

Chapter 1: Introduction

South Africa is a land of great diversity regarding its climate and physiography. Ranges from desert with little rainfall and high temperature variations, to coastal forests with seasonal rainfall and humid, warm conditions, including plains, mountains, valleys and hills are found. The result of this diversity is different habitat conditions and hence different vegetation types. These factors are responsible for the rich and varied flora that exists in South Africa (Germishuizen 1982). The disappearance of natural habitats and the danger of extinction of species are some of the consequences of mining, urbanisation, industrialisation and mismanagement and exploitation of natural resources.

The Grassland Biome covers approximately 27% of South Africa and is one of the most important agricultural areas, both in terms of extensive crop production and intensive stock farming (Mentis & Huntley 1982). The different kinds of exploitation and utilisation have had adverse effects on the grassland areas. Little of the natural vegetation is left and the remnants thereof are poorly conserved. The South African Grassland Biome Project was launched with the ultimate goal to produce a classification of the vegetation and an associated ecological interpretation. This should form a basis on which future programmes for natural resource management can be built, while conserving the natural resources of the area (Mentis & Huntley 1982; Scheepers 1986).

As an agricultural entity KwaZulu-Natal is the most intensively farmed regions in South Africa and has the highest investment and return per unit of area in the Republic of South Africa (Schulze 1982). Within the study area most of the farmers resort to stock farming, emphasising the need and importance of natural grassland. Crop production and cultivated fields only occur on a smaller scale.

Four nature reserves occur in the study area. The Rugged Glen Nature Reserve and Royal Natal National Park are situated on the extreme west of the study area on the border between the Free State and KwaZulu-Natal. Spioenkopdam Nature Reserve is situated

more centrally and Mfifiyela Nature Reserve occurs on the southern border of the study area. Afforestation is commencing in some areas and already two state forests have been declared namely Monks Cowl and Cathedral Peak State Forests.

The study area displays a diversity of topographic features. It includes the high altitude Drakensberg in the west as well as the lower foothills and the undulating plains situated more central as well as the valleys and hills to the east. Acocks (1953, 1988) conducted broadscale vegetation studies, which included the study area. The grassland of the study area comprises the largest part of the study area and conforms to the Southern Tall Grassveld (#65), described by Acocks (1953, 1988). It is dominated by *Themeda triandra* and *Hyparrhenia* species and can be divided into Open Thornveld that is dominated by *Acacia* species and Shrub Forest, which are dominated by various woody species.

The Southern Tall Grassveld is marginal and transitional to the Valley Bushveld (#23) which is found in the valleys of numerous rivers and dominated by species of a more tropical nature. These valleys are hot and receive less rain than the intervening ridges. The Valley Bushveld occurs as narrow belts on the steep, less arid, sides of the valleys, particularly towards the north.

Numerous papers were devoted to the phytosociology of the vegetation of different parts of the Grassland Biome. Some examples are Van Wyk & Bredenkamp 1986, Bezuidenhout 1988, Bloem 1988, Bredenkamp *et. al.* 1989, Turner 1989, Kooij 1990, Du Preez 1991, Matthews 1991, Fuls *et. al.* 1992, Smit 1992, Coetzee 1993 and Eckhardt 1993.

The northwestern part of KwaZulu-Natal was identified as an area where little or no phytosociological data exist. A phytosociological study of this area was proposed to contribute to a better understanding and knowledge of the Grassland biome. A study of this area was undertaken with the goals of the Grassland Biome Project in mind. The

collected data was therefore also used for the identification of potential conservation areas. The identification of such areas is considered most important by the Department of Environmental Affairs in ensuring the preservation of genetic resources and the diversity of species. Ultimately the results of all the phytosociological studies will be synthesised and a map of the vegetation units will be produced.

Chapter 2: Physical environment

2.1 The study area - physical and historical

The study area is situated in northwestern KwaZulu-Natal and extends from 28° 57'E to 30° 00'E and 28° 00'S to 29° 00'S (Figure 2.1). The Free State and Lesotho borders demarcate the western border of the study area. The study area covers approximately 9300 km² and embraces areas of different physiognomic appearances, such as the high Drakensberg in the west with the lower foothil's, the undulating plains situated more centrally and valleys and hills to the east and south (Figure 2.2 & 2.3). This varied and complex physiognomy cause gradients along climatic and other natural factors, as well as a variety of edaphic, geological, human distribution and agricultural factors (Edwards 1967).

In the study area only two large towns occur, i.e. Ladysmith and Colenso, with Estcourt on the southern border of the study area, while smaller towns, such as Bergville and Winterton also occur in the area. Throughout the area large black settlement areas occur. Mkukwini, Zwelisha, Ezakheni, Bonjajeni and Kwamija are situated to the western part of the study area and Driefontein, Watersmeet, Peacetown, Kurkintulloch, White City and Danskraal are located close to Ladysmith.

From the beginning of the present century, disturbances to the natural environment became more enhanced, due to continued growth in the human population and expansion of commercial and agricultural enterprises. These disturbances have been most severe in the areas covered by black settlements due to relatively high human and livestock densities. Agriculture in these areas consists essentially of intensive pasturing and cultivation, often on small patches located on steep slopes. The veld is continuously overgrazed, which give rise to problems such as the stripping of the topsoil over large areas and subsequent erosion and deterioration of the vegetation, soil and human life standards.

