

The vegetation of the Spitzkoppe area – 2115CC

Antje Burke

EnviroScience, P. O. Box 90230, Klein Windhoek,
E-mail: antje.burke@enviro-science.info

Abstract

A vegetation map is presented which has been compiled as part of the development of an area management plan for Spitzkoppe in the Erongo Region in western Namibia. Based on satellite imagery and extensive field surveys, 15 vegetation types were delineated at a 1:100,000 scale. Largely positioned along a west-east gradient of increasing rainfall, these comprise dwarf shrubland, grassland and shrubland types. Besides this rainfall gradient, local substrate and microclimatic conditions are important determinants of the vegetation. The study area is floristically diverse and supports a variety of vegetation types, some, such as the vegetation of the granite outcrops, unique to this area. Careful management, particularly of sensitive vegetation types, is called for. Local overgrazing, exploitation of woody resources for firewood and the impacts of an increasing number of tourists are potential threats to the natural vegetation. Hence resource use, vehicle movements as well as water abstraction and waste disposal need to be addressed in an area management plan.

Zusammenfassung

Eine Vegetationskartierung in der Spitzkoppe Gegend in der zentralen Namib, identifizierte 15 Vegetationstypen bei einem Maßstab von 1:100,000. Diese werden sowohl durch einen Gradienten von wachsendem Niederschlag von Westen nach Osten, als auch lokale Boden- und Klimabedingungen bestimmt. Zwergstrauch-Gras- und Strauchvegetationstypen wurden kartiert. Das Gebiet ist floristisch sehr artenreich und enthält einige einzigartige Pflanzengesellschaften, zum Beispiel die Vegetation der Granitinselberge. Besonders schutzwürdige Vegetationstypen benötigen umsichtiges "management". Momentan können lokal Eingriffe durch Überweidung, zunehmenden Tourismus und übermässiger Gebrauch von Holz beobachtet werden. Daher müssen Richtlinien sowohl für die Nutzung von Ressourcen und Autoverkehr, als auch Wasserverbrauch und Müllbeseitigung in einem "Area Management Plan" festgelegt werden.

Keywords: biodiversity hotspot, central Namib, conservation planning, endemism, vegetation mapping.

Introduction

The Spitzkoppe and associated granite inselbergs in central Namib are positioned at the interface of Savannah, Nama Karoo and Desert biome in Namibia (Irish 1994). As a result this area is characterised by high botanical diversity (Burke 2003), making it an important focal point for conservation and land use planning in the country (Barnard 1998).

It is also an important area for tourism which has increased over the past few years. Tourism on the other hand has provided an additional income to the impoverished local community and has created powerful incentives to manage the land in a sustainable manner. Communities in the greater area are at present in the process of establishing a conservancy which will facilitate integrated management of the entire communal area stretching from the Erongo Mountains to the West Coast Recreation Area (Tagg pers. comm.). However, tourism is developing fast at Gross Spitzkoppe, the main tourism attraction. The community has established basic camping facilities, and potential investors are now investigating the feasibility of establishing a lodge. This has prompted conservation-orientated, non-governmental organisations to support the development of an area management plan for the immediate area surrounding the Spitzkoppe group.

Although in a national context, from a botanical perspective this area is reasonably well studied (e.g. Gibbs Russell *et al.* 1984; Burke 2001, 2002b), background information on natural resources is fragmentary, has not been mapped or is not accessible to most people. As a first step towards the development of an area management plan, this paper presents a vegetation map to provide a spatial tool for identifying areas of particular conservation importance. The vegetation map and accompanying description has been compiled with three main objectives in mind:

- to place the described vegetation types in an ecological context
- to generate a land use planning tool backed by field data, and
- to provide practical management-orientated information.

A detailed phytosociological analysis had been provided for the main part of the study area in a previous study (Burke 2002b). This paper includes a vegetation map for the broader area, and focuses on providing management-orientated information. The nomenclature for plants follows Craven 1999.

Methods

Study area

The study area is placed in the central Namib, approximate position at 21°S latitude and 15°E longitude in the Erongo Region in Namibia (Figure 1).

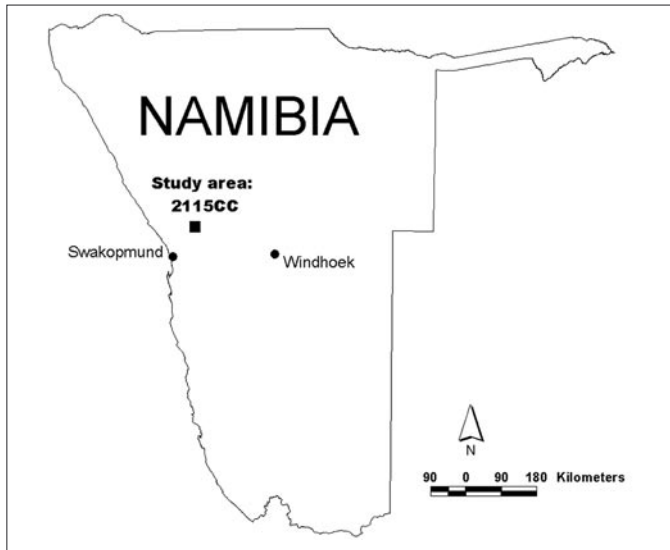


Figure 1: Position of the study area in Namibia.

As the inselbergs in focus are conveniently placed in the centre of one quarter degree square, the entire quarter degree square 2115CC was mapped (Figure 2).

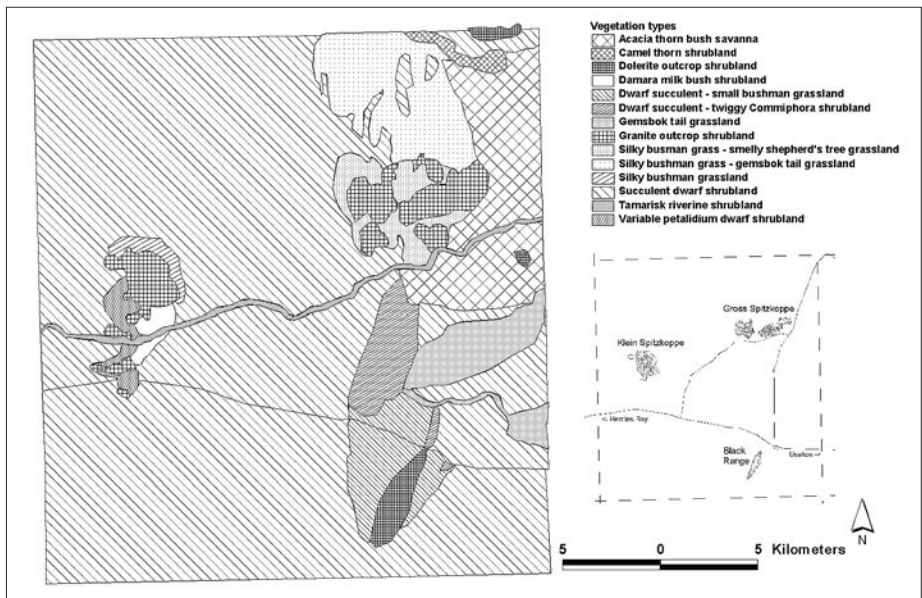


Figure 2: Vegetation of the Spitzkoppe area and landmarks.

Landforms in the study area comprise inselbergs (isolated mountains) and rocky ridges, plains and ephemeral drainage areas (dry rivers and drainage lines). Two groups of granite domes, one dolerite ridge and two dolerite outcrops provide the main topographic features in the study area. Lower dolerite ridges are prevalent in the south-eastern part of the study area.

The climate in the study area is arid with a west-east gradient of average mean rainfall of 50-100 mm. The area experienced exceptional rainfall during both survey periods. Temperatures are high in summer (mean daily maximum for hottest month: 31-32°C) and moderate in winter (mean daily maximum for coldest month 9-10°C) (van der Merwe 1983). The area is frost-free, but coastal fog occasionally reaches the study area. In general zonal vegetation in this area has been described as “central Namib” (Giess 1998), “grass zone” and “*Euphorbia damarana* zone” (Hachfeld 1996) and “dwarf and *Acacia* shrubland of central west” (Burke *et al.* 2002).

