types. Typical tree species include: *Acacia nigrescens, Acacia nilotica, Adansonia digitata, Albizia spp, Balanites spp, Combretum apiculatum, Commiphora spp, Kirkia acuminata, Sclerocarya birrea, Terminalia prunoides* and *Ziziphus mucronata*. Shrubs include *Dichrostachys cinerea, Grewia spp, Ximenia americana* and species of the family Capparidaceae, while the herb layer contains species of Acanthaceae. The grass layer is generally poor, and often dominated by annuals such as *Aristida, Enneapogon* and *Eragrostis* species (Werger 1978).

Other species worth mentioning that are common to the mopaneveld on Breslau include the trees *Acacia tortilis* and *Boscia foetida* and the forbs *Hibiscus micranthus, Evolvulus alsinoides* and *Melhania acuminata*.

Mopane generally occurs on clay-rich soils, or on soils with a clay layer some centimetres below the surface. Most reported cases of it occurring on sand probably refer to a thin sand layer overlying a clay-rich layer (Timberlake 1995).

Duplex soils, in particular those on sodium-rich granite in areas under 700 mm mean annual rainfall, have an impervious clay layer at 20-60 cm depth. Where this is exposed by natural or exposed soil erosion, mopane is generally found, usually as a small tree or shrub. The presence of mopane, its shallow root system, and the prevalence of surface capping on such soils (resulting from a relatively high silt content), often lead to further soil erosion and the expansion of the extent of exposed subsoil, in turn leading to expansion of the mopane zone and a reduction in the surrounding zone of miombo species (Timberlake 1995).

A most common type of soil in the study area is a sodic soil, which is highly erodable and unstable. In areas further away from the riverine which have silty soil, are the sandstone areas. This sandstone soil has very erodable properties and is found mainly in the *Colophospermum mopane* veld. It is in this *Colophospermum mopane* veld where considerable erosion is taking place. This is a result of the present policy forcing game farms to fully fence the farms in order for the farm to legally own the game. Thus, game is kept on the farms during the high and low rainfall years. This has resulted in increased erosion taking place in the *Colophospermum mopane* veld, due to the increased grazing pressure during the low rainfall years. Unfenced game farms would allow the animals to naturally move to areas with more abundant vegetation which would alleviate the pressure on certain areas like the *Colophospermum mopane* veld during the dry years and thus reduce erosion.

Although sometimes said to be an indicator of sodic or infertile soils, mopane is by no means confined to them, and indeed grows much better on deeper, less compact soils. The association with sodic soils, is said to be due to its shallow rooting system and ability to survive there, whereas many other woody species have difficulties. The root system coincides with the zone of maximum moisture retention on many soils, and mopane is excluded from better soils by deeper rooted *Acacia* species (Timberlake 1995).

One feature of some stands of mopane shrubland is the bareness of the soil and the prevalence of sheet erosion. Other woody plants in such areas tend to be clumped or associated with termitaria, and much of the remaining area has a poor cover of annual grasses and herbs. A major causative factor is probably the sodicity of these soils or the high silt content, leading to extensive surface capping, which in turn can lead to gulley formation. These areas often expand slowly, especially under heavy grazing, as the topsoil erodes and more subsoil is exposed (Timberlake 1995).

In the study area contour walls and gabions need to be built in the gulleys and dongas to prevent further erosion and removal of topsoil by water. However, the mopaneveld on Breslau does not seem to be expanding. This could be due to reduced grazing pressure on the mopaneveld by attracting the game to other areas by the building of dams, and the better control of game numbers. The *Colophospermum mopane* leaves are a valuable food source in the dry season. The mopane psyllid, *Arytaina mopane*, feeds on the leaves of mopane and produces an excretory product, lerp, which is said to make the leaves more palatable to browsing animals (Ernst & Sekhwela 1987). These leaves are favoured particularly by the impala and baboons.

The year 2000 was an exceptional year for the study area regarding rainfall. This exceptionally wet year in 2000 resulted in a very noticeable increase in vegetation cover and the abundance of other species. The vegetation became very dense due to the high rainfall.

The average rainfall from 1982, when records were first kept on Breslau, to the year 2000, was 277 mm per season. A season being from July the one year to June the following year. For the year 2000 the recorded rainfall was 812 mm for the season, which is the highest rainfall by far since records were kept since 1982. This study was undertaken after these exceptional rains. The average rainfall for the last 5 years up to 2000 was 447 mm per season, which is 170 mm higher than the average rainfall since 1982. As a result of this higher rainfall over the past 5 years the results of this study are exaggerated towards higher rainfall periods rather than lower rainfall periods. This is confirmed by Bothma (1989) who states that when good rains do fall in arid areas at the right times, the response of the veld is better than would be expected, resulting in a false impression that such areas are more adequate for ranching.

The year 2001, the year in which this vegetation study was undertaken, was not an exceptionally high rainfall year with 270 mm for the season. However, in the area under study the most important factor is not how much rainfall, but rather the frequency of the rainfall, that is, the periods between rainfall. In 2001 the frequency was favourable to plant growth, but unfavourable to filling dams. The result being that around the dams the herbaceous and shrub layers have suffered from lack of water, but the vegetation out on the plains and veld have grown well. However, the herbaceous layer in the mopaneveld was not as dense as in the more open areas. The frequency pattern of rainfall in this particular climate seems to be far more important than the amount of rain. The temperatures become so high that if the rainfall is not frequent enough it is not beneficial to the vegetation due to very high evapotranspiration.

The vegetation in this study area is relatively homogeneous (Species Group V, Table 3). In spite of this homogeneity, the classification resulting from using TWINSPAN (Hill 1979a), and the refinement thereof using the Braun-Blanquet procedure, these vegetation units are recognisable in the veld.

The stratification based on the five terrain units was effective in that the entire farm was covered and all areas were classified (Figures 12 & 13). The *Indigofera pongolana – Commiphora edulis* Community and the *Aristida adscencionis – Combretum apiculatum* Community (Communities 1 and 2 in this paper) include the koppies and rocky outcrops and ridges viz. the crest and scarp. The remaining communities were stratified as midslope terrain.

Colophospermum mopane is dominant in all the vegetation units, with the exception of the *Lyceum cinereum – Acacia tortilis* Community (Community 3), (Species Group V, Table 3), where the mopane trees were removed in the 1940's and have never recovered.

Some of the species which associate the communities in the *Terminalia prunoides - Colophospermum mopane* Main Community with one another are *Acacia tortilis, Sterculia rogersii,* (Species Group I, Table 3), *Urochloa mosambicensis* (Species group

N, Table 3), and *Dichrostachys cinerea* and *Terminalia prunoides* (Species Group P, Table 3). These communities show similarity to the *Combretum* spp./*Colophospermum mopane* Rugged Veld as described by Gertenbach (1983) as well as the *Colophospermum mopane – Commiphora glandulosa – Seddera capensis* Open Tree Savanna as described by van Rooyen, et al (1981), both descriptions of the Kruger National Park.

The communities in the *Salvadora australis – Colophospermum mopane* Main Community are associated with one another by the tree *Salvadora australis*. These communities show similarity to the *Salvadora australis* Floodplains of the Kruger National Park as described by Gertenbach (1983). The communities are found on flat floodplains, and the soils are usually brackish. The woody component is dominated by *Colophospermum mopane* trees and *Salvadora australis* shrubs of ± 3 metres high (Gertenbach, 1983).

This study may be used to assist the development of a management plan for Breslau Game Farm. A priority, due to the highly erodable nature of the soil, would be to control the present erosion and prevent further loss of soil by erosion.

Table 3: Phytosociological table of the *Colophospermum mopane* - *Hibuscus micranthus* Major Woodland Community of Breslau Game Farm

Unique releve no.	195	196	193	197	64	89	90	194	149	188	185	186	189	181	182	183	184	192	150	190	191	107	108	120	121	123	169	171	118	119	124	104	105	106	109	110	111	167	172	67	68	69	73	74	75	76	77	78	79	80	81	82	170	66	70	71	72	84	122	83	62	63	98	91	95	96	97	101	146	147	151	44	51	52	53	54	58	59	60	61	65	43	45	46	47	48	49	50	55	56	57	92	94	176	178	85	86	87	93	148	39	40	41	42
Main Community	A																																																																								B																																
Community	1		2																			3																		4																					5											6																																
Subcommunity			21							22									23																						41														42							51		52									61																				62												
Variant										221				222																																																											611										612										621									622			
Species Group A																																																																																																											
Indigofera pongolana	b	a																				r				+																																																	r																																										
Rhinacanthus xerophilus	a	+						r		1					+		1																																																																																								
Aloe globuligemma	1	1																																																																																																									
Commiphora edulis	+	1																																																																																																									
Acacia mellifera	+	+																																																																																																									
Balanites pedicellaris	+	+					+																														r																																																	r	+																		r
Combretum mossambicensis	1								a	1				r			1												r																																		r																																+										
Species Group B																																																																																																											
Aristida adscensionis	+	1				+	+	+	1	+			1	1	+	r	r	1	a	1	1						r																																					+																																	+		1	1					+				
Hexalobus monopetalus			a	1		b	1	b							+			1		a	1																																																																																	
Tricalysia junodii			1		r	+	+		+						+				+																																																																																				
Ehretia rigida			1		r		r	+						r				+		+																																																																						r										r		
Rhynchosia totta			+		r	r			r						r	+	+			+	+																																										r																																															
Brachiaria deflexa							r				r		+	+	+	+	r	+		+	r																																								r	r		r		r													r											+	+		1				+					
Albizia brevifolia				+				1						a	1					a	+																																																																																	
Acacia nigrescens										a		+	1					b		a							1																																																																+										
Commiphora merkeri	1													+		+					+		+																														1	r					+								+		+																																				
Acrachne racemosa													r					r			r																																																																																	
Combretum apiculatum			b	a	a	+	1	a	1	b	r			+	1	+	1	1	1	1													r					1		1	+	r	r	+	1					r		r									r	1					+	+																																								
Species Group C																																																																																																										
Hemizygia elliottii			r	+	a		+	+												+	1																	+																								r	+						+																																												
Indigofera vicioides				a		r	+	a																																																																																																	
Hemizygia petrensis			1		r			1																																												r										+					r		+																																									
Fluegg virosa A68	1	1			r		1	a				1						1	+																																																														r																								
Hibiscus calyphyllus			1					1	+							r																																																																																								
Tephrosia zoutpansbergensis			a					1																																																																																																	
Sida dregei			+	1				+											+	1									r			r	+									r																+		+																																																	
Chamaesyce neopolycnemoides							+	+	r																																																									r		r																												+								
Teramnus labialis							r	1																																																									+																																																
Species Group D																																																																																																											
Euphorbia cooperi											+	3		1	+	a	+																																																																																						
Cadaba aphylla										1	+	1	a	+	+	r	+	1						+							r								+																								r																											r														
Commiphora tenuipetiolata	a									+				a	+	1	+	1	1																													+																																																									
Cordia monoica	+										a	b		+			+							r			1				r				r																																																																						
Enneapogon scoparius												1		1	+	1	+	+																																																																								r															
Corbichonia decumbens	+		+							+				r			1		+																																																																																											
Species Group E																																																																																																											
Croton gratissimus		a								b	3	+	b																																																																																													
Pappea capensis										1	b	+	a		r				+																																																																																						
Solanum lichtensteinii											+	1																																																																									r									r										
Philyrophyllum schinzii											r		1																																																																																													
Antherothamnus pearsonii													a							1																																																																																				
Tragia rupestris													1																																																																																													
Species Group F																																																																																																											
Acacia senegal var. leiorachis														1	+	b		+																																																																																						
Barleria senensis														1	+	1	a													+																		r								+																																								+		+			+							
Ceratotheca triloba	1	+												1	+	r	+																																																																																										
Cardiospermum corindum														a			+																																																																																										

Barleria lugardii								1							1	+																																r																		r																																						
Otoptera species															+	1																																																																												
Xerophyta retinervis								1		1					r	r		+																																								r																																														
Commelina erecta															+	r		r			r																													r	r																																																					
Species Group G																																																																																																								
Commiphora mollis															+				1		1																										r			r	r					r																																																
Sclerocarya birrea																			+	1													+																																																																							
Pogonarthria squarrosa				1																+	1																											r					r				r		r													r											r					r	r									r						
Pogonarthria fleckii																				+	1																																																																																							
Melinis repens subsp. grandflora						+								+					1																																																r																																					
Ammannia baccifera																			+	r																																										r																																										
Species Group H																																																																																																								
Lycium cinereum		+																					r	1	+	+	+	+	+	1	+		+	r	r		+																			+	r																																												r			+
Tribulus zeyheri		r																				r	1		1		1		+		+				+		r										r							r		r						r																																	+		r							r
Hermbstaedtia linearis																					+	r	r		r	r	r		+	r	r				r		r	r														r								r																																			r			r						
Commicarpus plumbagineus	1																					r		+	+				r	r				r																						r								r																					r												+		+					
Phyllanthus parvulus							+															r	r	+			r		+	r					r		r															r		r		r	r			r																																				r	r						r	
Kohautia cynanchica			+																				r		1	+	+			+						r		1																							r														r			r	r																	r								
Acacia senegal var. rostrata	1	1																					+	+	r								r		r	r		1	+																																			r								r				r																		
Gisekia africana																							r				r		r						r																																																																					r
Chloris virgata																								r	r				r		r			r	r															r							r																											r						r					r	r	r							
Acanthospermum hispidum																											r		a	+	1							r																																																																		
Momordica balsamina																													r	r																																																																										
Acrotome inflata																														r	r						r	r																																																																		
Laggera decurrens																													r		r					r																	r																																									+										
Species Group I																																																																																																										
Acacia tortilis	+	1								+	+		r	1	1		+	1		+		3	a	1	1	+	b	1	a	b	3	b	a	a	a	a	b	1	1																r	r	r			r		r		r				r	+																	r							r	+	+	r	r	r	r	r	+	+	r	+
Aristida meridionalis		+		b		r								r	r					b			r	r	r	r	r		r	r			r			r														r				r																					r																													
Grewia flavescens	+		+					1	a				+				+	1		1	+			+	r		1	1	1	+	+																	r																			r																												+									
Grewia villosa	1	1						1	1			+	b	+	+		+			+	1		r	r	r									+	r						r													+															1	+																																		
Sterculia rogersii	1							1	b		+			+	1	1	1		1			+	+										+	+															+					r												+																																						
Species Group J																																																																																																										
Rhigozum zambesiacum				a											+	r					r			+														a	+		1	1		r	+	r	+	+	r		+	r		r	+	+	+	1	+							r	r	+					r				r																					+						
Sida chrysantha														r													+	+											+	+	+					r	r	r		r				1	+	+	+			+																																												
Pseudognaphalium luteo-album																										+				r										+						r			r	r	r	r	r	+		+	r	+	+	r																																		+	+		r	r			r		r	r
Cadaba termitaria								+	r						+																									r				r	r	r	r	+	+	+	+	r						r		+								r																														r							
Kirkia acuminata				+					a						+	r	+		a		1																										1	+	+	+	+					+	1	a		1																																												
Commiphora africana																																							+	+	+				+		+		r	r	r	r		r																																																		
Leucas glabrata									1						+															+																+		1														+																		r																								
Oxygonum delagoense																																															r		+	+	r																																																					
Aristida canescens					r																																							3	a																+	r																																										
Vernonia cinerascens	1	+																																						r	r				+			r		r				r				+		r																																												
Ipomoea bolusiana																																									r				r													r																																														
Clerodendrum ternatum																																									+	+		r															r																				r	r																								
Commelina benghalensis													r													r																				r										r	r	r		r	r																																			r	r							
Species Group K																																																																																																										
Endostemon tenuiflorus	+	+																		r			r		r																						r	+						+	r	r	+	+	+	+			+																																			+						
Litogyne gariepina																									r				r						r																		1	+		1	r	r	r																																						+							
Leucas sexdentata																				r							r								r		r																	r		r	r		r	+																																												
Pavonia burchellii																																																								r	r																																															
Mariscus rehmannianus																																																								1	r	r																																	r													
Species Group L																																																																																																										
Tephrosia rhodesica					a	+	+							a	+		a	1	+	1	1						+		r									1	+	r		+	+	r	1	+	+	1	1	1	1		+		+	+	r	+	r			r						r										+																										
Eragrostis lehmanniana											1			1	a	+				b	a	a		a	a	b	1	3	b	4	3	5	5	4	3	4	5	a	3	3	1	b	3	3	a	b	b	b	a	b	b	b	b	b	1	b	a	b	a	1				1																												+		1	1	r	b		+	+	1		+
Geigeria burkei				+										1	+					1	1	r	+	1	1	1	1	1	1	1	+	1	+	+	+	+	+	1	1		r	r	+	1			r	+	+	+		+	1	r	+	+	r	1	+	1		r	r				r													r		r		r													r		+	+	+	+
Aristida stipitata																												+	r				+					r					a										b																																																			
Leonotis nepetifolia																												r					r			r	r				r	r	r																																																													
Sesamothamnus lugardii		1													+								+											+							+													r																																																		