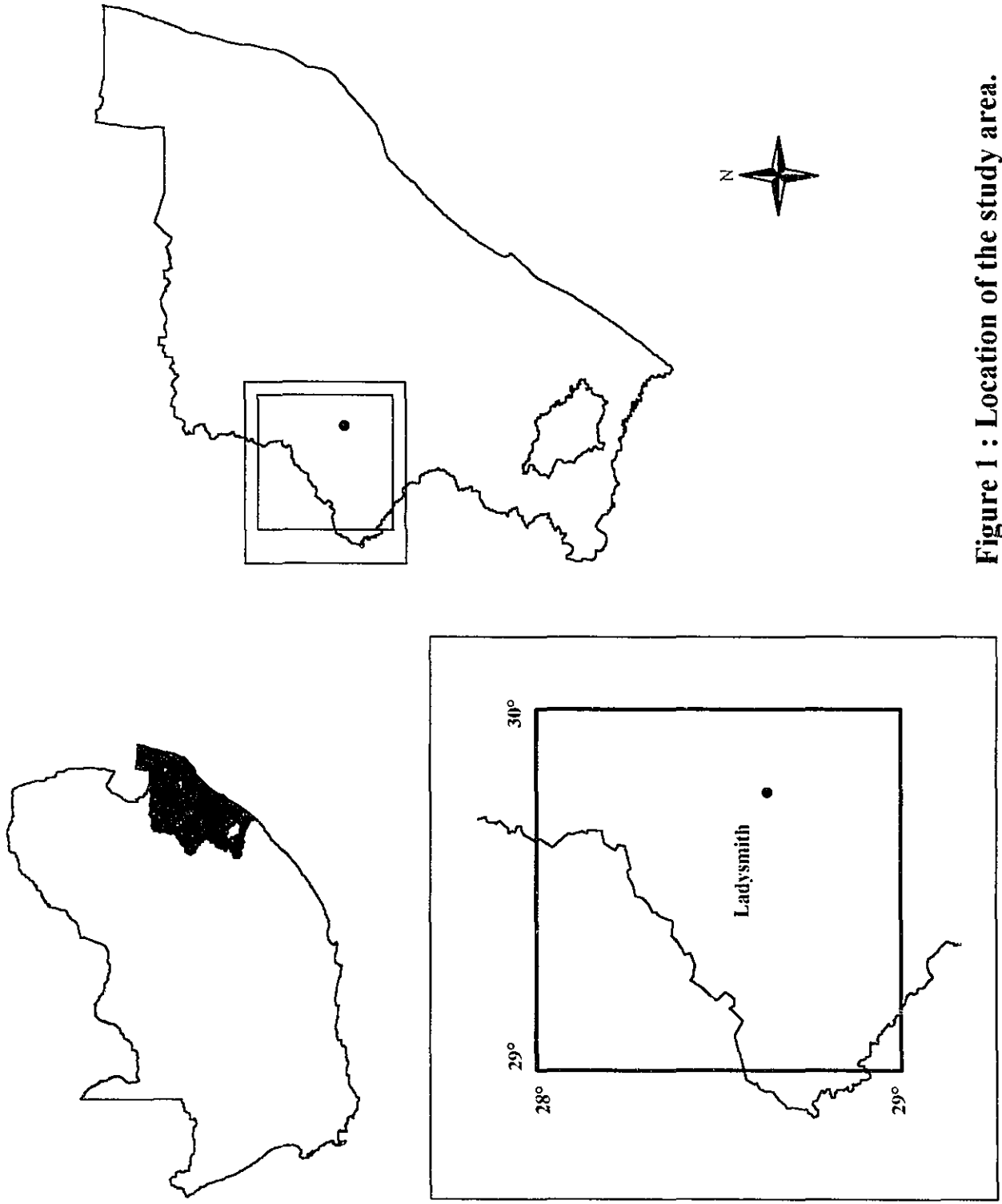


Figure 1 : Location of the study area.

Since earliest times of settlement there has been a general intensification of farming, reflected in the upward trend in stock numbers and areas under crop production as well as cultivation of commercial forests (Edwards 1967).

2.2 Physiography

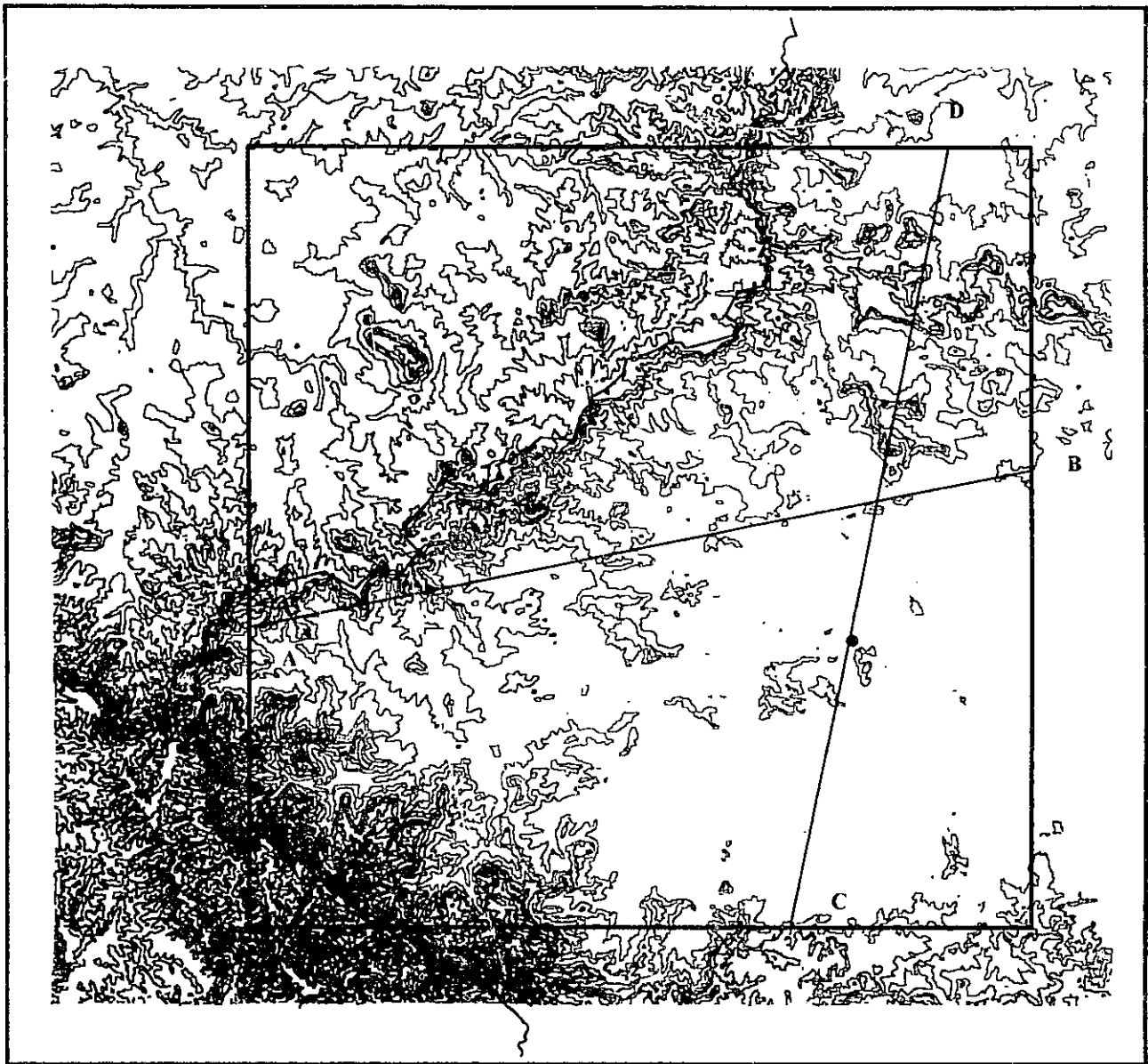
Morphologically, South Africa may be divided into the Interior Plateau and the surrounding Marginal Regions. The great escarpment that can be traced as an arc roughly parallel to the coast separates the two regions with the most impressive section, the Natal Drakensberg, in the east (Du Toit 1954, Wellington 1955).

KwaZulu-Natal, in particular, is noted for the variety of scenery presented by the varied physiography, ranging from mountains to plateaux, plains, deeply incised river valleys and coastal hinterlands (Phillips 1973). In 1967 Turner classified Natal into 49 physiographic regions of which eight occur in the study area. These eight regions can be grouped into four main physiographic regions, i.e. Mountain Regions, Plateau regions, Basin Plainlands and Low Lying Regions (Schulze 1982). The distribution of these areas are shown in Figure 2.4, with the key to the physiographic regions given in Table 2.1 (Phillips 1973).

a. The Mountain Regions

#1. The Lesotho Plateau and High Drakensberg Escarpment

This elevated plateau region known as Lesotho is the highest landmass in southern Africa. The surface of the plateau is bevelled across basalts of the Stormberg series; the widespread outpouring of lava which brought to a close, in early Jurassic times, the great accumulation of sediments known as the Karoo System. The lavas are exposed along the vertical face of the eastern escarpment - the High Drakensberg - that forms the KwaZulu-Natal Lesotho boundary. The plateau is tilted gently to the south-west and a system of perennial rivers and streams are fed by the high summer rainfall and heavy winter snows.