Present land use is communal livestock farming, largely with goats, sheep and to a lesser extent cattle. Tourism is another important land use at the Gross Spitzkoppe group of inselbergs in the centre of the study area.

Field work

This vegetation map has been based on field data that were collected (1) in March 1998 for inselbergs during a study on Namibian inselberg floras, and (2) in May 2003 for the purpose of the area management plan. The Braun-Blanquet method of plotless sampling, using cover-abundance per species, was employed to generate quantitative information on vegetation (Mueller-Dombois & Ellenberg 1974). Soil samples for soil laboratory analysis were collected at selected sites (for details, see Burke 2002a). The vegetation on plains was assessed by placing a sampling site in homogenous areas representing a particular vegetation type, while the inselberg vegetation was quantified along south-east to north-west transects over the highest peak of an inselberg. A total of some 120 vegetation points was established this way. Voucher specimens of unknown plant species were collected and lodged at the National Botanical Research Institute in Windhoek.

Mapping

A geo-referenced Landsat TM satellite image was used to a-priori stratify the area into mapping units. This mapping exercise was largely based on main landforms. These were verified and/or amended during the field work. Mapping was largely undertaken at 1:100 000 scale. Using the field data, perceived boundary points of vegetation types were plotted on the pre-stratified map and vegetation type boundaries were then defined and amended, where necessary. For the purpose of this study, the map was generated at the level of producing vegetation types rather than

plant communities. Hence each vegetation type provides a landscape level mapping unit with various plant communities contained in this mapping unit.

Data interpretation

The vegetation types were named after the main descriptors of the vegetation, usually the dominant plant and one characteristic plant species. To make it accessible to non-specialists, common names of plant species were used. In order to provide management-level information, the vegetation types were described in form of “fact sheets”. These were presented by the common name of the vegetation type and included a small map indicating the position in the study area as well as a photograph, where available. Further, the technical name of the vegetation type (based on Latin species name), locality, a description of subunits, habitat and environmental parameters, description of the vegetation, key plant species, extent, plant diversity, conservation importance, resource use, threats, recovery potential, sensitivity, management guidelines and relation to other vegetation classifications were provided (Appendix 1). Recovery potential and sensitivity were expert-opinion; subjective assessments using a three-point scale of low, medium and high. Recovery potential takes the longevity of the vegetation, the ability of individual plants species to establish from seeds or vegetative material and the dynamics of the habitat into account. The assessment of sensitivity takes an ecological approach and includes aspects of biodiversity as well as ecological function. Hence structural diversity, which gives an indication of habitat diversity for animals, plant species diversity, occurrence of species of conservation importance, uniqueness of the vegetation type, landscape function (e.g. erosion control, watershed management) and recovery potential are incorporated in the sensitivity assessment.

Results and discussion

Vegetation types

Fifteen vegetation types were described. Fourteen of these were mapped (Figure 2), one, shrubland of shallow drainage lines, was not mapped because of local extent. The vegetation types comprised:

- Camel thorn shrubland (*Acacia erioloba* – *Boscia foetida* shrubland)
- Damara milk bush shrubland (*Euphorbia damarana* shrubland)
- Dolerite outcrop shrubland (*Commiphora glaucescens* shrubland)
- Dwarf succulent – twiggy *Commiphora* shrubland (*Zygophyllum cylindrifolium* – *Commiphora virgata* shrubland)
- Dwarf succulent – small bushman grassland (*Zygophyllum cylindrifolium* – *Stipagrostis obtusa* grassland)
- Gembok tail grassland (*Stipagrostis hochstetteriana* var. *secalina* grassland)
- Granite outcrop shrubland (*Barleria lancifolia* – *Commiphora virgata* shrubland)

- Shrubland of shallow drainage lines (*Acacia reficiens* – *Catophractes alexandri* shrubland)
- Silky bushman grass – smelly shepherd's tree grassland (*Stipagrostis uniplumis* – *Boscia foetida* grassland)
- Silky bushman grass – gemsbok tail grassland (*Stipagrostis uniplumis* – *Stipagrostis hochstetteriana* grassland)
- Silky bushman grassland (*Stipagrostis uniplumis* var. *uniplumis* grassland)
- Succulent dwarf shrubland (*Zygophyllum cylindrifolium* dwarf shrubland)
- Tamarisk riverine shrubland (*Tamarix usneoides* shrubland)
- Variable petalidium shrubland (*Petalidium variable* dwarf shrubland)

Landforms, associated soil properties and erosion processes as well as position in the study area appear to be the main determinants of the mapped vegetation types. The west-east gradient of increasing rainfall (Hachfeld & Jürgens 2000) is likely responsible for the change from *Zygophyllum cylindrifolium* dwarf shrubland to *Acacia reficiens* shrubland. Sand sheets, in essence erosion products from the granite outcrops, support grass-dominated vegetation types, and surface and subsurface calcrete, which are relics of wetter conditions in the past (Blümel & Eitel 1994), are responsible for locally restricted vegetation types associated with calcium-rich habitats. The granite and dolerite outcrops support diverse, distinctly different plant communities which are explained by environmental as well as biogeographic parameters (Burke 2002b).

Vegetation boundaries in the study area are not clear-cut. Even between habitats that appear to be distinctly different (e.g. outcrops and plains) there are transitional areas with a species mix of both adjacent vegetation types. The provided map should hence be interpreted with this in mind. Due to the exceptional rainy season, ephemeral vegetation cover (grasses and herbs) was higher than during average conditions.

Plant diversity, conservation value and sensitivity

For an arid area, the vegetation in the study area is diverse, and includes a number of species endemic to the central and northern Namib as well as many protected species. The protected species are trees protected under forestry legislation. Every vegetation type supports at least one, more often several endemic or protected species. As a result of this, as well as the low recovery potential of the vegetation, there are no vegetation types of low sensitivity. Classified as highly sensitive are the granite and dolerite outcrop shrublands and their associated vegetation types in the vicinity, the camel thorn shrubland in the north-east of the study area, the tamarisk shrubland of the Spitzkoppe River and the shallow drainage line vegetation. This includes an area of temporary pools to the north of Gross Spitzkoppe.

Relationship to other classifications

The vegetation types in this study respond reasonably well to the Agroecological Zones provided for this area (De Pauw & Coetzee 1999). Vegetation types in the north-eastern part of the study area (*Acacia reficiens* shrubland and *Stipagrostis uniplumis* – *Stipagrostis hochstetteriana* grassland) fall within the CPL3-9 unit which describes the central plateau characterised by strongly dissected inselberg plains with an average growing period of 10 - 20 days (De Pauw & Coetzee 1999). The remaining vegetation types fall within NAM6, Namib Desert Plains with gravel and rock pavement. Vegetation mapping of the central Namib (Hachfeld 1996), undertaken at a much coarser level of resolution than this study only responded partially to the mapped vegetation types (Appendix 1).

These congruencies and discrepancies could well be explained by the used mapping sources. The agroecological zoning has been based on satellite imagery; the provisional map of the central Namib on extrapolation between transects (Hachfeld 1996).

Conclusion and implications for management

The study area is floristically diverse and supports a variety of vegetation types, some, such as the vegetation of the granite outcrops, unique to this area. Careful management, particularly of sensitive vegetation types is called for. Local over-grazing, exploitation of woody resources for firewood, the impacts of an increasing number of tourists, and in the past uncontrolled mineral collecting are potential threats to the natural vegetation. Hence resource use, vehicle movements as well as water abstraction and waste disposal need to be addressed in the area management plan.

Acknowledgements

My husband John Burke provided vital field assistance, Jo Tagg technical support and the Ministry of Environment and Tourism (Directorate of Environmental Affairs) and NACSO Natural Resources Working Group provided satellite imagery. The Ministry of Environment and Tourism granted permission for this research. This study was financially supported by a European Union grant ERBIC18CT970141, the World Wildlife Fund (WWF) and Namibia Nature Foundation (NNF). Comments from two reviewers improved the manuscript – many thanks to all.

