A DESCRIPTION OF THE ENDEMIC FLORA AND VEGETATION OF THE KAMIESBERG UPLANDS, NAMAQUALAND, SOUTH AFRICA.

by

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Cover picture: A view of the Kamiesberg Uplands in the Langkloof area east of Rooiberg, showing typical granite domes (photo: Nick Helme).

SUMMARY

The Kamiesberg massif (the key element of the Namaqualand Uplands SKEP priority area) lies northeast of the town of Garies, some 500km north of Cape Town, and at its highest point (Rooiberg peak) reaches 1706m, which is also the highest point in the broader Namaqualand region. The Kamiesberg Centre (KBC), as it has become known, was recognised as one of several foci of high endemism within the Succulent Karoo, and Van Wyk & Smith (2001) reinforced this, defining the area as the land above the 1200m contour.

The latest South African vegetation map (Mucina & Rutherford 2003) identifies five distinct vegetation types within the area, including one (Kamiesberg Granite Fynbos) that is restricted to the area, and another (Namaqualand Granite Renosterveld) that is found only here and on the escarpment west of Springbok. This national vegetation map also includes Blomveld, along with a division of the Upland Succulent Karoo into two Shrubland units - Namaqualand Klipkoppe Shrubland and Kamiesberg Mountain Shrubland. We regard these five vegetation types as being an acceptable and relatively accurate broad scale description of the vegetation types in the area, but have redrawn the extent of the individual vegetation types.

Habitat transformation is primarily associated with dryland cropping, followed by heavy grazing, and too frequent fires. Cropping naturally targets the higher rainfall areas and deeper soils, which corresponds closely with the upper Renosterveld plateau (above 1000m).

The currently mapped extent of Renosterveld is substantially smaller than previously thought and transformation is much more accurately mapped than previously. This vegetation type is the most heavily impacted vegetation type in the Kamiesberg, and is the one of greatest conservation concern. This vegetation type supports the second highest number of endemic plant species in the KBC (after Granite Fynbos), with at least 21 endemics or near endemics found in this vegetation type. This vegetation type is the only one in the Uplands that is regarded as threatened on a national basis, with a Vulnerable NSBA status (Rouget et al 2004).

During the course of this study at least three species were recorded which had not been previously recorded from Namaqualand, and five possible new (undescribed) species were discovered.

Fifty seven endemic plant species are known from the Kamiesberg, along with a further 57 near endemics, whose primary range lies within the Kamiesberg uplands, and all are listed along with the vegetation type with which they are most associated. Many endemics are restricted to the higher peaks (above 1300m) and to the Renosterveld plateau (900-1200m), and especially important upland areas are the three highest peaks - Rooiberg, Sneeukop, and Eselkop.

A Red Data Book listing exercise indicated that at least 37% of these 114 species are regarded as threatened in some way, with a further 23% on the Orange List, which is for species regarded as rare, but not currently threatened. Thus it can be said that some 60% of the endemic or near endemic flora is rare or threatened. Should some of the species on the Orange list become threatened they would immediately move onto the Red Data list. Renosterveld and Granite Fynbos habitats support the bulk of the threatened plant species.

Wetlands, particularly those on the plateau (in Renosterveld) have been identifed as special habitats in need of particular conservation attention, in view of their high levels of transformation, importance in terms of biodiversity conservation, and as water sources. Wetlands in the Granite Fynbos areas are usually in better condition, but are especially important in terms of biodiversity conservation, and as catchment areas and sponges for reliable water supply for large portions of the adjacent Kamiesberg lowlands.

Given that no land within the Kamiesberg Uplands is currently formally or informally conserved, a strong recommendation is thus made to establish a formal conservation network in the Kamiesberg Uplands, based on priority areas identified in this report.

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1 INTRODUCTION

The Kamiesberg massif (the key element of the Namaqualand Uplands SKEP priority area) lies northeast of the town of Garies, some 500km north of Cape Town, and at its highest point (Rooiberg peak) reaches 1706m, which is also the highest point in the broader Namaqualand region. The Kamiesberg (also spelt as Khamiesberg in older texts) was first recognised by Marloth (1908) as being a distinct outlier of the Cape Floristic Region (CFR), and this was emphasised by Adamson in 1938, and by Weimarck in 1941. More recently Hilton Taylor & Le Roux (1989) commented on the high levels of threatened plant taxa in the Kamiesberg, and Rourke (1990) noted some of the many endemics, with particular emphasis on their links with the Fynbos core some 180km to the south. The Kamiesberg Centre (KBC), as it has become known, was recognised by Hilton Taylor (1994, 1996) as one of several foci of high endemism within the Succulent Karoo, and Van Wyk & Smith (2001) reinforced this, defining the area as the land above the 1200m contour. The recent SANBI Vegetation Map of South Africa (Mucina & Rutherford 2003) recognises one distinct vegetation type (Kamiesberg Granite Fynbos) that is restricted to the area, and another (Namaqualand Granite Renosterveld) that is found only here and on the escarpment west of Springbok. But although the KBC is well recognised as a centre of diversity, and a priority conservation area in Namaqualand (Helme 1992; Lombard et al 1999; SKEP strategy 2003), no comprehensive inventory or analysis of the endemic or threatened flora has ever been conducted, hindering the ability to design an effective conservation strategy.

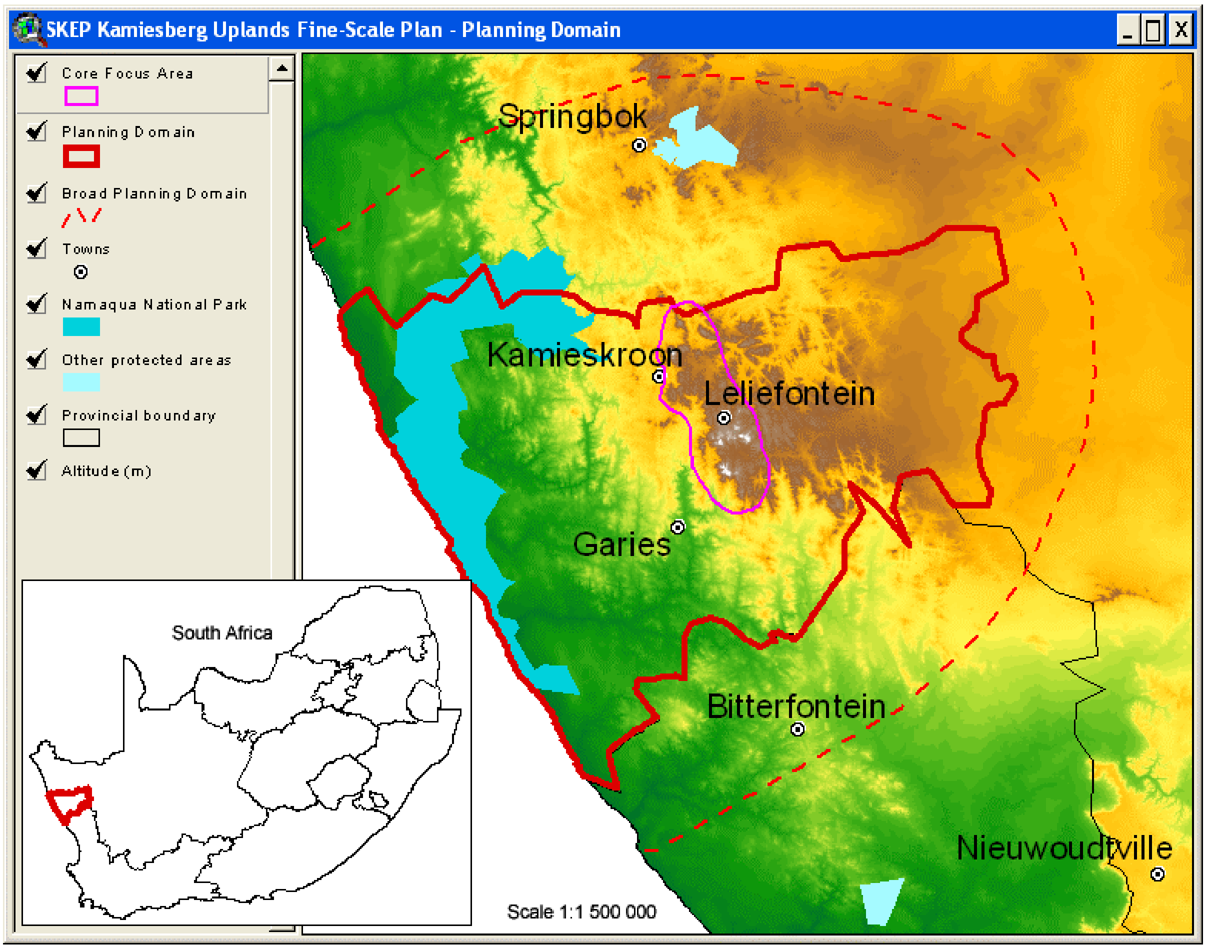
Project objective

- The objective of this project is to provide essential baseline data on the distribution and conservation status of the endemic and threatened flora and habitats of the KBC, along with assessment of vegetation boundaries.

2 STUDY AREA

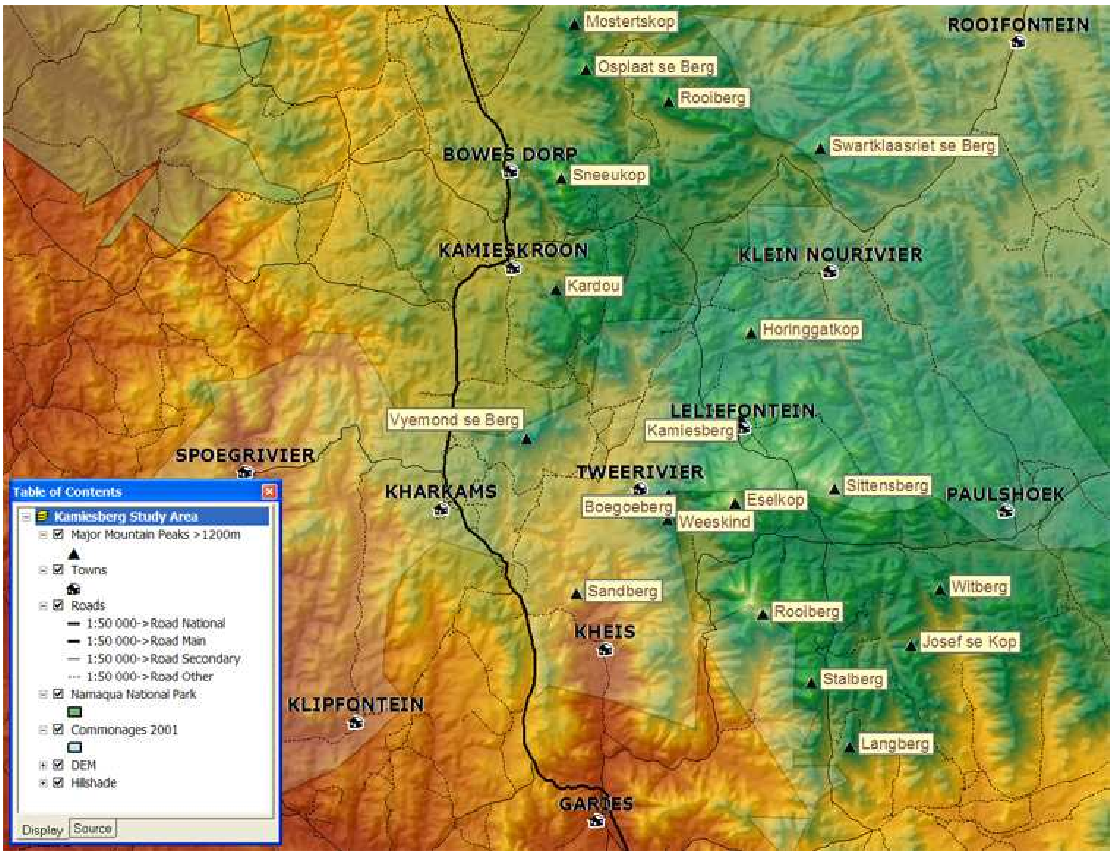
The total study area is approximately 7000km^2 in extent, and is broadly defined as the area above the 1000m contour, centred on the historic village of Leliefontein (**Figure 1** and **Figure 2**). The study area lies east of the N7 highway, and west of the Bushmanland plateau. The town of Kamieskroon lies some 15km southwest of the northern edge of the plateau, and the town of Garies is just outside the southwestern edge of the massif. The eastern boundary with Bushmanland is difficult to define, as there is no clear escarpment, and the Kamiesberg merely fades away in a series of ever lower ridges into the plateau. The western side is much better defined, with a significant escarpment evident as one drives north along the N7 from Garies to Springbok.

Figure 1: The location of the Kamiesberg within the broader regional (Namaqualand) context.



Most of the Fynbos elements in the Kamiesberg are restricted to areas above 1200m, and this altitude would thus serve as a better cut-off for these elements. The total area in the Kamiesberg above 1200m is 227km^2, although it is only the western half that is wet enough to support proper fynbos vegetation. However, much of the Renosterveld in the Kamiesberg occurs on a plateau that lies between 1000 and 1200m. Thus, defining the Kamiesberg Uplands as only the area above 1200m would thus exclude much of the Renosterveld, and the associated species restricted to this vegetation type. There is a complex interplay between elevation and rainfall such that in the southwest, on the rain-ward side of the Kamiesberg, fynbos and renosterveld element occur as low as 800m, whereas in the north and east similar elements are only encountered above 1200m.