Species Group M														
Denekia capensis									+ +		r			
Species Group N														
Hermannia glanduligera	1 1	+	+ a	r +	+ +	r r + r r r + r 1 +	+ + + 1 + + + + + + r + 1	+ r + + r +	r	r	r r +		r	
Urochloa mosambicensis	1		+ 1 + 1	+ 1 1 +	1 +	r r r + + 1 + 3 1 + a + +	+ + + a r b 1 1 b 1 1 3	+ + 1 + r r r	1 +		r r r	r r r	1 1 a + 1 +	r r r
Ptycholobium contortum	1		+	+		r r r	r r +	+ 1 1 + r		r r	r			
Solanum coccineum		+ r	+ 1	+ 1 1 + 1	+ 1	1 + + 1 1 1 1 1 r + + r r + +	+ r + 1 1 + 1 + + + 1	1 1 + +		r				
Justicia protracta s. rhodesica		+ +	1 1	1 1 a 1 a	1 1	+ + r 1	+ + r + + 1 1 + 1							
Species Group O														
Maerua parvifolia		+				r	r r	+		r + r r r r			r	
Fingerhuthia africana										+ r r				
Tephrosia villosa										+ r				
Species Group P														
Dichrostachys cinerea	+ +	+ r + +		+ 1	+ r	r r r r + + r r r 1 +	r r r r r r r r r	r r r r r	r	r r r r			r + r r r	
Terminalia prunioides	1 a	+ + r	b a	+ + + 1 a	+	b b a b b r a 1	+ + r r 1 + + + 1 1	+ + + r r 1	1	+ +	r			
Melinis repens subsp. repens	+ 1	r 1 r	+ + + +	+ + + +	+ + +	r			+ r	r r	r		r + +	
Blepharis aspera	+	1 + +	1	1	1	+	+ r + r r r + +	+	1	r +	r		r	
Asparagus suaveolens		r r r	+ 1 1	+ + +	r	r	+ r r r r r + r	r r r r r		r r				
Waltheria indica		+ 1 + +			a +	+ r r + r +	+ + r + r + + +	r r r r r +		r r r r				
Commiphora glandulosa	1				+	r + a	r + r r	r r 1	+	+ 1 +				
Asparagus nelsii	+	r +		r		r	r r	r r +	r	r				
Species Group Q														
Eragrostis heteromera	a	1 1		1	b a				r	r r	b a b b b b + 1 +	a b a b 1 1 a r r 1	1 +	
Ocimum americanum		r	+	r + +		+ r r r			r		r + + r r	1 + + + r + + r r		r + 1
Seddera suffruticosa		1 + 1	1	a 1 a a 1		+ +				+	+ + + + + + r	1 + + + + + + r +	+ r +	r r
Boscia albitrunca	a	+	+		1	+ +			r		+ r r +	+ 1 r r		
Melhania burchellii		+									+ + r			
Species Group R														
Indigofera sordida	b a	a +		a		r + r r r 1	+ 1 + 1 + + 1 1	r + +	+	r + r + r 1 r r	r 1 1 1 r + + r	+ + r + + + r r r	r	
Kyphocarpa angustifoli		1 r 1		r	r			+ r	r r	r + + r +	r r r r r	+ r +	r r	
Kyllinga alba		r r r 1 +	+ +	r	+	r	r r	r r r + r r	r r	r r	r r + r r		r	
Digitaria eriantha		1 1 r + +	+ a 1	a 3 3	+	r	1 r				+ + + +	r		
Ximenia americana		1 + 1		r r r		+	+ r r		r r	1	r + 1 1 r r		+ +	
Species Group S														
Abutilon grandiflorum	r a	r	1 1 a a	r r r	+	r r r r	r r r	r r r				+ r	r r + 1 r + r r +	+ + + +
Solanum panduriforme	+ 1			+		+		r	+		r	+ r	1 + + + r + r	+ r +
Hypertelis salsoloides						r r		r					r + 1 +	r r r r
Eragrostis trichophora		+						r		1	1	r	a 1 a r	r
Acacia grandicornuta					+	+							+ +	
Psiadia punctulata													r r	
Sporobolus ioclados										1			r + + 1 1	
Cucumis zeyheri				r		r r		r r r	r r			r	r r r +	r
Trianthema salsoloides													r r r	
Species Group T														
Boerhavia diffusa										r		r r	+	1 1 1
Ruellia patula										r		+ +	+	1 r r r
Chenopodium album	r					r						+		1 + + +
Abutilon angulatum	r					r		r r		r		+	r	1 + +
Hypoestes aristata											r + +	1 1 + +		1 a a
Hermannia modesta						r								r r
Species Group U														
Salvadora australis	1 1	1									r +	1 r 1 + + a a 1 +	r r + 1 1 + + 1	b b b b
Heliotropium steudneri	+					+ + 1 1 1 1 + r r + r +	r				+	+ + + + + r	r	1 + 1 1
Species Group V														
Colophospermum mopane		b 1 a a b 3 1	a 1	1 1 1 1	1 1 4	r r + 4	4 b 3 3 b 3 3 3 3 b 3 3 3 3	3 3 3 3 3 4 b	1 3	4 4 3 3 4 4 3 4 4	3 3 3 3 3 3 3 3 4 3	b 3 4 4 3 3 3 3 3 4	5 3 5 5 3 b 4 3 4	3 b a b
Hibiscus micranthus	+ +	+ + 1 + 1	+ r +	+ + + + +	+ + +	+ r + r r r + +	1 1 + + + + + r r + + + 1 +	1 + 1 + 1 r 1	+ 1	+ + + + + + + +	r r + 1 1 1 + r	+ + + + + + +	+ + + + + + r	r

Aristida congesta s. congesta		a	1	1	a	+		1	+		+	1				r			a	a		r	1	4	a	b	4	4	b	b	r	a	+	3	b	3	r	3	4	1	5	3	3	a	b	a	b	3	+	b	b	1	a	3	5	b	4	b	3	+	b	1	+	+	1	4	a	b	3	1	+	1	a	b	b	1	b	1	1	+	r	b	1	a	b	3	3	3	+	+	+			1	+	+	+	+	+	1	a	b		a
Evolvulus alsinoides		1	+		+			1	+				+	+	r				a	1	+			+	+	+	1	1		+	1	r	+	r	r	+	r	1	1	+	+	+	1	1	1	+	1	+	+	a	a	a	1	+	r	+	1	1	1	1	1	+	1	1	1	+	+	1	1	+	1		r	r		+	+	+	1	+	r	r			r	+	r		+	r			+		r		+		r	+	r	r		r
Boscia foetida	1		1	+			r	1				+		+		r	r	+		1	+	+	+	+	+	1	+	1	r	+		+	r	+	+	+	r		1			r				+	+	+	+	+	+	r	1	+		+	r			+		1	r	+	+	r	+	+	+	1	1	+	+		r	r	+	+	+	+	r	r	r		+	+	1	1	r	r		r	1		+		r	1	+	1	r	+	+	
Pupalia lappacea	1	+		+				1	+				+					1		+	1			1	r	+	+	+		+			r					+			r					r	r		+	+	r		+	+			r		+	r	1	+	+		r		+		1	+		+	+		+			r		+		1	1	1	1		1	1	+	1	+	a	+	1	+		r	r	+	+	1	1	1	1
Enneapogon cenchroides	1	b	1		+	+	1	1	1	b	+	1	b	b	+	a	a	a	a	1	3	4	3	+	3	b	a	1	r	r				r	r	r	r	b	1	r			+	r		+	1	1	r	+	+		+			+	1	r	r	1	1	1	1	1	1	a	a	b	1	1	+	+	+	+	+	1	1	1	1	1	r	1	1	1	+	+	+	+	1	+	1		a	1	a	4	4	r	a	3	+	+	1	+
Grewia bicolor	+		+		+		+	1	1	+			b	+	+	+	1	1	1	1	1			+	r	+	+	1	1	+						r		1	+	+	+		r	+	1		1	+	1	1	+	1	1	+	+	r	+	r	+	+	+	+	+			1	+	1	+	1			+	+	+	+	+	+		+				r	+	+									+		r		r					
Grewia subspathulata	1	1	1	+		+	+	1	b	1			a	+	+	+		1	b	b	1			1	+	+	a	1	a	1			+					1	1		r		+	1	+		1	+	1	r		+	1		r	+			+			r		r	1	1	1	1	1	+			+	+	+	+		+	+			r		+		+	+	+	r		+	r	+										
Melhania acuminata	+		+		r		1	+							+	+	+	+	+	+		1		r		r		+			r	r				r	+		+	+		+	1	1	1	+	+	r	+	+	+	1	+	1	+	+	+	+	+			+	+	+	+		+	r		+	+		+	+	+			+	+	+		r	+	+	+	+			+	r				+							+	r		+	+
Schmidtia pappophoroides			+		r					1	b	a	1	+	1					1	1					r								r				r			r			+	r	1				r	r	r				r						r														r	+		1	+	+	r								r					r	+										
Barleria bremekampii	1		+		r										+	1		1		1	+			r						r									+	1	+													1	+	1	+	r	+		+	+	+	+	+	+	+		+	1	+		+		r		+	+	+		r	r	+	+		r	+	r			+		r	+		r	+	1		1		r	r	+
Abutilon pycnodon	+		+				1	+						+	+	+	r	+			+	r	r	1	+		1							+						+		+												r	+			r	r	+	+	+		1		+	1	+	1	1	+			r			+			1	r	+	+	+	+		+		+	+		r	+	+	1		+		+	1	+			+
Acalypha indica	+	+				r	+		1	+	+	1	1	+	+	r	r		+	+				r	+	r			+					r																r										1	r		r			+									+								+			r		+	+	r			r			+	+	+				+	+	+	1
Corchorus asplenifolius					r														r					r	+																																				r			r	r			r	+		r					r											r	r		r				r													r	r			r		r
Limeum sulcatum														r									r																																		+		r							+				r																																		r		r			r	r
Aptosimum lineare				+	+									+						1		r		+	r		1	+		r				r		r		+	1																				r			+	+				r			+			r	+	+	+		+		r				+	r	r	1																r	+	+	+
Stipagrostis uniplumis		+		+				+					+	+			r		+	1	1			r									r				r						1	+					r								r					r		r		+		r	+	r	+	r					+		1							r	r	r								r	r	r	+		r		r
Dicoma tomentosa		r													r								r	r				+		r	r								r																				r										r		r																															r		r	+	r		r				
Ruellia otaviensis								+		+				+			+	+							r																																									+																				r				+				+			1	r		r							r
Heliotropium giessii		r																r	r				+						+										r										r		r		+		r				+	r	+		+		r			+																														+		1		+		1	+				
Commicarpus pilosus									r	1							1	a	+				1	r			1	+											+																											r			+																														1		+				1	r				
Cenchrus ciliaris	1	1				+		+		1	+		a	1	1	b	+	a																						+	r	r		r		+		r		r								r		r																r	r										r															1		r		r				+	
Asparagus setaceus+A237															r										r														r							r					r		+				r			r																			r	r	r		r																						r		
Amaranthus praetermisus																		r					r	+		r			+		r		r		r		r	r																		r	r				r	r		+			r												r				+										+		+	r	r		+		+			
Panicum maximum			1		r	r	1				a		b	+	a	1	r	1		+											r	r		r																			a	a	1	r					r																					r	r	r			r		+		r		r			+		r	r	+	4	r	b	+						r			
Sida cordifolia									+						r							r		+	r	1	+		r	r		+	+	+	+	+	r																+						r			+						r	r												r		+			+	+	+	+				+	+	+	+		r		+		r	+	+	+
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Limeum fenestratum																																																						r		+						r																																														
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Justicia flava																																																																																												r		1		+									
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Tephrosia oxygona				1																																																																																																				
Strychnos spinosa				1																																																																																																				
Psydrax livida				+																																																																																																				
Pavonia dentata				1																																																																																																				

CHAPTER 4c

SECTION B

A FLORISTIC DESCRIPTION OF THE PLANT COMMUNITIES ON BRESLAU GAME FARM IN THE NORTHERN PROVINCE, SOUTH AFRICA.

THE *SALVADORA AUSTRALIS* - *ACACIA TORTILIS* MAJOR WOODLAND COMMUNITIES:

ABSTRACT

The study was conducted on Breslau Game Farm (Pty) Ltd, in the Evangelina District in the Northern Province of South Africa. The farm covers 2 920 ha and borders on the Limpopo River opposite Botswana.

The floristic classification of the vegetation was done by means of the Braun-Blanquet method. The vegetation was divided into two distinct groups, namely the *Colophospermum mopane – Hibiscus micranthus* Major Woodland Community and the *Salvadora australis - Acacia tortilis* Major Woodland Community. A floristic description of the *Salvadora australis - Acacia tortilis* Major Woodland Community is included in this paper.

INTRODUCTION

This is the second paper of a vegetation analysis of Breslau Game Farm, in the Northern Province. In the first paper a general description was given on the location, topography, geology, soil, climate and methods as well as a floristic description of the mopaneveld. This paper is concerned with the *Salvadora australis – Acacia tortilis* Major Woodland Community.

Over the past two decades the keeping and commercial utilisation of game on private land in South Africa increased considerably. There is little information concerning the production of game on these private farms. This has, in some areas, contributed to the deterioration of the veld on farms with game as a result of mismanagement (Peel, Grossman & van Rooyen 1991).

Fragmentation of private game farms due to fencing may cause the potential loss of habitat for some species, the isolation of other species or the total extinction of certain plant species. The smaller the area, the more intensely it has to be managed, and vice versa, the larger the area the more possible it becomes to aim at natural conditions (Bothma 1989).

Wildlife management begins when an area on a map is marked off as a unit. No development, especially of an extensive nature, ought to take place before the environment has been thoroughly studied and its ability and limitations have been determined. It is unlikely that any game ranch would be so large that fencing it would have no artificial consequences. Wildlife management normally implies some form of active manipulation of the veld, or of one or more animal populations (Bothma 1989).

This paper is concerned with the *Salvadora australis – Acacia tortilis* communities. Not much published knowledge is available regarding the *Salvadora australis* Veld which is not very widespread in South Africa. The *Acacia tortilis* is widespread throughout most of southern Africa up to tropical Africa. The foliage of the *Acacia tortilis* is browsed by antelope and giraffe and the highly nutritious pods are eaten by virtually every browsing and grazing mammal, often in preference to any other pod (Grant & Thomas 2000).

A sound knowledge of the vegetation ecology of conservation areas is essential for the establishment of efficient wildlife management programs and the compilation of conservation policies (Bredenkamp & Theron 1978, 1990).

The vegetation analysis was conducted to produce a phytosociological inventory of the farm which can be used as the initial step for further studies to lead to the development of a scientific wildlife management plan for Breslau Game Farm, and to provide guidance towards the management of the farm's available natural resources by aiming at optimum production of game animals without causing degradation of these resources over the long term (Cauldwell 1998).

The aim of the study was to classify the vegetation into communities based on species composition, habitat and disturbances such as dams, and to analyse, describe and interpret these plant communities.

The vegetation was divided into two distinct groups, namely the *Colophospermum mopane – Hibiscus micranthus* Major Woodland Community and the *Salvadora australis - Acacia tortilis* Major Woodland Community. A floristic description of the *Salvadora australis – Acacia tortilis* Major Woodland Community is included in this paper. This community occurs on the northern and central part of the study area and west along the Limpopo River (Figure 19). It is divided into three main communities, ten communities, eight subcommunities and four variants, collectively named vegetation units.

The results are recorded in a series of two papers, of which this is the second.

STUDY AREA

A description of the location, topography, climate, geology and history of land-use and management is given in the first paper - A Floristic Description of the *Colophospermum mopane – Hibiscus micranthus* Major Community.

The *Salvadora australis - Acacia tortilis* Main Community is confined to the footslopes and floodplains of the study area. Sporadic flooding as well as intense grazing and browsing in these areas has lead to an abundance of pioneer species such as *Dicliptera spinulosa, Boerhavia diffusa, Tribulus zeyheri, Amaranthus praetermissus* and *Ammania baccifera*. However, in a favourable rainy season a good grass cover of *Urochloa mosambicensis* is formed together with *Chloris virgata* and *Panicum maximum*. The brackish soil is of a sodic nature and susceptible to erosion which is impeded with overgrazing and trampling

METHODS

The non-statistical Braun-Blanquet method has been successfully employed in South Africa since 1969 (Taylor, 1996) and is acceptable as a reliable and suitable method of vegetation classification. The use of a uniform surveying method ensures comparable results and makes a hierachical classification of the vegetation possible (Bredenkamp, 1975).

Data were incorporated into a data base using the TURBOVEG program (Hennekens 1996a). Two-Way Indicator Species Analysis (TWINSPAN) (Hill 1979a) was applied to the entire data set in order to identify the major plant communities. This initial classification was then refined, using the program MEGATAB (Hennekens 1996b) with Braun-Blanquet procedures (Westhoff & van der Maarel 1978; Behr & Bredenkamp 1988). The results of this classification was two distinct communities which are presented in two separate phytosociological tables. The two communities are:

1. *Colophospermum mopane – Hibiscus micranthus* Major Woodland Community, and
2. *Salvadora australis – Acacia tortilis* Major Woodland Community

In this paper the *Salvadora australis* - *Acacia tortilis* communities are described floristically according to the Braun Blanquet method (Werger, 1974).

The ordination algorithm DECORANA (Hill 1979b) was also applied to the floristic data set to illustrate relationships between the vegetation units and the environmental factors (Figure 23).

A general description of the methods used are described in the first paper - A Floristic Description of the *Colophospermum mopane – Hibiscus micranthus* Major Woodland Community.

RESULTS

The *Acacia tortilis – Salvadora australis* Major Woodland Community is divided into three main communities, ten communities, eight subcommunities and four variants. These communities are listed below:

Classification

The *Salvadora australis* - *Acacia tortilis* Major Woodland Community (Figure 19)

A. *Chloris virgata – Salvadora australis* Main Woodland Community

1. *Eragrostis porosa - Alternanthera pungens* Sparse Woodland Community on Barren High-lying Plains

2. *Boerhavia diffusa - Boscia foetida* Open Woodland Community on Flat Plains.
    - 2.1. *Boerhavia diffusa - Boscia foetida - Balanites pedicillaris* Open Woodland Subcommunity
    - 2.2. *Boerhavia diffusa - Boscia foetida - Verbesina enceloides* Open Woodland Subcommunity

3. *Portulaca oleracea - Salvadora australis* Open Woodland Community on Flat Plains
    - 3.1. *Portulaca oleracea - Salvadora australis - Acacia nebrownii* Mixed Thornveld Subcommunity on Flat Plains
    - 3.2. Typical Open Woodland Subcommunity on Flat Plains
        - 3.2.1. *Gisekia africana* Woodland Variant on Flat Plains
        - 3.2.2. *Leucosphaera bainseii* Open Woodland Variant on Flat Plains
        - 3.2.3. *Schkuhria pinnata* Open Woodland Variant on Low-lying Plains
        - 3.2.4. *Eriochloa parvispicula* Open Woodland Variant on Low- lying Plains

B. *Echinochloa colona - Acacia tortilis* Less Disturbed Main Woodland Community

4. *Acacia nilotica - Acacia tortilis* Woodland Community along Water Courses
    - 4.1. *Acacia nilotica - Acacia tortilis - Flueggea virosa* Woodland Subcommunity
    - 4.2. Typical Subcommunity

5. *Heliotropium supinum - Acacia tortilis* Woodland Community on Floodplains
    - 5.1. *Heliotropium supinum - Acacia tortilis - Zaleya pentandra* Woodland Subcommunity on Floodplains
    - 5.2. *Heliotropium supinum - Acacia tortilis - Cullen obtusifolia* Woodland Subcommunity on Low-Lying Plains

6. *Faidherbia albida - Acacia tortilis* Woodland Community around Bertha Dam

7. *Combretum imberbe - Acacia tortilis* Woodland Community on Dam Floodplains

C. *Lonchocarpus capassa - Acacia tortilis* Riverine Main Woodland Community

8. *Albizia anthelmintica - Acacia tortilis* Woodland Community on Higher-lying Riverine

9. *Xanthocercis zambesiaca - Acacia tortilis* Closed Woodland Community on High Banks of the Limpopo River

10. *Dovyalis caffra - Acacia tortilis* Woodland Community on Low-Lying Riverine

Description of the plant communities

The floristic composition of the *Salvadora australis - Acacia tortilis* Major Woodland Community is given in Table 4.