References

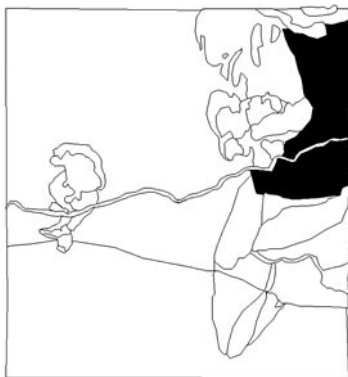
- BARNARD, P. (ed.) 1998. Biological diversity in Namibia - a country study. Namibian National Biodiversity Task Force, Windhoek.
- BLÜMEL, W. D. & EITEL, B. 1994. Tertiary calcic sediment covers and calcretes in Namibia - origin and geomorphic significance. *Zeitschrift für Geomorphologie* 38: 385-403.
- BURKE, A. 2001. Determinants of inselberg floras in arid Nama Karoo landscapes. *Journal of Biogeography* 28: 1211-1220.
- BURKE, A. 2002a. Properties of soil pockets on arid Nama Karoo inselbergs - The effect of geology and derived landforms. *Journal of Arid Environments* 50: 219-234.
- BURKE, A. 2002b. Plant communities of a central Namib Desert inselberg landscape. *Journal of Vegetation Science* 13: 483-492.
- BURKE, A. 2003. Floristic relationships between inselbergs and mountain habitats in the central Namib. *Dinteria* 28: 19-38.
- BURKE, A., DU PLESSIS, W., STROHBACH, B. 2002. Vegetation types in Namibia. Supplementary data to Environmental Atlas of Namibia, Ministry of Environment and Tourism, Windhoek.
http://www.dea.met.gov.na/data/Atlas/Atlas_web.htm#4Vegetation.
- CRAVEN, P. 1999. (ed.). A checklist of Namibian plant species. Southern African Botanical Diversity Network Report No. 7.
- DE PAUW, E. & COETZEE, M. E. 1999. Production of an agro-ecological zones map of Namibia. *Agricola* 1998/99: 27-43.
- GIBBS RUSSEL, G. E., RETIEF, E. & SMOOK, L. 1984. Intensity of plant collecting in southern Africa. *Bothalia* 15: 131-138.
- GIESS, W. 1998. A preliminary vegetation map of South West Africa, *Dinteria* 4, third revised edition, Namibia Scientific Society, Windhoek.
- HACHFELD, B. 1996. Vegetationsökologische Transektanalyse in the nördlichen Zentralen Namib. Diplomarbeit, Universität Hamburg.
- HACHFELD, B. & JURGENS, N. 2000. Climate patterns and their impact on the vegetation in a fog driven desert: The Central Namib Desert in Namibia. *Phytocoenologia* 30: 567-589.

IRISH, J. 1994. The biomes of Namibia, as determined by objective categorisation. Navorsinge van die Nasionale Museum Bloemfontein 10: 549-592.

MUELLER-DOMBOIS, D. & ELLENBERG, H. 1974. Aims and methods of vegetation ecology. John Wiley & Sons, New York, London, Sydney, Toronto.

VAN DER MERWE, J. H. 1983. National Atlas of South West Africa. National Book-printers, Goodwood, Cape.

APPENDIX 1: FACT SHEETS SPITZKOPPE VEGETATION TYPES

***Acacia* thorn bush savanna**

Technical name *Acacia reficiens* shrubland

Locality This shrubland occurs in the north-eastern section of the study area.

Subunits Several drainage lines and localised calcrete areas support different vegetation types. Hence *Zygophyllum cylindrifolium* and *Monechma cf cleomoides* can be locally dominant, as well as *Acacia senegal*.

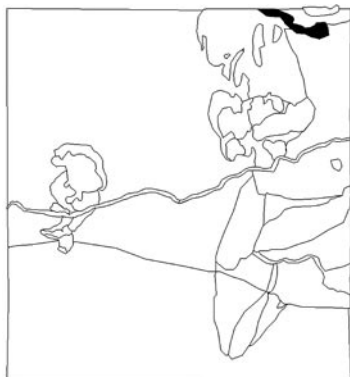
Habitat and environmental parameters Higher rainfall in this part of the study area is likely the main determinant of this vegetation type. The main habitat presents a plain dissected by shallow drainage lines.

Description The vegetation is characterised by low, thorn bushes, which can be shrubby or grow as single-stemmed trees. The average height is 1-2 m and vegetation cover ranges between 10 and 30%. Undergrowth of various height and growth forms is present. In terms of cover during a good growing season, grasses are the most abundant component.

Key species Besides *Acacia reficiens*, *Acacia senegal* and *Boscia foetida* are important woody components of the vegetation. There is a prevalence of grasses, with *Stipagrostis uniplumis* var. *uniplumis* being the most important grass. Several low shrubs occur, such as *Petalidium cf setosum*, *Monechma cleomoides* and *Monechma genistifolium*. There is a variety of other grasses as well as herbs.

Extent	Approximately 100 km ² are covered by this vegetation type, accounting for 14% of the study area.
Plant diversity	With some 30 plant species recorded during the survey period, plant diversity is relatively high. During the dry season, however, it is expected to decrease to 10 – 20 perennial species.
Conservation importance	<i>Boscia albitrunca</i> is protected under forestry legislation.
Resource use	The abundant grass cover, occurrence of fodder shrubs and the many perennial, woody species make this vegetation type important browse and grazing.
Threats	Overgrazing
Recovery	Low potential
Sensitivity	High
Management	<ul style="list-style-type: none"> • avoid overgrazing
Other...	AEZ: CPL3-9, Giess (1998): central Namib, Hachfeld (1996): <i>Calicorema capitata</i> – <i>Monsonia umbellata</i> , <i>Euphorbia damarana</i> and <i>Boscia foetida</i> zone, Burke <i>et al.</i> (2002): dwarf and <i>Acacia</i> shrubland of central west.

Camel thorn shrubland



Technical name *Acacia erioloba* – *Boscia foetida* shrubland

Locality This vegetation type occurs in the north-eastern corner of the study area.

Subunits While *Acacia erioloba* (camel thorn) is present in the main channel of the drainage area, *Boscia foetida* (smelly shepherd's tree) is more important in tributaries, which gradually become shallower as moving away from the main river course. Locally other species are prominent in drainage lines, such as *Acacia reficiens*, *Catophractes alexandri* and *Blepharis pruinosa*.

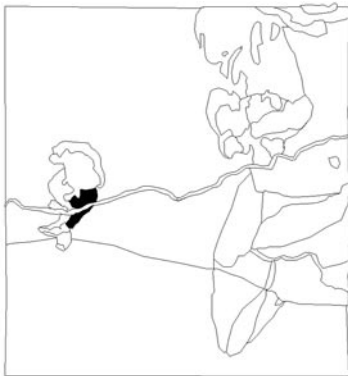
Habitat and environmental parameters It comprises a drainage area surrounding a dolerite ridge north-east of the Gross Spitzkoppe peaks. A wide, sandy riverbed and associated banks and tributaries are included in this vegetation type.

Description Characterised by large, majestic camel thorn trees, the vegetation is structurally more diverse than most other vegetation types in the study area. Although components of the vegetation are widely spaced, there are thickets formed by several shrubs species, extensive stretches of herbs and grasses on sandy, level ground and tuft-forming grasses. The trees can reach 7m height, shrub heights vary between 1.5 - 3m, and tuft-forming grasses grow up to 1.5m high.