- Ladysmith
- Gridlines 28° - 29°S and 29° - 30°E
- ∩ KwaZulu-Natal Boundary
- Altitude

- Altitude of the study area, contours 100m interval
- 750 - 1 100
 - 1 100 - 1 450
 - 1 450 - 1 850
 - 1 850 - 2 200
 - 2 200 - 2 550
 - 2 550 - 2 950
 - 2 950 - 3 300



Figure 2.2 Contours of the study area (100m interval) with transects AB and CD (See Figure 2.3)

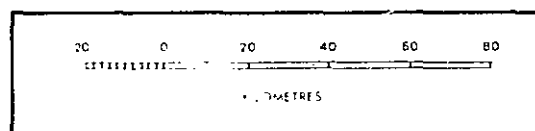
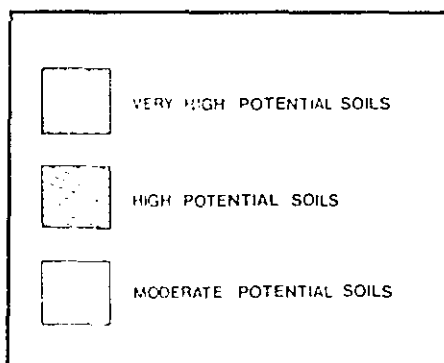
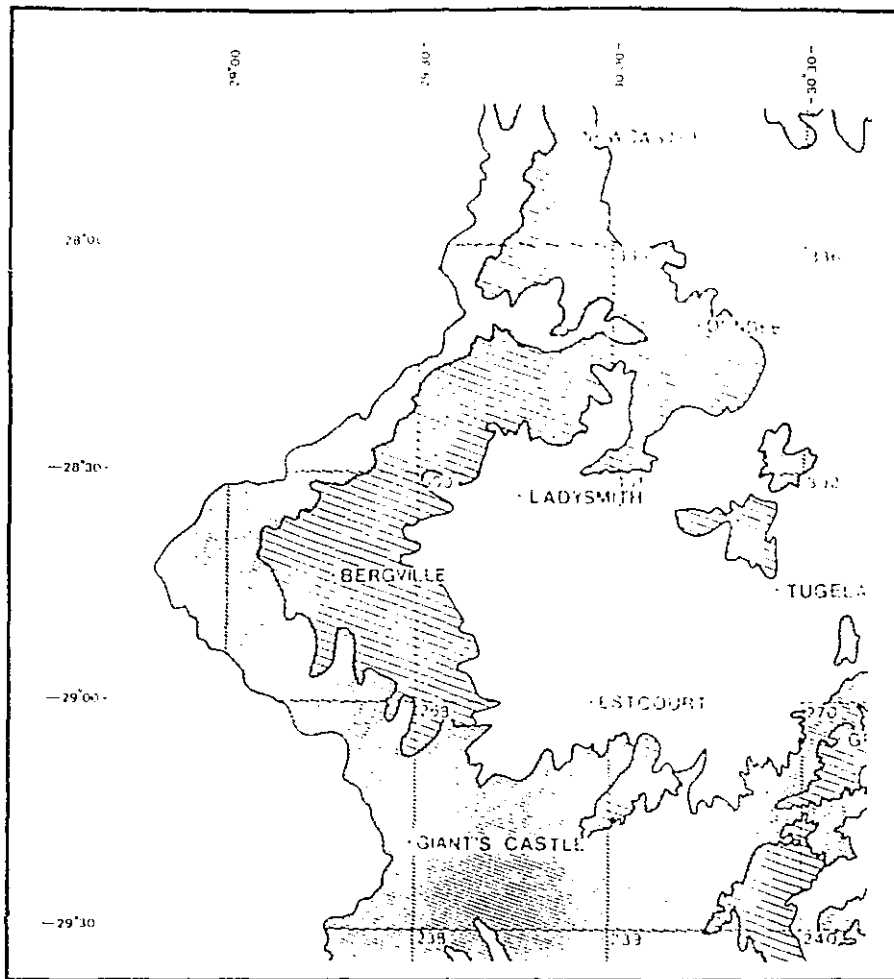


Figure 2.5 : Generalised soil potential of the study area (Schulze 1982).

#2. The Spurs and Foothills of the High Drakensberg

A borderland of spurs and foothills lies along the foot of the great escarpment. The area is deeply incised by the many streams and rivers which rise on the High Drakensberg. The more elevated points near the escarpment correlate with outliers that stand out above the highveld of the Free State farther to the north. The general level of this region is, however, the same as that of the highveld, and hence carries the so-called "African" landsurface of denudation.

#3. The Highveld of the Free State and the Low Drakensberg Escarpment

Between Mount aux Sources and Majuba, the highveld of the Free State is typical of the great interior of the plainlands of southern Africa. From the north to the south the highveld is bevelled across Beaufort and Ecca sediments. The border between KwaZulu-Natal and the Free State lies along the crest of an escarpment known as the Low Drakensberg.

#4. The Spurs and Foothills of the Low Drakensberg

A narrow zone of spurs and foothills extend along the entire length of the Low Drakensberg escarpment. These erosional features are carved in the shales and sandstones of the Beaufort and Ecca series. Moisture laden winds from the Indian Ocean are intercepted along the escarpment and dense clumps of indigenous forests nestle within its sheltered kloofs and ravines.

b. Plateau Regions

#7. The Biggarsberg Range

The narrow divide that separates the basin of the Buffalo from that of the Tugela River is known as the Biggarsberg. The remnant of the highveld is capped by strata of the Beaufort series, or in places by thick sills of intrusive Dolerite. The range is deeply dissected by a network of small streams.

c. Basin Plainlands

#17. The Winterton-Estcourt-Muden Plain

This region may be described as the transition country between the KwaZulu-Natal uplands and the Tugela thornveld. Beaufort beds extend well to the east of Estcourt, further east the underlying rocks are exposed. Several rivers that rise in the foothills of the High Drakensberg traverse this grassveld in the west.

#18. The Bergville-Ladysmith-Elandslaagte Plain

This, the northern part of the upper Tugela plainland, stretches from Bergville beyond Ladysmith to the extremely flat country in the vicinity of Elandslaagte. The underlying rocks are mainly Ecca, the upthrow of the Tugela fault being reflected in the displacement of the Beaufort contact. The discontinuity of the geological horizon between north and south is further evident in the appearance of a vast zone of Dolerite between Colenso and Ladysmith.

#22. The Ngagane Plain

This plain lies between the Biggarsberg and the low ridge of country the Horn and Incandu rivers, and extends westwards from the Dundee Plain to the Low Drakensberg escarpment. The underlying rocks belong to the Upper Ecca series and superficial deposits of the lateritic "oukclip" are widespread. High rainfall is noted along the foothills of the Drakensberg and the kloofs are filled with dense patches of indigenous forest.

d. Low-lying regions

#34. Valley of the Tugela River

The combined waters of its own catchment above Colenso have accomplished the spectacular excavation of this rugged and forbidding region. This stretch of the river is aligned along the great Tugela fault, a line of fracture and weakness in the underlying rocks which has contributed in the rapidity in which the valleys has advanced inland.