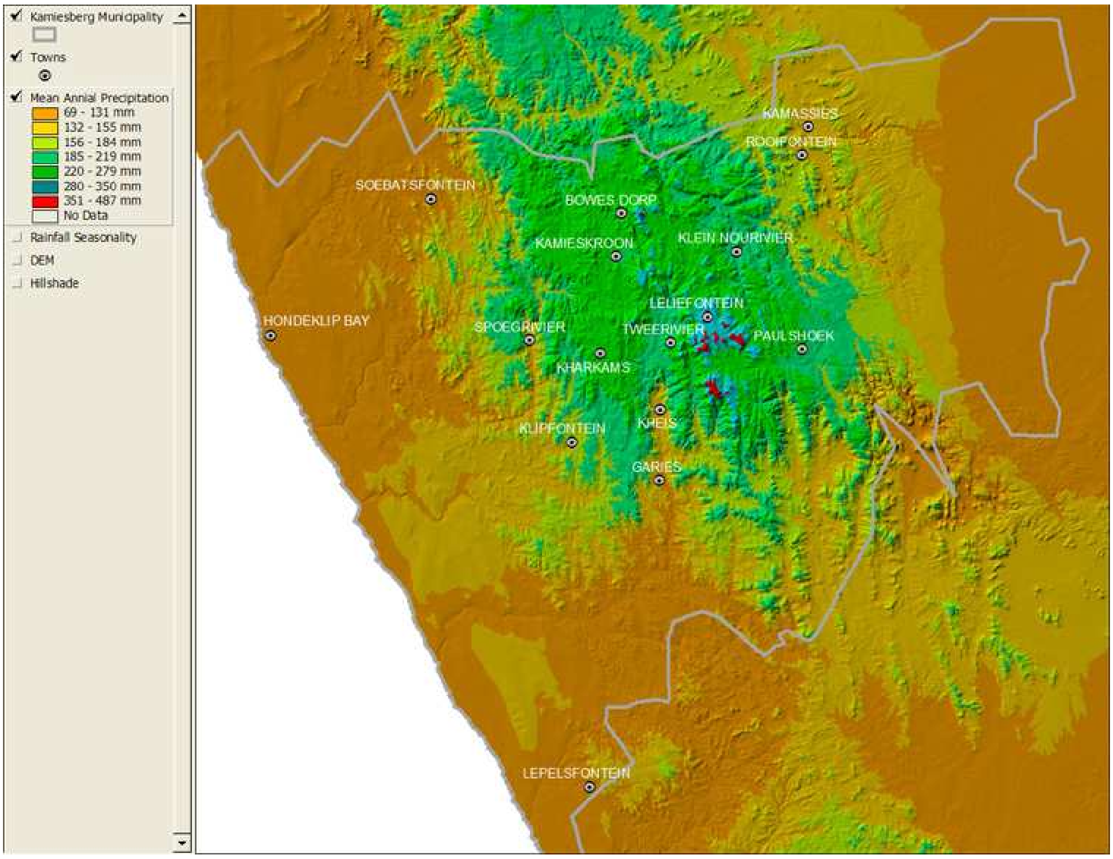
Figure 2: The core study area for this project centred on the main peaks of the Kamiesberg Mountains with elevation above 1200m.



There is a significant decline in average annual rainfall from the western escarpment to the Bushmanland plateau, and this also spans a transition from predominantly winter (cyclonic) rainfall to mainly summer thunderstorm rainfall (**Figure 3** and **Figure 4**). See Desmet and Cowling 1998 for a more detailed discussion of the regional climate.

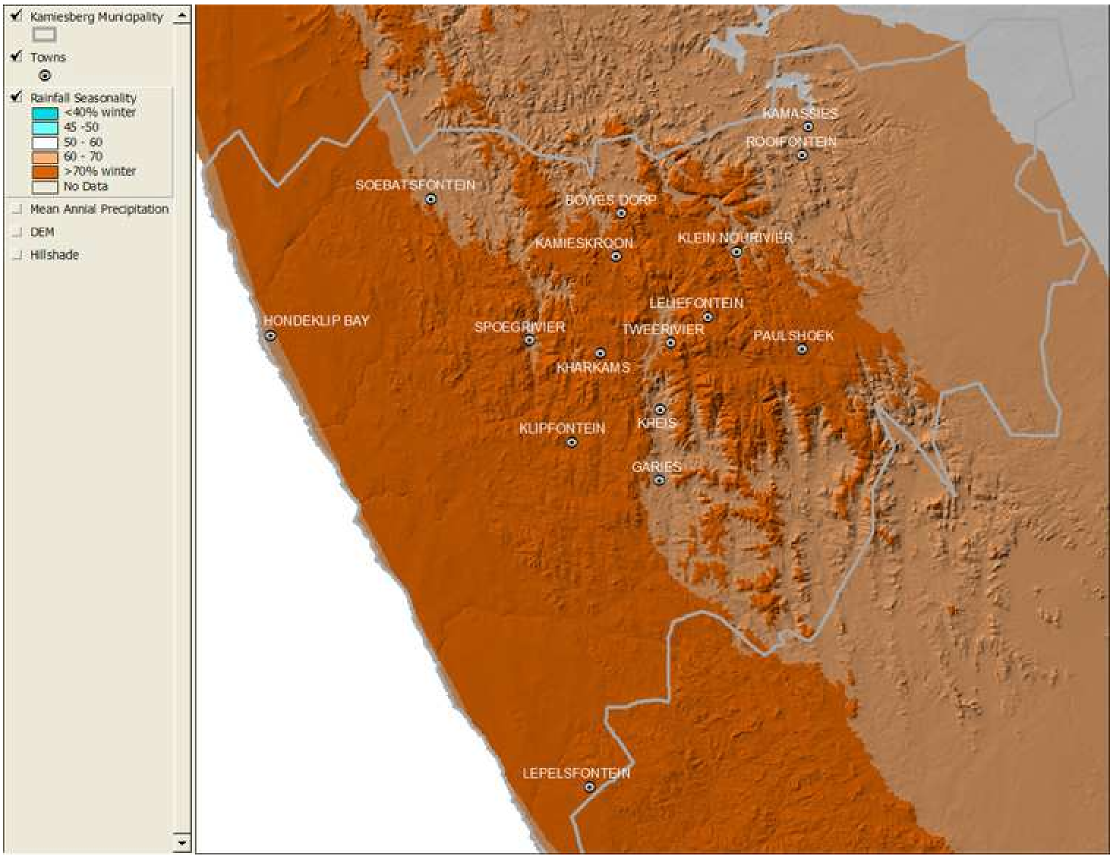
Both these factors have a significant effect on the vegetation structure and species present. The altitude of the massif means that not only are average temperatures cooler than the surrounding areas, but average rainfall is higher. The long-term average for Leliefontein (1350masl) noted by Adamson (1938) was 323mm per annum, with Garies (200masl) only recording only 126mm The interpolated rainfall data indicates that the high, southwestern peaks could be receiving in excess of 400mm per annum. Frosts are common in winter above 1000m, and snow falls on average once or twice a year, mainly above 1200m (pers. obs.). Summer maximum temperatures can be very high, even on the upper plateau, and many days are over 30^{0}C, with occasional peaks of over 40^0. Strong easterly bergwind conditions, especially in winter and spring, can rapidly raise ambient temperatures and lower humidity to very low levels. However, the persistent southern sea breeze off the cold Atlantic Ocean that dominates the littoral climate of Namaqualand significantly moderates the temperatures of south-west or seaward facing slopes of the Kamiesberg throughout the majority of the year. This oceanic influence also increases the incidence of fog and dew in these areas adding to the very strong west-east moisture gradient.

Figure 3: Mean annual precipitation for the Kamiesberg interpolated from long-term weather station data (>15 years) using a 90m digital elevation model and ANUSLIN interpolation software.



Soils throughout the study area are very consistent, and are all derived from the underlying granites and gneisses that form such prominent features in the landscape (see photo on title page). Convex slopes tend to have deeper colluvial soils, and the deepest soils (sandy loams) are found in the valleys and on the plateaus, where there may be accumulations of fine-grained silts as well as some areas of kaolinization of subsoils. The convex slopes are typically very rocky, with shallow, often coarse-grained, sandy soils. The nearest mountain Fynbos areas (some 180km to the south, with poorly defined outliers on the escarpment west of Springbok, some 40km to the northwest) are all found on sandstone or quartzite derived soils. On the Namaqualand coastal plain are scattered Sand Fynbos areas, but these are found on leached sands of marine origin. The nearest Fynbos on granite soils is in the Tulbagh area, some 350km to the south.

Figure 4: Rainfall seasonality expressed as percentage winter precipitation (May to October).



Fire is probably one of the most important management features that can be manipulated, and it is difficult to know what the original ("natural") fire frequency would have been. It is clear that lightning storms can and do start fires in the higher peaks (Mr Beukes – pers. comm.), and these fires occasionally burn large areas. These days people are probably the main source of fire ignition, and it is thus likely that fire frequency has increased in certain areas. The natural fire frequency in the Fynbos and Renosterveld areas would probably be less than for more typical Fynbos areas further south, simply because of the aridity of the area. A frequency of once every 20 - 30 years may be optimal. There are some Fynbos areas in the Kamiesberg that have apparently not burned for over forty or fifty years (various residents – pers. comm.), and although dense and quite woody, the vegetation is not yet fully senescent. This suggests that long periods without fire are probably a natural feature of this vegetation.

Detailed satellite data on fire occurences and spatial extent can be informative. Inspection of the satellite data on the occurrences of fires in the Kamiesberg between November 2000 and November 2005 indicates that all fires recorded occurred within or adjacent to the Leliefontein commonage (**Figure 5**). Fires appear to occur at fairly regular intervals (**Figure 6**) and their occurrence peaks in late summer (**Figure 7**) which coincides with the end of the dry-season as well as the period of peak thunderstorm activity. Fire incidence and management is certainly a serious conservation concern for the fynbos vegetation of the Kamiesberg. Some slow growing (frequent-fire intolerant) species, such as *Protea namaquana*, have suffered significant population crashes in parts of their former ranges in and adjacent to the Leliefontein commonage (Rebelo et al – in prep.). Any conservation program focussing on the endemic flora of the Kamiesberg will need to address issues around fire.

Figure 5: Occurrence of fires in the Kamiesberg between November 2000 and November 2005 based on data from NASA's MODIS satellites Firemap archive.

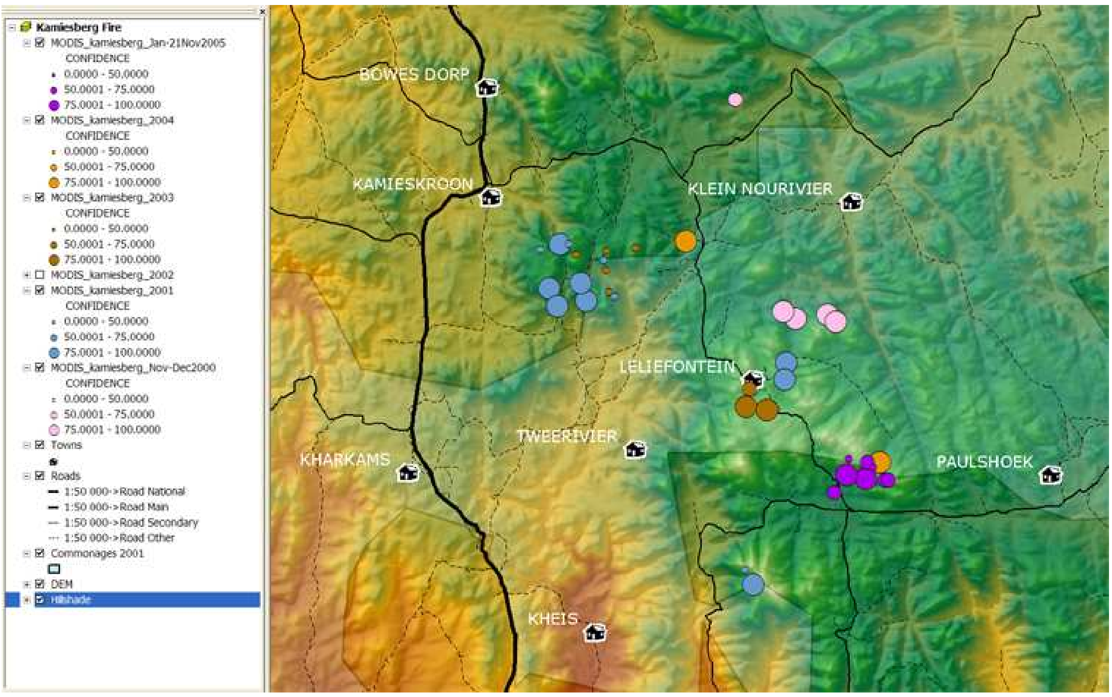


Figure 6: The occurrence of individual fire events and their relative size in the Kamiesberg.

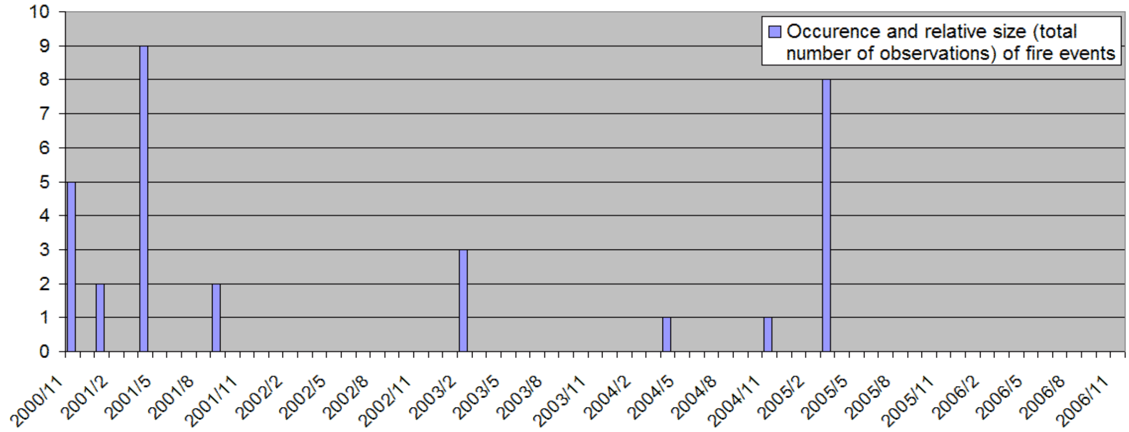
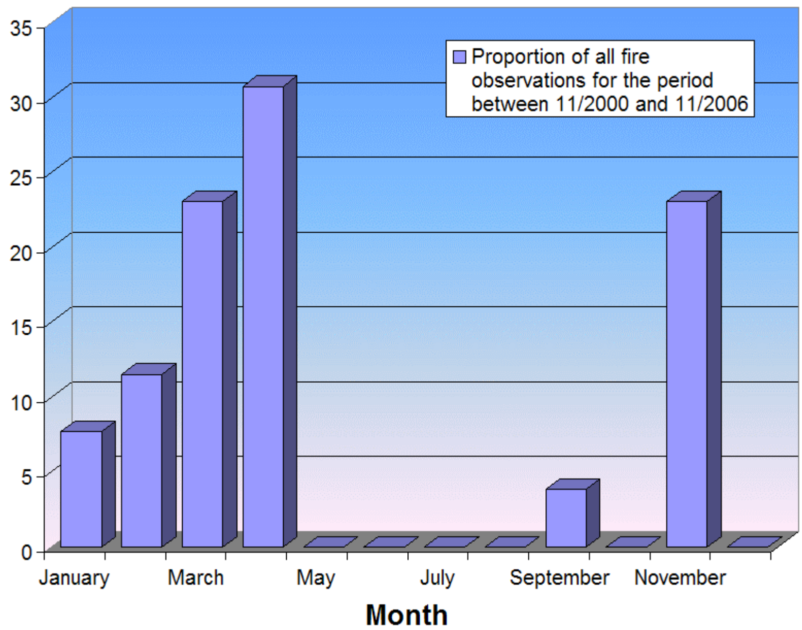


Figure 7: The seasonality of fires in the Kamiesberg between November 2000 and November 2005.