Key species In addition to *Acacia erioloba* and *Boscia foetida*, the trees *Boscia albitrunca* and *Euclea pseudebenus* occur. Important shrubby

	<p>species are <i>Acacia hebeclada</i>, <i>A. reficiens</i>, <i>Phaeoptilum spinosum</i> and <i>Salvadora persica</i>. Smaller shrubs include <i>Monechma cf genis tifolium</i>, <i>Pergularia daemia</i> and <i>Petalidium cf setosum</i>. <i>Stipagrostis damarensis</i>, <i>S. hochstetteriana</i>, <i>S. uniplumis</i> and <i>Schmidtia kalahariensis</i> are dominant grasses in this vegetation type. The herb layer is particularly diverse with <i>Gisekia africana</i>, <i>Felicia anthemidodes</i>, <i>Indigofera auricoma</i> and <i>Tribulus zeyheri</i> providing some of the most conspicuous components.</p>
Extent	Approximately 16 km ² are covered by this vegetation type in the study area. This comprises 2.2% of the area.
Plant diversity	Second to the vegetation on rocky outcrops, this vegetation type is very diverse. At the time of the survey some 70 species were recorded, but during the dry periods and in a less favourable season, these are expected to decrease to about 20 perennial species.
Conservation importance	<i>Acacia erioloba</i> is protected, and so are the trees <i>Euclea pseudobenus</i> , <i>Maerua schinzii</i> and <i>Parkinsonia africana</i> . <i>Stipagrostis hochstetteriana</i> var. <i>hochstetteriana</i> is endemic to Namibia. The high floristic and structural diversity is expected to make this an unique vegetation type.
Resource use	The diverse shrub, grass and herb layers provide a variety of browse and grazing. The many woody components provide firewood.
Threats	Overexploitation for firewood, building and fencing material, over grazing
Recovery	Low potential
Sensitivity	High
Management	<ul style="list-style-type: none"> • avoid overgrazing • monitor and control resource use
Other...	AEZ: CPL3-9, Giess (1998): central Namib, Hachfeld (1996): <i>Boscia foetida</i> zone, Burke <i>et al.</i> (2002): dwarf and <i>Acacia</i> shrubland of central west.

Damara milk bush shrubland



Technical name *Euphorbia damarana* shrubland

Locality This shrubland occurs in a small area adjoining the southern part of the main Klein Spitzkoppe mountain.

Subunits None

Habitat and environmental parameters This vegetation type is associated with a rocky area adjoining the banks of the Spitzkoppe River and foot slopes of the Klein Spitzkoppe mountain. There are boulders, depressions and many channels.

Description The tall stem-succulent shrub *Euphorbia damarana* characterises this vegetation type. It grows up to 2 m high. There are also smaller shrubs, herbs and grasses and the vegetation reaches about 30 % cover.

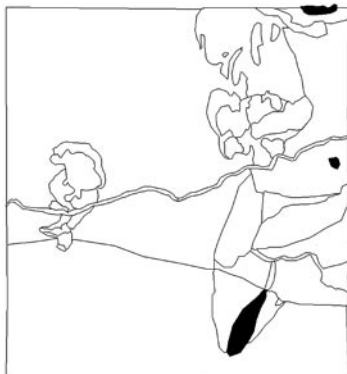
Key species Besides *Euphorbia damarana*, the low shrubs *Curroria decidua*, *Petalidium variabile* and *Sarcostemma viminale* occur frequently. The grass *Stipagrostis uniplumis* and the herb *Blepharis grossa* are other common components.

Extent Approximately 7.3 km² are covered by this vegetation type, accounting for 1 % of the study area.

Plant diversity Plant diversity, with some 30 species recorded during the survey period, is relatively high. During the dry season, however, it is expected to decrease to 10–20 perennial species.

Conservation importance	Euphorbia damarana is a Namib endemic and occurs only in the central and northern Namib. Other species of conservation importance are <i>Euphorbia mauritanica</i> and <i>Elephantorrhiza suffruticosa</i> , the protected stem-succulent <i>Cyphostemma currori</i> and the Namib endemic <i>Commiphora saxicola</i> . Although <i>E. damarana</i> is widespread in other parts of the Namib Desert, the combination of this shrub with rocky outcrop vegetation is unique.
Resource use	Some of the dwarf shrubs and the grasses are important browse and grazing.
Threats	Overgrazing
Recovery	Low potential
Sensitivity	High
Management	<ul style="list-style-type: none"> • Restrict tracks through this vegetation type • Avoid overgrazing
Other...	AEZ: NAM6, Giess (1998): central Namib, Hachfeld (1996): <i>Euphorbia damarana</i> zone, Burke <i>et al.</i> (2002): dwarf and <i>Acacia</i> shrubland of central west.

Dolerite outcrop shrubland



Technical name *Commiphora glaucescens* shrubland

Locality This vegetation type comprises all dolerite outcrops and higher dolerite ridges in the study area. These are the Black Range in the south-east and a nameless outcrop in the north-east corner of the study area.

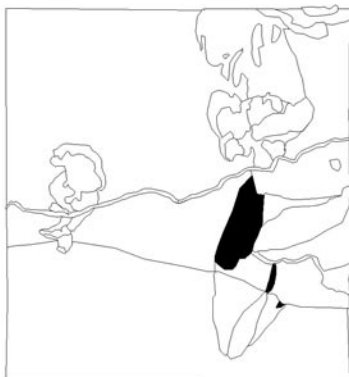
Subunits The vegetation differs between dolerite outcrops, depending on the height and extent of an individual outcrop and position in the study area. Hence there are outcrops where *Commiphora tenuipetiolata* and *Commiphora virgata* dominate, and various grass and shrub species are prevalent on different outcrops. *Stipagrostis hirtigluma* subsp. *hirtigluma*, for example, is prevalent on the Black Range, *Triraphis ramosissima* on the outcrop to the north of Gross Spitzkoppe.

Habitat and environmental parameters Dolerite outcrops of various heights and extent provide a habitat for this vegetation type. In the study area these are characterised by medium to steep slopes and a height above surrounding ranging from 100 – 200 m. The soils derived from dolerite are relatively fertile and show a high phosphorous, calcium and magnesium content (Burke 2002a).

Description The vegetation of dolerite outcrops is structurally diverse, with prominent stem-succulents, trees, many shrubs and dwarf shrubs and a large component of grasses and herbs. Cover values range between 20 and 40 % and a mean height of 2 m was recorded.

Key species	Besides the three <i>Commiphora</i> species, (<i>C. glaucescens</i> , <i>C. tenuipetiolata</i> , <i>C. virgata</i>), <i>Euphorbia virosa</i> is another prominent component of the vegetation. Shrubs of greater abundance are <i>Amphiasma divaricatum</i> , <i>Commicarpus squarrosus</i> and <i>Polygala guerichiana</i> in the north-east, and <i>Monechma cleomoides</i> and <i>Monechma genistifolium</i> in the south-east. The herb <i>Chamaesyce glanduligera</i> and various grass species, such as <i>Eragrostis nindensis</i> , <i>Stipagrostis hirtigluma</i> and <i>S. uniplumis</i> are common on these outcrops.
Extent	The outcrops on the study area cover 7.6 km ² . This amounts to 1.1 % of the study area.
Plant diversity	The vegetation of dolerite outcrop is diverse and, depending on the size of the outcrop, well over 50 species are associated with these outcrops.
Conservation importance	There are many species of conservation importance such as <i>Euphorbia virosa</i> and <i>Euphorbia guerichiana</i> , and the protected <i>Boscia albitrunca</i> . Range-restricted (endemic) species comprise, amongst others, <i>Amphiasma divaricatum</i> , <i>Commiphora saxicola</i> , <i>Commiphora virgata</i> , <i>Solanum rigescentoides</i> and <i>Stipagrostis hochstetteriana</i> var. <i>hochstetteriana</i> .
Resource use	The outcrops provide diverse forage for livestock and wildlife.
Threats	Overgrazing and overexploitation of woody resources.
Recovery	Low potential
Sensitivity	High
Management	<ul style="list-style-type: none"> • avoid overgrazing by placing water points away from outcrops • monitor, and, if necessary, control use of woody resources
Other...	AEZ: Undifferentiated rock, Giess (1998): central Namib, Hachfeld (2000): <i>Euphorbia damarana</i> and <i>Boscia foetida</i> zone, Burke <i>et al.</i> (2002): dwarf and Acacia shrubland of central west.