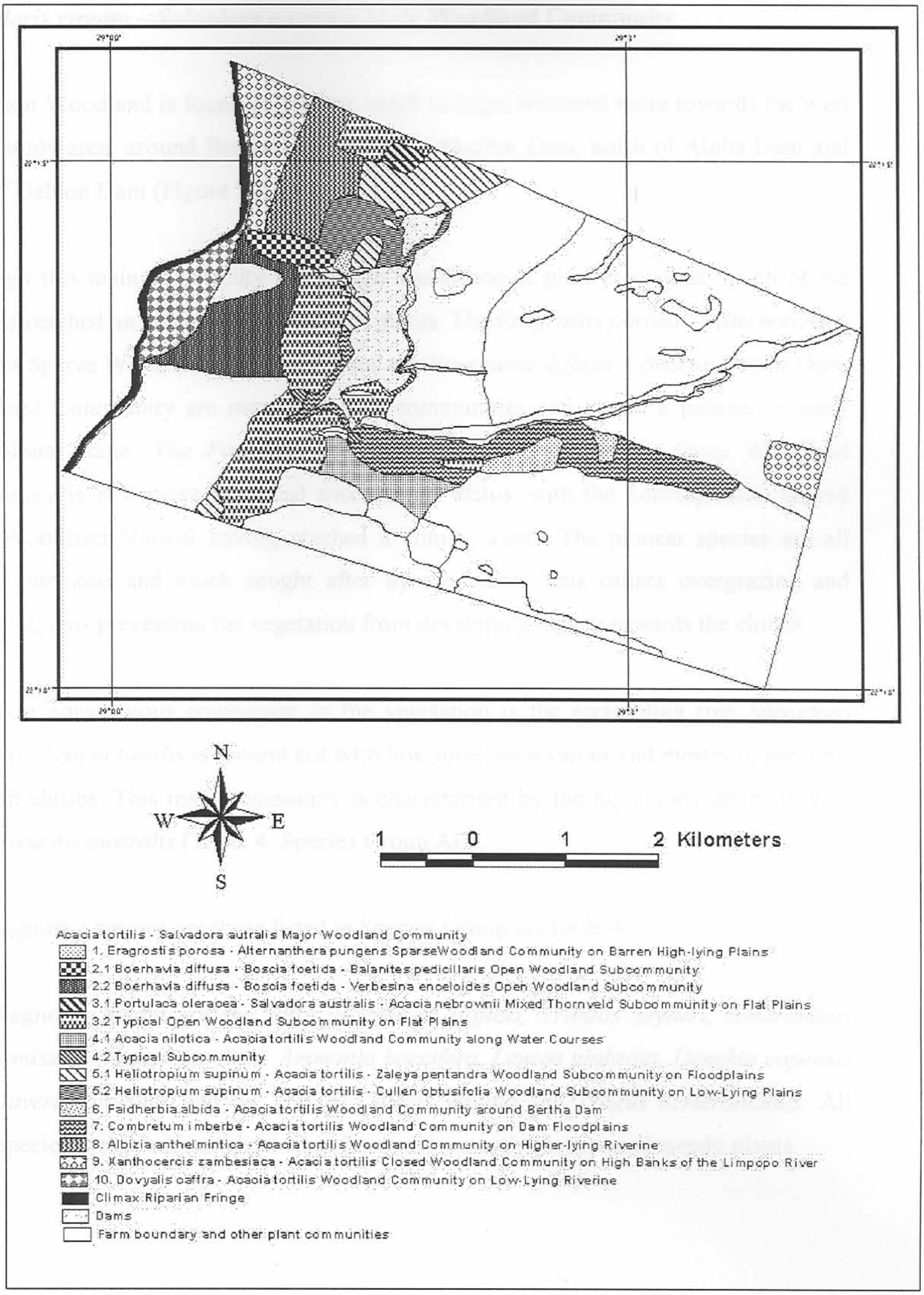

Figure 19: Map of the *Salvadora australis - Acacia toritlis* Major Woodland Community

A. *Chloris virgata – Salvadora australis* Main Woodland Community

This main Woodland is found in patches, small to large, scattered more towards the west of the study area, around Bertha Dam, south of Pluchea Dam, north of Alpha Dam and west of Gabion Dam (Figure 5 & 19).

Although this main community has a high abundance of pioneer species, much of the area has reached an advanced successional status. The *Eragrostis porosa – Alternanthera pungens* Sparse Woodland Community and the *Boerhavia diffusa – Boscia foetida* Open Woodland Community are more disturbed communities and are in a pioneer or early successional stage. The *Portulaca oleracea – Salvadora australis* Open Woodland Community is at a more advanced successional status, with the *Leucosphaera bainsii* Open Woodland Variant having reached a climax status. The pioneer species are all highly nutritious and much sought after by the game. This causes overgrazing and trampling, thus preventing the vegetation from developing further towards the climax.

The most conspicuous component in the vegetation is the scrambling tree *Salvadora australis*. *Acacia tortilis* is present but with low abundance values and mostly in the form of small shrubs. This main community is characterised by the high cover abundance of the *Salvadora australis* (Table 4, Species Group AF).

The diagnostic species are those listed in Species Group N (Table 4).

The diagnostic herbs are the forbs *Boerhavia diffusa, Tribulis zeyheri, Amaranthus praetermissus, Cucumis zeyheri, Ammania baccifera, Leucas glabrata, Denekia capensis* and *Flaveria bidentis*, and the grasses *Chloris virgata* and *Tragus berteronianus*. All these species are annuals or short-lived perennials, mostly pioneer and weedy plants.

1. *Eragrostis porosa – Alternanthera pungens* Sparse Woodland Community on Barren High-lying Plains

This woodland is very sparsely vegetated with only a few small trees and shrubs, and patches of herbs and grasses found in slight indentations on the soil surface. More than 50% of the area is bare with very little vegetation.

This pioneer community is found in the "Dead Valley" area on the flat, higher ground between dongas (Figure 5 & 19), where years of overgrazing and erosion have caused the runoff of all rainwater into nearby dongas which have become wide and deep. The soil is sandy-silty on the surface and compact underneath with numerous cracks. A number of impala middens and some termitaria occur in this area indicating that this area is utilised by game. Many of the pioneer species are highly nutritious and sought after by the game, especially the impala. The trampling of the area probably contributes to keeping it at a low successional stage.

The diagnostic species of this sparse woodland community are listed in Species Group A (Table 4). These include the grasses *Eragrostis porosa* and *Dactylocteni aegyptium*, both of which grow in disturbed places, and the forbs *Heliotropium giessii, Chenopodium carinatum, Alternanthera pungens, Aizoon glinoides* and the legume *Indigofera sordida*.

Hypertelis salsoloides is the most abundant forb, growing no more than 2 cm high, and found throughout the bare patches. Other forbs, which have relatively high cover values, include *Trianthema salsoloides, Boerhavia diffusa, Tribulus zeyheri* and *Ammania baccifera* and the grass *Urochloa mosambicensis*.

Trees are scarce and small with the most conspicuous being *Boscia foetida* and *Acacia tortilis* which average only 1 to 2 metres in height. *Salvadora australis* and *Balanites pedicellaris* are rare and restricted to around the termitaria.

Shrubs are sparse and small and include *Lycium cinereum, Solanum panduriforme* and *Abutilon grandiflora.*

All the species in this community are pioneers or are weedy, indicating the low successional status of the vegetation.

This community is subdivided into two subcommunities described below.

2. The *Boerhavia diffusa – Boscia foetida* Open Woodland Community on Flat Plains.

This open woodland consists of a scattered mix of trees and a reasonably well-developed herbaceous layer dominated by grasses. Amongst the scattered trees and grasses are open patches with small forbs, *Boerhavia diffusa* being the most abundant. The ground has been dug-up by warthogs and numerous springhare holes are evident.

This open woodland is found on flat high ground close to the Limpopo River adjacent to the *Colophospermum mopane* communities (Figure 19, Comminities 2.1. & 2.2.). It is probable that this was originally also part of the *Colophospermum mopane* community, but the trees were removed by earlier settlers to make way for farming activities, as there is evidence of buildings and other human and domestic animal activity in the vicinity.

The greyish-brown silty-clayey soil is soft and friable where trampled, otherwise firm with a compact crust.

The diagnostic species of this community are those listed in Species Group B (Table 4). These include the forbs *Corchorus asplenifolius* and *Barleria bremekampii* and the grasses *Aristida congesta* subsp. *barbicollis* and *Eragrostis trichophora.*

The most striking trees are *Boscia foetida* and *Salvadora australis* which reach heights of 4 metres, and smaller *Acacia tortilis* of 2 to 3 metres high. Very small *Acacia tortilis* of less than 1 metre tall are scattered throughout this woodland, and some *Boscia albitrunca* are also present. *Acacia tortilis* is probably the pioneer woody species starting to establish and indicating a succession to a more closed woodland. The density of the *Acacia tortilis* trees may also be indicative of the beginning of undesirable bush thickening (encroachment), however, the *Acacia tortilis* pods provide the game with invaluable, highly nutritious food in times of drought.

The most abundant species are the annual forbs *Boerhavia diffusa* and *Tribulis zeyheri* and the weak perennial grass *Aristida congesta* subsp. *congesta* which is associated with disturbed soil. The forb *Chenopodium album* is common in the shade under the trees.

The low successional status grasses and weedy forbs that dominate the herbaceous layer are also indicative of the low successional status of this community.

2.1. *Boerhavia diffusa - Boscia foetida - Balanites pedicillaris* Open Woodland Subcommunity

This subcommunity is found within the general habitat of the *Boerhavia diffusa – Boscia foetida* Open Woodland Community. It is located close to the riverine woodland on a very gentle north facing slope (Figure 19). It has fewer large trees than the *Boerhavia diffusa - Boscia foetida - Verbesina enceloides* Open Woodland Subcommunity (2.2 below).

The brownish-red silty-sandy soil has a crust on the surface but is friable when trampled. Numerous impala biddens and springhare holes are evident in this subcommunity.

The diagnostic species are the trees *Balanites pedicellaris, Acacia senegal* var. *rostrata,* and *Commiphora glandulosa* and the forbs *Hermbstaedtia linearis* and *Aptosimum lugardiae* as shown in Species Group C (Table 4).

The most abundant trees are *Salvadora australis* which are larger, spreading to 8 metres in diameter, than in the *Boerhavia diffusa - Boscia foetida - Verbesina enceloides* Open Woodland Subcommunity (2.2 below). *Boscia foetida* is also present.

The most abundant forb is *Boerhavia diffusa* while *Aristida congesta* subsp. *congesta* is the most abundant grass. *Lyceum cinereum* and *Abutilon grandiflorum*, although not very common, are the most abundant shrubs.

2.2 *Boerhavia diffusa - Boscia foetida - Verbesina enceloides* Open Woodland Subcommunity

This woodland has an open mixed woody layer with numerous small *Acacia tortilis* and not a noticeably well-developed shrub layer. The herbaceous layer consists mainly of grasses and small forbs.

This subcommunity is located on a high-lying plain, between two *Colophospermum mopane* communities, east of the upper riverine woodland and west of the airstrip as shown in Figure 19.

The soil is friable and silty-clayey and much disturbed by animal activity which includes the scratchings of guinea fowl, warthog diggings, springhare holes and numerous animal tracks. This is a favourite area of the game such as zebra, wildebeest, impala, kudu, warthog, steenbuck and guinea fowl.

The diagnostic species are listed in Species Group D (Table 4). The herbaceous component is characterised by *Geigeria burkei, Verbesina encelioides, Commelina erecta, Evolvulus alsinoides, Cleome gynandra, Hermbstaedtia odorata* and *Aptosimum lineare*. *Boerhavia diffusa* is the most abundant forb with a 30 to 40 % cover.

The dominant grasses are *Aristida congesta* subsp. *congesta* (Species Group L, Table 4) and *Urochloa mosambicensis,* with *Digitaria velutina* (Species Group AF, Table 4) being characteristic to this subcommunity.

The diagnostic tree is *Boscia albitrunca*. Other common woody species include *Boscia foetida* and *Salvadora australis* which reach heights of 4 metres, and numerous *Acacia tortilis*, from shrubs of 300 mm to trees of 4 metres high.

The shrub layer is dominated by *Abutilon grandiflorum, Lycium cinereum* and *Solanum panduriforme*.

It is likely that the low successional status of this vegetation is maintained by the disturbance and by the many animals that utilise this habitat. The pioneer forbs are sought after by the game as they are highly nutritious.

3. The *Portulaca oleracea – Salvadora australis* Open Woodland Community on Flat Plains

This community covers the largest *Salvadora* woodland area on Breslau and represents the typical scrambling *Salvadora australis* tree scattered amongst the grassland on flat plains. The grass layer is well developed resulting in some organic material being present. The soil is silty-clayey and of different shades of brown.

The *Portulaca oleracea – Salvadora australis* Open Woodland Community is found north of the higher-lying riverine towards the northern border and south and west of Bertha Dam (Figure 19, Communities 3.1 & 3.2).

This community is diagnosed by the presence of the herb *Portulaca oleracea* and the absence of the diagnostic species listed in Species Groups A to E (Table 4), which belong to the *Eragrostis porosa – Alternanthera pungens* Sparse Woodland Community and the *Boerhavia diffusa – Boscia foetida* Open Woodland Community.

The dominant characteristic tree is *Salvadora australis*.

The grass layer is well developed and dominant to the herbaceous layer. It is dominated by *Urochloa mosambicensis* and *Chloris virgata. Setaria verticillata* is abundant in the shade underneath the *Salvadora australis*.

The shrub layer is poorly developed with the most abundant shrubs being *Lycium cinereum* and *Acacia tortilis* which are no higher than 800 mm.

Two subcommunities can be distinguished in this community, namely the *Portulaca oleracea - Salvadora australis - Acacia nebrownii* Mixed Thornveld Subcommunity and the Typical Open Woodland Subcommunity.

3.1. *Portulaca oleracea - Salvadora australis - Acacia nebrownii* Mixed Thornveld Subcommunity on Flat Plains (Figure 20)

The most conspicuous vegetation is the dense, multi-stemmed, shrubby *Acacia nebrownii* (Figure 20). The ground cover is sparse with many bare patches. The soil is a fine silty-loam and brown in colour.

This subcommunity covers a small area and is found on flat, high ground just to the North of Alpha Dam (Figure 19).

The diagnostic tree, which is also the most dominant tree, is *Acacia nebrownii*. (Species Group G, Table 4). Other trees include *Acacia tortilis, Salvadora australis* and *Albizia anthelmintica. Acacia nebrownii* is also very prevalent in the ecotone between the lower lying floodplains of Alpha Dam and the higher ground which was sampled.

The shrub layer is very weakly developed, almost lacking. The herbaceous layer is sparse with the diagnostic forb being the geophyte *Dipcadi marlothii*. The more dominant herbs include *Trianthema salsoloides, Hypertelis salsoloides, Tribulus zeyheri* and *Ammania*

Figure 20: *Acacia nebrownii* in the *Portulaca oleracea – Salvadora australis – Acacia nebrownii* Mixed Thornveld Subcommunity on Flat Plains. This photo was taken in November 2001 after the dry season and after the first rains.

baccifera which are all annuals associated with disturbed areas.

The grass cover is sparse with the most dominant grasses being *Urochloa mosambicensis, Chloris virgata* and *Tragus berteronianus. Setaria verticillata* is found in the shade around the base of the trees and is also associated with disturbed ground.

3.2. Typical Open Woodland Subcommunity on Flat Plains

This subcommunity is typical of the *Potulacea oleracea – Salvadora australis* Open Woodland Community. It is an open woodland on flat plains with large scrambling, multi-stemmed *Salvadora australis* within the grasslands.

This subcommunity has no diagnostic species and is characterised by the absence of the shrubby tree, *Acacia nebrownii*, and the geophyte, *Dipcadi marlothii* which is very rare (Species Group G, Table 4).

The more dominant species are shown in Species Group AF (Table 4). The dominant grass is *Urochloa mosambicensis*. The dominant tree is *Salvadora australis,* with small, shrubby *Acacia tortilis* being common but with low cover values. The shrub, L*ycium cinereum*, is common throughout this subcommunity.

This subcommunity is subdivided into 4 variants described below:

3.2.1. *Gisekia africana* Woodland Variant on Flat Plains (Figure 21)

This variant is located on high flat ground north of the riverine woodland and west of Alpha Dam. The soil is a fine silty-loam. Trees are 3 to 4 metres high and the herbaceous stratum has a relatively low canopy cover with up to 60% of the ground being bare.

The diagnostic species are those listed in Species Group H (Table 4). The diagnostic herb

Figure 21: *Salvadora australis* trees in the *Gisekia africana* Woodland Variant on Flat Plains. The *Salvadora australis* in this vegetation unit has the largest canopy cover and spread the widest of all the *Salvadora australis* in the study area.

is *Gisekia africana*. The dominant herbs are *Trianthema salsoloides, Boerhavia diffusa* and *Tribulus zeyheri,* which are all indicative of degradation. The most common grasses are *Urochloa mosambicensis, Setaria verticillata* and *Panicum maximum,* of which the latter two are found in the shade underneath the trees.

The diagnostic shrub, which is not abundant, is *Solanum coccineum*.

Salvadora australis is the largest and most dominant tree (Figure 21). *Acacia tortilis* is also present, but the trees are small.

3.2.2. *Leucosphaera bainseii* Open Woodland Variant on Flat Plains (Figure 22)

This variant covers the largest area of the Typical subcommunity and is located around the airstrip and Balancing Rock Koppie (Figures 5 & 19) on the higher lying flat plains. The soil is silty-clayey and varies from light brown to reddish in colour. Termites are active in this area.

The herbaceous layer is well developed with a canopy cover of 98 % in some areas. The grasses are by far more dominant than the forbs.

This vegetation is characterised by species listed in Species Group I (Table 3). The more conspicuous diagnostic species is the forb *Leucosphaera bainseii*.

The characteristic tree is *Salvadora australis*, which is evenly spread throughout the area (Figure 22).

The grass with the highest cover value is *Urochloa mosambicensis*, with *Chloris virgata* and *Aristida congesta* subsp. *congesta* also being present but less abundant.

The shrub layer is sparse. The characteristic shrubs are *Lycium cinereum* and *Abutilon*

Figure 22: *Salvadora australis* in the *Leucosphaera bainseii* Open Woodland Variant. These photos were taken in November 2001, after the dry season and first rains.

grandiflorum which are most commonly found growing within the *Salvadora australis*.

This variant is at a more advanced successional stage than the other variants in this community, and has most probably reached climax status for this particular type of vegetation and soil type. The soil associated with *Salvadora australis* is brackish.

3.2.3. *Schkuhria pinnata* Open Woodland Variant on Low-lying Plains

This variant occurs on lower lying flat plains to the south and west of Balancing Rock Koppie (Figures 5 & 19). The soil is silty-clayey and is brownish-grey in colour. Dead grass resulting from the floods in February 2000 covers the ground surface.

The diagnostic species for this Open Woodland variant are the forbs *Schkuria pinnata, Neucranthus africanus, Philyrophyll schinzii* and *Brassica elongata* as listed in Species Group K (Table 4).

The grasses, *Chloris virgata* and *Urochloa mosambicensis* have high cover values, while *Setaria verticillata* is common within the *Salvadora australis* trees, which is the characteristic tree.