Different models of land tenure are a feature of the Kamiesberg, with the central portion of the uplands being communally owned (Leliefontein, Nouriver, Paulshoek), and with the northern and southern parts being privately owned (eg. Sneeukop, Rooiberg, Anegas). Sheep and boerbok (goat) farming (with some cattle), is the primary agricultural activity in the area, with dryland cereals being planted in cultivated lands on the deeper colluvial soils in the valleys. Cropping has almost entirely eradicated renosterveld in the valleys. There are few extensive examples of this vegetation left, with perhaps the largest areas being in the rolling hills in Rooiberg to Welkom area. Wetlands have also been significantly impacted. It is apparent that crop yields have dropped dramatically over the last forty years, which is attributed to increasingly unreliable winter rainfall (various residents – pers. comm.). Donkeys are a feature primarily of the communally owned land, and in some areas these appear to be largely wild populations, with no clear owners. Stocking rates are generally lower now than they were in the past, and some areas have been much more heavily grazed than others. Grazing management is a complex and often hotly disputed issue, and will not be discussed in any detail in this report, but different grazing management strategies can clearly have significant impacts on the natural vegetation (pers. obs.). Land tenure models are also a "hot" topic, with significant management implications, but are not discussed in any detail in this report. Other components of the Namaqualand Uplands project discuss land tenure and farming practices in more detail. See also the forthcoming special issue of the Journal of Arid Environments that is devoted to ecological and social issues in Namaqualand.

No permanent streams exist in the area, although there are a number of perennial springs. Numerous seasonal streams flow from the peaks in winter and spring, often well into November. Seasonal wetlands are a unique feature of the higher mountain slopes and valleys, as well as on the upper plateau above about 1000m.

3 METHODOLOGY

3.1 Field Survey

The study area was visited on at least four separate occasions, in July, Sep, and Nov 2004, and again in late Oct 2005. Previous fieldtrips were made in 1988, 1991, and 2000, but these were not part of this project. Fieldtrips usually lasted three or four days, and an effort was made to visit as many of the high altitude areas (>1200m) as possible. Most of the peaks over 1400m were surveyed.

Background research included the compilation of a list of the endemic species of the Kamiesberg Uplands. This was done from various published (Rourke 1990, Hilton Taylor 1996, Van Wyk & Smith 2001) and unpublished references. Extensive literature reviews of formal taxonomic revisions (eg. Dahlgren 1988, Linder & Ellis 1990, Van Wyk 1991, Hammer 1993, Perry 1994, Perry 1999, Manning & Goldblatt 2001, Linder 2002) revealed the presence of previously unlisted endemic species, and various specialists were consulted.

Whenever an endemic species was found during fieldwork a GPS location was recorded using a handheld Garmin eTrex Summit GPS unit. 77 such points were recorded. In addition 37 vegetation plots were surveyed, where a range of environmental variables were recorded, Braun Blanquet values for the dominant species, and all endemic species in the area were recorded. Plants were identified at the Compton Herbarium (Kirstenbosch), or by relevant experts, and voucher specimens were deposited at the Compton Herbarium (NBG).

3.2 Climatic data

Long-term rainfall data for weather stations occurring in Namaqualand was obtained from the South African Weather Bureau. A mean annual rainfall surface was interpolated for the Kamiesberg from this data using ANUSPLIN (Hutchinson, 2001) software and using the SRTM digital elevation model as a co-variant. This rainfall surface was used in the model predicting the occurrence of the different vegetation types in the Kamiesberg.

3.3 Fire Data

Data on the incidence of fires in the Kamiesberg was obtained from NASA's firemap archive. These data are based on observations made by the MODIS Terra and Aqua satellites. This data can be accessed via http://rapidfire.sci.gsfc.nasa.gov/, or for South Africa via SAFNet (http://safnet.umd.edu/index.asp), which is a regional network that fosters collaborative efforts in fire monitoring and management in southern Africa.

3.4 Vegetation Mapping

The vegetation of the entire Kamiesberg Municipality was mapped by combining four separate mapping approaches. During the mapping process South African vegetation type categories were subdivided where appropriate to reflect east-west and lowland-upland biogeographical gradients (**Table 1**). The aim of the mapping approach was to refine the boundary accuracy of the South African vegetation map and not delineate new or finer-scale vegetation units. Therefore, the resultant map fits seamlessly into the current national vegetation classification and descriptions.

Table 1: The classification of vegetation within the Kamiesberg municipal area.

South African Vegetation Type	South African Vegetation Sub-Type (Class1)	Bio-Physical Region (Class2)
Platbakkies Succulent Shrubland	Platbakkies Succulent Shrubland	Hardeveld east
Bushmanland Vloere	Bushmanland Vloere	Bushmanland
Namaqualand Heuweltjieveld	Namaqualand Heuweltjieveld Quartz Patches	Hardeveld west
Namaqualand Strandveld	Namaqualand Strandveld Inland	Sandveld
Riethuis Quartz Vygieveld	Riethuis Quartz Vygieveld	Hardeveld west
Namaqualand Heuweltjieveld	Namaqualand Heuweltjieveld	Hardeveld west
Namaqualand Arid Grassland	Namaqualand Arid Grassland	Sandveld
Namaqualand Riviere	Namaqualand Riviere	Rivers
Bushmanland Arid Grassland	Bushmanland Arid Grassland	Bushmanland
West Bushmanland Klipveld	West Bushmanland Klipveld	Bushmanland
Namaqualand Blomveld	Namaqualand Blomveld Eastern	Hardeveld east
Arid Estuarine Salt Marshes	Arid Estuarine Salt Marshes	Estuaries
Namaqualand Sand Fynbos	Namaqualand Sand Fynbos	Sandveld
Namaqualand Strandveld	Namaqualand Strandveld Coastal	Sandveld
Namaqualand Inland Duneveld	Namaqualand Inland Duneveld	Sandveld
Namaqualand Strandveld	Namaqualand Strandveld Coastal Odyssea Grassland	Sandveld
Namaqualand Coastal Duneveld	Namaqualand Coastal Dune Corridors	Sandveld
Namaqualand Coastal Duneveld	Namaqualand Coastal Duneveld Wooleya Veld	Sandveld
Namaqualand Salt Pans	Namaqualand Salt Pans	Sandveld
Namaqualand Coastal Duneveld	Namaqualand Coastal Duneveld	Sandveld
Kamiesberg Granite Fynbos	Kamiesberg Granite Fynbos	Kamiesberg
Namaqualand Granite Renosterveld	Namaqualand Granite Renosterveld	Kamiesberg
Kamiesberg Mountains Shrubland	Kamiesberg Mountains Shrubland	Kamiesberg
Namaqualand Klipkoppe Shrubland	Namaqualand Klipkoppe Shrubland Eastern	Hardeveld east
Namaqualand Blomveld	Namaqualand Blomveld	Kamiesberg
Namaqualand Klipkoppe Shrubland	Namaqualand Klipkoppe Shrubland Upland	Kamiesberg
Namaqualand Klipkoppe Shrubland	Namaqualand Klipkoppe Shrubland	Hardeveld west

3.4.1 Wetlands

The extent of seasonal wetlands and riparian zones in the Kamiesberg Mountains was mapped from Ikonos satellite imagery from 2003 using the RGB and infrared spectral bands. Although the imagery was from the summer months, wetland and riparian vegetation still showed a high degree of photosynthetic activity relative to surrounding vegetation and were therefore fairly easy to distinguish. The scale of mapping was 1:5000. Only existing wetlands were mapped, and although former wetlands, which are now converted to croplands, are in many cases still discernable as a result of observable soils differences, these were not mapped.

The mapped wetlands and riparian areas were classified into six broad habitat units (BHU) based on elevation and slope (**Table 2**).

Table 2: Wetland and riparian zone broad habitat units.

	Wetland Broad Habitat Unit
1	Flat valley bottom below <1000m
2	Flat valley bottom between 1000 to 1300m
3	Flat valley bottom above >1300m
4	Mountain slopes below <1000m
5	Mountain slopes between 1000 to 1300m
6	Mountain slopes above >1300m

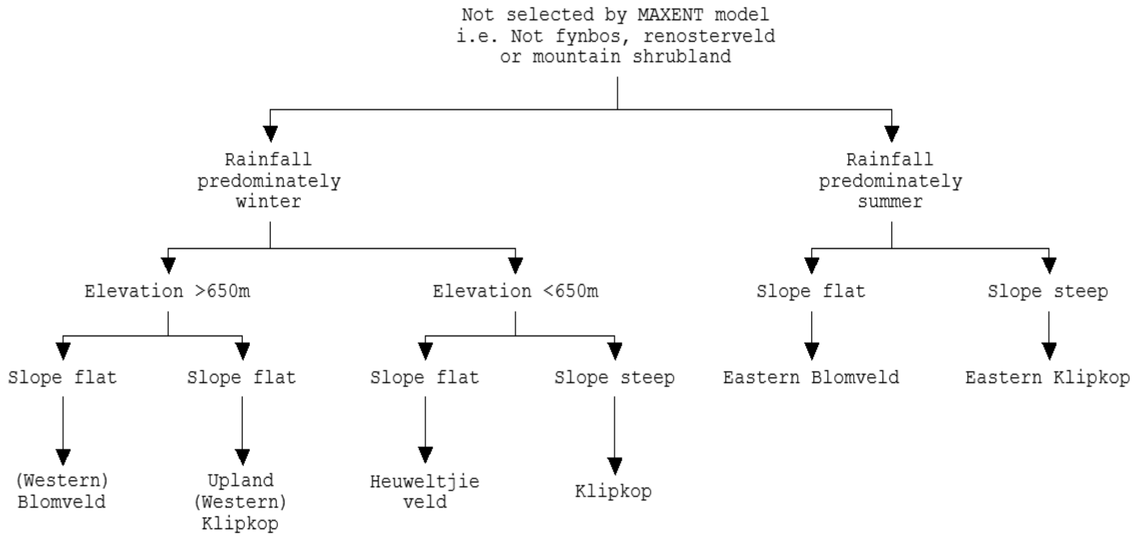
3.4.2 Modelling Fynbos, Renosterveld and Mountain Shrubland Vegetation

For the Kamiesberg fynbos, renosterveld and mountain shrubland vegetation types a GIS-based statistical modelling approach was used. Mapping these vegetation types from aerial imagery is very difficult as there are no sharp boundaries between them. Transitions from one to the next are generally marked by a gradual transition rather than a distinct or observable interface. Added to this is the topographic complexity of the landscape meaning that with frequent changes in elevation, slope and aspect the vegetation changes similarly. Therefore, a modelling approach was used to generate a map that represents the approximate occurrences of these vegetation types within the region rather than a manual digitising method. We used a stand-alone modelling package called MAXENT that uses a general-purpose maximum entropy method for making predictions or inferences from incomplete information (Philips *et al*. 2004 and 2005). It was developed for modelling species distributions using presence only data, but in our case vegetation types replaced the "species". The software uses training sites based on known occurrences of the vegetation type and then predicts the probability of occurrence of the vegetation based on a set in input environmental variables. In our modelling we used elevation, slope, aspect and rainfall as explanatory variables. The software is freely available from http://www.cs.princeton.edu/~schapire/maxent.

3.4.3 Modelling the Remainder of the Vegetation of the Kamiesberg Uplands (i.e. Klipkop/pe)

For the remainder of rocky or upland (Klipkop/pe) areas, vegetation types were mapped using a simple classification tree model based on rainfall seasonality, slope and elevation (**Figure 8**). This was done as the complex topography of the region made manual digitising difficult, in addition to the problem associated with diffuse vegetation boundaries. This re-mapping of vegetation types was necessitated as the existing South African vegetation map represented a poor interpretation of patterns observable in the field.

Figure 8: The decision tree for classifying the remainder of the vegetation of the Kamiesberg uplands (i.e. Klipkop/pe) within the municipal study area, using rainfall seasonality, slope and elevation into South African vegetation sub-types.



3.4.4 Refining the South African Vegetation Map for the Remainder of the Kamiesberg Municipality

For the coastal plain (Sandveld and Hardeveld) and Bushmanland plateau areas of the Kamiesberg municipal area (i.e. non-klipkoppe or upland areas) the boundaries between vegetation types of the existing South African vegetation map were manually refined to improve boundary accuracy. The refined boundaries represent a significant improvement in boundary accuracy as well as change in the distribution of respective vegetation units.

3.5 Vegetation Transformation

The extent of croplands in the Kamiesberg was mapped from the Ikonos imagery obtained for this project. Outside of the Ikonos coverage croplands and mined areas were mapped from the ASTERSAT imagery. Scale of mapping for the Ikonos imagery was 1:5000 and 1:20 000 for the ASTERSAT imagery. Degradation due to livestock grazing was not quantified.

3.6 Wetland Transformation

An accurate measure of the degree of transformation of wetlands in the Kamiesberg could not be calculated, as the original extent of wetlands could not be accurately mapped. Wetlands are often closely associated with croplands in valley bottoms.

Field observations indicate that there are very few examples of intact wetland in valleys as croplands often cut into or totally destroy these habitats. On mountain slopes, however, wetlands and riparian areas appear relatively intact. Therefore to estimate the degree of transformation/degradation of wetlands, the proportion of each wetland BHU type bounded by a cropland relative to the total length of that wetland type was used as a coarse surrogate for the degree to which a wetland type has been negatively impacted by land-use practices.