Dwarf succulent – twiggy *Commiphora* shrubland



Technical name *Zygophyllum cylindrifolium* – *Commiphora virgata* shrubland

Locality This vegetation type is found in the south-east of the study area and is associated with low dolerite ridges.

Subunits Different species may be prominent on some of the dolerite ridges which could not be accessed during this survey.

Habitat and environmental parameters Several north-south trending, low dolerite ridges and surrounding plains provide a habitat for this vegetation type.

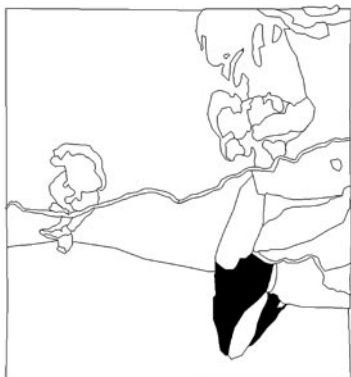
Description Although during the growing season grasses are the most abundant component of this vegetation type, low shrubs are characteristic. Average height is approximately 1 m and vegetation cover reached 20 % during the survey period.

Key species *Commiphora virgata* and *Zygophyllum cylindrifolium* characterise this vegetation type. The former is prominent on ridges, the latter on plains in between these ridges. *Commiphora glaucescens* also occurs on some of the ridges. In addition to these species, the herb *Chamaesyce glanduligera*, and the grasses *Stipagrostis obtusa*, *S. uniplumis* and *Eragrostis nindensis* occur frequently.

Extent 14 km² or 2 % of the study area are covered by this vegetation type.

Plant diversity	Ten to 30 species are expected to be associated with this vegetation type.
Conservation importance	<i>Commiphora virgata</i> and <i>Zygophyllum cylindrifolium</i> are endemic to the central and northern Namib.
Resource use	The shrubs and grasses associated with this vegetation type provide grazing and browse for livestock and wildlife.
Threats	Overgrazing
Recovery	Low potential
Sensitivity	Medium
Management	<ul style="list-style-type: none"> • avoid overgrazing
Other...	AEZ: NAM6, Giess (1998): central Namib, Hachfeld (1996): <i>Euphorbia damarana</i> , <i>Calicorema capitata</i> – <i>Monsonia umbellata</i> and <i>Boscia foetida</i> zone, Burke <i>et al.</i> (2002): dwarf and <i>Acacia</i> shrubland of central west.

Dwarf succulent – small bushman grassland



Technical name *Zygophyllum cylindrifolium* – *Stipagrostis obtusa* grassland

Locality This grassland type is found in the vicinity of the Black Range in the south-east of the study area.

Subunits None

Habitat and environmental parameters This vegetation type grows on plains surrounding a dolerite ridge. The soils on these plains are characterised by high pH (8.2) and high calcium content (Burke 2002d).

Description Dwarf shrubs and grasses characterise this vegetation type. An average height of 0.3 m and plant cover of approximately 20 % were recorded during the survey.

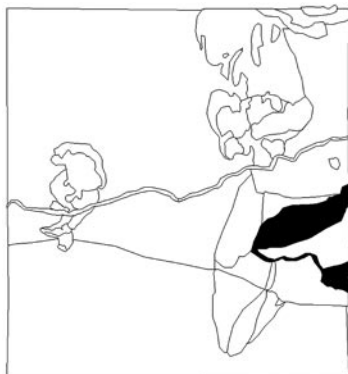
Key species The grass *Stipagrostis obtusa* and the dwarf shrub *Zygophyllum cylindrifolium* are the most important species. Further the grasses *Stipagrostis hirtigluma*, *S. uniplumis* and *Eragrostis nindensis* occur. There is a variety of herbs associated with this vegetation type such as *Chamaesyce glanduligera*, *Geigeria alata*, *Monsonia umbellata* and *Zygophyllum simplex*.

Extent This vegetation type covers approximately 21 km² and hence 3 % of the study area.

Plant diversity Approximately 10 – 30 species are associated with this vegetation type.

Conservation	Zygophyllum cylindrifolium is restricted to the central and northern Namib.
Resource use	The prevalence of grasses makes this vegetation type an important rangeland resource.
Threats	Overgrazing
Recovery	Medium potential
Sensitivity	Medium
Management	<ul style="list-style-type: none"> • Avoid overgrazing • Control tracks
Other...	AEZ: NAM6, Giess (1998): central Namib, Hachfeld (1996): <i>Calicorema capitata</i> – <i>Monsonia umbellata</i> zone, Burke <i>et al.</i> (2002): dwarf and <i>Acacia</i> shrubland of central west

Gemsbok tail grassland



Technical name *Stipagrostis hochstetteriana* var. *secalina* grassland

Locality A drainage area in the south-eastern portion of the study area supports this vegetation type.

Subunits The main drainage lines harbour some large *Acacia erioloba* (camel thorn) trees, which provide a different subunit, while other grass species, such as *Stipagrostis uniplumis* and dwarf shrubs become more prominent where the depth of sand is reduced. In shallow drainage lines *Catophractes alexandri* becomes dominant.

Habitat and environmental parameters This vegetation type is linked to a sandy area dissected by several drainage lines to the south of Gross Spitzkoppe. Sandy soils and occasional disturbance by floods in the main channel are important environmental determinants.

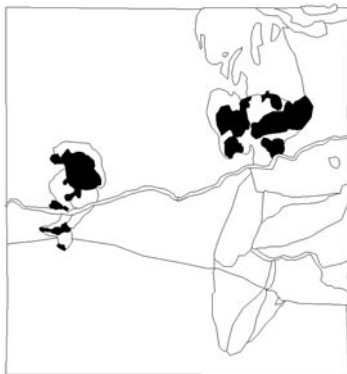
Description Grasses are the main components of this vegetation type. Plant cover reaches 30 % and a mean height of 0.3 m. Dwarf shrubs form the second most important component of this vegetation type. Occasional taller shrubs provide thickets which enable herbs to establish in their shelter.

Key species Apart from *Stipagrostis hochstetteriana* var. *secalina* (gemsbok tail grass), *S. uniplumis* var. *uniplumis* and *Eragrostis nindensis* are frequent. Common dwarf shrubs are *Aptosimum spinescens*, *Monechma cf genistifolium* and *Zygophyllum cylindrifolium*.

Extent This sandy drainage area covers 21.8 km², amounting to 3.1 % of the study area.

Plant diversity	During the survey period plant diversity was medium, ranging between 10 and 20 species. The main drainage channels are more diverse.
Conservation importance	<i>Acacia erioloba</i> is a protected tree and <i>Zygophyllum cylindrifolium</i> a central Namib endemic.
Resource use	Trees and shrubs in the riverbeds are a source of firewood and building material. The grasslands are important grazing.
Threats	Overgrazing
Recovery	Medium potential
Sensitivity	Medium
Management	<ul style="list-style-type: none"> • Avoid overgrazing • Monitor and control use of firewood and building material
Other...	AEZ: NAM6, Giess (1998): central Namib, Hachfeld (1996): <i>Calicorema capitata</i> – <i>Monsonia umbellata</i> and <i>Boscia foetida</i> zone, Burke <i>et al.</i> (2002): dwarf and <i>Acacia</i> shrubland of central west.

Granite outcrop shrubland



Technical name *Barleria lancifolia* - *Commiphora virgata* shrubland

Locality Two groups of granite outcrops in the study area provide a habitat for this vegetation type. These are the Klein and Gross Spitzkoppe group of inselbergs.

Subunits There are differences between the two groups of granite outcrops. While Klein Spitzkoppe supports more low shrubs, such as *Barleria lancifolia*, tall *Commiphora* species and other stem succulents are more prominent on Gross Spitzkoppe. The vegetation also changes with elevation, with *Euclea undulata* and *Triraphis ramosissima* becoming more prevalent on higher slopes (Burke 2002d).