Lycium cinereum and *Abutilon grandiflorum* are the most common shrubs also found mostly growing within the *Salvadora australis*.

The lower successional status of this variant compared to the *Leucosphaera bainseii* Open Woodland Variant above, is probably due to the damage caused to the vegatation by the floods in 2000, which would have set back the successional status. This area is generally not flooded and waterlogged even during high rainfall seasons as it was during these floods.

3.2.4. *Eriochloa parvispicula* Open Woodland Variant on Low-lying Plains

This variant is found just to the south of Balancing Rock Koppie and Pluchea Koppie (Figures 5 & 19) and occurs on lower-lying flat plains which are water-logged during high rainfall seasons.

The soil is brownish-red, clayey, and cracked during the dry season. The floods in February 2000 have left their mark by the presence of dead grass which was drowned, and very uneven ground.

The diagnostic species are those listed in Species Group M (Table 4). The diagnostic forbs are *Brachystelma elongatum, Hibiscus trionum, Pancratium tenuifolium, Tribulus terrestris, Ruellia cordata* and *Corbichonia decumbens.* The dominant forbs are *Amaranthus praetermissus, Cyathula orthacantha* and the legume *Indigofera schimperi*.

The diagnostic grasses are *Eriochloa parvispicula* and *Aristida adscensionis*. Other common grasses are *Chloris virgata, Dinebra retroflexa,* and *Setaria verticillata* which grows under the trees.

The characteristic tree is *Salvadora australis*, which are quite bare underneath with the exception of a few young herbs like *Cyathula orthacantha* and the grass *Setaria verticillata.*

The associated shrubs are *Abutilon grandiflorum* and *Lycium cinereum* which also grow mostly within the *Salvadora australis*.

The floods in 2000 resulted in this area being waterlogged for a far longer period than in a normal high rainfall season. This flooding, which destroyed most of the herbaceous layer, would have set back the successional status to the early successional stage at which it is presently.

B. *Echinochloa colona – Acacia tortilis* Less Disturbed Main Woodland Community

This main woodland community includes areas around all the dams, along the watercourses and on the low-lying plains and floodplains.

The tree stratum is well-developed, 5 metres tall, reasonably dense and at an advanced successional stage. The herbaceous layer and shrub layer vary from well-developed to under-developed and the tree canopy cover is almost 100 %. The floods in 2000 would also have contributed to the lack of vegetation in the herbaceous stratum, as the flood waters remained for a long period of time, thus drowning much of the vegetation.

This community is mostly under water when the dams are overflowing and while the water is flowing along the Matlamakadi watercourse (Figure 5). This flooding does not usually last for a long period of time, maybe days or weeks at the most.

The soil is mostly silty-clayey but may be sandy in the watercourses.

The most significant form of vegetation is the tree stratum, dominated by *Acacia tortilis,* which is generally 4 – 5 metres tall. Other trees include *Salvadora australis* and *Ziziphus mucronata,* which both have low cover values.

This main community is characterised by species listed in Species Group Z (Table 4). These include the grass *Echinochloa colona* and the forbs *Cyathula orthacantha, Alternanthera nodiflora* and *Litogyne gariepina*.

This main community has four communities and four subcommunities described below:

4. *Acacia nilotica – Acacia tortilis* Woodland Community along Water Courses

This community is found in the flat, lower-lying areas around Nilotica Pool and Pluchea Dam and near Island Kop and Bertha Dam (Figure 5 & Figure 19, Communities 4.1 &

4.2). These areas may be flooded in high rainfall seasons. The soil is a clayey-silt and uneven with numerous large cracks.

Characteristic of this vegetation is the dominance of the trees *Salvadora australis* and *Acacia nilotica*.

The diagnostic species of this community are those listed in Species Group O (Table 4). They are the tree *Acacia nilotica*, which are mostly associated with wetter areas and whose pods have a high nutritional value which are very sought after by the game, and the shrubby tree *Flueggea virosa*.

This community is subdivided into two subcommunities described below.

4.1. *Acacia nilotica - Acacia tortilis - Eriochloa fatmensis* Woodland Subcommunity

This subcommunity is found in the low-lying flat plains where the soil is more clayey. The clayey soil becomes waterlogged during a good rainfall, which is evident by the large cracks. The cracks appear with shrinking of the soil when dry.

The herbaceous layer is well developed with 90% canopy cover. The most conspicuous tree is *Salvadora australis*, which has a canopy cover of about 40%. This is the most densely populated area of *Salvadora australis* in the study area.

The diagnostic species are the grass *Eriochloa fatmensis,* the forb *Lintonia nutans* and the sedge *Mariscus cyperoides*.

The legume *Indigofera schimperi* has a particularly high cover abundance in this subcommunity (Species Group Q, Table 4). The grasses *Panicum maximum* and *Setaria verticillata* are also common but are found mostly in the shade of the *Salvadora australis*.

4.2. Typical Subcommunity

This subcommunity is found behind the dams on the higher floodplains. The soil is clayey but tends to have a higher silt content than the *Acacia nilotica - Acacia tortilis - Eriochloa fatmensis* Subcommunity in 4.1. above. The ground is cracked and uneven due to water activity, with the surface crumbling when trampled.

The herbaceous layer, particularly under the trees, is minimal, having been drowned in the lower-lying areas.

This subcommunity has no diagnostic species and can be distinguished from the previous subcommunity by the absence of the grass *Eriochloa fatmensis*, where it was abundant, and the absence of the forb *Lintonia nutans* and the legume *Indigofera schimperi*.

Whereas *Acacia tortilis* is almost absent in the previously described subcommunity, it is abundant in this Woodland (Species Group AF, Table 4). Other species which have high cover values include the grass *Eriochloa meyeriana* and the tree *Acacia nilotica* which tends to favour wetter areas.

5. *Heliotropium supinum – Acacia tortilis* Woodland Community on Floodplains

This community is found in the overflow floodplain of Bertha Dam towards Alpha Dam, in the floodplains around Kraalkop Dam, Bertha Dam and Alpha Dam (Figure 5 & Figure 19, Communities 5.1. & 5.2.). These floodplains are underwater only briefly during high rainfall seasons and while the dams are overflowing.

The herbaceous layer is well-developed with a canopy cover of 60 to 90 %. An exception is the floodplain area west of Bertha Dam where the vegetation was drowned during the floods in 2000 resulting in a herbaceous canopy cover of less than 5 %.

The diagnostic species for this community are the forbs *Heliotropium supinum* and *Glinus lotoides*. Both these forbs are abundant with cover values of about 50 %.

The most conspicuous and abundant tree is *Acacia tortilis*. *Salvadora australis* is present but with low cover values.

This community is subdivided into two subcommunities described below.

5.1. *Heliotropium supinum – Acacia tortilis – Zaleya pentandra* Woodland Subcommunity on Floodplains

This subcommunity is found in the floodplains of Alpha Dam, Kraalkop Dam and Bertha Dam (Figure 19). These areas are within the high water mark and are flooded when the dams are full and overflowing. The flooding only lasts while the dams are overflowing. The soil is more clayey than in the subcommunity 5.2 below.

The herbaceous layer has a canopy cover of 60 to 80 %, with the grass component being minimal. Large bare patches of soil are also present. The tree layer is dense with a canopy cover of up to 90 %.

The diagnostic species are those listed in Species Group T (Table 4). These species include the forbs *Zaleya pentandra*, *Sphaeranthus incisus, Aster squamatus* and *Moluga nudicaulis*, the grass *Panicum deustum* and the shrub *Phaeoptilum spinosum*.

Some conspicuous species include the herbs *Litogyne gariepina, Cyathula orthacantha, Heliotropium supinum* and *Glinus lotoides*.

The dominant tree is *Acacia tortilis* with a height of 4 to 5 metres, but reaching 9 metres around Bertha Dam. The tree *Salvadora australis* is also conspicuous.

5.2. *Heliotropium supinum – Acacia tortilis – Cullen obtusifolia* Woodland Subcommunity on Low-Lying Plains

This subcommunity is located on the higher floodplains of the dams (Figure 19). The soil is more sandy than the subcommunity 5.1 above.

The canopy cover of the tree layer is not as dense as that of subcommunity 5.1 above and the trees are not as tall, reaching an average height of 4 metres. The herb layer is reasonably dense, with a canopy cover of about 80 %.

The diagnostic species are the herbs *Cullen obtusifolia*, which grows flat on the ground as a result of grazing, and *Withania somnifera,* as shown in Species Group V (Table 4).

The more common species include the forb *Pseudognaphalium luteo-album*, the grass *Urochloa mosambicensis*, which has particularly high cover values, and the shrub *Lycium cinereum*. *Acacia tortilis* is by far the most abundant tree (Species Group AF, Table 4).

6. *Faidherbia albida – Acacia tortilis* Woodland Community around Bertha Dam

This community is found around Bertha Dam, in the floodplain and below the wall (Figure 19). The soil is more silty than the previously mentioned community, and brown to grey in colour.

The tree canopy is very dense and tall, covering 98 % and reaching a height of 20 metres. The herbaceous layer canopy cover is 80 to 90 %, with the grass layer being only about 10 %.

The diagnostic species are those listed in Species Group W (Table 4). These species are the creeping tree, *Phyllanthus reticulatus* and the very tall tree, *Faidherbia albida*, both characteristic of deep soil and an indication of underground water.

The more abundant herbs include *Achyranthes aspera* and *Dicliptera spinulosa,* the latter having a very high cover value. The shrubs include *Grewia subspathulata* and *Abutilon ramosum.*

Acacia tortilis is extremely abundant with cover values of over 75 %. The absence of *Salvadora australis* is noteworthy.

7. *Combretum imberbe – Acacia tortilis* Woodland Community in Dam Floodplains

This community is found in the dam floodplains and in the lower-lying area along the watercourses (Figure 19). The soil is greyish-pink in colour, silty-clayey and crumbles when trampled.

The canopy cover of the herbaceous layer is about 75 %, with the grass cover being more dominant. The tree layer has a canopy cover of 60 to 90 %, and reaches heights of about 6 metres.

The diagnostic species are those listed in Species Group X (Table 4) and include the forbs *Bidens pilosa, Datura ferox*, which are both weeds, and *Commicapus pilosus* and the grasses *Cenchrus ciliaris* and *Panicum coloratum.*

The diagnostic trees are *Combretum imberbe* and *Acacia grandicornuta* which is associated with rivers and drainage lines.

Other abundant species are the forbs *Justicia flava, Cyathula orthacantha, Dicliptera spinulosa* and *Sida cordifolia*, the grasses *Echinochloa colona, Urochloa mosambicensis, Panicum maximum* and *Setaria verticillata* and the shrubs *Grewia subspathulata.*

The most abundant tree is *Acacia tortilis.* Other trees include *Ziziphus mucronata* and *Salvadora australis,* both of which have low cover values.

C. *Lonchocarpus capassa – Acacia tortilis* Riverine Main Woodland Community

This main community is located in the riverine woodland and on the high and lower banks of the Limpopo River.

This vegetation has reached a climax stage, with the exception of the lower-lying banks of the Limpopo River where the flooding in 2000 drowned most of the herbaceous and shrub stratum, as well as some trees. Large amounts of sand was also deposited. These floods have set back the successional status of this lower-lying area from a climax status. However, the tree layer is more stable than the herbaceous and shrub layer which are more dynamic due to floods and other disturbances.

This main community has one of the largest diversities of trees. The trees are large with wide canopy covers. The diagnostic species for this main community are shown in Species Group AD (Table 4). These diagnostic species are the trees *Lonchocarpus capassa* which reach heights of 30 metres, *Croton megalobotrys* and the ramblers *Combretum mosambicensis* and *Acacia schweinfurthii*. *Acacia tortilis* is common in this main community and has reasonably high cover values

This main community is subdivided into three communities described below.

8. *Albizia anthelmintica – Acacia tortilis* Woodland Community in High-lying Riverine

This community is a high closed woodland with tall trees and a well developed grass layer. It is located mostly in the flat, higher riverine but also around the dams (Figure 19). The soil is grey in colour, silty-clayey and reasonably loose.

The diagnostic species are those listed in Species Group AA (Table 4), which are the trees *Albizia anthelmintica* and *Ehretia rigida,* the grasses *Urochloa oligotricha* and

Eragrostis nindensis and the legume *Hypoestes aristata.* The shrub *Grewia tenax* is also diagnostic for this community.

The most conspicuous tree is *Acacia tortilis*, which reaches heights of up to 12 metres in the riverine. *Salvadora australis* are present but less abundant and very large, reaching 5 metres in height and up to 7 metres in width. Other common trees are *Croton megalobotrys* and *Lonchocarpus capassa*, both of which are common in the riverine and where the alluvial soil is deep.

The dominant grasses, in order of dominance, are *Urochloa mosambicensis, Panicum maximum* and *Setaria verticillata*.

The shrubs are tall and include *Grewia flavescens, Abutilon ramosum, Abutilon angulatum* and *Lycium cinereum*. The herbaceous layer is not well developed. The most common herb is *Achyranthes aspera*.

9. *Xanthocercis zambesiaca – Acacia tortilis* Closed Woodland Community on High Banks of the Limpopo River

This community is found in the higher-lying riverine but close to and adjacent to the Limpopo River (Figure 19).

The alluvial soil is deep, a silty-clay and grey in colour. The trees are very large and very tall, reaching up to 30 metres tall with an equal canopy width. The grasses are more abundant than the forbs in the herbaceous layer. This community has reached climax status.

The canopy cover of the shrub stratum is 15 to 20 % and is dominated by *Abutilon ramosum*.

This community is diagnosed by the grasses *Urochloa panicoides, Brachiara deflexa* and *Setaria sagittifolia* and the creeper *Pergularia daemia* as shown in Species Group AB (Table 4).

The diagnostic tree, which is also the most conspicuous, is *Xanthocercis zambesiaca,* which reaches heights of 30 metres with a canopy spread equal to the height.

The herbaceous and shrub layers are not as well developed in the solid shade underneath the larger trees as in the semi-shade or full sunlight. The shrubs, specifically the *Grewia spp*, are very large. These include *Grewia flavescens, Grewia subspathulata* and the Abutilons which also grow in the shade and include *Abutilon ramosum, Abutilon angulatum* and *Abutilon grandiflorum*.

The grass layer is characterised by *Urochloa mosambicensis* and *Panicum maximum*, which are the most dominant grass species, and *Setaria verticillata.*

10. *Dovyalis caffra – Acacia tortilis* Woodland Community in Low-lying Riverine

This Community is found in the lower-lying riverine adjacent to the Limpopo River and East of Gabion Wall on the East border (Figure 19).

The soil is light grey to brown in colour and is silty. These areas were under water for a couple of months during the floods in February 2000 which resulted in the formation of large gulleys and huge amounts of silt being deposited.

The herb and shrub stratum have low species diversity due to most of the vegetation being drowned and the silt deposits during the floods. The trees are very tall, with average heights of 9 metres but attaining heights of up to 22 metres. The tree stratum has a canopy cover of 80 %. There is high species diversity amongst the trees. The large number of dead individuals of *Croton megalobotrys* which drowned during the flooding is noteworthy. The lower-lying riverine is underwater when the Limpopo River is full, which is usually only for short periods. The area east of Gabion Wall (Figures 5 & 19) is underwater for short periods during heavy rains, as the rainwater enters Breslau at this point.

This community was a climax community before the floods in 2000. However, the damage caused by these floods has set this community back to a lower successional status.

The diagnostic species for this low-lying woodland are those listed in Species Group AC (Table 4), and include the tree *Dovyalis caffra*, the creeper *Cocculus hirsutus*, the grass *Eriochloa meyeriana* which is very tall, and the shrubs *Nidorella resedifolia* and *Datura innoxia*, whose seeds were deposited with the silt.

Other trees which have high cover values include *Lonchocarpus capassa*, *Croton megalobotrys*, *Combretum imberbe*, *Acacia tortilis*, *Faidherbia albida*, *Ziziphus mucronata* and the scrambling trees *Acacia schweinfurthii* and *Combretum mosambicensis*.

Other common species include the grass *Panicum maximum*, the forbs *Pseudognaphalium luteo-album* and *Litogyne gariepina*, the shrub *Solanum panduriforme* and the creeping tree *Phyllanthus reticulatus*. *Litogyne gariepina* and *Panicum maximum* are the most abundant species in the herbaceous layer and are more conspicuous along the higher ridges of the gulleys.

ORDINATION

An ordination algorithm, DECORANA (Hill 1979b) was also applied to the floristic data to determine possible environmental and disturbance gradients. The results were also used to confirm the order of the communities and variations in the TWINSPAN generated phytosociological tables. These results are shown in Figure 23.

On inspection it seems that the vegetation communities are distributed along a salt content moisture gradient on the first axis. On the left of the diagram are the communities which are below the high water mark and are under water when the dams and Limpopo River are full. The salt content of the water is low. These include community 10 (the *Dovyalis caffra – Acacia tortilis* Woodland Community) and subcommunity 5.1 (the *Heliotropium supinum – Acacia tortilis - Zaleya pentandra* Woodland Subcommunity). On the right of the diagram are the communities which are found on higher ground and unlikely to be under water even during floods, and the underground water has a very high salt content, up to 18 grams per litre of water. These include communities 1 (the *Eragrostis porosa – Alternanthera pungens* Sparse Woodland Community), 2 (the *Boerhavia diffusa – Boscia foetida* Open Woodland Community) and 3 (the *Portulacea oleracea – Salvadora australis* Open Woodland Community). Thus, the first axis probably represents the salt content of the water table, with higher salt content to the right and lower salt content to the left.

The second axis may represent a soil texture gradient, with the more clayey soil being at the bottom of the diagram and the more silty soil being at the top. Thus the communities with the more clayey soils are to the bottom of the scatter diagram and those with the more silty soil, as in the riverine, are towards the top. Subcommunity 5.1, the *Heliotropium supinum – Acacia tortilis - Zaleya pentandra* Woodland Subcommunity, is at the bottom of the scatter diagram and is located in the high-water level of the dams, which are clayey. Communities 9, the *Xanthocercis zambesiaca – Acacia tortilis* Woodland Community, and 10, the *Dovyalis caffra –Acacia tortilis* Woodland Community, are both in the riverine and have more silty soils.