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4 DESCRIPTION OF VEGETATION TYPES

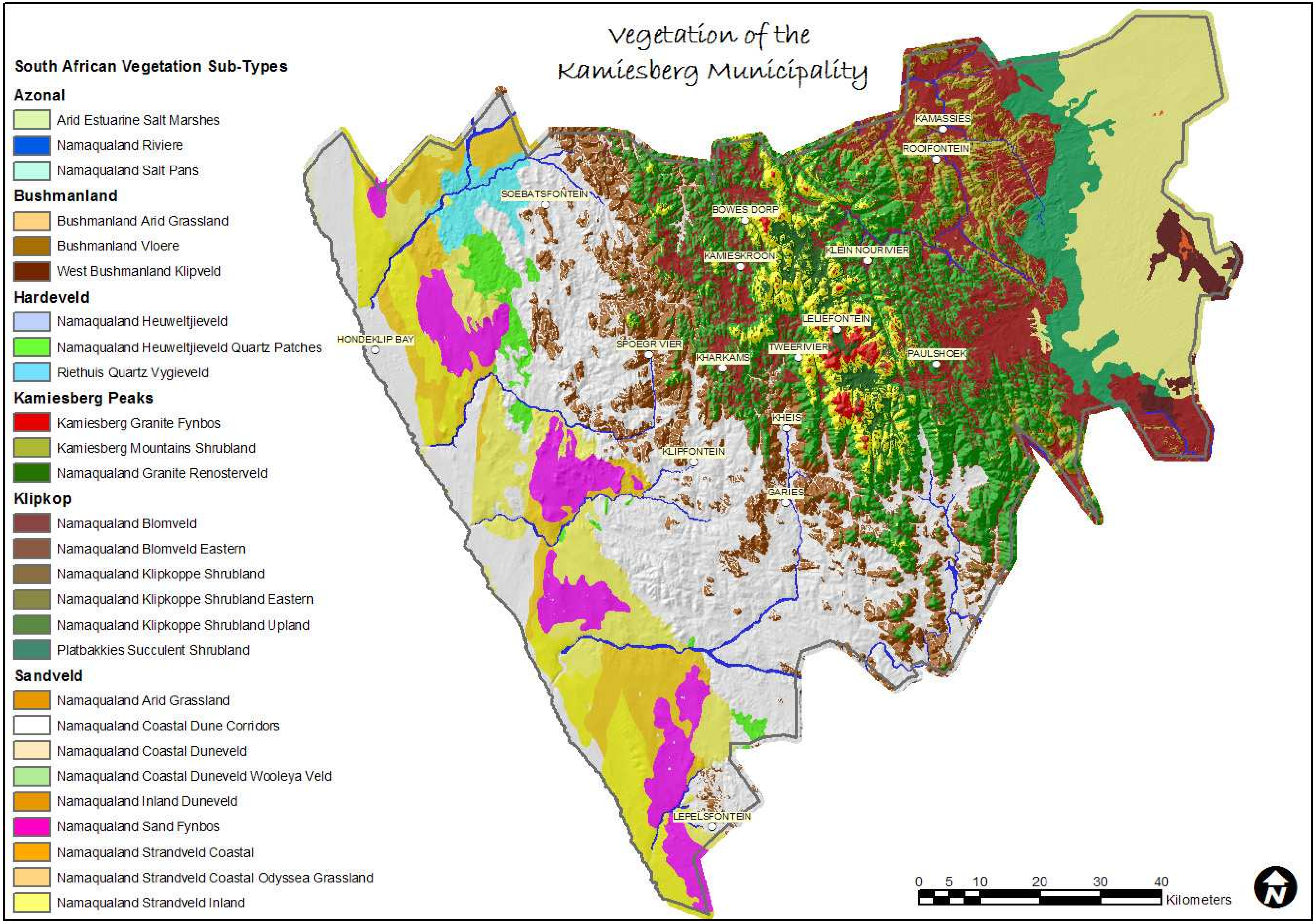
The only published description of the vegetation of the Kamiesberg remains that of Adamson (1938). This account is relatively accurate, and is regarded as a solid base for further work. Adamson (1938) distinguished three main vegetation types, viz.: a dry form of Mountain Fynbos on the upper slopes, Renosterveld on the deeper soils of the plateau, and Upland Succulent Karoo on the lower hills.

The latest South African vegetation map (Mucina & Rutherford 2003) identifies five distinct vegetation types within the area, adding something that they call Blomveld (literally "flower veld"), along with a division of the Upland Succulent Karoo into two distinct units that are difficult (but not impossible) to distinguish (Namaqualand Klipkoppe Shrubland and Kamiesberg Mountain Shrubland). We regard these five vegetation types as being an acceptable and relatively accurate broad scale description of the vegetation types in the area, and **Table 3** has been included as a guide to the synonyms for the different vegetation types referred to by different authors. The names used by Mucina & Rutherford (2003) will be used throughout this report. A full description of these vegetation types will be found in the publication accompanying the new SA vegetation map, and is thus not repeated here in any detail, as the main focus of this study was the endemic flora. Fieldwork for the current study allowed a fine-tuning of the SA vegetation map, and the results are presented in this report.

Table 3: A guide to the synonyms for the different vegetation types in the Kamiesberg Uplands, as referred to by different authors.

SA Vegetation Map names	Synonyms
Kamiesberg Granite Fynbos	Macchia (Acocks 1953) Mountain Fynbos (Low & Rebelo 1996)
Namaqualand Granite Renosterveld	Mountain Renosterbosveld & Namaqualand Broken Veld (Acocks 1953) North-western Mountain Renosterveld & Upland Succulent Karoo (Low & Rebelo 1996)
Namaqualand Klipkoppe Shrubland	Namaqualand Broken Veld (Acocks 1953) Upland Succulent Karoo (Low & Rebelo 1996)
Namaqualand Blomveld	Namaqualand Broken Veld (Acocks 1953); Upland Succulent Karoo (Low & Rebelo 1996); Namaqualand Klipkoppe Flats (SKEP)
Kamiesberg Mountain Shrubland	Namaqualand Broken Veld & Mountain Renosterbosveld (Acocks 1953) Upland Succulent Karoo & North-western Mountain Renosterveld (Low & Rebelo 1996)

Figure 9: (Following page): The vegetation of the Kamiesberg Municipality as mapped for this project.


Vegetation of the
Kamiesberg Municipality
South African Vegetation Sub-Types
Azonal
Arid Estuarine Salt Marshes
Namaqualand Riviere
Namaqualand Salt Pans
Bushmanland
Bushmanland Arid Grassland
Bushmanland Vloere
West Bushmanland Klipveld
Hardeveld
Namaqualand Heuweltjieveld
Namaqualand Heuweltjieveld Quartz Patches
Riethuis Quartz Vygieveld
Kamiesberg Peaks
Kamiesberg Granite Fynbos
Kamiesberg Mountains Shrubland
Namaqualand Granite Renosterveld
Klipkop
Namaqualand Blomveld
Namaqualand Blomveld Eastern
Namaqualand Klipkoppe Shrubland
Namaqualand Klipkoppe Shrubland Eastern
Namaqualand Klipkoppe Shrubland Upland
Platbakkies Succulent Shrubland
Sandveld
Namaqualand Arid Grassland
Namaqualand Coastal Dune Corridors
Namaqualand Coastal Duneveld
Namaqualand Coastal Duneveld Wooleya Veld
Namaqualand Inland Duneveld
Namaqualand Sand Fynbos
Namaqualand Strandveld Coastal
Namaqualand Strandveld Coastal Odyssea Grassland
Namaqualand Strandveld Inland
KAMASSIES
ROOIFONTEIN
SOEBATSFONTEIN
BOWES DORP
KAMIESKROON
KLEIN NOURIVIER
LELIEFONTEIN
HONDEKLIP BAY
SPOEGRIVIER
KHARKAMS
TWEERIVIER
PAULSHOEK
KHEIS
KLIPFONTEIN
GARIES
LEPELSFONTEIN
0 5 10 20 30 40
Kilometers
N

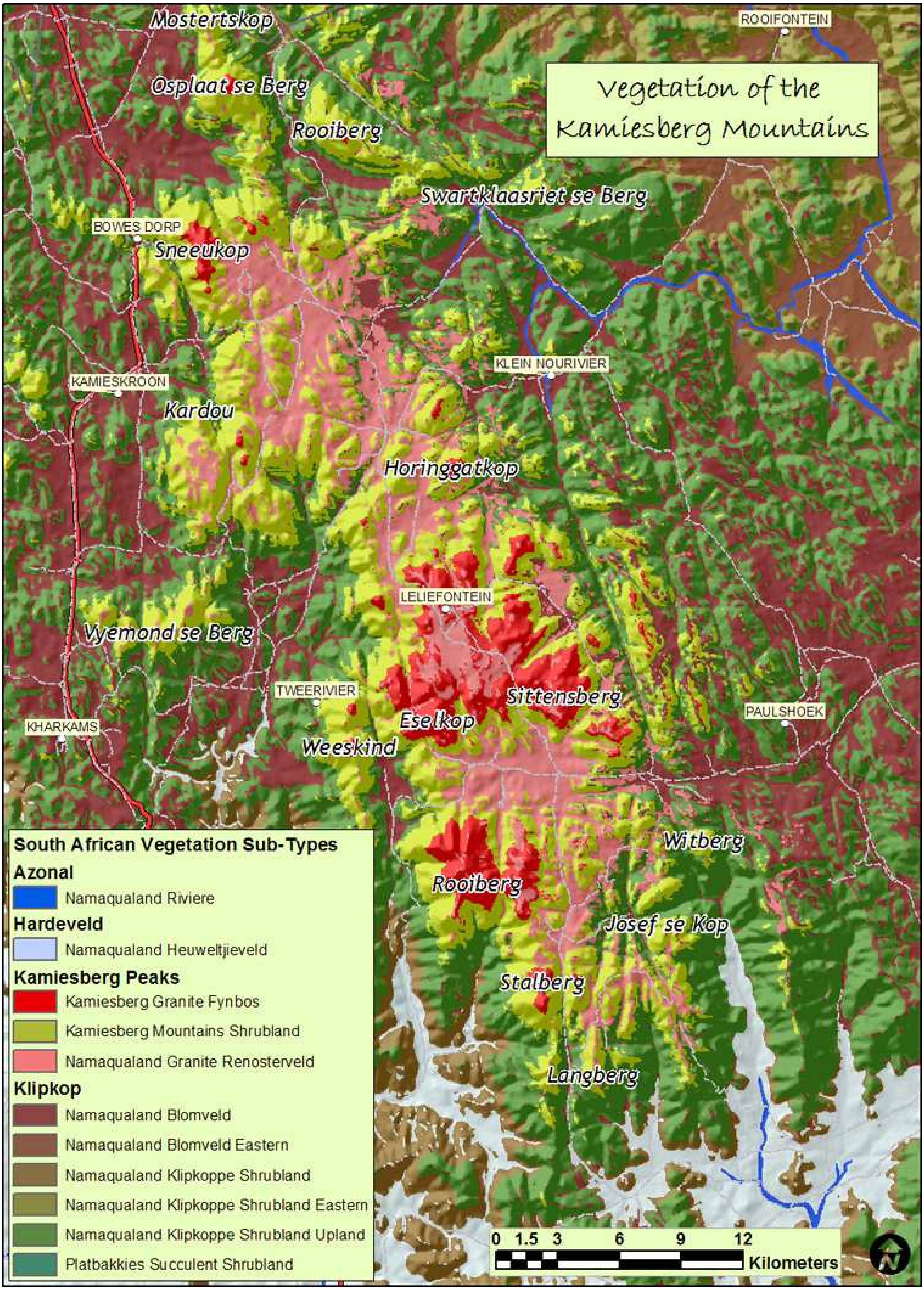

Vegetation of the Kamiesberg Mountains
Mostertskop
Osplaat se Berg
Rooiberg
Swartklaasriet se Berg
ROOIFONTEIN
BOWES DORP
Sneeukop
KLEIN NOURIVIER
KAMIESKROON
Kardou
Horinggatkop
LELIEFONTEIN
Vyemond se Berg
TWEERIVIER
Sittensberg
Eselkop
KHARKAMS
Weeskind
PAULSHOEK
Witberg
Rooiberg
Josef se Kop
Stalberg
Langberg
South African Vegetation Sub-Types
Azonal
Namaqualand Riviere
Hardeveld
Namaqualand Heuweltjieveld
Kamiesberg Peaks
Kamiesberg Granite Fynbos
Kamiesberg Mountains Shrubland
Namaqualand Granite Renosterveld
Klipkop
Namaqualand Blomveld
Namaqualand Blomveld Eastern
Namaqualand Klipkoppe Shrubland
Namaqualand Klipkoppe Shrubland Eastern
Namaqualand Klipkoppe Shrubland Upland
Platbakkies Succulent Shrubland
0 1.5 3 6 9 12
Kilometers

Figure 10: (Previous page): The modelled distribution of Kamiesberg fynbos, renosterveld and shrubland vegetation types in the Kamiesberg.

4.1 Kamiesberg Granite Fynbos

This is the only vegetation type restricted to the Kamiesberg Uplands, and it should thus be a key element of any conservation strategy for the area. This vegetation type supports the highest number of endemic plant species in the KBC, with at least 29 endemics (or near endemics) wholly restricted to or found primarily in this vegetation type (see Appendix 1).

The Fynbos vegetation is very seldom found below 1200m, and only in the vicinity of the Rooiberg peak are there fairly extensive Fynbos patches below 1200m. Due to the bulk of the Rooiberg (the so-called “mass-effect”), and its position as the most south-westerly high peak, without significant peaks between it and the sea, it attracts more cloud and moisture than elsewhere, and is also cooler, all factors which contribute to the lower Fynbos boundary in this area. The lower boundary occasionally extends as far down as 1000m, especially on the eastern and south-eastern side of Rooiberg (upper Langkloof area). In the drier eastern fringes of the Kamiesberg the Fynbos is restricted to the few summit ridges above 1300m.

Within this vegetation type are also very small pockets of Afromontane (or Southern Afrotemperate) Forest, that are usually too small to map. These occur only in the most fire protected situations, where there are also elevated moisture levels. The forest patches are always small (< 1ha), and are usually dominated by *Olea europaea* ssp. *africana* (wild olive), *Kiggelaria africana* (wild peach), and *Maytenus oleoides* (kliphout).