Habitat and environmental parameters Granite outcrops in the study area are characterised by steep slopes, large boulders around their bases and occasional depressions providing temporary pools. Due to their elevation, they receive and retain more moisture than their surroundings. The granite-derived soils show a near neutral pH, but are relatively low in essential nutrients such as nitrogen, potassium and magnesium (Burke 2002a).

Description Structurally very diverse, trees, shrubs of various heights as well as grasses, herbs and bulbs are present. Total height averages at 2 m and plant cover ranges between 20 and 40 %.

Key species *Commiphora* species, *Cyphostemma currori* and *Euphorbia virosa* are some of the most conspicuous components of the vegetation.

	<p>Lower shrubs such as <i>Barleria lancifolia</i>, <i>Euclea undulata</i>, <i>Monochma cleomoides</i> and <i>Tephrosia dregeana</i> are locally dominant. Grasses are other important components of the outcrop vegetation. <i>Enneapogon scaber</i>, <i>Stipagrostis hirtigluma</i>, <i>S. uniplumis</i>, <i>Tricholaena capensis</i> and <i>Triraphis ramosissima</i> are overall the most abundant grasses.</p>
Extent	<p>The granite outcrops in the study area comprise (projected 2-dimensionally) 32.8 km². This is 4.6 % of the study area.</p>
Plant diversity	<p>Plant diversity on these granite outcrops is extremely high, considering the general aridity of the area. Between 150 and 200 plant species have been recorded on the various outcrops.</p>
Conservation importance	<p>Three <i>Euphorbia</i> species of conservation importance occur, <i>E. guerichiana</i>, <i>E. mauritanica</i> and <i>E. virosa</i>. Protected species are <i>Boscia albitrunca</i>, <i>Cyphostemma currori</i>, <i>Euclea pseudebenus</i>, <i>Moringa ovalifolia</i>, <i>Hoodia currori</i>, <i>Parkinsonia africana</i> and <i>Sterculia africana</i>. Many endemic species occur such as <i>Amphisma divaricatum</i>, <i>Antiphona fragrans</i>, <i>Sarcocaulon marlothii</i> and <i>Senecio alliariifolius</i>. Species of temporary pools such as <i>Aponogeton desertorum</i> and <i>Chamaegigas intrepidus</i>, although not protected, are of conservation importance because of their rarity. The granite outcrop vegetation is unique to this area.</p>
Resource use	<p>Many woody species provide firewood, and the high plant diversity makes it likely that species of potential economic importance (e.g. medicinal, horticultural or agricultural value) are amongst the granite inselberg flora.</p>
Threats	<p>Physical damage of vegetation through uncontrolled mineral collecting and firewood collection around the base of the outcrops.</p>
Recovery	<p>Low potential</p>
Sensitivity	<p>High</p>
Management	<ul style="list-style-type: none"> • Avoid damaging vegetation through mineral collecting • Prohibit collection of firewood
Other...	<p>AEZ: undifferentiated rock, Giess (1998): central Namib, Hachfeld (1996): <i>Euphorbia damarana</i> and grass zone, Burke <i>et al.</i> (2002): dwarf and <i>Acacia</i> shrubland of central west.</p>

Shrubland of shallow drainage lines

NOT MAPPED

except for *Catophractes*
– *Cordia*



Technical name *Acacia reficiens* – *Catophractes alexandri* shrubland

Locality Shrublands of shallow drainage lines are distributed throughout the study area. These shallow, dry river courses drain into the Spitzkoppe and Black Range Rivers, or north and north-west into the Uithou drainage system, which flows towards the large Omaruru River.

Subunits As distributed throughout the study area, the species composition changes depending on position in study area and the size of drainage. Locally *Acacia senegal*, *Adenolobus garipensis*, *Boscia foetida*, *Commiphora dinteri* and *Cordia sinensis* and *Parkinsonia africana* become dominant. Towards the more arid, western part of the study area, these small trees are replaced by shrub species, such as *Calicorema capitata*, *Curroia decidua* and *Petalidium cf setosum*. The spiny shrub *Blepharis pruinosa* is prevalent in drainage lines north and west of Gross Spitzkoppe.

Habitat and environmental parameters This vegetation type is confined to drainage areas which provide well draining, sandy soils. It also includes areas surrounding temporary pools, such as the *Catophractes alexandri* – *Cordia sinensis* unit, which was mapped because of particular sensitivity.

Description The thorny *Acacia reficiens* and *Catophractes alexandri* characterise this vegetation type. *A. reficiens* can grow as a single-stemmed tree or multi-stemmed shrub, reaching between 2 and 3 m height. The shrubs are widely spaced and reach up to 15 % cover. Grasses are the second most important component of this

	vegetation type. Herbs and other shrubs are common. Total cover of this vegetation type can reach 25 %.
Key species	Apart from <i>Acacia reficiens</i> and <i>Catophractes alexandri</i> , the grasses <i>Stipagrostis damarensis</i> , <i>S. hochstetteriana</i> and <i>S. uniplumis</i> var. <i>uniplumis</i> and var. <i>intermedia</i> occur frequently in these drainage lines. A variety of herbs is associated with this vegetation type; for example <i>Cleome suffruticosa</i> , <i>Citrullus ecirrhosus</i> , <i>Tribulus zeyheri</i> , and <i>Zygophyllum simplex</i> .
Extent	These drainage lines are distributed throughout the study area and, with the exception of the sensitive shrubland area surrounding temporary pools, have not been mapped because of their local extent.
Plant diversity	The drainage line vegetation is more diverse than plains and harbours approximately 20 to 40 species.
Conservation importance	Some trees occurring in this vegetation type are protected. These include <i>Acacia erioloba</i> , <i>Boscia albitrunca</i> , <i>Maerua schinzii</i> and <i>Parkinsonia africana</i> . <i>Stipagrostis damarensis</i> is endemic to the central and northern Namib.
Resource use	Generally denser vegetation, particularly in the eastern part of the study area and the occurrence of many woody species make drainage line vegetation an important source of firewood, fencing and building material. Grasses and shrubs provide forage for livestock and wildlife.
Threats	Excessive wood collection, overgrazing
Recovery	Low potential
Sensitivity	High
Management	<ul style="list-style-type: none"> • Prohibit collection of firewood • Avoid overgrazing
Other...	AEZ: NAM6 and CPL3-9, Giess (1998): central Namib, Hachfeld (1996): <i>Acacia reficiens</i> , grass, <i>Euphorbia damarana</i> and <i>Calicorema capitata</i> – <i>Monsonia umbellata</i> zone, Burke <i>et al.</i> (2002): dwarf and <i>Acacia</i> shrubland of central west.

Silky bushman grass – smelly shepherd's tree grassland



Technical name *Stipagrostis uniplumis* – *Boscia foetida* grassland

Locality This vegetation type is confined to the sandy plains surrounding the Gross Spitzkoppe group.

Subunits Within this vegetation type, drainage lines support vegetation dominated by *Acacia senegal*, *Adenolobus garipensis* and *Blepharis pruinosa*. The drainage and boulder areas adjoining the footslopes of the mountains are often dominated by the trees *Dombeya rotundifolia* and *Cordia sinensis* as well as the tall shrub *Adenolobus garipensis*.

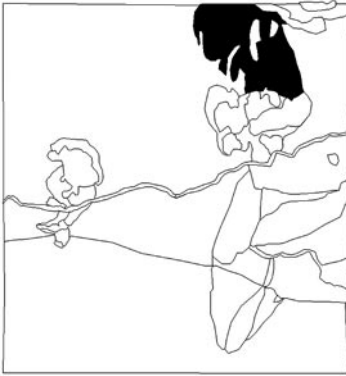
Habitat and environmental parameters Sandy plains, boulder and drainage areas in the direct vicinity of the mountains support this vegetation type. The soils are granite-derived, coarse sands with a near neutral pH (7.9) and medium calcium content (Burke 2002d).