DISCUSSION

According to Acocks, the study area is part of the Mopaneveld. However, the vegetation unit covered in this paper, has no *Colophospermum mopane* present, and would thus be more suitably classified as the Arid Sweet Bushveld. (Acocks 1988). *Acacia tortilis* is found throughout the Mopaneveld and the Arid Sweet Bushveld. Very little information

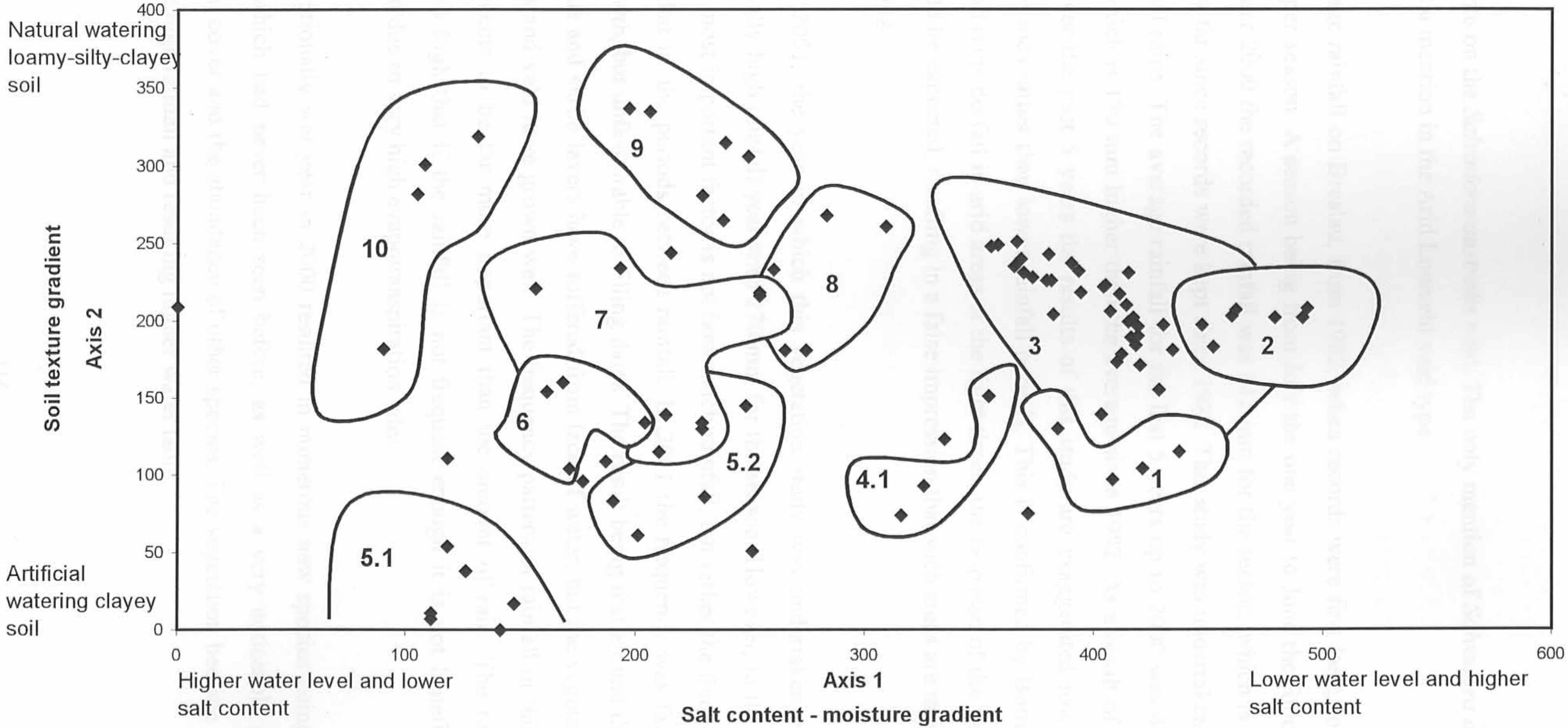

Figure 23: Scatter diagram of the relevés along the first and second axis of a DECORANA ordination for the *Salvadora australis - Acacia tortilis* Major Woodland Community showing the vegetation units

is available on the *Salvadora australis* veld. The only mention of *Salvadora australis* by Acocks is a mention in the Arid Lowveld veld type.

The average rainfall on Breslau, from 1982, when records were first kept, to 2000, was 277 mm per season. A season being from July the one year to June the following year. For the year 2000 the recorded rainfall was 812 mm for the season, which is the highest rainfall by far since records were kept since 1982. This study was undertaken after these exceptional rains. The average rainfall for the last 5 years up to 2000 was 447 mm per season, which is 170 mm higher than the average since 1982. As a result of this higher rainfall over the past 5 years the results of this study are exaggerated towards higher rainfall periods rather than lower rainfall periods. This is confirmed by Bothma (1989): when good rains do fall in arid areas at the right times, the response of the veld is better than would be expected, resulting in a false impression that such areas are more adequate for ranching.

The year 2001, the year in which this vegetation study was undertaken, was not an exceptionally high rainfall year with 270 mm for the season. However, in the area under study the most important factor is not how much rainfall, but rather the frequency of the rainfall, that is, the periods between rainfall. In 2001 the frequency was favourable to plant growth, but unfavourable to filling dams. The result being that around the dams the herbaceous and shrub layers have suffered from lack of water, but the vegetation out on the plains and veld have grown well. The frequency pattern of rainfall in this particular climate seems to be far more important than the amount of rain. The temperatures become so high that if the rainfall is not frequent enough it is not beneficial to the vegetation due to very high evapotranspiration rates.

The exceptionally wet year in 2000 resulted in numerous new species being found on Breslau which had never been seen before, as well as a very noticeable increase in vegetation cover and the abundance of other species. The vegetation became very dense due to the high rainfall and resulting higher water table.

A most common type of soil in the study area is a sodic soil, which is highly erodable and unstable. The soil in the *Salvadora australis – Acacia tortilis* Major Woodland Community also has a high salt content and is susceptible to drought. Erosion, which is prominent on Breslau, needs to be addressed in both the *Salvadora australis – Acacia tortilis* Major Community as well as in the *Colophospermum mopane – Hibiscus micranthus* Major Community. The positive change in the vegetation resulting from dams and contour walls can be seen in the *Echinochloa colona – Acacia tortilis* Main Woodland Community (Chapter 4, Section B, Community B), specifically in the *Heliotropium supinum – Acacia tortilis* Woodland Community, the *Faidherbia albida – Acacia tortilis* Woodland Community and the *Combretum imberbe – Acacia tortilis* Woodland Community (Chapter 4, Section B, Communities 5, 6 and 7 respectively). This improved condition of the veld increases the carrying capacity on Breslau. The construction of dams and contour walls increases the woody layer which is the more stable stratum, as well as the herbaceous layer, which is less stable due to seasonal/occasional flooding.

The dams are surrounded by dense stands of tall *Acacia tortilis* trees. The construction of contour walls also encourages the growth of the vegetation, of which *Acacia tortilis* are the pioneers and the most dominant trees. The herbaceous layer is also greatly improved around the dams, but is less stable due to seasonal flooding and drought. The *Acacia tortilis* pods are a valuable food source for the browsers, as well as the grazers who eat the pods off the ground. In the very dry seasons this is the only food available to the game. During flooding, the herbaceous layer dies down, and the pods remain a source of food in these areas. However, where the *Acacia tortilis* are very dense, they may be thinned out to allow the canopy's to spread which will increase pod production.

The presence of *Salvadora australis* is an indicator of brackish soils. This is confirmed by Gertenbach (1983) in the *Salvadora australis* floodplains in the Kruger National Park. *Salvadora australis* are found on flat floodplains, which is also the case in the Kruger National Park (Gertenbach 1983, van Rooyen, et al 1981)

The vegetation in this study area is relatively homogeneous (Species Group AF,Table 4). In spite of this homogeneity, the classification resulting from using TWINSPAN (Hill 1979a), and the refinement thereof using the Braun-Blanquet procedure, these vegetation units are easily recognisable in the veld.

The stratification based on the three terrain units was effective in that the entire farm was covered and all areas were classified (Figures 12 & 20). The *Chloris virgata – Salvadora australis* Main Woodland community, which includes the *Eragrostis porosa – Alternanthera pungens* Community, the *Boerhavia diffusa – Boscia foetida* Community and the *Portulaca oleracea – Salvadora australis* Community (Communities 1, 2 and 3 respectively) occur on the midslopes and plains. The *Echinochloa colona – Acacia tortilis* Main Woodland Community occurs on the footslopes which include the floodplains. The *Lonchocarpus capassa – Acacia tortilis* Main woodland Community occurs in the riverine which includes the lower-lying floodplains. The crest and scarp, which include the koppies, rocky outcrops and ridges and the higher-lying midslopes are covered by the *Colophospermum mopane – Hibiscus micranthus* Major Community in Paper One.

For the first time in the history of Breslau, some communities are at an advanced successional stage, which is probably the climax for this vegetation under these conditions. An example of such a community is the *Leucosphaera bainsii* Woodland Variant (Chapter 4, Section B, Community 3.2.2.). The most dominant species in this variant is the grass *Urochloa mosambicensis,* which is an indicator of the good condition of the veld, and in this case may be an indicator of a climax successional state. Even though a number of species which are not climax species are present, for example *Aristida congesta* subsp. *congesta, Tribulus zehyeri* and *Boerhavia diffusa,* considering the salty and sodic conditions of the soils and the climatic conditions, these communities may be considered having reached a climax successional stage. Due to the droughts and very warm temperatures of the study area, pioneer species and species in the early successional stage will always be present. However, certain communities which have not recovered from the floods in 2000, and which were in an advanced successional stage before the floods, have been set back to an earlier successional stage. These communities include the *Eriochloa parvispicula* Open Woodland Variant and the *Dovyalis caffra* – *Acacia tortilis* Woodland Community (Chapter 4, Section B, Communities 3.2.4 and 10, respectively), both of which were at an advanced successional stage before the floods, but were under water for long periods of time during the floods. Most of the communities would, however, be somewhere between the earlier and more advanced successional stages.

Before a wildlife program can be established for the study area, a detailed study on veld condition and carrying capacity would need to be conducted. Due to the very unreliable rainfall in the area, studies would need to be conducted in the wet and dry seasons. The dry seasons are a major limiting factor regarding carrying capacity of game as no visible food is available. During droughts the game has to be fed.

This study may be used as a basis for further studies to develop an effective management plan for the area.

Table 4: Phytosociological table of the *Salvadora australis - Acacia tortilis* Major Woodland Community of Breslau Game Farm

Unique releve no.	98	99	100	102	112	113	33	34	35	36	37	38	4	5	6	1	2	3	8	12	14	15	16	18	19	20	21	22	23	7	9	10	11	13	17	24	26	29	25	27	28	30	103	125	31	32
Main Community	A																																													
Community	1				2								3																																	
Subcommunity					21		22						31			32																														
Variant																321			322																				323						24	
Species Group A																																														
Heliotropium giessii	r	r	r	+																																										
Chenopodium carinatum	+	r	+	+																																										
Eragrostis porosa	r	r	+	+																																										
Alternanthera pungens	r	r	r	r																															r											
Dactylocteni aegyptium	r	r	r	r							r								r	+	r										r															
Cadaba aphylla		r	+				+																																							
Indigofera sordida	r	r		r																																										
Aizoon glinoides			r	r																																										
Species Group B																																														
Corchorus asplenifolius					r		+	+	+	+	+	+								+						r			+		r	+			r										1	+
Aristida congesta s. barbicollis						3	a	a											1																											
Eragrostis trichophora					1	r	r	r	r	r	+								+	+				r		a		r	+																	
Barleria bremekampii						+	r	r		r																																				
Species Group C																																														
Hermbstaedtia fleckii	r	r			+	+																																								
Balanites pedicellaris		1			+	+																																								
Acacia senegal v. rostrata					r	+													r	r																										
Aptosimum lugardiae					r	r																																								
Commiphora glandulosa						+																																								
Species Group D																																														
Geigeria burkei							+	+	+	+	+	1								r		+		+	r	r			+		r						+							1	r	
Verbesina encelioides							+	1	1	+	+																																			
Commelina erecta							+	+	+	+	+	r																						+				+	+						+	+
Evolvulus alsinoides							r	+	+	+	+	+																	+																+	1
Cleome gynandra							+	+			+																																			
Boscia albitrunca								+	1																																					
Aptosimum lineare								+	+																																					
Kigelia africana							+	r	r																																					
Hermbstaedtia odorata							r	r	+		+					+				r																										
Species Group E																																														
Boscia foetida	1	1	+	+		1	1	+	1	1	+	+																															r			
Leucas sexdentata	r	r	r	+	+	r	r		r			r							+																			r					r			
Chenopodium album			r			r	+	+	+	1		+					r	+							+	+		r						+												
Eragrostis cilianensis	r	r	+	+		r		+																																					r	
Species Group F																																														
Portulaca oleracea													+		+		+	+	+	+	+		r	+		+	+	+	+	+	+	+	+	+	+			+	r		r	+			+	+
Species Group G																																														
Acacia nebrownii													a	a	a																															
Dipcadi marlothii													+	+	+						r	r		r							r				+											
Species Group H																																														
Gisekia africana						r	r	r			r				+	1	+	+	r						1				r																	
Solanum coccineum						+	+			+			+					r				+			+	1	+																			
Species Group I																																														
Leucosphaera bainesii																			1	+	1	1	+	+						r	1	1	a	+	1											
Commelina benghalensis														r					+	+					+																r	+				
Sida chrysantha											+										r			r					+																	
Momordica balsamina									r				r							r					r																			r		

Unique releve no.	126	128	130	127	163	173	116	117	142	143	152	153	154	166	132	141	155	156	157	115	158	159	168	129	131	164	165	174	175	179	180
Main Community	B																														
Community	4						5													6				7							
Subcommunity	41			42			51								52																
Variant																															
Species Group A																															
Heliotropium giessii																+												+	1	1	
Chenopodium carinatum									+	+																			+		
Eragrostis porosa																															
Alternanthera pungens																						+						+	+		
Dactylocteni aegyptium		r																+	+												
Cadaba aphylla																															
Indigofera sordida													r																		
Aizoon glinoides												1																			
Species Group B																															
Corchorus asplenifolius	r	r																													
Aristida congesta s. barbicollis																															
Eragrostis trichophora																									r				r		
Barleria bremekampii																															
Species Group C																															
Hermbstaedtia fleckii																										+					
Balanites pedicellaris																															
Acacia senegal v. rostrata					a														+												
Aptosimum lugardiae																															
Commiphora glandulosa																															
Species Group D																															
Geigeria burkei																			r												
Verbesina encelioides																							1								
Commelina erecta																															
Evolvulus alsinoides									r																						
Cleome gynandra																															
Boscia albitrunca																														+	
Aptosimum lineare																															
Kigelia africana																															
Hermbstaedtia odorata																															
Species Group E																															
Boscia foetida										+									+											+	
Leucas sexdentata																		r													
Chenopodium album							r	+	+	a		1	1			+	+														
Eragrostis cilianensis																															
Species Group F																															
Portulaca oleracea																															
Species Group G																															
Acacia nebrownii	+																														
Dipcadi marlothii																															
Species Group H																															
Gisekia africana																															
Solanum coccineum																															
Species Group I																															
Leucosphaera bainesii					1																										
Commelina benghalensis																															r
Sida chrysantha																		1													
Momordica balsamina																															

Unique releve no.	114	140	145	133	135	139	144	134	136	137	138	160	161	162	177
Main Community	C														
Community	8					9						10			
Subcommunity															
Variant															
Species Group A															
Heliotropium giessii							r								
Chenopodium carinatum						r									
Eragrostis porosa															
Alternanthera pungens															
Dactylocteni aegyptium	r														
Cadaba aphylla					+										
Indigofera sordida															
Aizoon glinoides															
Species Group B															
Corchorus asplenifolius										r					
Aristida congesta s. barbicollis															
Eragrostis trichophora															
Barleria bremekampii	+														
Species Group C															
Hermbstaedtia fleckii															
Balanites pedicellaris		r								r					
Acacia senegal v. rostrata															
Aptosimum lugardiae															
Commiphora glandulosa															
Species Group D															
Geigeria burkei															
Verbesina encelioides						1				+	1	1			
Commelina erecta															
Evolvulus alsinoides															
Cleome gynandra															
Boscia albitrunca											a				
Aptosimum lineare															
Kigelia africana				+											
Hermbstaedtia odorata															
Species Group E															
Boscia foetida	1														
Leucas sexdentata										r	r				
Chenopodium album					r	+	1								
Eragrostis cilianensis															
Species Group F															
Portulaca oleracea															
Species Group G															
Acacia nebrownii				+	1										
Dipcadi marlothii															
Species Group H															
Gisekia africana															
Solanum coccineum		+													
Species Group I															
Leucosphaera bainesii															
Commelina benghalensis		r													
Sida chrysantha	r														
Momordica balsamina											r				+