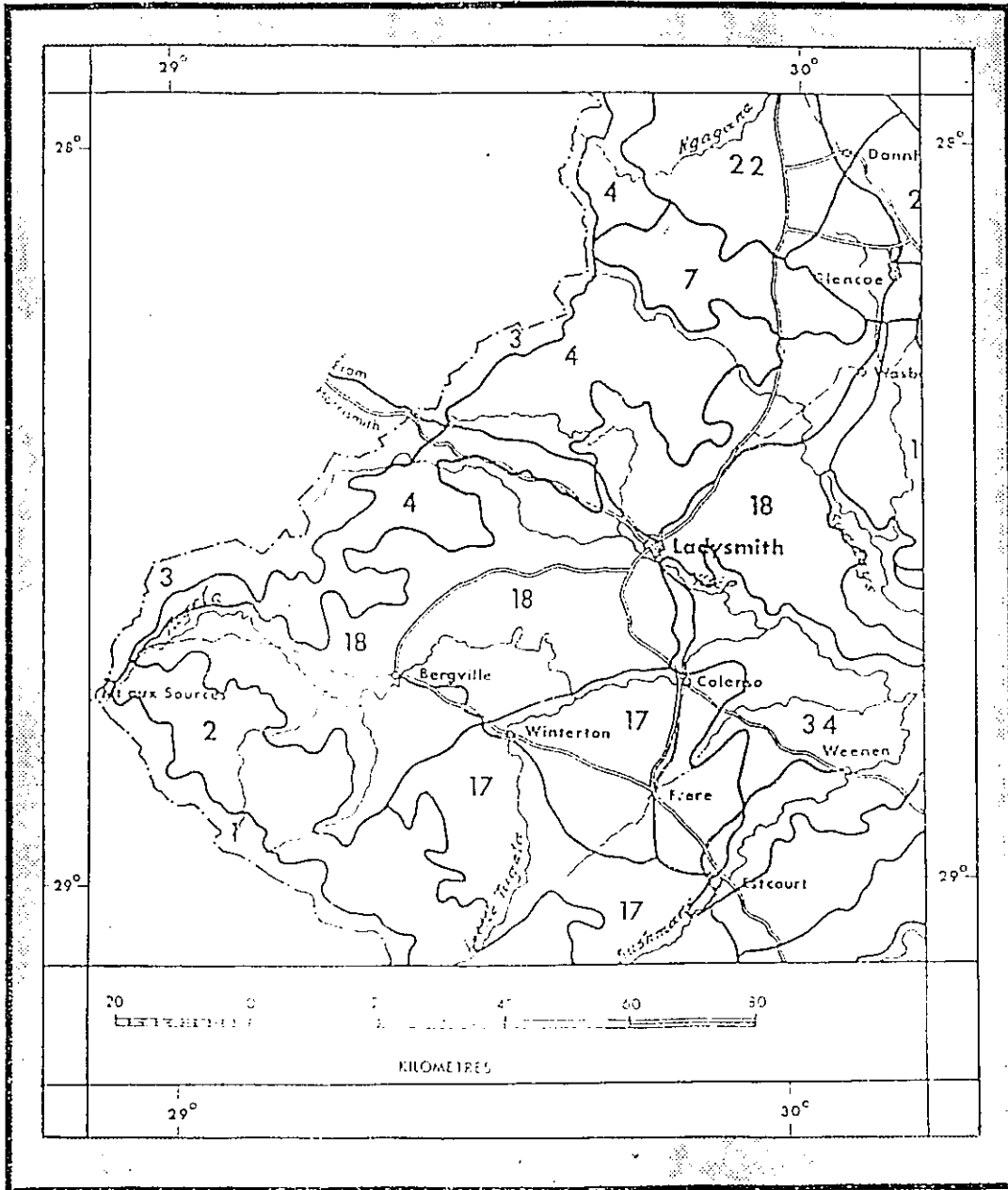


FIGURE 2.4 : PHYSIOGRAPHIC REGIONS OF THE STUDY AREA (AFTER EDWARDS)

TABLE 2.1: KEY TO PHYSIOGRAPHIC REGIONS OF THE STUDY AREA AND SURROUNDING AREAS (AFTER TURNER 1967 AND FIELDWORKERS, SCHULZE 1979)

Region	Typical elevation (m)
A : <u>Mountain Regions</u>	
2 : Spurs & Foothills of the High Drakensberg	1 800 - 2 100 m
3 : OFS Highveld & Low Drakensberg Escarpment	2 000 - 2 100 m
4 : Foothills of the Low Drakensberg	1 350 - 1 800 m
B : <u>Plateau Regions</u>	
7 : Biggarsberg range	1 650 m
C : <u>Basin Plainlands</u>	
17: Winterton-Estcourt-Muden Plain	1 000 - 1 100 m
18: Bergville-Ladysmith-Elandslaagte Plain	1 150 - 1 200 m
22: Ngagane Plain	1 300 - 1 400 m
D : <u>Low Lying Regions</u>	
34: Valley of the Tugela River	100 - 800 m

The study area is situated in the Tugela Basin, which comprises approximately one third of the area of KwaZulu-Natal. Multitudes of small rivers originate in the higher Drakensberg and the lower foothills. The main river in the area, being the Tugela, has its origin in the Drakensberg and runs into the Woodstock dam as well as feeding the Spioenkop Dam, running through the main part of the study area. Smaller rivers, such as the Klip River, that runs through Ladysmith and N'kunzi also form part of the catchment area for the Tugela River.

The high-lying topography of the study area is dominated by the north-south running Drakensberg mountain range levelling out towards the east and south. Height above maritime sea level varies from 1 500 m to 1 000 m in the western mountainous and

northern part of the study area. In the southwestern part of the study area, along the Lesotho border, altitude reaches higher than 3 100 m a.m.s.l., but as a result of inaccessibility no relevés were compiled in this area and is effectively excluded from the rest of the area.

The slopes and foothills of the mountain extend into the undulating plains, valleys and hills in the central, eastern and southern part of the study area. The altitude varies between 900 and 1 400 m a.m.s.l.

2.3 Soil

At the time this data were compiled, the Landtype map for this region was not available and very little published data exists on soil types in the study area. Climatic differences are responsible for soils which have developed in widely diverging directions, while local differences in parent material and topographic position have caused the formation of many soil series with strongly contrasting characteristics (Edwards 1967).

Distrophic Ferralitic soils occur in the well drained upland areas because of the high rainfall and relatively low temperatures of these areas. The natural fertility of these soils is low, acidic and the plant nutrients present are virtually confined to the top soil, which is rich in organic matter. The chemical poverty, however, is balanced by favourable physical properties. In most places the soils are deep and subsoils very friable, porous and permeable. In general erodability is low and a favourable comparison can be drawn between the Ferralitic soils and soils with a very high agricultural potential (Edwards 1967).

Distinction can be made between red and grey brown Ferralitic soils. The former has reddish brown topsoil, merging into dark red to yellowish subsoil (Phillips 1973). It has developed from Dolerite and forms deposits that are at least partly of doleritic origin. Soils of the second group have formed from shales or sandstone or deposits derived from these rocks. The grey brown topsoils are underlain by yellowish brown subsoil, which

however may turn reddish at deeper levels.

Fersialitic soils are predominant in the relatively moist parts of the Tugela Basin. Many of these Fersialitic soils are friable, porous and permeable, for a considerable depth (Schulze 1982). Due to great variation in clay content and depth, the production potential level is lower than in the preceding soils, but rates are still high. Instead of mere loose concretions, the Fersialitic soils contain a layer of indurated ironstone ("oukclip"), often situated directly underneath the topsoil.