Description The vegetation is structurally diverse, with trees, stem-succulents, shrubs of various heights interspersed with extensive grasslands. There are also dwarf shrubs, herbs and trees. The height of the vegetation is hence variable, but approximately 3 m is the maximum height. Cover can reach 40 %.

Key species *Boscia foetida* is characteristic and *Stipagrostis uniplumis*, with both varieties, var. *intermedia* and var. *uniplumis*, are the most abundant components of the vegetation. Other important grass species are *Eragrostis nindensis*, *Schmidtia kalahariensis* and *Stipagrostis hochstetteriana* var. *secalina*. Shrubs comprise

	<p>another important component of the vegetation, with <i>Acacia senegal</i>, <i>A. reficiens</i>, <i>Adenolobus garipensis</i> and <i>Blepharis pruinosa</i> locally abundant. Frequent dwarf shrubs are <i>Adenolobus pechuelii</i>, <i>Aptosimum spinescens</i> and <i>Monechma cf genistifolia</i>. There are various tree species, such as <i>Boscia albitrunca</i>, <i>Cyphostemma currori</i>, <i>Dombeya rotundifolia</i> and <i>Maerua schinzii</i>.</p>
Extent	13.3 km ² were mapped during the survey, comprising 1.9 % of the study area.
Plant diversity	Plant diversity is high and 30–50 species can be expected during a good season.
Conservation importance	There are a number of protected trees, such as <i>Boscia albitrunca</i> , <i>Cyphostemma currori</i> and <i>Maerua schinzii</i> . <i>Commiphora saxicola</i> is endemic to the central and northern Namib.
Resource use	The many woody species provide firewood and building material and the grasslands provide important grazing.
Threats	Overgrazing, overexploitation of wood and physical damage through vehicles and fire.
Recovery	Low potential
Sensitivity	High
Management	<ul style="list-style-type: none"> • Minimise tracks • Prohibit collecting of firewood • Avoid overgrazing • Provide dedicated, contained places for camp fires
Other...	AEZ: undifferentiated rock, Giess (1998): central Namib, Hachfeld (1996): <i>Euphorbia damarana</i> zone, Burke <i>et al.</i> (2002): dwarf and <i>Acacia</i> shrubland of central west.

Silky bushman grass – gemsbok tail grassland



Technical name *Stipagrostis uniplumis* –
Stipagrostis hochstetteriana
grassland

Locality This vegetation type covers the sandy drainage area north of Gross Spitzkoppe.

Subunits Likely depending on sand depth, either *Stipagrostis uniplumis* var. *uniplumis* or *Stipagrostis hochstetteriana* var. *secalina* is dominant. On calcrete patches in between the sandy areas, *Monsonia umbellata* and *Xerophyta humilis* prevail.

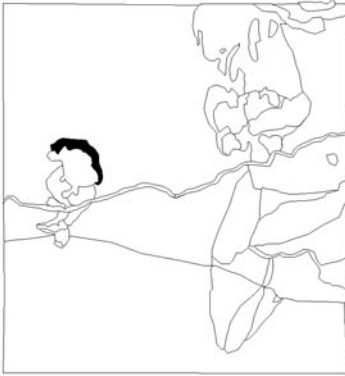
Habitat and environmental parameters Granite-derived sands and position in the eastern part of the study area which likely receives more rain than the west, are the main environmental determinants of this vegetation type.

Description This vegetation type comprises tracts of grassland interspersed with occasional shrubs. The average height on grasslands is 0.3 and, where shrubs occur 1.5 m. Vegetation cover averaged 30 % during the survey period.

Key species In addition to the two *Stipagrostis* species, *Eragrostis nindensis* and *Schmidtia kalahariensis* are other important grass species. Common shrubs are *Acacia reficiens*, *A. senegal* and *Boscia foetida*. The herbs *Monsonia umbellata*, *Limeum argute-carnatum* and *Indigofera auricoma* are common in this vegetation type. Bulbs are expected to occur in this vegetation type.

Extent	These grasslands cover 37 km ² or 5.2 % of the study area.
Plant diversity	Discounting drainage lines, plant diversity is medium with about 20-30 plant species.
Conservation importance	There may be endemic bulb species associated with this vegetation type.
Resource use	The grasslands are important range resources.
Threats	Overgrazing
Recovery	Medium potential
Sensitivity	Medium
Management	<ul style="list-style-type: none"> • Avoid overgrazing
Other...	AEZ: CPL3-9, Giess (1998): central Namib, Hachfeld (1996): <i>Euphorbia damarana</i> zone, Burke <i>et al.</i> (2002): dwarf and <i>Acacia</i> shrubland of central west.

Silky bushman grassland



Technical name *Stipagrostis uniplumis* var. *uniplumis* grassland

Locality This grassland type surrounds northern and eastern section of the main Klein Spitzkoppe mountain.

Subunits On less sandy patches away from the mountain, *Blepharis grossa* becomes locally dominant.

Habitat and environmental parameters Coarse, granite-derived sand largely determines this vegetation type.

Description The vegetation cover reaches 30 % and an average height of 0.3 m. Grasses are dominant, but towards the base of the mountain larger trees, such as *Acacia erioloba*, and shrubs occur. Dwarf shrubs are interspersed between the grasses.

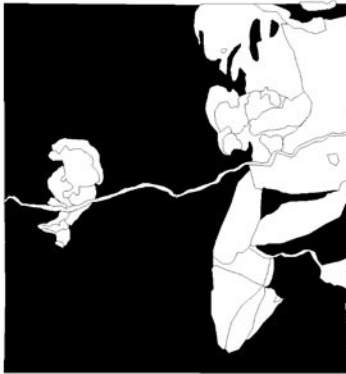
Key species Although *Stipagrostis uniplumis* var. *uniplumis* is dominant, the annual *S. uniplumis* var. *intermedia*, as well as *S. hochstetteriana* var. *hochstetteriana* and *Eragrostis nindensis* occur. *Monechma cf cleomoides*, *Boscia foetida* and *Aptosimum spinescens* are important shrub species.

Extent This vegetation type covers 3.6 km² or 0.5 % of the study area.

Plant diversity Plant diversity is medium and expected to comprise some 20-30 species during the growing season. Plant diversity increases towards the base of the mountain.

Conservation importance	<i>Acacia erioloba</i> trees are protected.
Resource use	The grasses are important grazing, the dwarf shrub <i>Monechma cf cleomoides</i> an important fodder species and <i>Acacia erioloba</i> provides excellent firewood.
Threats	Overgrazing and excessive use of firewood
Recovery	Medium potential
Sensitivity	Medium
Management	<ul style="list-style-type: none"> • Avoid overgrazing • Prohibit collecting of firewood
Other...	AEZ: NAM6, Giess (1998): central Namib, Hachfeld (1996): grass zone, Burke <i>et al.</i> (2002): dwarf and <i>Acacia</i> shrubland of central west.

Succulent dwarf shrubland



Technical name *Zygophyllum cylindrifolium* dwarf shrubland

Locality This vegetation type covers the majority of the study area, particularly in the western parts.

Subunits Depending on microhabitat conditions and phytogeographic zones other grass and shrub species are locally dominant. *Eragrostis nindensis* and *Stipagrostis obtusa* dominate locally in the western and southern parts of this dwarf shrubland, *Calicorema capitata* in the vicinity of the Spitzkoppe River drainage areas, and *Salsola tuberculata* occurs where saline conditions prevail. *Petalidium cf setosum* is co-dominant in many parts of the study area, but becomes locally dominant in some areas.

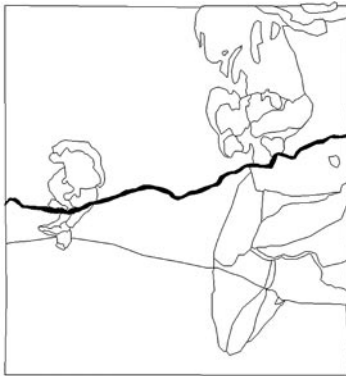
Habitat and environmental parameters Gravel plains with subsurface or surface calcrete support this vegetation type. In parts of the study area desert pavement is also present. The calcrete crusts result in a relatively high pH (around 8) and high calcium content of the soil (Burke 2002d).