Species Group J																																																																																												
Hypertelis salsoloides	3	b	1	r	+	+	+	+	+	+	+	+	+	1	+	+	+	+	+	+					+	+	+	+	+	+	+	+		+	r										+								r						1			r	+		+																							r					
Hermannia modesta	r	r	r		+	+	+	+	+	+	+	+	+	+	+	r	+	r	+	+	+			+	+	+	r	+	+	+	+			+	+										r											r						r			r																											
Species Group K																																																																																												
Schkuhria pinnata																																							+			1	+	+							r																											r																
Neuracanthus africanus																																							+	+	+	+			r																																																	
Philyrophyllum schinzii																																			r				r	+	+				1																																																	
Brassica elongata																																									r		r		1																																														
Species Group L																																																																																												
Aristida congesta s. congesta		r		r	b	3	+	1	b	b	3	b	+	+		r					1	+		a	1	1	1	a	a		1	1		1	1		1					+																																																						
Enneapogon cenchroides	r	r	r		r	+	+	+	+	+	+	+	r		+				+	1	+			1		+			r	+	+	+	+	+	+	r	+	r	r	1		r											r								r		1		+		+								1	+							r										
Trianthema salsoloides	1	1	+	+	+	+				r			1	1	+	1	1	1	+	1	1			1	+	+	+	a		+	1		+	1	1	r	+	1	+	1	+		+	r											+				1				1														+							1										
Heliotropium steudneri						+	+	+	+	+	+	r	+	+	+	+	+	+			r	+	+	+	r	r	r	+	+	+				r					r		r																						+	1				1																						r									
Limeum sulcatum					r	+	+	+	+	+	+	+			+	1		+	+	+				+	+	+		+	r		+	+		+	+								r																							r													r											r									
Cucumis metuliferus			r				r	r	r	r	r	r		+		+	+		+	r	r			r	+	r	1	r	r					r	r						r						r				r		r		r						+			r																					+							r							
Cyathula lanceolata				r		r		r	r	r		+							+	+	+		+			+	+		1		+	+					+					+									1																																													
Justicia matammensis																									+	+				r	+										+		r																																					r								+								
Acalypha indica							+			r																				+							+				r			r															+																							+					r											
Species Group M																																																																																											
Eriochloa parvispicula																																												|b|b|																																																
Hibiscus trionum																																													1	+		r									r		+																																					
Brachystelma elongatum																																												|1|																																																	
Pancratium tenuifolium																						r	r																																																																							
Tribulus terrestris																																												|+|+|																																																
Aristida adscensionis																																												|+|																																																	
Ruellia cordata																																													|+|																																																
Corbichonia decumbens															+																														+	r																																																	
Species Group N																																																																																												
Boerhavia diffusa	r	+	+	r	4	1	3	b	3	3	4	4	+	+	+	1	1	1	1	1				1	a	+	1	1	1	1	1	+		+	1		r	1	r	r		r			1																r														1			r	+														
Chloris virgata	r	r	r	r	+	r	+		+	+	+	1	+	+	+	+	r	+	+	b	a			a	1	1	+	+	+	1	1	1	1	a	b	1	b	3	1	4	a	1	3	1	a		r		+			+							1		r		+	1	1									1	+			r			r	r	r				1	r				
Tribulus zeyheri	+	1	1	a	1	a	a	1	1	+	1	1	+	1	1	1	1	1	+	1	1	r		1	1	1	+	1	+	1	+	+	+	1	a	1	+	+	+	+	+	r	r	r	+										r	r			b					+	+						+				+	+																
Amaranthus praetermissus	+	r	1	+		r		+	+	+	+	+	+	+	r	+	+	+		+	+		r	+	+	+	+	+	+	+	+	+	+	+	+	+	r	+	r		r	r		+	+	r					+	+					r	1	+		+		+								+	1			+	+		r	r		r	r			+			r				
Cucumis zeyheri	r	r	r	r	r		r	r	r	r	r	r	+	+	+	r	r	r	+	r		r	+	r	r	r	r	r		r	r	r		r	r	+		r			+			r	r	r															r	r				r					r					r			r													
Ammannia baccifera	+	b	b	b						+	+		1	+	1	1	1		+	+				+	+			1		1	+	+						r			r		+		+														+		+	r	1																																
Tragus berteronianus	r	r	r	r			+			+			+	+	+	1	+	+	+					+		r	r	+		+	+	+	+	+				r		r	r				r																r																																			
Leucas glabrata				r				r												+							+		+	+	+		+	+		1	1	1	1	1	1	1			1																									+				1	+																		
Denekia capensis							r	+						+	+												1											r	+		r	+			+																																																
Flaveria bidentis	r	r																													r							r					+	1	r		+										r				r									+	r		r	1		r																
Species Group O																																																																																													
Acacia nilotica																																											r	r			r		+	4	a	3		1			1	a		1									1						b	1	a													1		
Flueggea virosa																																															r	+	+	1	1		r			+										r						+	+				1							+									1
Species Group P																																																																																												
Eriochloa fatmensis																																												r		+	4	4	1						r	r			a																																						
Lintonia nutans																																														|+|+|r|																																															
Mariscus cyperoides																																															r	r		r																								+																		
Species Group Q																																																																																												
Indigofera schimperi																			+	1	+						+	+		+	+	+	1	1	+		r	r	r	r	r	r			+	+	b	b	4																																																	
Species Group R																																																																																												
Phyllanthus parvulus			r		+	+	r	r	r			r				+	+	+		+	+		+	+	r	+	+	+			r	+	r	+	+	+						+			+	+	r	r							+				r																										+		+		+	+				
Species Group S																																																																																												
Heliotropium supinum																																													r								a	4	4	4	b	b	3			a	b	+	+			+																	1								
Glinus lotoides																																												r		r					+		1	1	3	3	3	b	a	+		+	1	+	+			+										+	+								a					+			+
Species Group T																																																																																												
Zaleya pentandra																																																						r	+	+			+																										+								
Sphaeranthus incisus																																r																					1	+				1								1																								+	+		
Panicum deustum																																																					1	1																					+																		
Aster squamatus																																																			r		r	+		r			+												+				+																	
Mollugo nudicaulis																																														+												+	+			r																														

Phaeoptilum spinosum															r																																								1	1									1																											
Species Group U																																																																																											
Dinebra retroflexa																																												b	1	a	1	1	r	+					+	r	r	1	1								+																									
Species Group V																																																																																											
Cullen obtusifolia																																																											+			+	b																													
Withania somnifera															+																																											1	r		r	+	+	1			+																							
Species Group W																																																																																											
Phyllanthus reticulatus																																																																		+	a	a																				r	1	1	1	1
Faidherbia albida																																						r																	a	a											b	1																					a	a		
Species Group X																																																																																											
Datura ferox	r		r																																								r					r		r						1					1									1	a			1	+		+															+
Cenchrus ciliaris																																																																						+				+	1	+	1											+				+
Combretum imberbe																																																																								a			a	a	a			1					a					b		a
Acacia grandicornuta																																														+																										a	a																			
Commicarpus pilosus	+		+																																																																								1	1			1													
Bidens pilosa																																											+																		+								r					+			1															
Panicum coloratum																																											r																											+						+																
Species Group Y																																																																																											
Acanthospermum hispidum	+		r	+																																							r																	3								a		+			+			1	+														
Grewia bicolor	r	r																																																											r						+	1	+						1	a										+						1
Plumbago zeylanica																																																					r														+	1		r	+																					
Abutilon pycnodon			r	r																										r						+																r												+	+				+						+				r	+												
Ocimum americanum						+						r													+																																							r	r				+						+		+															
Species Group Z																																																																																											
Echinochloa colona	r	r		r											+																														r	1	3	b	r	1	a			+	+	+			a		+					+	+			+	+	1	1		+	+	a							a								+
Cyathula orthacantha		r																																					+		1		+		1	1	1	+	1		1			r	+	+	1	+	+			r								+	a	1	1	+	+	+	+															
Alternanthera nodiflora			r	r																																							r				+	+		+	1		r		+	1	1	1	+		a	r		+		+						+			+	+	1												+			+
Litogyne gariepina													+					r			r							r							r									1						r	+	+	4	3			3	3	a			+	1	3	a			b	1						+	+							r	+					5	1	3	
Species Group AA																																																																																											
Urochloa oligotricha																																																																																	1	1	3		1	1								
Albizia anthelmintica					+							r		1																																																							a									1				b	1									
Hypoestes aristata							a																																																													a									1		b			1					1				
Ehretia rigida																																																																								+							r	+								r				
Eragrostis nindensis																r		r						r											r																																								1	+			r		r	1										
Grewia tenax																																	+										r					r	1																								+	+					+		r	+											
Species Group AB																																																																																											
Urochloa panicoides																1			1											+	a	a													a		+														+																					3			a	a	1	a				
Pergularia daemia																											r	r																	+																						r													1					1	+		+				
Xanthocercis zambesiaca																																																																																			3	b			3	b				
Brachiaria deflexa																																																																			+								+	+	+				r		+	+	1	r	1	+				
Setaria sagittifolia																																																																																			+		1		1	+				
Species Group AC																																																																																											
Eriochloa meyeriana																																														r	r			4	a							1												b																			+	3	a	
Dovyalis caffra																																																																																									1	a	1	
Cocculus hirsutus																																																																			1																	+					1	+	1	1
Datura innoxia			r																				r																																																																	1	1		
Nidorella resedifolia																																																																																									1		+	
Species Group AD																																																																																											
Lonchocarpus capassa																																																																												1			a	b			a	b	a	b	b	a	3	b	3	1
Croton megalobotrys																																																																							1							+	1	1		r	a	a	a	1	b	1	a	a	b	b
Combretum mossambicensis																																																																	+						r		1				+				+				a	+	1	1		+	+	+
Acacia schweinfurthii																																																																																					a	+	1	1	a	+	1	b
Species Group AE																																																																																											
Achyranthes aspera			r																																							r					r									1					1	1		r		a	1	b	+	+	+		1		+	+		1	+	+	+	1	1	b	+	1	+		+		1	
Justicia flava																																																			+			r		1									a	a		1	+	r	a		+	a	+	1	1			+				+	1				+		+	+
Grewia subspathulata						r		r				r								+																											r	+	1											r	r			+	+	+	1	1	+	+	1			+	b	b	3	r			+	1		+	1	1	1	1			+	a
Dichrostachys cinerea																																																			+	1									r			+	+		1	+			r				1	1	1	1		+			+	r			1					1

Maytenus heterophylla																																																													1							+	r																		4					a		
Abutilon angulatum			r		r	r		+			+	+	+	+																										r																			+	+	r	+		+				+			+				+		+	+	+	1	r	+	1	a	1	a	1	1				
Maerua juncea			r		r																																																									r			r			r							r				r		r				r							
Abutilon ramosum						r																						+														1													r	+				1		+					b	a	+		+		+		+	+		r	1	1	1	1	b	a	a	b	r	a	+		+	+
Grewia flavescens																				+						1																							1													+					1	1	1		1				1	1	a	r	+	+	+	1	1	+	1	1	1	1			+	1
Ziziphus mucronata																																																		1			+	+						+							+	1	r		1	+		+	1	1	1	1	r		+				+				+	1		b
Species Group AF																																																																																															
Acacia tortilis	1	1	1	1	1	1	1	a	1	a	1	1	r	r	+	+	+	+	+	+		+	+	+	r	+	r	+	+	+	r	+		+	+		+	+	r	r	r	+	r	1	r			r	r	a	4	3	4	4	3	3	3	3	b	5	4	3	4	5	5	5	4	4	4	3	4	4	4	4	b	3	b	4	a	b	3	b	a	b	a	3	a	a	b	3	a	a
Urochloa mosambicensis	r	+	1	+	a	b	1	a	+	1	+	a	+	+	+	1	1	+	3	b	b	4	4	a	b	4	5	a	3	4	3	3	b	a	b	5	3	3	4	3	4	4	4	+	1				r		1		+	r	r	+			1			5	3	b	4	a			1	+	b	b	3	a	4	4	a	4	5	3	b	3	4	3	3	4	a	3	+	a	1	
Dicliptera spinulosa	r		r				+	+		r	r																						+											+			1	1	+	+	a	1	a		+					1	b	+		1	a	5	3	b	b	1	a	b	3	a	1	1	b	1		1	+		+	+	1		1	1	1			1
Panicum maximum			r				r	r	+		+					1	+													+	+															+	+	a	a		+					r			1	+	r					1		a	1	3	1	1	1	1	+	1	3	1	r	3	3	3	3	a	3	b	4	3	1	4	3	+
Salvadora australis		+		1	+	b	a	1	+	1	1	1	1	r	r	1	1	1	a	a	a	a	a	a	a	a	a	a	a	b	1	a	a	a	a	a	b	a	a	a	b	b	a	3	b	b	b	3	3		1	1			1	1	1	1	b	a	+	1		r						+		1	a	1				1	r	1	3	b			a							
Solanum panduriforme	r		r	r			+	+	+	+			+			r	r			+	+		1		+			+						+						r			+	r		r							r	r	r	r		r	+		+			r		+	+	1		1	a	+		1			1	1	+	+			+	1	+	1			+	+	+	+
Setaria verticillata	r		r			1		+	+	+	+	+	+		+	+	+	+		+							1			+	+	+	1	1	+	a	1	+	1	1	1	+	1	1	a		1	a	b		+	+			r	+			1		r	1	+	1			1	1	1		+	b	1	1	1	1		+	+	1	+	1	1	a	1	1	1	1	+		r	
Sida cordifolia	r	r	r	r	+	r	1	1	1	1	1	1					r	r					r		+	+	r		+			r			+		+		+	+	r		+	1	+	+	r	1	r		+		r	r	+	+			+	+	r		1	+	1	r	1		+		+	b	1	+	+	+	+	r	+				1		r				+			+
Abutilon grandiflorum	r	r	r		r	r	1	+	1	+	+	+	+		+		+		r	+	+	+	1	+	r				1		r		r	+	1			r	1	+	1	1	r	r	1	+	+	+	+		+	+	r		+	+			1	1	+	+					1	1	+	+	+	+	+	a	+	+	+	r	+	1	r		+	1	1	1	1	1				+
Lycium cinereum	r	r	+	r	r	+	1	+	+	+	+		+	+		+	+		+	+	+	+	1	+	1	1	1	1	+	+	+	+		+	+	+	1	+	+	+	1	+	+	+	+	1	+	+	1		+	r	r	r			1	a	1		+	1	+	+	+	+	+		1	1	+	+	1		+	1		+	a	+	+	1	+	+	r	r	+					
Pseudognaphalium luteo-album			r				+	+	+	+		r	r	+					r						r					r		r		r	r	r	r	r	r						+	r							r		1	a			r		r	+	+	1	+	r		+	r						+						r		r	+	r	r	r	r	1	+	1	+
Pupalia lappacea	r		r			+	1	+	+	1			+		+											r																r			1			+	+																+			+			+		1		1	+	1	1	+		+	r										
Ruellia patula												+	+											r				1		+			r						+			r			1		r	r											+			r			+					r	r		+			+	1		+		r	r	r	+								
Digitaria velutina									+	+	+	+												r																											+				r	r									+			+	+			1			+									+		r		1					
Commicarpus plumbagine		r	+		+	r									+						+			+									+																														1	1		1		+											+	r	1										
Scarce Species List																																																																																															
Sida dregei																										+																																																																		
Asparagus suaveolens																																																				|r|																																			|r|					
Waltheria indica																																																																								+																				
Asparagus nelsii																											+																																																																	
Rhynchosia totta																																																																																															|a
Blepharis aspera																		|r|																																																																										
Kyllinga alba																																																				+																																											
Ruellia otaviensis																																																																																	+														
Melinis repens s. repens																																																														|+|																														
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Sonchus wilmsii																																															r							r																						r															
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Laggera decurrens	r																																																																											+															
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Maerua angolensis			r																																																																																										
Panicum schinzii						r																																																																																						
Acrotome inflata					r																																																																																							
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Nesaea ondongana																																														+								r				r																																
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Senecio apiifolius																																																											+																														+			
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Urochloa trichopus																																																																+																											
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Teramnus labialis																																																																													1														
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Grewia villosa		r																																									r																																+						+									
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Diospyros lycioides																																																																																							1					
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CHAPTER 5

DISCUSSION

The year 2000 was an exceptional year for the study area regarding rainfall. This exceptionally wet year in 2000 resulted in numerous new species being found on Breslau which had never been seen before, as well as a very noticeable increase in vegetation cover and the abundance of other species. The vegetation became very dense due to the high rainfall.

The average rainfall from 1982, when records were first kept on Breslau, to 2000, was 277 mm per season. For the year 2000 the recorded rainfall was 812 mm for the season, which is the highest rainfall by far since records were kept since 1982. This study was undertaken after these exceptional rains. The average rainfall for the last 5 years up to 2000 was 447 mm per season, which is 170 mm higher than the average since 1982. As a result of this higher rainfall over the past 5 years the results of this study are exaggerated towards higher rainfall periods rather than lower rainfall periods. This is confirmed by Bothma (1989) where he states that when good rains do fall in arid areas at the right times, the response of the veld is better than would be expected, resulting in a false impression that such areas are more adequate for ranching.

The year 2001, the year in which this vegetation study was undertaken, was not an exceptionally high rainfall year with 270 mm for the season. However, in the area under study the most important factor is not how much rainfall, but rather the frequency of the rainfall, that is, the periods between rainfall. In 2001 the frequency was favourable to plant growth, but unfavourable to filling dams. The result being that around the dams the herbaceous and shrub layers have suffered from lack of water, but the vegetation out on the plains and veld have grown well. The frequency pattern of rainfall in this particular climate seems to be far more important than the amount of rain. The temperatures become so high that if the rainfall is not frequent enough it is not beneficial to the vegetation due to very high evapotranspiration.

A most common type of soil in the study area is a sodic soil, which is highly erodable and unstable. In areas further away from the riverine which have silty soil, are the sandstone areas. This sandstone soil has very erosive properties and is found mainly in the *Colophospermum mopane* veld. It is in this *Colophospermum mopane* veld where considerable erosion is taking place. This is a result of the present policy forcing game farms to fully fence the farms in order for the farm to legally own the game. Thus game is kept on the farms during the high and low rainfall years. This has resulted in increased erosion taking place, generally in the *Colophospermum mopane* veld, due to the increased grazing pressure during the low rainfall years. Unfenced game farms would allow the animals to naturally move to areas with more abundant vegetation which would alleviate the pressure on certain areas like the *Colophospermum mopane* veld during the dry years and thus reduce erosion.

Although sometimes said to be an indicator of sodic or infertile soils, *Colophospermum mopane* is by no means confined to them and indeed grows much better on deeper, less compact soils. The association with sodic soils is said to be due to its shallow rooting system and ability to survive there, whereas many other woody species have difficulties. The root system coincides with the zone of maximum moisture retention on many soils and *Colophospermum mopane* is excluded from better soils by deeper rooted *Acacia* species (Timberlake 1995).

One feature of some stands of mopane shrubland is the bareness of the soil and the prevalence of sheet erosion (Timberlake 1995). Other woody plants in such areas tend to be clumped or associated with termitaria, and much of the remaining area has a poor cover of annual grasses and herbs. Examples are the *Kirkia acuminata* – *Colophospermum mopane* Woodland community and the *Boscia foetida* – *Colophospermum mopane* – *Abutilon grandiflorum* Woodland Subcommunity (Chapter 4, Section A, Communities 4.2. and 6.2, respectively). A major causative factor is probably the sodicity of these soils or the high silt content, leading to extensive surface capping, which in turn can lead to gulley formation. These areas often expand slowly, especially under heavy grazing, as the topsoil erodes and more subsoil is exposed (Timberlake 1995).

Contour walls and gabions need to be built in the gulleys and dongas to prevent further erosion and removal of topsoil by water. However, the mopaneveld on Breslau does not seem to be expanding. This could be due to reduced grazing pressure on the mopaneveld by attracting the game to other areas by the building of dams and the better control of game numbers on Breslau.

The underground water on Breslau is plentiful, but very salty. Numerous boreholes have been sunk throughout Breslau to provide watering points for the game. Most of the water cannot be used, not even for the game, as it is too salty. Two boreholes were measured at 16 and 18 grams of salt per litre respectively. One of the aims of building dams has been to increase the water table and thus reduce the salt content.

The *Salvadora australis* - *Acacia tortilis* Major Woodland Community is found largely on the more brackish soils which are very susceptible to drought.

The presence of *Salvadora australis* is an indicator of brackish soils. These findings are confirmed by Gertenbach (1983) in the *Salvadora australis* floodplains in the Kruger National Park. In the *Salvadora australis* – *Colophospermum mopane* Main Community, (Chapter 4, Section A, Main Community B) of the study area, the soils are more salty than the *Terminalia prunoides* – *Colophospermum mopane* Main Community (Chapter 4, Section A, Main Community A), which is indicated by the presence of *Salvadora australis*. *Salvadora australis* are also found on flat floodplains, which is also the case in the Kruger National Park (Gertenbach 1983, van Rooyen, et al 1981)

On the northern border of Breslau is a large agricultural establishment. Over the past 4 years this neighbour has increased his agricultural fields. At least 40 % of this farm is now under irrigation. This farm has a very small river frontage. As a result of the huge amounts of water being pumped from underground wells in the riverbed, the salt has been moving to the surface of the ground, drastically increasing the salt content of the water nearer the surface. During the drier seasons the water table has also been drastically lowered. To add to this burden, until recently, directly across the Limpopo River, in Botswana, were nine central pivots which were constantly irrigating, also from wells in the riverbed. This has had dramatic effects on the vegetation on Breslau, especially the huge *Lonchocarpus capassa* trees, which started dying in the higher and lower areas of the riverine. Alpha Dam (Figure 24) was specifically built to counter this problem, by increasing the water table in the riverine and thus reducing the salt content. The effects of Alpha Dam can be seen in communities 5 – *Heliotropium supinum – Acacia tortilis* Woodland Community (Figure 24), 8 – *Albizia anthelmintica – Acacia tortilis* Woodland Community and 9 – *Xanthocercis zambesiaca – Acacia tortilis* Closed Woodland Community (Chapter 4, Section B).