Next on the scale of decreasing weathering and leaching is the Clay pan soils, which have the greatest extension in the relatively dry part of the Interior Basin. These soils are characterised by grey brown acid topsoil on a dark grey to black, neutral to alkaline clay horizon (Schulze 1982). The topsoil is partly leached but base saturation increases with depth. The Clay pan soils are highly erodible and thus their agricultural potential limited because of extremely unpermeable subsoil.

A group of upland soils, showing a still lower degree of weathering and leaching is the Vertisols ("black turfs"). They have developed from dolerite or transported materials or pediments, which are partly of dolerite origin. These soils are mainly found in the driest parts of the Interior Basin. Due to their low permeability, the Vertisols are highly erodible and subsequently have a moderate agricultural potential (Schulze 1982).

The map depicting the generalised soil potential (Figure 2.5) should be interpreted with caution. It depicts only an overall regional soil potential, which may vary considerably within a region because of local topographical differences (Schulze 1982). Phillips (1973) divided the soils of the study area in the following zones (Table 2.2 & Figure 2.6).

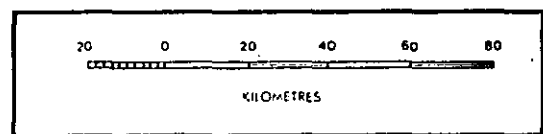
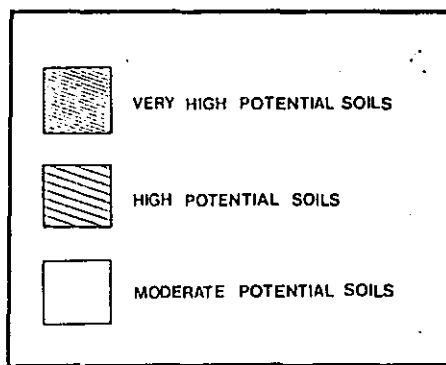
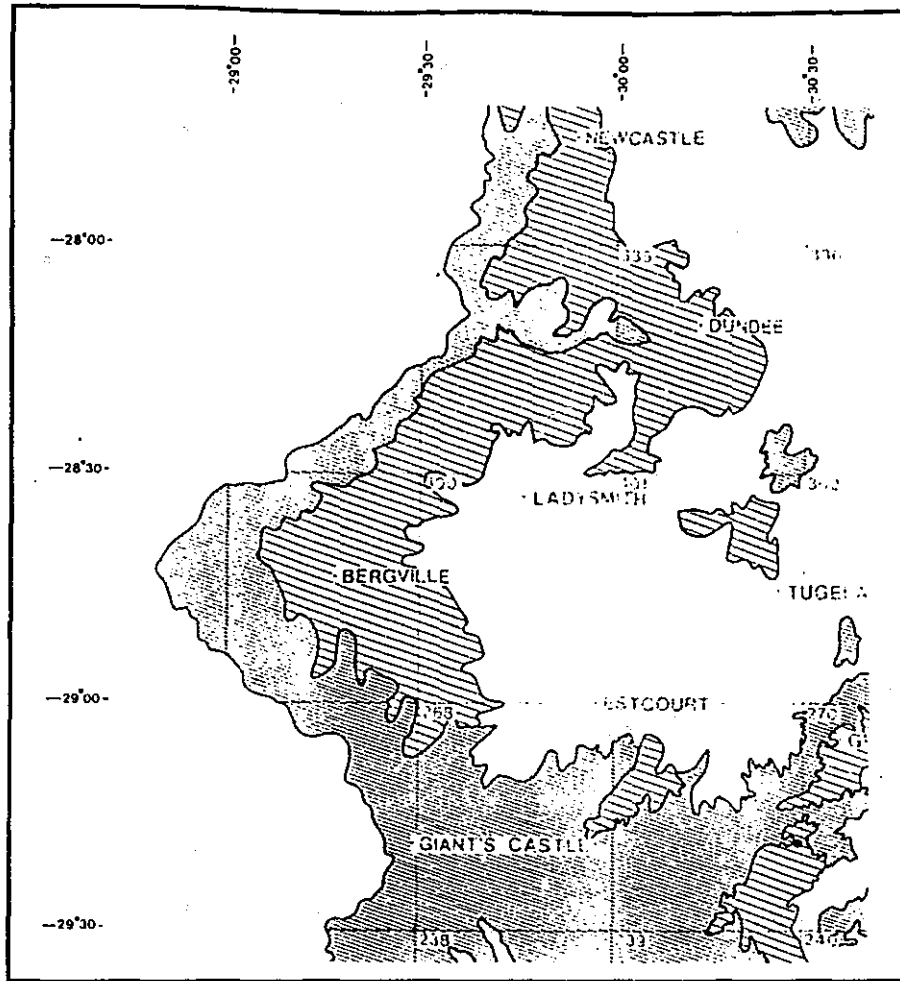


Figure 2.5 : Generalised soil potential of the study area (Schulze 1982).

TABLE 2.2: SOIL ZONES AND KEY SERIES FOR FIGURE 2.6

No.	Soil zones	Key series
1	Leached soils derived from Karoo rocks in the Highland Sourveld	Balmoral, Farningham, Doveton, Griffin, Clovelly, Mispah
3	Soils, many of which contain soft plinthite, derived from agrillaceous Karoo sediments.	Avalon, Southwold, Doveton, Shortlands
4	Soils, many of which contain soft or hard plinthite or a natric horizon, derived from arenaceous Karoo sediments	Leksand, Springfield, Dunbar, Klipfontein, Wasbank Uitvlugt, Wesselsnek, Longlands, Shortlands
5	Soils, most of which contains either plinthic or a natric horizon, derived from agrillaceous Karoo sediments in dry parts.	Avalon, Klipfontein, Estcourt, Shortlands
6	Sodic and calcareous soils derived from agrillaceous Karoo sediments	Estcourt, Arrochar, Bonheim, Rensburg, Arcadia
7	Sodic and calcareous soils derived from arenaceous Karoo sediments	Uitvlugt, Rensburg, Arcadia, Bonheim

2.4 Geology

At the time of the survey and synthesis, the geological map of the study area was not available. This information was obtained as digital data on a 1 : 1 000 000 scale at the Counsel of Geoscience (1997). The geological structure of the study area consists essentially of younger, predominantly sedimentary members of the Karoo system, resting upon a number of ancient, folded, intrusive and intensely metamorphosed formations of the Archaean Basement Complex (Edwards 1967). Geological formations present in the study area are indicated in Figure 2.7 and include the following:

- Vryheid Formation
- Karoo Dolerite
- Volksrust Formation
- Beaufort Group
- Tarkastad Sub-group
- Drakensberg Group.