Description The vegetation is composed largely of the low succulent shrub *Zygophyllum cylindrifolium*, which hardly reaches 30 cm height. The shrubs are widely spaced and can reach about 10 % cover. Grasses, herbs, other dwarf shrubs, and the occasional tree are associated with this vegetation type.

Key species Apart from *Zygophyllum cylindrifolium*, the dwarf shrubs *Petalidium cf setosum*, *Monechma cf genistifolium* and *Aptosimum spinescens* are frequent companion species. The second important com-

	ponent of the vegetation is grasses. <i>Stipagrostis uniplumis</i> var. <i>uniplumis</i> , <i>S. uniplumis</i> var. <i>intermedia</i> and <i>Enneapogon desvauxii</i> are most prevalent. Frequent herbs are <i>Chamaesyce glanduligera</i> , <i>Cleome suffruticosa</i> , <i>Indigofera auricoma</i> , <i>Monsonia umbellata</i> and <i>Tribulus zeyheri</i> . <i>Commiphora virgata</i> and the tree <i>Maerua schinzii</i> occur occasionally.
Extent	In the study area, approximately 474 km ² are covered by this vegetation type, comprising 66 % of the mapped area.
Plant diversity	Depending on nature of the growing season and the time of the year, species numbers range from 5 to approximately 30.
Conservation importance	<i>Zygophyllum cylindrifolium</i> is a central Namib endemic. Although common where it occurs, it is restricted to the central and northern Namib gravel plains. The tree <i>Maerua schinzii</i> is protected. <i>Stipagrostis uniplumis</i> var. <i>intermedia</i> are a central Namib endemic.
Resource use	The majority of the shrub species in this vegetation type are palatable, and particularly <i>Monechma cf genistifolium</i> and <i>Petalidium cf setosum</i> are important fodder shrubs for livestock and wildlife. The accompanying grasses and herbs provide important graze and foliage.
Threats	Overgrazing and physical damage through vehicles.
Recovery	Low potential
Sensitivity	Medium
Management	<ul style="list-style-type: none"> • avoid overgrazing • reduce tracks by implementing controlled track network • rehabilitate and block off tracks no longer required
Other...	AEZ: NAM6, Giess (1998): central Namib, Hachfeld (1996): grass and <i>Euphorbia damarana</i> zone, Burke <i>et al.</i> (2002): dwarf and <i>Acacia</i> shrubland of central west.

Tamarisk riverine shrubland



Technical name *Tamarix usneoides* shrubland

Locality The east-west running Spitzkoppe River to the south of Gross and Klein Spitzkoppe supports this vegetation type.

Subunits The species composition changes along the river course and many subunits can be recognised. The large tree *Faidherbia albida* is prevalent along stretches in the centre of the study area, *Zygophyllum stapffii* is associated with river banks in the vicinity of Klein Spitzkoppe, and *Acacia reficiens* becomes dominant along the eastern section of the Spitzkoppe River. Locally, sedges and salt-tolerant grasses occur in the vicinity of seepage areas.

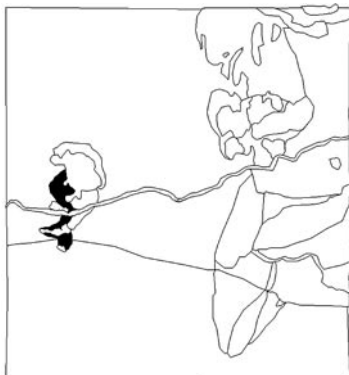
Habitat and environmental parameters This vegetation type is associated with a wide, sandy dry river and comprises the riverbed itself as well as adjoining banks. Sub-surface flow and occasional disturbance through floods are important environmental variables. The soils largely comprise coarse sands, but there are also temporary seepage areas where saline conditions prevail.

Description The vegetation is structurally diverse with large trees, reaching 6 m height, shrubs, dwarf shrubs, grasses and herbs well represented. Large tufts of grasses and sedges occur. Vegetation cover is patchy and variable along this river course and ranges between 10 and 30 %.

Key species Apart from *Tamarix usneoides* and locally *Faidherbia albida*, most species that are associated with shallower drainage lines occur in

	<p>this vegetation type. This includes <i>Acacia reficiens</i>, <i>Boscia foetida</i>, <i>Catophractes alexandri</i> and <i>Cordia sinensis</i>. Important also are <i>Euclea pseudebenus</i> and <i>Salvadora persica</i>. A variety of grasses, herbs and sedges occur.</p>
Extent	<p>Approximately 7 km² are covered by the river and associated banks. This comprises 1 % of the study area.</p>
Plant diversity	<p>As this vegetation type snakes east to west through the study area, a large complement of species is associated with this vegetation type. Throughout the study area well over 50 species are expected to occur.</p>
Conservation importance	<p>Several of the tree species in this river such as <i>Acacia erioloba</i>, <i>Faidherbia albida</i>, <i>Euclea pseudebenus</i> and <i>Tamarix usneoides</i> are protected under forestry legislation.</p>
Resource use	<p>The river is a potential source of water. Woody components of the vegetation provide firewood and building material.</p>
Threats	<p>Overexploitation of firewood and overgrazing, water abstraction, as well as pollution of subsurface water</p>
Recovery	<p>Low potential</p>
Sensitivity	<p>High</p>
Management	<ul style="list-style-type: none"> • Monitor and control use of firewood • Avoid overgrazing • Monitor the effect of water abstraction on vegetation • Avoid development of waste and sewage disposal points near the river
Other...	<p>AEZ: NAM6 and CPL3-9, Giess (1998): central Namib, Hachfeld (1996): grass, <i>Euphorbia damarana</i>, <i>Calicorema capitata</i> – <i>Monsonia umbellata</i>, <i>Acacia reficiens</i> and <i>Boscia foetida</i> zone, Burke <i>et al.</i> (2002): dwarf and <i>Acacia</i> shrubland of central west.</p>

Variable petalidium dwarf shrubland



Technical name *Petalidium variable* dwarf shrubland

Locality This dwarf shrubland type is found adjoining the western and southern footslopes of the Klein Spitzkoppe group.

Subunits None

Habitat and environmental parameters This vegetation type is associated with the boulders areas surrounding Klein Spitzkoppe. A high pH (> 8) and relatively high calcium content characterise the soils of this vegetation type (Burke 2002d).

Description Although dwarf shrubs characterise this vegetation type, there are various trees and taller shrubs, giving this vegetation type a diverse structure. Vegetation cover is approximately 20 % and height averages at about 0.5 m.

Key species In addition to *Petalidium variable* (variable petal bush), the herbs *Cleome suffruticosa* and *Indigofera auricoma*, as well as *Monsonia umbellata* are common. *Blepharis pruinosa*, *Eragrostis nindensis* and *Commiphora saxicola* and *Commiphora tenuipetiolata* are other conspicuous components.

Extent This vegetation type covers 5.2 km², comprising 0.7 % of the study area.

Plant diversity At the time of the survey moderate diversity was recorded and it is expected to harbour 10–30 species.

Conservation importance	<i>Commiphora saxicola</i> and <i>Sarcocaulon marlothii</i> are endemic species occurring in this vegetation type. <i>Commiphora saxicola</i> occurs in the central and northern Namib, <i>Sarcocaulon marlothii</i> in the central Namib and along the central western escarpment. The combination of the dominant dwarf shrub with rocky outcrops vegetation makes this a unique vegetation type.
Resource use	The main component of this vegetation type, <i>Petalidium variable</i> (variable petal bush), is an important fodder shrub.
Threats	Physical damage through vehicles and overgrazing
Recovery	Low potential
Sensitivity	High
Management	<ul style="list-style-type: none"> • Avoid overgrazing • Reduce tracks to avoid physical damage
Other...	AEZ: NAM6, Giess (1998): central Namib, Hachfeld (1996): grass zone, Burke <i>et al.</i> (2002): dwarf and Acacia shrubland of central west.