Overgrazing is particularly important in the savanna areas with an annual rainfall of 600 mm or less. Here there is a balance in the vegetation between the extensive and deep rooting woody plants and the intensive and shallow rooting grasses. Early in the season the precipitation mainly benefits the grasses which grow quickly. In the course of the rainy season the soil moisture deepens and the water becomes more beneficial to the woody species. With overgrazing the grasses are considerably damaged and evapotranspire less water, thus leaving more water in the soil for the woody species and thus increasing their growth possibilities. Over the years this is cumulative, and the effect is a bush encroachment resulting in a densely wooded area or even a thicket. The most common encroachers are *Acacia mellifera, Acacia tortilis* and *Dichrostachys cinera* (Werger 1978).

At other places the effects of overgrazing are somehow different and result in denuded areas with severe erosion. Less severe overgrazing can act selectively on the species

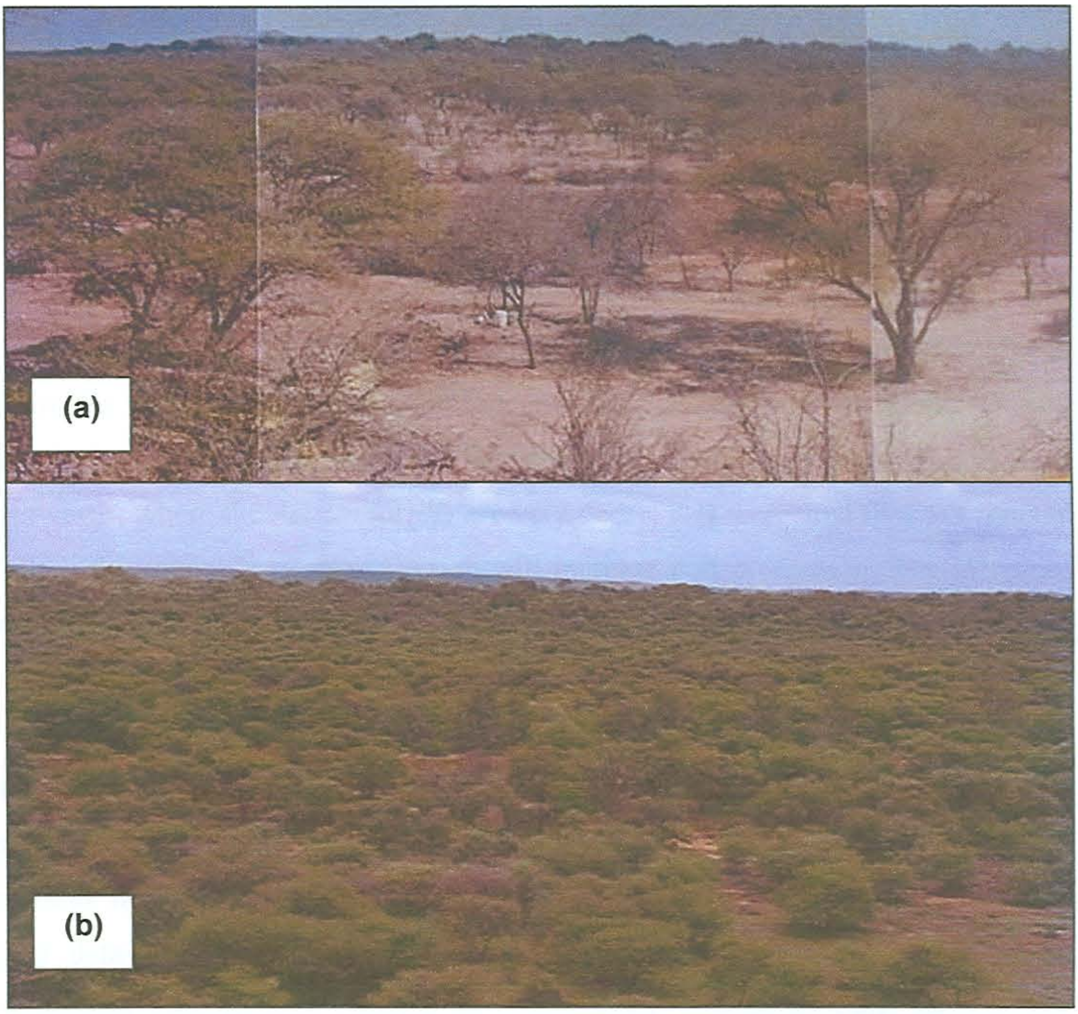

Figure 24: (a) Alpha Dam in 1993 when it was built. *Heliotropium supinum – Acacia tortilis* Woodland Community on Floodplains. (b) Alpha Dam in 2001. The results of Alpha Dam can clearly be seen.

composition of a community, and in this way can damage the community structure as well. Overgrazing is often associated with domestic livestock, but it can also occur when indigenous game reaches a too high population density and does not move due to game fences (Werger 1978).

In the study area, bush encroachment by *Acacia tortilis* can be seen around many of the dams, particularly around Bertha Dam (Figure 1). The *Heliotropium supinum – Acacia tortilis – Zaleya pentandra* Woodland Subcommunity (Chapter 4, Section B, Subcommunity 5.1) is representative of encraochment, with 90 % canopy cover by *Acacia tortilis*. However, these dense stands of *Acacia tortilis* around the dams are not a threat, but rather advantageous, in that during the dry seasons their pods provide a very valuable food source for the browsers as well as the grazers, who eat the pods off the ground. In the very dry seasons this is the only food available to the game. During flooding, the herbaceous layer dies down, and the pods remain a source of food in these areas. However, where the *Acacia tortilis* are very dense, it is suggested they are thinned out to allow the canopy's to spread which will increase pod production. The increased light will also encourage the establishment of the herbaceous and grass layer.

In this study, standard Braun-Blanquet procedures were used as a means of describing the vegetation of Breslau Game Farm. The process was successful from this descriptive point of view in that vegetation units could be described on the basis of both vegetation structure and floristic elements. The comprehensive collection of good floristic and ecological data enabled the production of a good classification of the bushveld vegetation. This classification resulted in two distinct vegetation units, namely, the *Colophospermum mopane – Hibiscus micranthus* Major Woodland Community and the *Salvadora australis – Acacia tortilis* Major Woodland Community. These vegetation units are not presented as merely academic exercises but are easily recognisable in the veld. These two major vegetation communities reflect the influence of the geology on the composition and distribution of plants.

The aims set out for this study were successfully achieved. The presented detailed identification, description, classification and ecological interpretation of the plant communities encountered on Breslau Game Farm contribute substantially towards the knowledge of the vegetation of this area. This knowledge of the vegetation on Breslau is essential for the establishment of an efficient management plan with effective wildlife management programs.

This study may be used to identify management units based on the two distinct major vegetation communities identified. The *Colophospermum mopane – Hibiscus micranthus* Major Community is located on sodic soils with highly erodable properties, whereas the soils of the *Salvadora australis – Acacia tortilis* Major Woodland Community have a higher salt content and are more susceptible to drought. Erosion, which is prominent on Breslau, needs to be addressed in both the *Colophospermum mopane – Hibiscus micranthus* Major Community as well as in the *Salvadora australis – Acacia tortilis* Major Community. The positive change in the vegetation resulting from dams and contour walls can be seen in the *Echinochloa colona – Acacia tortilis* Main Woodland Community (Chapter 4, Section B, Community B), specifically in the *Heliotropium supinum – Acacia tortilis* Woodland Community, the *Faidherbia albida – Acacia tortilis* Woodland Community and the *Combretum imberbe – Acacia tortilis* Woodland Community (Chapter 4, Section B, Communities 5, 6 and 7 respectively). This improved condition of the veld increases the carrying capacity on Breslau. The construction of dams and contour walls increases the woody layer which is the more stable stratum, as well as the herbaceous layer, although it is less stable due to seasonal/occasional flooding (Figure 25).

During the drier seasons, Breslau is more favourable to browsers, as the herbaceous layer is the first to die off. The building of dams and contour walls along dongas, which spreads the water and increases the water table, and thus increases the woody stratum as well as the herbaceous stratum, should be a priority.

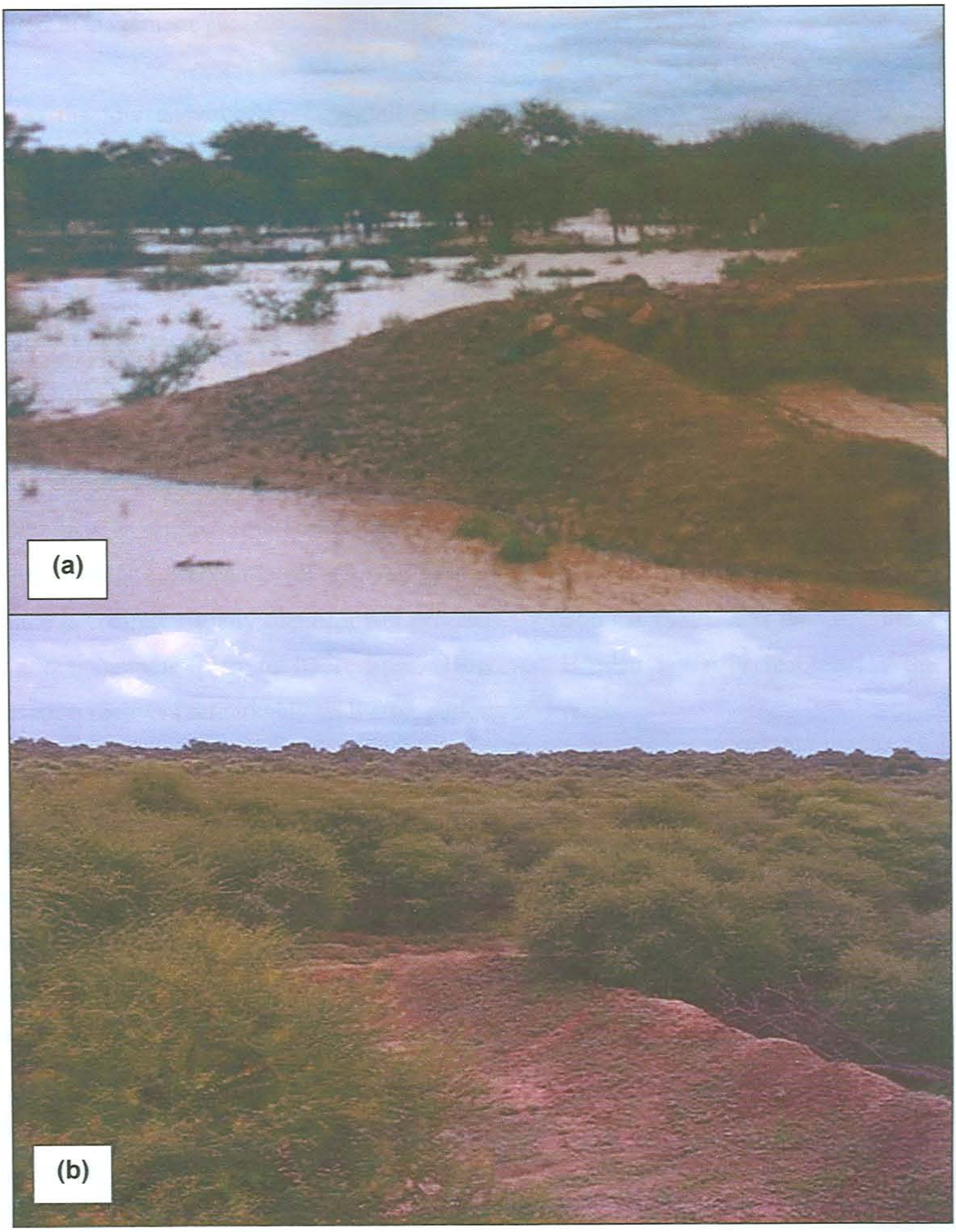

Figure 25: (a) Alpha Dam wall in 1996 (Built in 1993), (b) Alpha Dam wall in 2001. The increase in the woody layer can clearly be seen.

The smaller the area, the more intensely it has to be managed. Vice versa, the larger the area the more possible it becomes to aim at natural conditions (Bothma 1989). Breslau, being under 3 000 hectare in size, and fully fenced, has to be managed more intensely. A detailed management plan may be followed on from this study.

Due to the low and unreliable rainfall of the study area, a management plan should attempt to increase the resilience of an ecosystem by means of healthy veld management which periodically allows for years of drought without causing damage to the ecosystem. Ecosystems, being dynamic, are constantly changing. Fluctuations are a necessary and integral part of any ecosystem – without them the ecosystem cannot remain viable. Stability is the tendency to counteract change, while resilience is a barometer for a system's ability to recover after a disturbance. Stable systems often have a low resilience, while unstable systems are often fairly resilient. With an increase in stability ecosystems lose their resilience, just as increasing inbreeding among animals decreases their genetic adaptability to future environmental changes. However, resilience can only operate within a definite amplitude for a given system. If the lower limit is exceeded, a new balance is created, usually one of lower productivity (Bothma 1989). It is thus important for a management plan to be resilient. However, Breslau is fairly resilient as the vegetation recovers remarkably well after periods of drought.

This study may be used as a basis to conduct a vegetation condition assessment in order to estimate the carrying capacity, which is necessary before a wildlife program can be established. Due to the very unreliable rainfall in the area, studies would need to be conducted in the wet and dry seasons. The dry seasons are a major limiting factor regarding carrying capacity of game as very little food is available. During droughts the game has to be fed.

Changes of vegetation from one area to another, or even from one place to another on one game ranch, are either the result of inherent differences (for example soil variations) or disturbances of some nature. Disturbed areas are inclined to return to a state of balance with the prevailing environmental factors, with time. This leads to successive types of vegetation, each type characteristic of a particular phase of recovery or deterioration. (Bothma 1989).

Due to the climate and unpredictable rainfall of the study area, it is imperative that the vegetation is fairly resilient. The floods in 2000 increased the water table on Breslau but destroyed large areas of veld due to flooding. In 2001, when this study was conducted, the water table was still high, but most of the veld had time to recover, and even though the rainfall was below average at 270 mm for the 2000/2001 season, the different successional stages can be identified. Certain communities, particularly in the *Salvadora australis – Acacia tortilis* Major Community, are for the first time in the history of Breslau at an advanced successional stage, which is likely the climax for the conditions. An example of such a community is the *Leucosphaera bainsii* Woodland Variant (Chapter 4, Section B, Community 3.2.2). The most dominant species in this variant is the grass *Urochloa mosambicensis,* which is an indicator of the good condition of the veld, and in this case may be an indicator of a climax successional state. Even though a number of species which are not climax species are present, for example *Aristida congesta* subsp. *congesta, Tribulus zehyeri* and *Boerhavia diffusa,* considering the salty and sodic conditions of the soils and the climatic conditions, these communities may be considered having reached a climax successional stage. Due to the droughts and very warm temperatures of the study area, pioneer species and species in the early successional stage will always be present. However, certain communities which have not recovered from the floods in 2000, and were in an advanced successional stage before the floods, have been set back to an early successional stage. These communities include the *Eriochloa parvispicula* Open Woodland Variant and the *Dovyalis caffra – Acacia tortilis* Woodland Community (Chapter 4, Section B, Communities 3.2.4 and 10, respectively), both of which were at an advanced successional stage before the floods, but were under water for long periods of time during the floods. Most of the communities would, however, be somewhere between the earlier and more advanced successional stages.

The classification of the vegetation in the study area stresses the correlation between habitat and floristic composition of the communities as well as relationships between communities. Differences and variations in the vegetation can be ascribed to differences in geological formation, soil depth, soil texture, soil structure, consistency and the concentration of salts in the soil, water-holding capacity of the soil, water table level and rockiness of the soil surface.

SUMMARY

The study area is located along the Limpopo River in the Northern Province, in an arid region, where a major delimiting factor is the lack of sufficient, reliable rainfall. The vegetation consists of thorn savanna and broad-sclerophyll arid bushveld or woodland, which is dominated by *Colophospermum mopane*.

The aim of the study was to classify the vegetation into communities based on species composition, habitat and disturbances such as dams and contour walls, and to analyse, describe and interpret these plant communities.

The study area was stratified into three main units, namely (1) the crest and scarp, which include the koppies, rocky outcrops and ridges, (2) the valley bottom and floodplains, which include the riverine, floodplains and dams and (3) the midslope and footslope which include the plains and flatter areas. Sampling was carried out during the growing season from March 2001 to June 2001. A total of 187 plots were sampled. Species were listed according to the Braun-Blanquet cover-abundance scale.

Data were incorporated into a data base using the TURBOVEG (Hennekens 1996a) program. Two-Way Indicator Species Analysis (TWINSPAN) (Hill 1979a) was applied to the entire data set in order to identify the major plant communities. This initial classification was then refined, using the program MEGATAB (Hennekens 1996b) with Braun-Blanquet procedures (Westhoff & van der Maarel 1987; Behr & Bredenkamp 1988). The results of this classification was two distinct communities which are presented in two separate phytosociological tables. The two communities are (1) The *Colophospermum mopane – Hibiscus micranthus* Major Woodland community which is divided into two main communities, nine subcommunities and six variants and (2) The *Salvadora australis - Acacia tortilis* Major Woodland Community which is divided into three main communities, eight subcommunities and four variants. The ordination

algorithm DECORANA (Hill 1979b) was also applied to the floristic data set to illustrate relationships between the vegetation units and the environmental factors.

The soil type was a major factor influencing the vegetation. The most common type of soil is a sodic soil which is highly erodable and unstable and is dominated by the *Colophospermum mopane* veld. The *Salvadora australis* veld is found on the more brackish soils. The thornveld is found in the wetter areas around the dams and the riverine which has a more silty-clayey soil.

The effect of spreading and retaining the water by the construction of dams and contour walls can clearly be identified by the improved growth of the vegetation in these areas, resulting in increased feed for the game.

This study can be used as a basis for further studies to develop an efficient management plan with effective wildlife management programs for Breslau Game Farm.

OPSOMMING

Die studie gebied is geleë langs die Limpoporivier in die Noordelike Provinsie, in ‘n droë streek, waar die hoof beperkende faktor ‘n tekort aan genoegsame, betroubare reën is. Die plantegroei bestaan uit doring savanna (mikrofille) en breë blaar (sklerofille) droë bosveld of boomveld, wat gedomineer word deur *Colophospermum mopane*.