Plate 1:View of mature Fynbos vegetation on Sneeukop showing abundant restioid cover.

As for “normal” Fynbos areas much further south, the characteristic elements are Proteaceae (protea family; 2 species, both endemic)), Ericaceae (heaths; 9 species, no endemics), and Restionaceae (Cape reeds; approx. 6 species, 1 endemic). The former occur only in this vegetation type in the Kamiesberg, whilst the latter are also present (but seldom significant; <10% cover) in some of the Renosterveld areas, but are a significant feature of the Fynbos. Geophytes (bulbs) would appear to be more prominent in the Kamiesberg Fynbos than in Fynbos areas elsewhere, but most endemic species are shared with the Renosterveld. The Rutaceae (citrus family) is also a rather typical Fynbos element, and two species occur here, one of which is endemic to this vegetation type. The genus *Phylica* is a large and typical Fynbos element, and respresented by one true endemic in this vegetation, and two near endemics (species restricted to an area slightly greater than just the Kamiesberg, often extending as far north as Springbok). The single orchid species endemic to the area is restricted to this vegetation type. Four succulent species (Mesembryanthem-aceae) are restricted to rocky outcrops in this vegetation type, including three undescribed species.

Plate 2: Protea namaquana (skaamroos; Proteaceae) is the only Protea found in the Kamiesberg, and is endemic to Fynbos areas on Rooiberg and Eselkop. This striking plant is Red Data Book listed as Critically Endangered.

4.2 Namaqualand Granite Renosterveld

This vegetation type is well represented on the upper plateaus of the Kamiesberg (at 1000 – 1300m), but is also found elsewhere in Namaqualand, mainly on the western escarpment from Skilpad (Namaqua National Park) north to Steinkopf. Renosterveld is typically found on the flat, deeper soils of the plateaus (see Plate 3), and has thus been heavily transformed by agriculture, primarily by ploughing for cereals and the planting of grazing. Over 20% of the Renosterveld on the Kamiesberg has been transformed, although the NSBA figures for the vegetation type as a whole indicate that only 5% has been lost throughout the greater Namaqualand region (Rouget et al 2004). The currently mapped extent of renosterveld is substantially smaller than previously thought and transformation is much more accurately mapped than previously. This vegetation type is thus undoubtedly the most heavily impacted vegetation type in the Kamiesberg, and is the one of greatest conservation concern. This vegetation type supports the second highest number of endemic plant species in the KBC, with at least 21 endemics wholly restricted to or found primarily in this vegetation type (see Appendix 1).

Plate 3: View of mature Renosterveld near Rooiberg, with agricultural lands visible in background. The grey shrub is Elytropappus rhinocerotis (renosterbos), the yellow is Oedera genistifolia (gombos), and the tall green is Dodonaea angustifolia (ysterhout).

Renosterveld here, as elsewhere, supports a significant diversity of geophytes, especially evident in recently burnt veld. At least nine of the endemic species are bulbs that are found primarily or wholly within Renosterveld habitats.

As this is a valley bottom habitat it also incorporates significant seasonal wetlands and floodplains, a habitat to which at least three of the endemic species (*Moraea pendula, Moraea rivulicola, Crocosmia fucata*) are restricted. The wetlands are heavily utilised by stock (see Plate 4), and in many cases have been extensively converted to or encroached upon by croplands, and are severely trampled and overgrazed, with resultant loss of species, but a number of relatively intact systems still exist. All wetlands should have a very high conservation value, as they are important ecological corridors and gradients, and are likely to be key habitats in the survival of many small animals, birds, and insects in the Kamiesberg. A number of endemic insects are known from wetlands in the Kamiesberg (J.Colville – pers. comm.).

Plate 4: Spring view of the north slopes of Rooiberg (with Fynbos), with Renosterveld on the plateau (grey lower slopes). Colourful spring annuals dominate the previously ploughed areas, and a small seasonal stream is an important habitat for numerous species.

4.3 **Namaqualand Klipkoppe Shrubland** & **Kamiesberg Mountain Shrubland**

These two vegetation types are structurally very similar, and also share a lot of species. Typically Kamiesberg Mountain Shrubland occurs at higher elevations (900 – 1300m) than Namaqualand Klipkoppe Shrubland (<600 – 1300m), or in moister situations, such as on south and east facing slopes or in the western part of the Kamiesberg. The two vegetation types have been lumped together for purposes of this analysis, as they were found to be difficult to distinguish at the time of the fieldwork due to lack of information about distinguishing elements, and in addition, there does not seem to be a significant difference in the endemic flora of these two vegetation types (which may be partly due to insufficient information being available about the habitat requirements or ranges of many endemic species). The analysis shows that a significant number (>25) of endemic species occur primarily or wholly within these two vegetation types (see Appendix 1), but as noted, this may be partly a function of insufficient habitat or locality information, and also partly a function of the physical extent of these two vegetation types, which cover very large areas in Namaqualand.

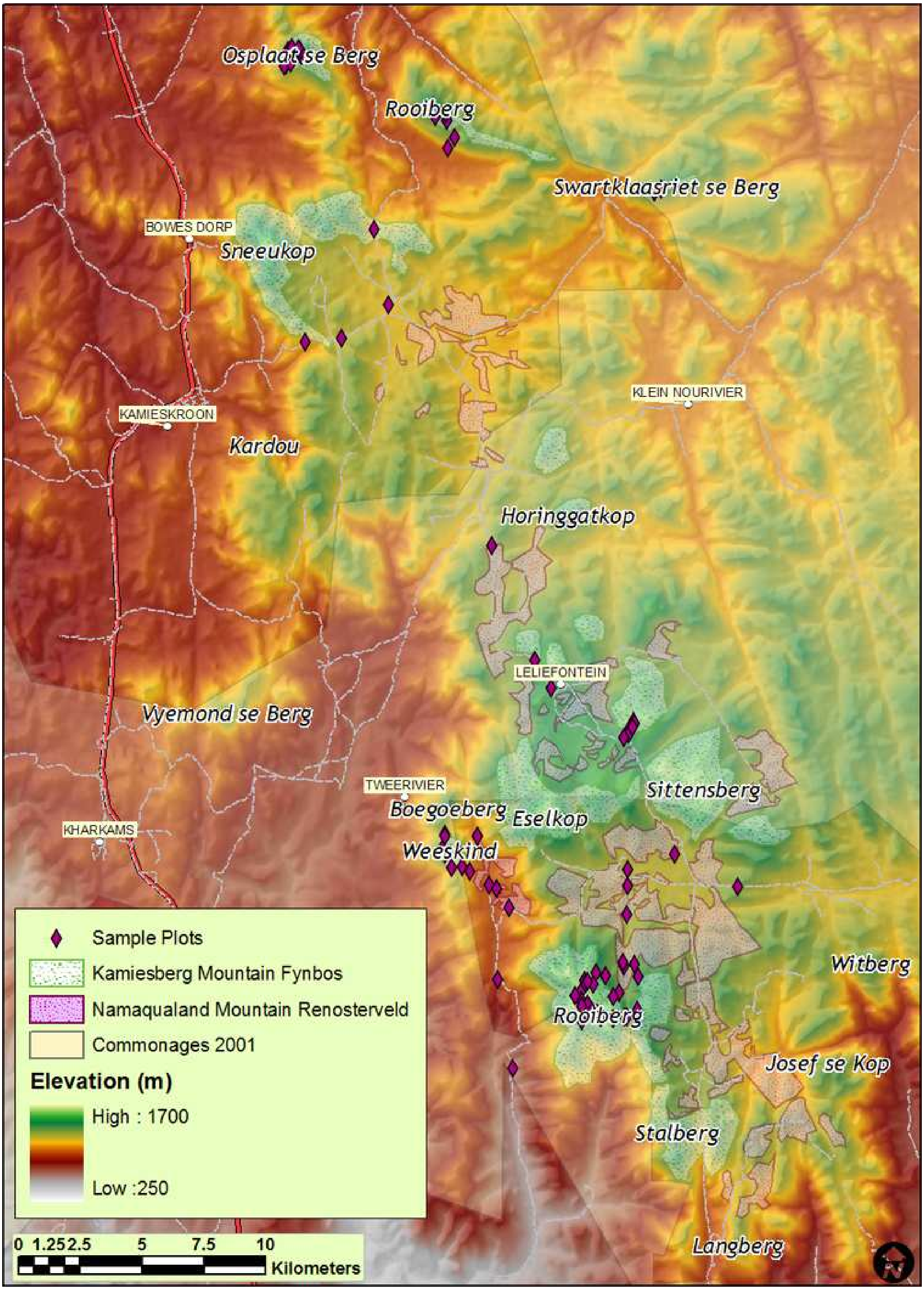
Namaqualand Klipkoppe Shrubland fades into various forms of Succulent Karoo at lower elevations, and on the dry eastern fringes of the Kamiesberg (at the relatively high altitude of 1000m) changes into Platbakkies Succulent Shrubland (and **Blomveld**). This latter vegetation type supports at least five endemic succulents (*Lithops* and *Conophytum* species) and two endemic geophytes which are listed in Appendix 1 as near endemics, but their ranges are perhaps best regarded as being outside the true Kamiesberg Uplands.

In all situations the Shrubland vegetation occurs in rocky areas, with relatively shallow soils. In areas where deeper soils are found it changes to Renosterveld (above about 1000m, and where there is enough moisture), or to Blomveld (in drier situations, or below about 1000m). Typical species in the Shrubland vegetation include *Rhus undulata* (taaibos), *Rhus horrida, Lebeckia sericea* (fluitjiesbos), *Didelta spinosa* (perdebos), *Pteronia incana* (asbos), *Pentzia incana* (ankerkaroo), *Euphorbia mauritanica* (melkbos), *Zygophyllum morgsana* (slaaibos), *Cotyledon cuneata* and *C. orbiculata* (plakkies), and *Ruschia* spp. *Ozoroa dispar* (resin tree) and *Aloe dichotoma* (kokerboom) are useful indicators of Klipkoppe Shrubland, and seldom occur in Kamiesberg Shrubland. *Elytropappus rhinocerotis* (renosterbos) may be present in Kamiesberg Shrubland, but is never dominant, and is not present in Klipkoppe Shrubland.

5 DISTRIBUTION OF ENDEMIC SPECIES

The endemic species are not randomly distributed in the landscape, and distinct patterns can be observed when their known distributions are plotted. It should be noted that that the absence of a record of a certain species for an area does not necessarily mean that it is not there. Many species are highly seasonal (eg. the geophytes), and are consequently very easy to miss during random, irregular surveys. Veld age also has a dramatic effect on species composition and abundance, and species common in 3 year old veld may be very rare in fifteen year old veld, or *vice versa*.

Figure 11 (following page): Location of sample plots and extent of focal vegetation types as mapped in the field on 1:50 000 topographical maps.


Osplaat se Berg
Rooiberg
Swartklaasriet se Berg
BOWES DORP
Sneeukop
KLEIN NOURIVIER
KAMIESKROON
Kardou
Horinggatkop
LELIEFONTEIN
Vyemond se Berg
TWEERIVIER
Boegoeberg
Eselkop
Sittensberg
KHARKAMS
Weeskind
Witberg
Rooiberg
Josef se Kop
Stalberg
Langberg
Sample Plots
Kamiesberg Mountain Fynbos
Namaqualand Mountain Renosterveld
Commonages 2001
Elevation (m)
High : 1700
Low :250
0 1.25 2.5 5 7.5 10
Kilometers

5.1 Peaks

Fynbos endemics are most common on peaks of over 1300m, and the highest ground around Rooiberg peak (1706m) is particularly important. Well over 80% of the Fynbos endemics are known to occur within the Rooiberg/Blouberg/Welkom/ Karas/Stalberg area, at elevations of over 1200m.

Plate 5: View from the top of Rooiberg Peak (1706m) to the south, with Stalberg visible on the left.

The Rooiberg area supports no less than nine Kamiesberg endemic species which have not been recorded elsewhere, plus a further species which was discovered during the course of fieldwork for this study and may prove to be an undescribed species (*Geissorhiza* sp*. aff. aspera*). The nine species include *Cheiridopsis* sp.nov., *Disa macrostachya, Centella tridentata* spp. *dregeana, Cyphia* sp.nov*., Felicia diffusa* ssp. *khamiesbergensis, Amphithalea obtusiloba, Moraea kamisensis, Romulea neglecta*, and *Watsonia rourkei*. The area also supports a further six species which are known only from here and one other locality (noted in parentheses), including *Oedera conferta* (Sneeukop), *Moraea longiflora* (Leliefontein area), *Moraea* *kamiesmontana* (Sors Sors area east of Sneeukop), *Romulea rupestris* (Richtersveld), *Protea namaquana* (Eselkop), and *Phylica retrorsa* (Eselkop). The greater Rooiberg area (including Stalberg) is thus clearly a remarkably important focus for rare endemic species in the Kamiesberg Uplands, which is not surprising given that it is one of the two largest areas above 1400m.

Eselkop, the second highest peak, is not known to harbour any endemic species not found elsewhere, but it does support one of only two populations of the Critically Endangered *Protea namaquana* (see Plate 2), although this population has been severely impacted by too frequent fires in the last twenty years (Rebelo et al – In prep.). It also supports one of only two known populations of *Pentaschistis lima* (Poaceae), the other on Leliefontein se Berg.

Sneeukop (1588m) is the third highest peak in the area, and is the only known home of at least three species - *Xenoscapa uliginosa, Hesperantha minima,* and *Crocosmia fucata*, which are restricted to the east slopes, the latter along a seasonal stream. The area also supports a further two species which are known only from here and one other locality (noted in parentheses), viz. *Oedera conferta* (Rooiberg), and *Moraea kamiesmontana* (Rooiberg area).

Other important peaks which all support significant populations of at least some Fynbos endemics include (see **Figure 2**; from N – S, with elevations indicated) Osplaat se Berg (1450m), Anegas Rooiberg (1395m), Swarklaasriet se Berg (1375m), Grasberg (1364m), Horinggatkop (1461m), Kamiesberg (1527m), Johannes se Berg (1550m), Sittensberg (1552m), Weeskind (1440m), Josef se Kop (1253m), and Suurberg (1276m).