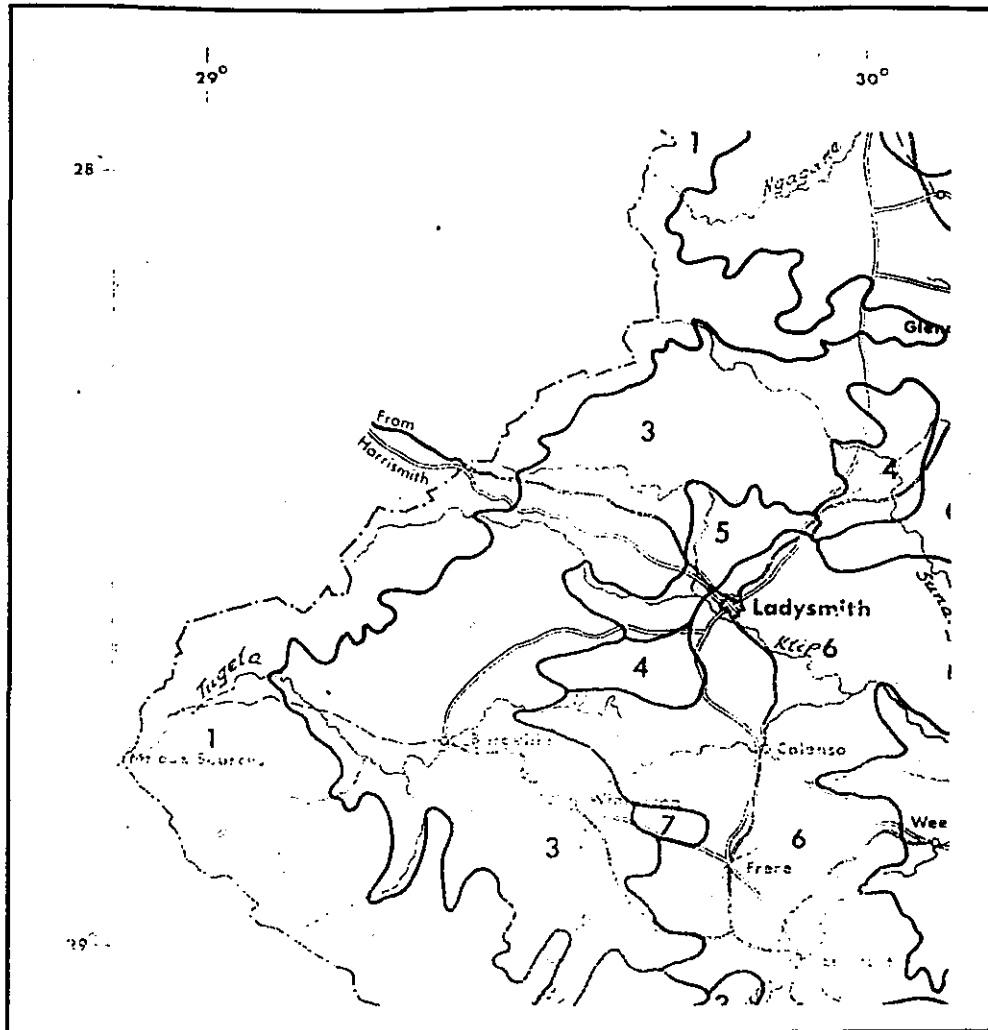


Figure 2.6 : Soil zone map of the study area and surrounding area (Phillips 1973)
(For explanation see Table 2.2).

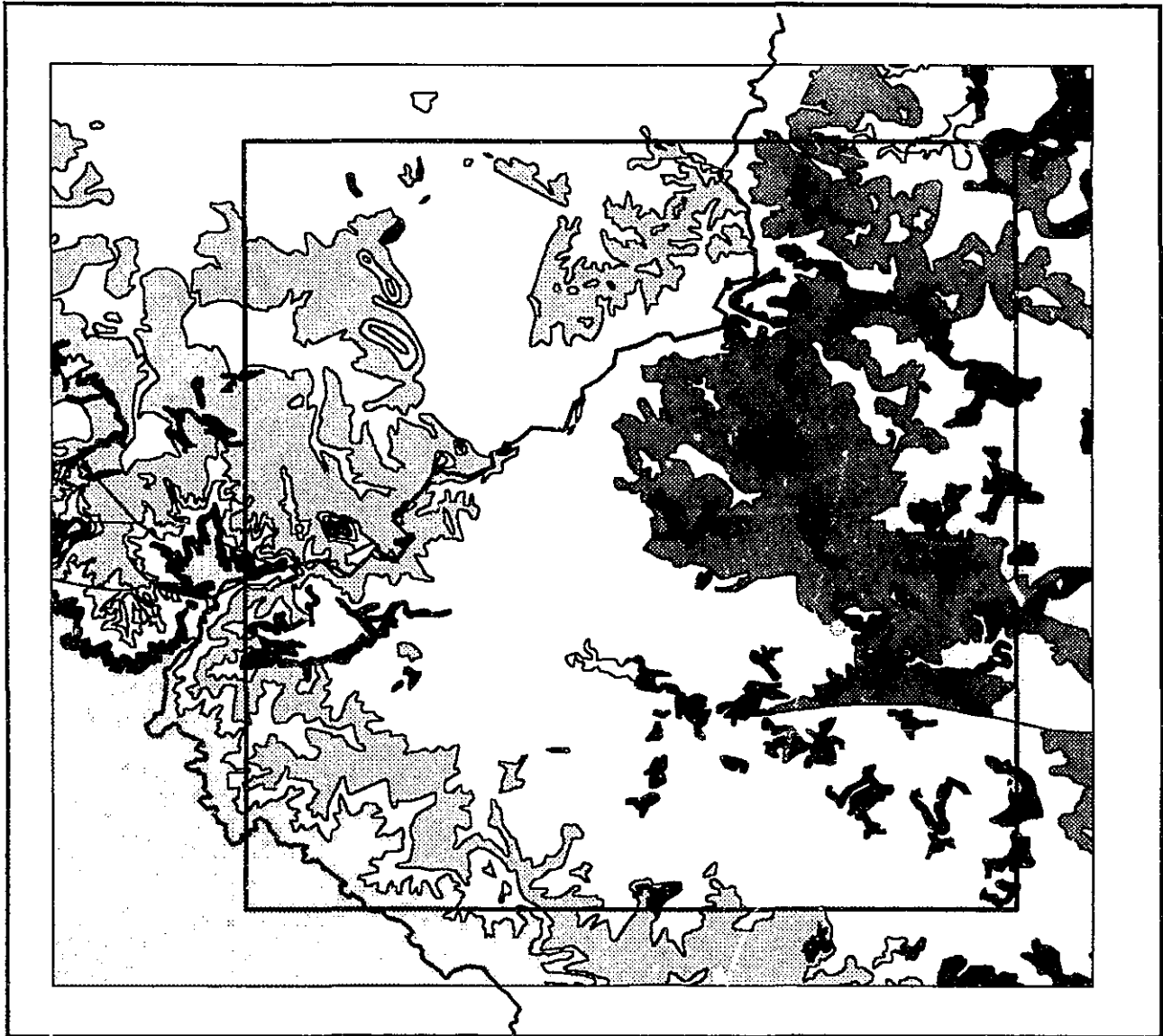


The dominant geological group in the study area is the Karoo Supergroup, comprising alternating bands of fine-grained sandstone, shale and mudstone that were deposited in the slowly subsiding Karoo Basin. The Karoo sedimentation was ended by an extrusion of the volcanic basalt lavas of the Drakensberg Group. At the same time the Karoo sedimentary rocks were intensively intruded by dykes, sills and inclined sheets of Dolerite (Johnson *et. al.* 1976).

The Karoo System occupies about half the area of South Africa and completely covers the study area. It is entirely of continental origin and is subdivided into the Dwyka-, Eccla-, Beaufort- and Stormberg series (Du Toit 1954, King 1972). The Eccla Series is exposed in two belts with the monocline between them. This series is subdivided into three groups. The dark blue to green Lower Eccla shales, resting evenly and sharply on the tillite formed as a periglacial deposit. The Middle Eccla Beds or Coal Measures are the dominant member of the series, covering the largest area, with the Upper Eccla being formed under lacustrine conditions.