Die doel van die studie was om die plantegroei in verskillende gemeenskappe te klassifiseer, gebaseer op die spesie samestelling, habitat en versteurings soos damme en kontoerwalle, sowel as om hierdie plantgemeenskappe te analiseer, beskryf en te interpreteer.

Die studiegebied was in drie hoof eenhede gestratifiseer, naamlik: (1) die kruin en eskarp, wat bestaan uit die koppies, rotsriwwe en bergkruine, (2) die valleie (laaglande) en vloedvlaktes, wat bestaan uit die rivierkom, vloedvlaktes en damme; en (3) die middelhang en voethang wat die vlaktes en platter areas omvat. Proewe was gedurende die groeiseisoen vanaf Maart 2001 tot Junie 2001 uitgevoer. ‘n Totaal van 187 persele was uitgevoer. Spesies was volgens die Braun-Blanquet bedekkingswaardes gelys.

Data was in ‘n databank ingevoer deur gebruik te maak van die program TURBOVEG (Hennekens 1996a). Die hoof plantgemeenskappe is geidentifiseer met die toepassing van die program TWINSPAN (“Two-Way Indicator Species Analysis”) (Hill 1979a) op die volledige datastel. Hierdie eerste klassifikasie is verfyn met die gebruik van die program MEGATAB (Hennekens 1996b) met behulp van die Braun-Blanquet prosedure (Westhoff & van der Maarel 1987; Behr & Bredenkamp 1988). The gevolg van hierdie klassifikasie was twee duidelike gemeenskappe wat in twee afsonderlike fitososiologiese tabelle voorgestel word. Die twee gemeenskappe is (1) Die *Colophospermum mopane – Hibiscus micranthus* Hoof Boomveld Gemeenskap wat verdeel word in twee hoof gemeenskappe, nege subgemeenskappe en ses variante, en (2) Die *Salvadora australis - Acacia tortilis* Hoof Boomveld Gemeenskap wat verdeel word in drie hoof gemeenskappe, agt subgemeenskappe en vier variante. Die ordinasie algoritme DECORANA (Hill 1979b) was ook toegepas op die floristiese datastel, om die verhouding tussen die plantegroei eenhede en die omgewingfaktore te illustreer – verskeie omgewingsfaktore het 'n korrelasie getoon met die plantgemeenskappe.

Die grondtipe was 'n groot faktor wat die plantegroei beïnvloed het. Die mees algemene tipe grond is 'n natruimhoudende grond wat hoogs erodeerbaar en onstabiel is. Die grondtipe word geassosieer met die die *Colophospermum mopane* veld. Die *Salvadora australis* veld word aangetref op die brakker gronde. Die doringveld word aangetref in die natter areas rondom die damme en die rivierkom wat slik-klei grond bevat.

Die gevolg van die verspreiding en opgaar van water deur die bou van damme en kontoerwalle is duidelik sigbaar deur die verbeterde groei van die plante in hierdie gebiede, en gevolglik is daar 'n toename in weiding vir die wild.

Hierdie studie kan as 'n basis beskik vir verdere studies om 'n effektiewe bestuursplan te ontwerp met effektiewe natuurlewebestuur programme vir Breslau Wildsplaas.

PLANT SPECIES RECORDED ON BRESLAU GAME FARM IN ALPHABETICAL ORDER

Abutilon grandiflorum G.Don
Abutilon pycnodon Hochr.
Abutilon ramosum (Cav.) Guill. & Perr.
Abutilon angulatum (Guill. & Perr.) Mast.
Acacia erubescens Welw. ex Oliv.
Acacia grandicornuta Gerstner
Acacia nebrownii Burtt Davy
Acacia nigrescens Oliv.
Acacia senegal (L.) Willd. var. leiorhachis Brenan
Acacia senegal (L.) Willd. var. rostrata Brenan
Acacia xanthophloea Benth.
Acacia mellifera (Vahl) Benth.
Acacia nilotica (L.) Willd. ex Delile
Acacia schweinfurthii Brenan & Exell
Acacia tortilis (Forssk.) Hayne
Acalypha indica L.
Acanthospermum hispidum DC.
Achyranthes aspera L.
Achyrocline stenoptera (DC.) Hilliard & B.L.Burtt
Acrachne racemosa (Roem. & Schult.) Ohwi
Acrotome inflata Benth.
Adansonia digitata L.
Aeschynomene indica L.
Aizoon glinoides L.f.
Albizia anthelmintica (A.Rich.) Brongn.
Albizia brevifolia Schinz
Aloe globuligemma Pole-Evans
Alternanthera nodiflora R.Br.
Alternanthera pungens Humb., Bonpl. & Kunth
Ammannia baccifera L.
Antherothamnus pearsonii N.E.Br.
Aptosimum lineare Marloth & Engl.
Aptosimum lugardiae (N.E.Br.) E.Phillips
Aristida adscensionis L.
Aristida congesta Roem. & Schult. ssp. barbicollis (Trin. & Rupr.) De Winter
Aristida congesta Roem. & Schult. ssp. congesta
Aristida meridionalis Henrard
Aristida rhiniochloa Hochst.
Aristida canescens Henrard
Aristida congesta Roem. & Schult.
Aristida stipitata Hack.
Aspalathus suaveolens Eckl. & Zeyh.

Asparagus burchellii Baker
Asparagus nelsii Schinz
Asparagus suaveolens Burch.
Aster squamatus (Spreng.) Hieron.
Balanites pedicellaris Mildbr. & Schltr.
Barleria affinis C.B.Clarke
Barleria bremekampii Oberm.
Barleria lancifolia T.Anderson
Barleria lugardii C.B.Clarke
Barleria ovata E.Mey. ex Nees
Barleria senensis Klotzsch
Becium filamentosum (Forssk.) Chiov.
Berchemia discolor (Klotzsch) Hemsl.
Bergia salaria Bremek.
Berzelia abrotanoides (L.) Brongn.
Bidens pilosa L.
Blepharis aspera Oberm.
Boerhavia diffusa L.
Boerhavia erecta L.
Boscia albitrunca (Burch.) Gilg & Gilg-Ben.
Boscia foetida Schinz
Bothriochloa radicans (Lehm.) A.Camus
Brachiaria deflexa (Schumach.) C.E.Hubb. ex Robyns
Brachystelma elongatum (Schltr.) N.E.Br.
Brassica elongata Ehrh.
Cadaba aphylla (Thunb.) Wild
Cadaba termitaria N.E.Br.
Cardiospermum corindum L.
Cassia abbreviata Oliv.
Cenchrus ciliaris L.
Ceratandra bicolor Sond. ex Bolus
Ceratotheca triloba (Bernh.) Hook.f.
Chamaesyce inaequilatera (Sond.) Soják
Chamaesyce neopolycnemoides (Pax & K.Hoffm.) Koutnik
Chenopodium album L.
Chenopodium carinatum R.Br.
Chloris virgata Sw.
Cissus quadrangularis L.
Cleome gynandra L.
Cleome monophylla L.
Cleome oxyphylla Burch.
Clerodendrum ternatum Schinz
Cocculus hirsutus (L.) Diels
Colophospermum mopane (J.Kirk ex Benth.) J.Kirk ex J.Léonard
Combretum imberbe Wawra
Combretum mossambicense (Klotzsch) Engl.

Combretum apiculatum Sond.
Commelina benghalensis L.
Commelina erecta L.
Commicarpus pilosus (Heimerl) Meikle
Commicarpus plumbagineus (Cav.) Standl.
Commiphora africana (A.Rich.) Engl.
Commiphora edulis (Klotzsch) Engl.
Commiphora glandulosa Schinz
Commiphora merkeri Engl.
Commiphora mollis (Oliv.) Engl.
Commiphora tenuipetiolata Engl.
Corbichonia decumbens (Forssk.) Exell
Corchorus asplenifolius Burch.
Corchorus trilocularis L.
Cordia monoica Roxb.
Crotalaria damarensis Engl.
Crotalaria sphaerocarpa Perr. ex DC.
Crotalaria virgulata Klotzsch
Croton megalobotrys Müll.Arg.
Croton gratissimus Burch.
Ctenolepis cerasiformis (Stocks) Hook.f.
Cucumis metuliferus Naudin
Cucumis zeyheri Sond.
Cullen obtusifolia (DC.) C.H.Stirt.
Cyathula lanceolata Schinz
Cyathula orthacantha (Hochst. ex Asch.) Schinz
Cyperus obtusiflorus Vahl var. obtusiflorus
Dactyloctenium aegyptium (L.) Willd.
Datura ferox L.
Datura innoxia Mill.
Datura stramonium L.
Denekia capensis Thunb.
Dichanthium annulatum (Forssk.) Stapf
Dichrostachys cinerea (L.) Wight & Arn.
Diclis petiolaris Benth.
Dicoma tomentosa Cass.
Digitaria eriantha Steud.
Digitaria velutina (Forssk.) P.Beauv.
Dinebra retroflexa (Vahl) Panz.
Diospyros lycioides Desf.
Dipcadi marlothii Engl.
Dovyalis caffra (Hook.f. & Harv.) Hook.f.
Echinochloa colona (L.) Link
Ehretia rigida (Thunb.) Druce
Endostemon tenuiflorus (Benth.) M.Ashby
Enneapogon cenchroides (Roem. & Schult.) C.E.Hubb.

Enneapogon scoparius Stapf
Eragrostis aspera (Jacq.) Nees
Eragrostis bicolor Nees
Eragrostis biflora Hack. ex Schinz
Eragrostis chloromelas Steud.
Eragrostis cilianensis (All.) F.T.Hubb.
Eragrostis heteromera Stapf
Eragrostis nindensis Ficalho & Hiern
Eragrostis porosa Nees
Eragrostis racemosa (Thunb.) Steud.
Eragrostis rigidior Pilg.
Eragrostis rotifer Rendle
Eragrostis superba Peyr.
Eragrostis tef (Zucc.) Trotter
Eragrostis trichophora Coss. & Durieu
Eragrostis lehmanniana Nees
Eriochloa fatmensis (Hochst. & Steud.) Clayton
Eriochloa parvispiculata C.E.Hubb.
Eriochloa meyeriana (Nees) Pilg.
Eriospermum mackenii (Hook.f.) Baker
Euclea natalensis A.DC.
Euphorbia cooperi N.E.Br. ex A.Berger
Evolvulus alsinoides (L.) L.
Faidherbia albida (Delile) A.Chev.
Ficus sycomorus L.
Fingerhuthia africana Lehm.
Flaveria bidentis (L.) Kuntze
Flueggea virosa (Roxb. ex Willd.) Voigt ssp. virosa
Gardenia volkensii K.Schum.
Geigeria acaulis (Sch.Bip.) Benth. & Hook.f. ex Oliv. & Hier
Geigeria burkei Harv.
Gisekia africana (Lour.) Kuntze
Glinus lotoides L.
Gomphrena celosioides Mart.
Grewia bicolor Juss.
Grewia subspathulata N.E.Br.
Grewia tenax (Forssk.) Fiori
Grewia villosa Willd.
Grewia flavescens Juss.
Helichrysum argyrosphaerum DC.
Helichrysum stellatum (L.) Less.
Heliotropium giessii Friedr.-Holzh.
Heliotropium steudneri Vatke
Heliotropium supinum L.
Hemizygia elliottii (Baker) M.Ashby
Hemizygia petrensis (Hiern) M.Ashby

Hermannia burchellii (Sweet) I.Verd.
Hermannia glanduligera K.Schum.
Hermannia modesta (Ehrenb.) Mast.
Hermannia odorata Aiton
Hermbstaedtia linearis Schinz
Hermbstaedtia odorata (Burch.) T.Cooke
Hexalobus monopetalus (A.Rich.) Engl. & Diels
Hibiscus calyphyllus Cav.
Hibiscus cannabinus L.
Hibiscus coddii Exell
Hibiscus engleri K.Schum.
Hibiscus micranthus L.f.
Hibiscus trionum L.
Hypertelis salsoloides (Burch.) Adamson
Hypoestes aristata (Vahl) Sol. ex Roem. & Schult.
Indigofera dimidiata Vogel ex Walp.
Indigofera holubii N.E.Br.
Indigofera pongolana N.E.Br.
Indigofera schinzii N.E.Br.
Indigofera sordida Benth. ex Harv.
Indigofera vicioides Jaub. & Spach var. vicioides
Indigofera schimperi Jaub. & Spach
Indigofera vicioides Jaub. & Spach
Ipomoea cairica (L.) Sweet
Ipomoea bolusiana Schinz
Ipomoea sinensis (Desr.) Choisy
Justicia betonica L.
Justicia flava (Vahl) Vahl
Justicia odora (Forssk.) Vahl
Justicia thymifolia (Nees) C.B.Clarke
Justicia protracta (Nees) T.Anderson
Kalanchoe lanceolata (Forssk.) Pers.
Kirkia acuminata Oliv.
Kohautia cynanchica DC.
Kyllinga alba Nees
Kyphocarpa angustifolia (Moq.) Lopr.
Laggera decurrens (Vahl) Hepper & J.R.I.Wood
Lannea stuhlmannii (Engl.) Engl.
Leonotis nepetifolia (L.) R.Br.
Leucas sexdentata Skan
Leucas glabrata (Vahl) Sm.
Leucobryum acutifolium (Mitt.) Cardot
Leucosphaera bainesii (Hook.f.) Gilg
Limeum fenestratum (Fenzl) Heimerl
Limeum sulcatum (Klotzsch) Hutch.
Lintonia nutans Stapf

Litogyne gariepina (DC.) Anderb.
Lonchocarpus capassa Rolfe
Lycium cinereum Thunb. sensu lato
Maerua angolensis DC.
Maerua parvifolia Pax
Maerua juncea Pax
Mariscus cyperoides (Roxb.) A.Dietr.
Markhamia zanzibarica (Bojer ex DC.) K.Schum.
Maytenus heterophylla (Eckl. & Zeyh.) N.Robson
Melhania burchellii DC.
Melhania rehmannii Szyszyl.
Melhania acuminata Mast.
Melinis repens (Willd.) Zizka ssp. grandiflora (Hochst.) Ziz
Melinis repens (Willd.) Zizka ssp. repens
Mollugo nudicaulis Lam.
Momordica balsamina L.
Nesaea ondongana Koehne
Neuracanthus africanus S.Moore
Nicotiana glauca Graham
Nidorella agria Hilliard
Nidorella resedifolia DC.
Ochna inermis (Forssk.) Schweinf.
Ocimum americanum L. var. americanum
Otoptera species
Oxygonum delagoense Kuntze
Oxygonum sinuatum (Hochst. & Steud. ex Meisn.) Dammer
Pancratium tenuifolium Hochst. ex A.Rich.
Panicum deustum Thunb.
Panicum maximum Jacq.
Panicum schinzii Hack.
Panicum coloratum L.
Pappea capensis Eckl. & Zeyh.
Pavonia burchellii (DC.) R.A.Dyer
Pavonia dentata Burtt Davy
Pergularia daemia (Forssk.) Chiov.
Phaeoptilum spinosum Radlk.
Philyrophyllum schinzii O.Hoffm.
Phyllanthus angolensis Müll.Arg.
Phyllanthus incurvus Thunb.
Phyllanthus reticulatus Poir.
Pluchea dioscoridis (L.) DC.
Plumbago zeylanica L.
Pogonarthria fleckii (Hack.) Hack.
Pogonarthria squarrosa (Roem. & Schult.) Pilg.
Polygala hottentotta C.Presl
Portulaca foliosa Ker Gawl.

Portulaca oleracea L.
Pseudognaphalium luteo-album (L.) Hilliard & B.L.Burtt
Psiadia punctulata (DC.) Oliv. & Hiern ex Vatke
Psydrax livida (Hiern) Bridson
Ptycholobium contortum (N.E.Br.) Brummitt
Pupalia lappacea (L.) A.Juss.
Rhigozum zambesiacum Baker
Rhinacanthus xerophilus A.Meeuse
Rhynchosia longiflora Schinz
Rhynchosia totta (Thunb.) DC.
Ricinus communis L.
Ruellia cordata Thunb.
Ruellia otaviensis P.G.Mey.
Ruellia patula Jacq.
Salvadora australis Schweick.
Sansevieria aethiopica Thunb.
Sarcostemma viminale (L.) R.Br.
Schkuhria pinnata (Lam.) Cabrera
Schmidtia pappophoroides Steud.
Sclerocarya birrea (A.Rich.) Hochst.
Secamone parvifolia (Oliv.) Bullock
Seddera suffruticosa (Schinz) Hallier f.
Selaginella dregei (C.Presl) Hieron.
Senecio apiifolius (DC.) Benth. & Hook.f. ex O.Hoffm.
Sesamothamnus lugardii N.E.Br. ex Stapf
Setaria sagittifolia (A.Rich.) Walp.
Setaria verticillata (L.) P.Beauv.
Sida chrysantha Ulbr.
Sida cordifolia L.
Sida dregei Burtt Davy
Sida ovata Forssk.
Solanum coccineum Jacq.
Solanum lichtensteinii Willd.
Solanum nigrum L.
Solanum panduriforme E.Mey.
Sonchus wilmsii R.E.Fr.
Sorghum bicolor (L.) Moench
Sphaeranthus incisus Robyns
Sporobolus ioclados (Trin.) Nees
Sterculia rogersii N.E.Br.
Stipagrostis uniplumis (Licht.) De Winter
Strychnos spinosa Lam.
Tephrosia zoutpansbergensis Bremek.
Tephrosia oxygona Welw. ex Baker
Tephrosia rhodesica Baker f.
Tephrosia villosa (L.) Pers.

Teramnus labialis (L.f.) Spreng.
Terminalia prunoides M.A.Lawson
Tetrapogon tenellus (Roxb.) Chiov.
Tragia rupestris Sond.
Tragus berteronianus Schult.
Trianthema salsoloides Fenzl ex Oliv.
Tribulus terrestris L.
Tribulus zeyheri Sond.
Tricalysia junodii (Schinz) Brenan
Tricholaena monachne (Trin.) Stapf & C.E.Hubb.
Urochloa brachyura (Hack.) Stapf
Urochloa mosambicensis (Hack.) Dandy
Urochloa oligotricha (Fig. & De Not.) Henrard
Urochloa panicoides P.Beauv.
Urochloa stolonifera (Gooss.) Chippind.
Urochloa trichopus (Hochst.) Stapf
Vahlia capensis (L.f.) Thunb.
Verbena officinalis L.
Verbesina encelioides (Cav.) Benth. & Hook.
Vernonia cinerascens Sch.Bip.
Vernonia fastigiata Oliv. & Hiern
Waltheria indica L.
Withania somnifera (L.) Dunal
Xanthium strumarium L.
Xanthocercis zambesiaca (Baker) Dumaz-le-Grand
Xerophyta humilis (Baker) T.Durand & Schinz
Xerophyta retinervis Baker
Ximenia americana L.
Zaleya pentandra (L.) Jeffrey
Ziziphus mucronata Willd.

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