Although it was not visited during this study, and although there are no previous collections known to be definitely from this peak, the modelling done suggests that Vyemond se Berg (1291m, 6km NE of Karkams) will also support significant Fynbos elements, as it is high enough, and further west than any other peaks of this height.

5.2 Renosterveld Flats

Given that this habitat has been heavily transformed by agriculture in the Kamiesberg it is likely that species endemic to this habitat have lost significant portions of their populations, and are thus probably threatened.

The most important areas of Renosterveld identified during this survey (and there are likely to be others not surveyed) were (see **Figure 10**; quarter degree grid reference in parentheses) Groot Tuin to De Kuilen and Bovlei area (3018AA), north of Leliefontein near Langvlei (3018AC), west of Leliefontein along escarpment edge (3018AC), south of Leliefontein to Naras and Vissersplaat (3018AC), east of Sittensberg near Natpad (3018AC), Boplaas area southeast of Weeskind peak to Platberg and Botuin area south of Eselkop (3018AC), Jakkalshok and Damsland area north of Rooiberg (3018AC), a large area from Die Kruis in the north, to Rondefontein in the south, Swartmatjie in the east, and Welkom in the west (3018AC), and an outlier in the southeast around Grasberg (3018AD).

Plate 6: Moraea longiflora (Iridaceae) is a rare Kamiesberg endemic largely restricted to Renosterveld areas. Each flower is open for only a single day.

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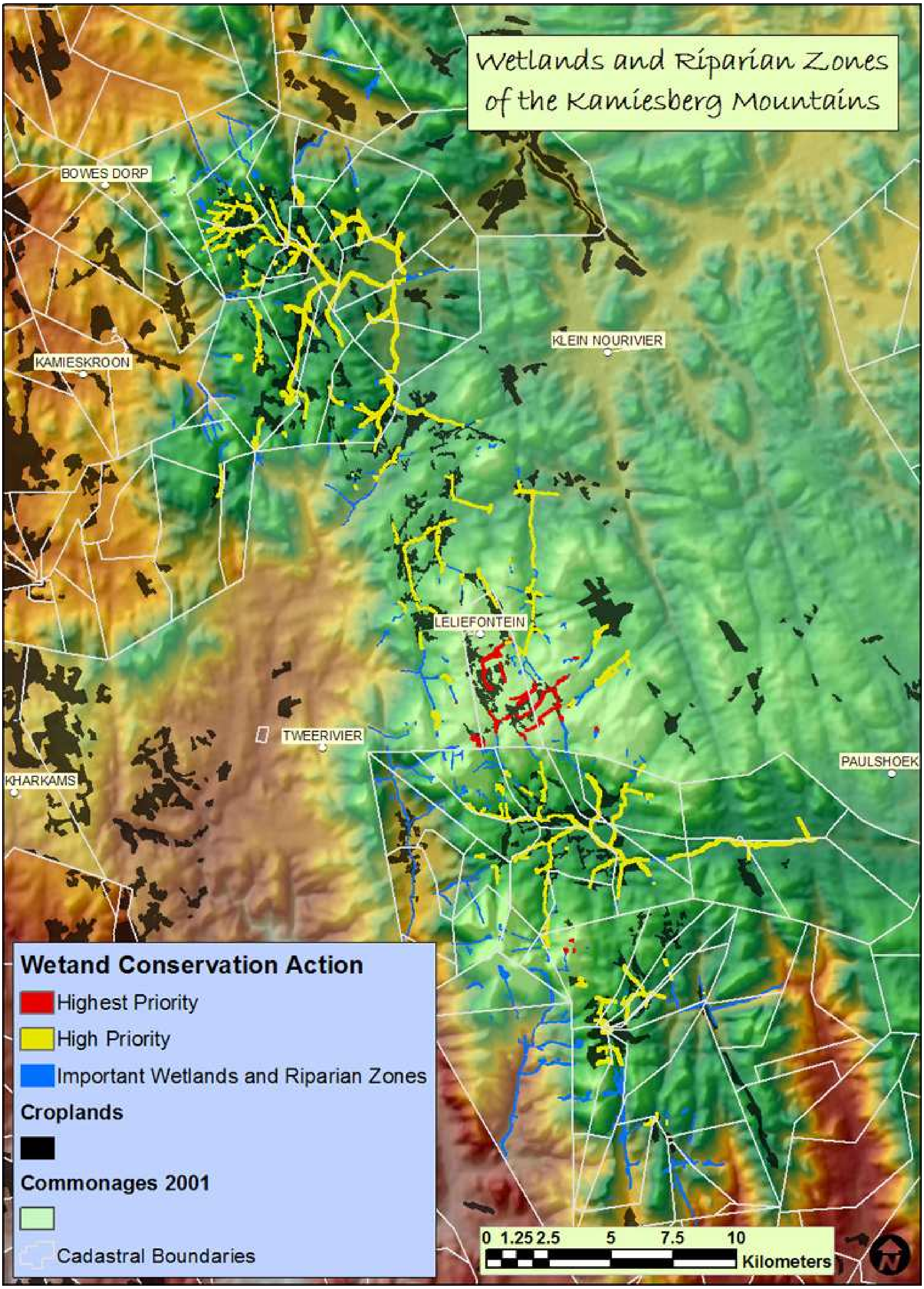
6 IMPORTANT HABITATS

As previously noted, wetlands and seepage areas are key habitats, especially in a semi-arid area of summer drought. The Kamiesberg is blessed with a large number of seasonal wetlands and streams, and a subjective analysis of some of the most important ones is presented graphically in **Figure 12**. It should be noted that wetlands and streams identified are not necessarily the most important, or the only important ones, but are merely those that were studied or observed, and were found to be of significant ecological value and interest.

One of the most important features of an intact wetland system is its ability to absorb rainfall, store it, and release it slowly (the so-called "sponge effect"). This is a valuable feature in a semi-arid area, as it allows seasonal streams to carry water for longer periods. Overgrazed or too-frequently burnt wetlands will not perform this function nearly as efficiently, and will also be more likely to erode, with loss of valuable topsoil. Some of the wetlands in the Kamiesberg are very heavily grazed and trampled, and/or burnt too regularly, and are consequently not in good condition, whilst others are in almost pristine condition. Those closest to farmsteads, ploughed lands, and stock kraals tend to be in poor condition, whilst the remoter ones tend to be in better condition. The importance of the wetlands in the Kamiesberg Uplands needs to be emphasised in terms of its role in supplying water for a large proportion of the rural community living in the surrounding lowlands.

Plate 7: View of seasonal wetland in early summer, east of Sneeukop, on Renosterveld plateau. This area is heavily grazed and is dominated by a large sedge ("matjies").

Figure 12 (following page): The distribution of important wetlands and riparian areas within the Kamiesberg, and a classification of their conservation priority based on the degree to which they are transformed through cropping.


Wetlands and Riparian Zones of the Kamiesberg Mountains
BOWES DORP
KAMIESKROON
KLEIN NOURIVIER
LELIEFONTEIN
TWEERIVIER
KHARKAMS
PAULSHOEK
Wetand Conservation Action
Highest Priority
High Priority
Important Wetlands and Riparian Zones
Croplands
Commonages 2001
Cadastral Boundaries
0 1.25 2.5 5 7.5 10
Kilometers

One of the important habitats in the Kamiesberg is also a form of wetland, but on a very small scale. The extensive granite domes have numerous cracks and drainage lines, and these typically channel runoff and create tiny, highly seasonal wetlands. The soil in these areas is very thin (<10cm), but is often saturated with water for long periods in winter and spring. Moss, lichen, and liverwort coverage is high. Soil moisture conditions vary dramatically over very small distances, creating a variety of different micro-habitats, and it can be seen how different plant species preferentially exploit these different niches. Because the soils are so shallow large shrubs are rare in these habitats, and the dominant seed plants are bulbs, succulents, and restios. All three lifeform categories have endemic species virtually restricted to this habitat in the Kamiesberg (see Plate 8). The shallow soils also mean that it is extremely vulnerable to trampling, and larger animals like cattle and donkeys are particularly destructive.

Plate 8: Hesperantha latifolia (Iridaceae) is dwarf geophyte restricted to shallow pockets of seasonally wet sand on rocky domes in the Kamiesberg.

The final special habitat singled out occurs within Renosterveld, and is found in flat, dry areas where soils are relatively shallow, with outcropping rock. This rock is usually granite, but in rare instances (such as near Welkom) there are small patches of ironstone (ferricrete, koffieklip). The shallow soils seem to discourage dominance by tall shrubs, and instead the community is dominated by restios, succulents, herbs, dwarf shrubs, and geophytes. Many of these are rare Renosterveld endemics (eg. *Lotononis* spp., *Cheiridopsis* sp. nov., *Arctotis canescens*). Because of the shallow soils these areas have escaped the plough, but they tend to be heavily grazed and trampled.

7 DISCOVERIES

During the course of this study at least three species were recorded which had not been previously recorded from Namaqualand. These species are *Metalasia fastigiata* (on Stalberg and Grasberg), *Buddleja salviifolia* (on Weeskind and Sneeukop), and *Moraea tripetala* (on Stalberg). Voucher specimens have been deposited at Compton Herbarium, Kirstenbosch.

In addition, five possible new species were discovered during the course of fieldwork. All superficially resemble other, described species, but further study has shown them to be distinct, and all are currently still undescribed. **Table 4** lists the new species, the family to which they belong, and their known distribution.

Table 4: The list of new and possible new species discovered or recognised during this project.

	Taxon	Family	Known Range
1	*Antimima* sp. (cf. hallii)	Mesembryanthemaceae	Most peaks over 1250m
2	*Antimima* sp. (cf. persistens)	Mesembryanthemaceae	Most peaks over 1250m
3	*Cyphia* (aff. longipetala)	Campanulaceae	Rooiberg, Stalberg
4	*Geissorhiza* (aff. aspera)	Iridaceae	Stalberg
5	*Ruschia* (cf. dichroa)	Mesembryanthemaceae	Most peaks over 1250m
6	*Cheiridopsis* sp. nov.	Mesembryanthemaceae	Welkom farm

A further new species (*Cheiridopsis* sp. nov.) was not found during this survey, but is certainly new, and is still only known from a single, very vulnerable population near Welkom farm (S. Hammer – pers. comm.).

The fieldwork also resulted in the re-discovery of a number of very rare species, some of which were known only from a single, original type collection. Voucher material for all these species has been deposited in the Compton Herbarium, Kirstenbosch.

A significant new population of *Disa macrostachya* (Orchidaceae) was discovered by the entomologist J. Colville on Rooiberg peak, bringing the total known population to about 80 plants. *Felicia diffusa* ssp. *khamiesbergensis* (Asteraceae) was found on Stalberg, the first collection since its discovery in probably the same area some forty years ago. *Centella tridentata* ssp*. dregeana* (Araliaceae) was also known only from the type collection, over a century ago, and was re-discovered on Rooiberg. *Oedera conferta* (Asteraceae) is only known from two previous collections on Sneeukop and Rooiberg, the most recent over thirty years ago, and a healthy population was found on Rooiberg. *Amphithalea obtusiloba* (Fabaceae) was only known from the original type collection fifty years ago, and a small population was relocated on Rooiberg. The spectacular *Geissorhiza kamiesmontana* (Iridaceae) was only known from three previous collections, and was found at a new locality on Anegas Rooiberg.

8 RED DATA BOOK STATUS OF FLORA

Valuable information has been gathered on the habitat, location, and numbers of numerous rare and threatened endemics or near endemics, and this information was used to assess the Red Data Book status of these species. Almost 20% of the endemics were unfortunately not found during fieldwork for this project, and their status remains poorly known, and is a future challenge. The Red Data Book status of endemic or near endemic taxa presented in Appendix 1 is in draft form and will be edited, and published in the forthcoming revision of the South African Red Data Book later in 2006. Categories are according to current IUCN criteria.

Table 5 displays a breakdown of the Red Data status of the endemic and near endemic flora. At least 37% of this group is regarded as threatened in some way, with a further 23% on the Orange List, which is for species regarded as rare, but not currently threatened. Thus it can be said that some 60% of the endemic or near endemic flora is rare <u>or</u> threatened. Should some of the species on the Orange list become threatened they would immediately move onto the Red Data list. It should also be noted that 22.8% of the flora was not assessed in the current analysis, as some of these taxa are poorly known, or may be subject to analysis by other specialists, but it is very possible that at least some of these will also be Red Data listed. This would potentially push the total number of rare or threatened species in the Kamiesberg as high as 84, which is a significant 74% of the total endemic flora.

Table 5: Analysis of the Red Data Book status of the Kamiesberg endemic and near endemic flora.