- The Lower Eccla, also referred to as the Vryheid formation by SACS (1980), is a periglacial lacustrine deposit on Tillite (Dwyka) (Van der Eyk *et. al.* 1969). It occurs to the south of Newcastle in the Kilbarchan area (Visser & Bishopp, 1976). The shale is fine, laminated and uniformly bleached.

- The Middle Eccla beds are fluvial and deltaic deposits (Van der Eyk *et. al.* 1969), which, due to the presence of coal bearing seams, are referred to as "Coal Measures". According to Visser & Bishopp (1976), the greatest part of the sheet area lying below the Great Escarpment is occupied by Middle Eccla sediment with numerous dolerite intrusions. It consists mainly of sandstone that is of the Vryheid formation (Land Type Survey Staff 1990). The beds are thick, whitish to yellowish in colour, and fine to coarse grained. Micaceous and felspathic varieties are common, while sandstone alternate with softer micaceous flagstones and sandy shale layers.



- Ladysmith
 - Gridlines 28° - 29°S and 29° - 30°E
 - ▽ KwaZulu-Natal Boundary
- Geological Formations**

- Beaufort
- Clarens
- Drakensberg
- Karoo
- Karoo Dolerite
- Molteno
- ▨ Tarkastad
- ▩ Volksrust
- Vryheid



Figure 2.7: Geological map of the study area.

Conglomerate bands occur sporadic at or near the base (Van der Eyk *et. al.* 1969, Visser & Bishopp 1976). Most of the shale in which the coal seams occur is well-bedded (Visser & Bishopp 1976). These beds occur in the study area in the region referred to as the Plainlands. The thick upper sandstone layer of the lower transition zone is a prominent topographical feature (Visser & Bishopp 1976).

- The Upper Ecca Stage, termed the Volksrust Shale Formation by SACS (1980), was deposited under lacustrine conditions (Van der Eyk *et. al.* 1969). This formation forms a belt along the foothills of the Drakensberg and varies in width. The base of the Upper Ecca Stage is not well defined along the escarpment, due to the soft beds at the top of the Middle Ecca Stage (Visser & Bishopp 1976). The main constituent is blue-black to blue-grey shale, which weathers very easily. The weathered shale, and that bleached by intrusive dolerite, is buff or yellow.

The Beaufort Series was formed in the late perian to mid-triassic time period and rests upon Upper Ecca shales surrounding the Lesotho plateau. It occupies approximately 25% of the Tugela Basin and includes the Low Drakensberg (Van der Eyk *et. al.* 1969). Visser & Bishopp (1976) recognise three groups of this series.

- The Lower Beaufort Stage or the Adelaide Subgroup (SACS 1980) sediments form the greatest part of the Great Escarpment (Visser & Bishopp 1976). Prominent sandstone bands mark the contact between Lower Beaufort and Upper Ecca, provided it is not covered with scree. Arenaceous sediments, very similar to those of the Upper Ecca, predominate in the lower portion of the Lower Beaufort and form prominent cliffs and ledges.

Light coloured fine to medium-grained feldspathic sandstone bands with lenticular grid layers alternate with blueish or buff sandy shale or blue shale. Sandy, micaceous, poorly bedded shale and mudstone with some intercalated bands of sandstone constitute the rest of the Lower Beaufort Stage. The sandstone is easily observed in the landscape, while the

blueish to greenish grey and buff scaly strata weathers rather easily to sandy clays (Visser & Bishopp 1976). Thin bands of carbonaceous shale in which plant impressions occur are found in the coal seams.

- The Middle Beaufort Stage occurs west of the Great Escarpment at altitudes of approximately 2 000 m. It consists mainly of resistant sandstone with few scaly bands forming the capping of a dissected plateau. Characteristics of this sandstone are the grit layers and lavas that contain angular pieces of feldspar, pebbles and pieces of bone. Clay pellet conglomerate is commonly found with the grit, while small ferruginous partings give rise to lateritic material on bare weathered surfaces (Visser & Bishopp 1976).

- Only a few outliers of the Upper Beaufort Stage occur on secondary watersheds. It consists mainly of mudstone with a couple of thin bands of greenish, grey sandstone or sandy shale (Visser & Bishopp 1976).

The Stormberg Series consists of sediments overlain by volcanic lavas. The former was exposed in the great spurs protruding from the High Drakensberg and in isolated mesas nearby. Three groups of sediments are distinguished.

- The Molteno beds, following conformably upon the upper Beaufort, are dominated by coarse grained, felspathic, "glittering" sandstone.

- The Red beds are mainly formed by purple and red mudstone and shales.

- The Cave Sandstone is an extraordinary uniform rock, consisting of white, pale yellow or pink massive fine-grained sandstone made of rounded quartz grains. These sediments are mid- to late-Triassic in age whereas the Molteno and Red Beds were of fluvial and lacustrine origin, the cave sandstone formed from windblown sand, was probably of desert origin.

During the late-Triassic the Karoo sediments were crowned with the Stormberg lavas. These volcanic beds constitute the Lesotho plateau, bounding the Tugela Basin in the west.

Although exposed to weathering for some 100 million years, their thickness in the high Drakensberg is still 1 300 - 1 450 m. The lavas consist of a great number of evenly superposed flows, ranging in thickness from a few feet to over 50 m. The rock is brownish or purplish grey to black basalt, consisting of alternating compact and highly amygdaloidal varieties.

2.5 Climate

Van der Eyk *et. al.* (1969) describes the climate of KwaZulu-Natal as warm, temperate and rainy. The study area lies in the high rainfall area of South Africa (Weather Bureau, 1986). According to Köppen's classification the climate is mainly of the Cwb Type, a warm, temperate, rainy with markedly dry winters and warm summers (Köppen & Geiger 1936). Temperature and rainfall in the study area are greatly influenced by altitude and topographical ranges.

Climatological data were obtained from The Institute for Soil, Climate and Water (1994), and used in conjunction with certain maps from Schulze (1982). Rainfall and temperature data were only used when the station's credibility exceeded 75%. The Institute for Soil, Climate and Water divided the study area into 16 homogenous climate zones according to rainfall and temperature criteria.

Climatic diagrams for selected areas and climate zones are represented in Figure 2.8. Additional data for all the climate zones are available in Tables 2.3, 2.4 & 2.5 (The Institute for Soil, Climate and Water 1994).

2.5.1 Precipitation

Schulze and McGee (1978) considered water to be the most important climatic parameter that influences the gross features of the vegetation differences on earth. The reservoir of soil water available for plantlife is derived in the form of rainfall, fog, snow and hail.