Assessed Red Data Status	Number of species	Percentage of the endemic flora
Critically Endangered	4	3.5
Endangered	11	9.6
Vulnerable	27	23.6
Near Threatened	1	0.8
Data Deficient	7	6.1
Orange List	26	22.8
Least Concern	12	10.5
Not Assessed	26	22.8

9 CONSERVATION STATUS AND THREATS TO THE VEGETATION OF THE KAMIESBERG

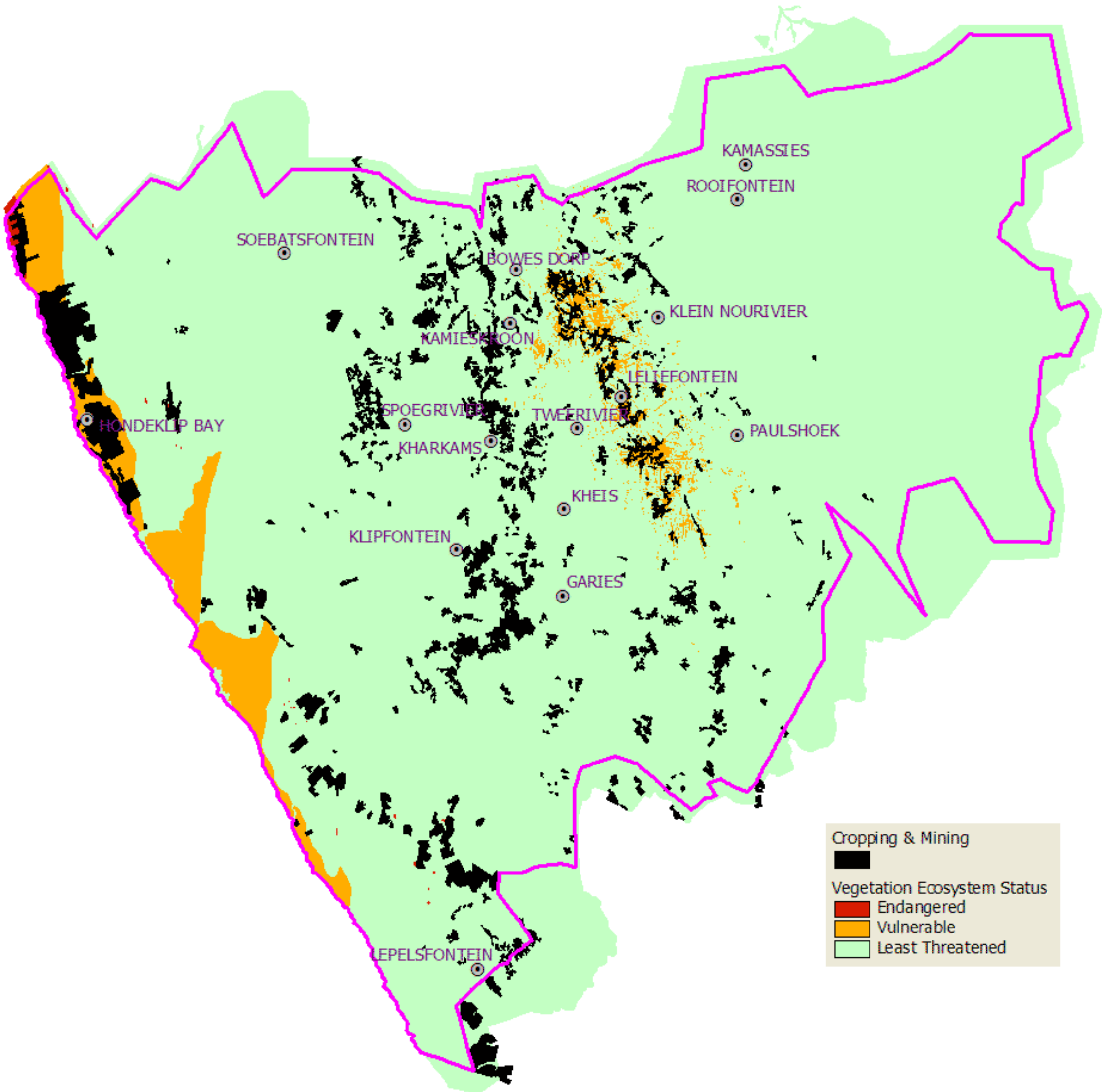
There are currently no formal conservation areas anywhere within the Kamiesberg, a situation which has been recognised as a problem for some time (Helme 1992). In the light of the current study, which highlights the fact that 57 plant species are strict endemics, this is particularly worrying, as the only opportunity to conserve these species, plus a complete vegetation type (Kamiesberg Granite Fynbos), is within this region. There are also no current informal conservation networks in the area, such as Conservancies or Private Nature Reserves. A strong recommendation is thus made to establish a formal conservation network in the Kamiesberg Uplands, based on priority areas identified in this report.

Overall less than 5% of the Kamiesberg municipal area is transformed through cropping and mining (**Table 6**). This transformation is concentrated along the coast (mainly mining) and in the western uplands (mainly cropping) with the coastal strandveld and upland renosterveld vegetation types being most impacted (**Table 6**). Unfortunately there are not data on degradation due to overgrazing or poor fire management, therefore, this may not be an accurate reflection of the state of biodiversity within the municipality. **Table 6** also presents the ecosystem status for each vegetation types as used in the NSBA (Driver *et al.* 2004). Note that ecosystem status is calculated based on transformation relative to the total extent of vegetation types within the municipal area and not the global extent of respective vegetation types. Thus, only the ecosystem status for fynbos, renosterveld and mountain shrubland is an accurate reflection of the national status as these vegetation types are restricted to this municipality. The renosterveld in the uplands, and the coastal zone, are priorities for conservation action based on this analysis.

Table 6: A summary of the extent of transformation of vegetation due to cropping and mining within the Kamiesberg Municipality, and the resultant ecosystem status classification. Upland vegetation types highlighted.

SA Vegetation Sub-Types	Total Extent (ha)	% Transformed by Cropping	% Transformed by Mining	% Total Transformed	Ecosystem Status
Platbakkies Succulent Shrubland	38207	0	0	0	LT
Bushmanland Vloere	592	0	0	0	LT
Namaqualand Heuweltjieveld Quartz Patches	14176	0.03	0	0.03	LT
Namaqualand Strandveld Inland	59645	6.81	0	6.81	LT
Riethuis Quartz Vygieveld	13669	0.07	0	0.07	LT
Namaqualand Heuweltjieveld	246717	6.71	0	6.71	LT
Namaqualand Arid Grassland	6475	0	0	0	LT
Namaqualand Riviere	16009	2.25	0.01	2.26	LT
Bushmanland Arid Grassland	108120	0	0	0	LT
West Bushmanland Klipveld	9274	0	0	0	LT
Namaqualand Blomveld Eastern	52795	0.61	0	0.61	LT
Arid Estuarine Salt Marshes	545	0	7.03	7.03	LT
Namaqualand Sand Fynbos	55742	8.85	0	8.85	LT
Namaqualand Strandveld Coastal	46900	0.88	5.3	6.18	LT
Namaqualand Inland Duneveld	45457	3.06	0.03	3.1	LT
Namaqualand Strandveld Coastal Odyssea Grassland	748	0	0	0	LT
Namaqualand Coastal Dune Corridors	18980	0	20.11	20.11	V
Namaqualand Coastal Duneveld Wooleya Veld	1039	0	56.55	56.55	E
Namaqualand Salt Pans	569	0.38	47.61	47.99	E
Namaqualand Coastal Duneveld	27170	0	20.03	20.03	V
Kamiesberg Granite Fynbos	6432	0.71	0	0.71	LT
Namaqualand Granite Renosterveld	17147	20.89	0	20.89	V
Kamiesberg Mountains Shrubland	35872	0.78	0	0.78	LT
Namaqualand Klipkoppe Shrubland Eastern	35798	0.27	0	0.27	LT
Namaqualand Blomveld	77785	10.45	0	10.45	LT
Namaqualand Klipkoppe Shrubland Upland	145662	1.96	0	1.96	LT
Namaqualand Klipkoppe Shrubland	92896	1.71	0	1.71	LT
Total	**1174423**	**3.8**	**1.08**	**4.88**	

Figure 13: The ecosystem status of SA vegetation sub-types within the Kamiesberg Municipality.



Unfortunately, the ecosystem status for vegetation types does not adequately reflect the severe impacts on many of the Kamiesberg wetland habitats (**Figure 14**). The analysis of wetland transformation shows that high elevation wetlands in open valleys or plateaus are highly transformed (**Figure 15**). The areas most important for wetland conservation action are indicated in **Figure 12**.

Figure 14: The overall level of transformation of wetlands and riparian areas in the Kamiesberg.

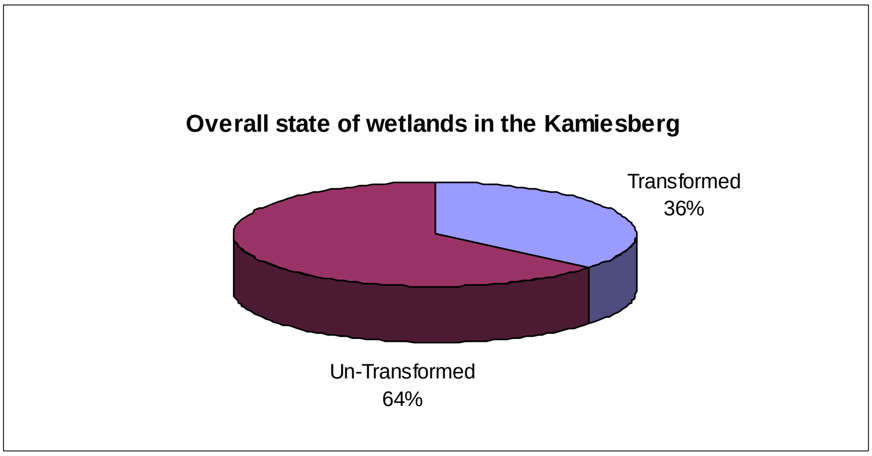
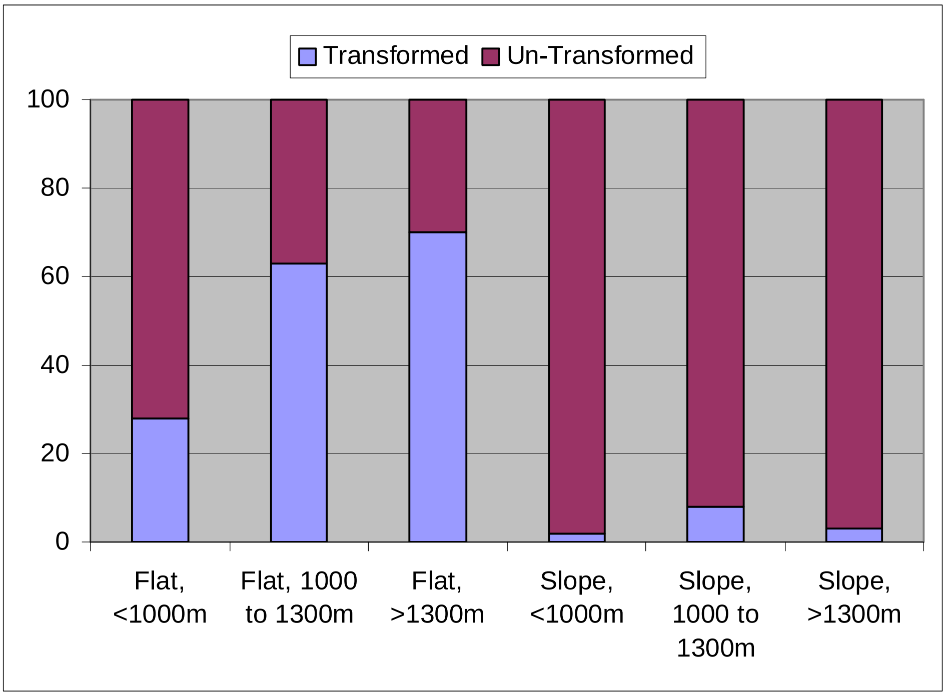


Figure 15: Transformation of the six different wetland broad habitat units.



The primary pressures on Kamiesberg Granite Fynbos areas are innapropriate fire regimes (most often this means too frequent fires), and to a much lesser extent overgrazing and trampling, especially in certain wetlands. Most of this grazing and trampling is caused by larger stock units such as donkeys and cattle, with goats being a lesser problem. Trampling of sensitive moss pads and shallow soils on sloping granite domes is a threat to many species in this upper area, as these microhabitats are home to many geophytes (see Plate 8). Alien invasive plants are not a significant feature of this vegetation type.

The primary pressures on Namaqualand Granite Renosterveld are agricultural transformation (ploughing), and heavy grazing and trampling. Valley bottoms, deep soil plateaus, and Renosterveld wetlands are particulary heavily transformed (>60% lost), and are vulnerable to further transformation. A very rare habitat is where ferricrete comes close to the surface of Renosterveld plateaus (such as near Karas/Welkom), and this tends to support numerous rare species, perhaps responding to the different mineralogy. Flats, shallow soils over granites can also be very interesting, and are perhaps at their best on Boplaas farm, just southeast of Weeskind Peak. Numerous special species are threatened as a result of agricultural transformation of the Renosterveld plateau.

Shrubland habitats tend to be much more widespread and are thus less of an immediate conservation priority. These habitats are typically very rocky, and are thus not subject to transformation, but where there are deeper soils ploughing has had a significant impact on habitat loss. Very few special species are known to be solely associated with this habitat.

Blomveld occurs in more arid areas, but because it is usually on level, sandy soils it has been transformed by agriculture to a moderate degree. Grazing and trampling effects are often more significant in this habitat, which is not particularly well represented within the study area. Particularly on its eastern edge (Bushmanland border) it supports a number of interesting geophytic and succulent endemics, but these areas are so arid that there has been little agricultural transformation.

10 SPATIAL PRIORITIES FOR CONSERVATION ACTION

Most of the rare or threatened endemic plant species in the Kamiesberg Uplands are found on the higher peaks above 1300m, and in the Renosterveld and associated wetlands on the plateau at 900-1200m, and these should thus be the focus of conservation efforts in the region. Not only do these areas support the special plant species, but they are home to a wide diversity of other plant and animal groups, including rare and endemic reptiles and invertebrates (see report by J.Colville). The wetlands of the higer peaks are critical water sources and sponges for the lowlands, and are generally in much better condition than the wetlands on the Renosterveld flats.

Plateau wetlands should be rehabilitated where possible (by leaving buffers of at least 30m each side of all seasonal and permanent wetlands), allowing the natural vegetation to slowly return. In many cases ploughing has taken place right up to the edge of streams, and often right through seasonal wetlands, with resultant erosion after heavy rains. Wetlands should not be deliberately burnt, although if they burn as part of a much larger wildfire that should not be a problem. In some areas it would be best to fence off all wetlands and 30m buffers, so that these areas are not trampled and grazed by stock while in the process of rehabilitation.

The most important areas of Renosterveld identified during this survey (and there are likely to be others not surveyed) were (see **Figure 10**; quarter degree grid reference in parentheses) Groot Tuin to De Kuilen and Bovlei area (3018AA), north of Leliefontein near Langvlei (3018AC), west of Leliefontein along escarpment edge (3018AC), south of Leliefontein to Naras and Vissersplaat (3018AC), east of Sittensberg near Natpad (3018AC), Boplaas area southeast of Weeskind peak to Platberg and Botuin area south of Eselkop (3018AC), Jakkalshok and Damsland area north of Rooiberg (3018AC), a large area from Die Kruis in the north, to Rondefontein in the south, Swartmatjie in the east, and Welkom in the west (3018AC), and an outlier in the southeast around Grasberg (3018AD).

The Renosterveld around Karas (Welkom farm) seems to be specially rich in localised species, including a number of undescribed species. The sandy flats, and the tiny patches of shallow ferricrete some 500m northeast and southeast of the farmhouse are especially important, and are currently heavily grazed and degraded.

Fynbos endemics are most common on peaks of over 1300m, and the highest ground around Rooiberg peak (1706m) is particularly important. Well over 80% of the Fynbos endemics are known to occur within the Rooiberg/Blouberg/Welkom/ Karas/Stalberg area, at elevations of over 1200m, and this area is thus the major Fynbos priority in the Kamiesberg. This area extends east across the top of the Langkloof to the vicinity of Rondefontein, where there are also extensive Renosterveld patches and some important Afromontane forest patches. The extensive wetlands of the Rooiberg massif are perhaps the priority Fynbos wetland system in the uplands.

Eselkop, the second highest peak, is not known to harbour any endemic species not found elsewhere, but it does support one of only two populations of the Critically

Endangered *Protea namaquana* (see Plate 2), although this population has been severely impacted by too frequent fires in the last twenty years (Rebelo et al – In prep.). It also supports one of only two known populations of *Pentaschistis lima* (Poaceae), the other on Leliefontein se Berg.

Sneeukop (1588m) is the third highest peak in the area, and is the only known home of at least three species - *Xenoscapa uliginosa, Hesperantha minima,* and *Crocosmia fucata*, which are restricted to the east slopes, the latter along a seasonal stream. The area also supports a further two species which are known only from here and one other locality (noted in parentheses), viz. *Oedera conferta* (Rooiberg), and *Moraea kamiesmontana* (Rooiberg area). Fynbos in this area is very old (>50yrs) and is in need of a fire, as it is becoming woody and senescent, with reduced diversity.

Other important peaks which all support significant populations of at least some Fynbos endemics include (see **Figure 2**; from N – S, with elevations indicated) Osplaat se Berg (1450m), Anegas Rooiberg (1395m), Swarklaasriet se Berg (1375m), Grasberg (1364m), Horinggatkop (1461m), Kamiesberg (1527m), Johannes se Berg (1550m), Sittensberg (1552m), Weeskind (1440m), Josef se Kop (1253m), and Suurberg (1276m).

Although it was not visited during this study, and although there are no previous collections known to be definitely from this peak, the modelling done suggests that Vyemond se Berg (1291m, 6km NE of Karkams) will also support significant Fynbos elements, as it is high enough, and further west than any other peaks of this height.

11 PRIORITIES FOR FUTURE RESEARCH

Information gaps that my hinder ecological management in the Kamiesberg Uplands could be addressed by some of the following suggested projects:

- Establish long term monitoring plots and programs for selected rare and threatened indicator species (that are easy to identify), such as *Protea namaquana* (skaamroos), *Otholobium hamatum*, *Lotononis polycephala*, *Moraea pendula*, and *Arctotis canescens*. Some of the main pressures affecting these species respectively include fire, road construction and maintenance, agricultural expansion and grazing, wetland drainage or damming, and agricultural expansion and grazing.

- Mapping the original extent of the wetlands on the plateau.
- Determining the cost to farmers of returning ploughed fields to wetlands and natural grazing areas.
- Investigating alternative indigenous dryland crops for use in the area, eg. kankerbos (*Lessertia frutescens*), kougoed (*Sceletium* sp.), rooibos (*Aspalathus linearis*), and essential oils (*Pelargonium* spp.).
- Fire monitoring and collection of data to determine appropriate fire intervals for different habitats and areas.

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13 APPENDIX 1: List of Kamiesberg Endemic and Near Endemic Seed Plants, with Red Data Book status

- Where endemism or habitat is uncertain due to lack of collections this is indicated by a blank or question mark.
- Preferred vegetation type listed first. Abbreviations: Sh: Shrubland (both Klipkoppe and Kamiesberg types); Rv: Renosterveld; Fyn: Fynbos.
- Red Data Categories according to latest IUCN criteria. Abbreviations: DD: Data Deficient; LC: Least Concern; NT : Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered
- Near endemic includes species with single disjunctions but where the main population is on the Kamiesberg, and species with total ranges that lie mostly in the study area but extend up to 70km outside the study area, usually in upland areas.
- There are 57 True endemics**;** 57 Near Endemics, or unknown.
- Species with no noted Red Data status were not assessed in this project.
- Orange List status includes rare or range restricted species that are not known to be threatened in any way.

Family	Taxon	Endemism	Vegetation Type	Red Data Status
Acanthaceae	Acanthopsis horrida	near endemic	Shrubland/Karoo	
Amaryllidaceae	Haemanthus amarylloides subsp. polyanthus	near endemic	Shrubland	
Amaryllidaceae	Hessea incana	endemic	Shrubland/Rv	NT
Amaryllidaceae	Hessea stenosiphon	near endemic	Fynbos/Sh	Orange
Amaryllidaceae	Haemanthus graniticus	near endemic	Shrubland/Rv	EN
Apiaceae	Peucedanum kamiesbergense	near endemic	Fynbos	Orange
Apiaceae	Peucedanum pearsonii	endemic	Fynbos	VU
Apocynaceae	Quaqua pallens	endemic	Shrubland	
Apocynaceae	Stapeliopsis khamiesbergensis	near endemic	Shrubland	
Araliaceae	Centella tridentata ssp. dregeana	endemic	Renosterveld/Fyn	EN
Asphodelaceae	Bulbinella ciliolata	near endemic	Shrubland	LC
Asteraceae	Antithrixia flavicoma	endemic	Shrubland	VU
Asteraceae	Arctotis canescens	endemic	Renosterveld	CR
Asteraceae	Felicia diffusa ssp. khamiesbergensis	endemic	Fynbos	VU
Asteraceae	Lopholaena longipes	near endemic	Shrubland/ Karoo ?	DD
Asteraceae	Oedera conferta	endemic	Fynbos	Orange
Asteraceae	Othonna divaricata		?	DD
Asteraceae	Othonna retrorsa	near endemic	Sh/Rv/Fyn	LC
Asteraceae	Pteronia pillansii	near endemic	Shrubland	
Brassicaceae	Heliophila schulzii	endemic	Shrubland	
Crassulaceae	Tylecodon nigricaulis	endemic	Shrubland/Fyn?	VU
Eriospermaceae	Eriospermum multifidum	near endemic	Fynbos/Sh	LC
Eriospermaceae	Eriospermum sabulosum	endemic	Shrubland	VU
Eriospermaceae	Eriospermum tuberculatum	endemic	Shrubland	VU
Euphorbiaceae	Clutia imbricata	near endemic?	Fynbos	DD
Fabaceae	Amphithalea obtusiloba	endemic	Fynbos	EN
Fabaceae	Argyrolobium petiolare	endemic	Shrubland	VU
Fabaceae	Aspalathus angustifolia ssp. robusta	endemic	Fynbos/Sh	VU
Fabaceae	Indigofera limosa		?	DD
Fabaceae	Lessertia microcarpa	near endemic	Shrubland/Rv	DD
Fabaceae	Lotononis acutiflora	endemic	Renosterveld	EN

Family	Taxon	Endemism	Vegetation Type	Red Data Status
Fabaceae	Lotononis magnifica	endemic	Renosterveld	CR
Fabaceae	Lotononis mollis	near endemic	Renosterveld	EN
Fabaceae	Lotononis polycephala	near endemic	Renosterveld/Sh	EN
Fabaceae	Otholobium hamatum	endemic	Renosterveld	VU
Geraniaceae	Pelargonium hirtipetalum	near endemic	Shrubland	
Geraniaceae	Pelargonium pubipetalum	endemic	Renosterveld/Sh	VU
Hyacinthaceae	Lachenalia inconspicua	near endemic	Karoo	
Hyacinthaceae	Tenicroa nana	near endemic	Fynbos/Sh	Orange
Iridaceae	Babiana attenuata	near endemic	Renosterveld	LC
Iridaceae	Babiana dregei	endemic	Sh/Rv/Fyn	LC
Iridaceae	Babiana framesii var. kamiesbergensis	endemic	Shrubland	Orange
Iridaceae	Crocosmia fucata	endemic	Renosterveld	VU
Iridaceae	Ferraria kamiesbergensis	near endemic	Renosterveld/Sh	EN
Iridaceae	Geissorhiza kamiesmontana	endemic	Shrubland/Rv	Orange
Iridaceae	Geissorhiza namaquensis	near endemic	Renosterveld/ Fyn	Orange
Iridaceae	Geissorhiza sp. nov. (aff. aspera)	endemic	Fynbos	VU
Iridaceae	Gladiolus kamiesbergensis	endemic	Fynbos	Orange
Iridaceae	Hesperantha flexuosa	near endemic	Sh/Rv/Fyn	LC
Iridaceae	Hesperantha latifolia	endemic	Fynbos/Rv	LC
Iridaceae	Hesperantha minima	endemic	Renosterveld/Sh	EN
Iridaceae	Ixia latifolia var. ramulosa	near endemic	Shrubland/Rv	
Iridaceae	Moraea fenestralis	near endemic	Karoo	
Iridaceae	Moraea kamiesensis	endemic	Renosterveld	EN
Iridaceae	Moraea longiflora	endemic	Renosterveld/Fyn	VU
Iridaceae	Moraea kamiesmontana	endemic	Renosterveld/Fyn	VU
Iridaceae	Moraea pendula	endemic	Renosterveld	VU
Iridaceae	Moraea rivulicola	near endemic	Renosterveld/Fyn	VU
Iridaceae	Romulea citrina	near endemic	Shrubland/Rv	
Iridaceae	Romulea kamisensis	near endemic	Sh/Rv/Fyn/Karoo.	LC
Iridaceae	Romulea namaquensis	near endemic	Renosterveld/Fyn/Sh	
Iridaceae	Romulea neglecta	endemic	Fynbos/Rv	VU
Iridaceae	Romulea pearsonii	near endemic	Sh/Rv/Fyn	Orange
Iridaceae	Romulea rupestris	near endemic	Fynbos	Orange
Iridaceae	Tritonia kamiesbergensis	endemic	Sh/Rv/Fyn	VU
Iridaceae	Watsonia rourkei	endemic	Fynbos	VU
Iridaceae	Xenoscapa uliginosa	endemic	Fynbos	VU
Lobeliaceae	Cyphia sp.nov. (aff. longipetala)	endemic	Fynbos	Orange
Mesembryanthemaceae	Antimima sp. nov. (aff. hallii)	endemic	Fynbos	Orange
Mesembryanthemaceae	Antimima sp. nov. (aff. persistens)	endemic	Fynbos	Orange
Mesembryanthemaceae	Cheiridopsis pearsonii	endemic	Renosterveld	VU
Mesembryanthemaceae	Cheiridopsis sp. nov.	endemic	Renosterveld	CR
Mesembryanthemaceae	Conophytum chauviniae	near endemic	Shrubland/Karoo	Orange
Mesembryanthemaceae	Conophytum cylindratum	near endemic	Shrubland/Karoo	
Mesembryanthemaceae	Conophytum danielii	near endemic	Shrubland/Karoo	Orange
Mesembryanthemaceae	Conophytum hanae	near endemic	Shrubland/Karoo	Orange
Mesembryanthemaceae	Conophytum khamiesbergense	endemic	Fynbos	Orange
Mesembryanthemaceae	Conophytum pellucidum subsp. cupreatum	near endemic	Karoo	
Mesembryanthemaceae	C. pubicalyx	near endemic	Sh/ Karoo	
Mesembryanthemaceae	Conophytum roodiae	near endemic	Shrubland	Orange
Mesembryanthemaceae	C. rugosum ssp. rugosum	near endemic	Shrubland/Fyn	Orange
Mesembryanthemaceae	C. rugosum ssp. sanguineum	endemic	Shrubland	Orange
Mesembryanthemaceae	Lithops naureeniae	near endemic	Shrubland/Karoo	Orange
Mesembryanthemaceae	Ruschia sp. nov. (cf. dichroa)	endemic	Fynbos	Orange
Orchidaceae	Disa macrostachya	endemic	Fynbos	EN

Family	Taxon	Endemism	Vegetation Type	Red Data Status
Oxalidaceae	Oxalis albiuscula	endemic	Shrubland	VU
Oxalidaceae	Oxalis ambigua	near endemic	Shrubland/Karoo	
Oxalidaceae	Oxalis campylorrhiza	near endemic	Shrubland	
Oxalidaceae	Oxalis clavifolia	near endemic	Shrubland/Karoo	
Oxalidaceae	Oxalis comosa	near endemic	Shrubland/Fyn	LC
Oxalidaceae	Oxalis creaseyi	endemic	Renosterveld?	EN
Oxalidaceae	Oxalis exserta	near endemic	Shrubland	
Oxalidaceae	Oxalis flaviuscula	near endemic	Shrubland	
Oxalidaceae	Oxalis furcillata	near endemic	Shrubland	
Oxalidaceae	Oxalis helicoides	endemic	Shrubland?	
Oxalidaceae	Oxalis inconspicua	near endemic	Shrubland	
Oxalidaceae	Oxalis kamiesbergensis	endemic?	Renosterveld/Sh?	
Oxalidaceae	Oxalis knuthiana	endemic	Shrubland	
Oxalidaceae	Oxalis louisae	endemic	Shrubland	
Oxalidaceae	Oxalis virginea	endemic	Shrubland	VU
Poaceae	Pentaschistis lima	endemic	Fynbos	VU
Poaceae	Helictotrichon barbatum	near endemic	Renosterveld?	VU
Polygalaceae	Muraltia rigida	endemic	Fynbos	Orange
Proteaceae	Protea namaquana	endemic	Fynbos	CR
Proteaceae	Vexatorella alpina	endemic	Fynbos	LC
Restionaceae	Ischyrolepis vilis	endemic	Fynbos	Orange
Rhamnaceae	Phylica montana	near endemic	Fynbos/Rv/Sh	LC
Rhamnaceae	Phylica retrorsa	endemic	Fynbos	VU
Rhamnaceae	Phylica pearsonii	near endemic	Shrubland	Orange
Rutaceae	Agathosma namaquensis	endemic	Fynbos	Orange
Scrophulariaceae	Dischisma clandestinum	near endemic	Shrubland/Karoo	DD
Scrophulariaceae	Hebenstretia kamiesbergensis	endemic	Fynbos	VU
Scrophulariaceae	Oftia revoluta	near endemic	Shrubland/Fyn	LC
Scrophulariaceae	Selago ferrago	?	Renosterveld/Sh?	DD