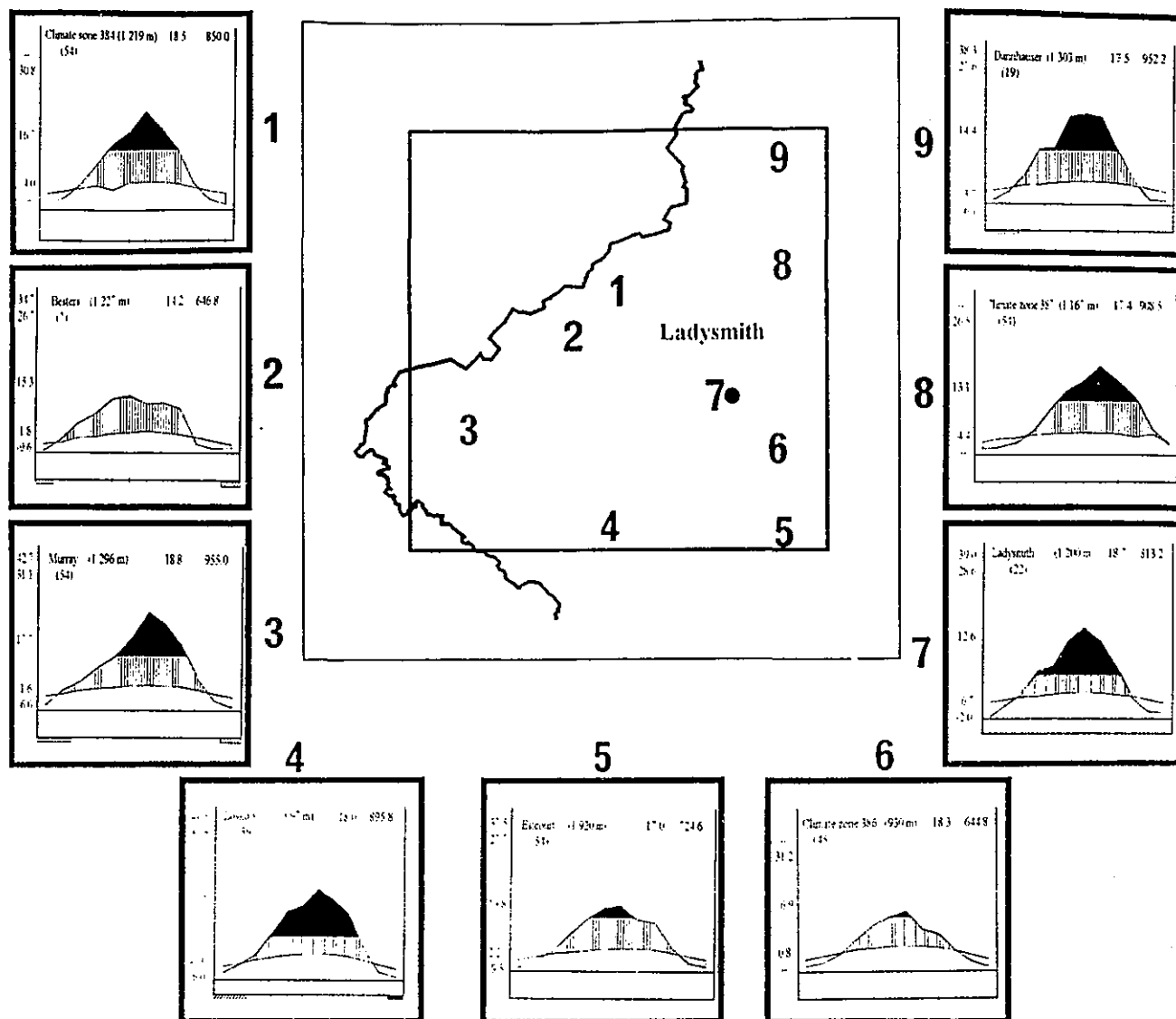
2.5.1.1 Rainfall

The mean annual precipitation (MAP) characterises the quantity of water that is available to a region in the long run. It therefore gives an upper limit to the agricultural potential of a region, if other factors are in no way limiting to growth (Van der Eyk *et. al.* 1969).

The study area lies in a summer rainfall area where part of the precipitation is of orographic origin, especially in the beginning of summer. Later in the season precipitation results from convectional instability (Van der Eyk *et. al.* 1969). The highest MAP recorded in the area is in the high Drakensberg at Cathedral Peak rainfall station (1 500 mm per annum). The mountain areas clearly receive a higher annual precipitation than the other areas, such as the Tugela Ferry rainfall station, where the lowest figure was recorded (650 mm). A distinct rainfall gradient can be observed, leading from west to east, from the high mountain areas to the low plains in the east.

The main growing season, according to Schulze (1982), starts as early as the beginning of October in the high mountain areas, but only as late as middle November in the Bergville area. The length of the moisture growing season, derived as the time between the beginning and the end of the moisture growing season varies, depending on the soil moisture balance of the area. For the greater part of the study area, the average time for the moisture growing season to start is the beginning of November. High rainfall areas correspond significantly with areas where the moisture growing season starts early, as well as areas with a long moisture growing season, like the mountain areas, despite being frequently exposed to frost. The growing season can be up to 250 days.

In certain areas of Natal, there is often a humid period, when precipitation exceeds evapotranspiration. When this period ends plants begin to draw upon moisture stored in the soil. The moisture growing season ends in the beginning of April in the drier parts of northern Natal around Dundee and Newcastle, while extending through June and July in the west of the study area. However, in these high elevation areas growth would probably cease earlier than June or July because of the incidence of frost.



LEGEND: (See example on right)

Twelve month period starts with July on left hand side. (a) Name of station; (b) Altitude (m); (c) Number of years of observation; (d) Mean annual temperature; (e) Mean annual precipitation (mm); (f) Mean daily minimum temperature of coldest month; (g) Absolute minimum temperature; (h) Mean daily maximum temperature of hottest month; (i) Absolute maximum temperature; (j) Mean range of temperature; (k) Curve of mean monthly temperature (1 unit = 10°C); (l) Curve of mean monthly precipitation (1 unit = 20mm); (m) Dry season; (n) Wet season; (o) Mean monthly precipitation over 100 mm per month; (q) Months with mean daily minimum temperature under 0°C; (r) Months with absolute daily minimum temperature under 0°C.

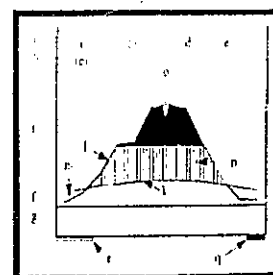


FIGURE 2.8 : CLIMATIC DIAGRAMS FOR SELECTED AREAS AND CLIMATE ZONES IN THE STUDY AREA.

2.5.1.2 Fog

Fog is an important ecological agent if taken into account that at the foothill of the Drakensberg, the orographic fog contribution is an additional 403 mm per annum, which is a third of the annual precipitation (Schulze & McGee 1978). Though fog often occurs in the mountain regions, this figure may be considerably less for the greater part of the study area. The coalescence of fog droplets on foliage and branches of trees leads to dripping on the ground and thus contributes to soil moisture (Deall *et. al.* 1989). Schulze & McGee (1978) stated that summer fog predominates in the summer rainfall areas, but the occurrence of winter fog in the early mornings in the low-lying basin plainlands is commonly observed. This fog is the result of cold-air drainage on calm winter nights (Deall *et. al.* 1989).

2.5.1.3 Snow

In South Africa snow occurs sporadically. Along the Drakensberg escarpment it falls mainly during May to August. The contribution of snow to soil moisture can therefore be regarded as minimal.

2.5.1.4 Hail

Convictional thunderstorms are often accompanied by hail, but does not contribute significantly to soil moisture. Its damaging effect on indigenous vegetation is also minimal. According to Tyson *et. al.* (1976), the Natal escarpment experiences more than 100 days on which thunderstorms are recorded and only eight on which hail is recorded. These numbers decrease with increasing distance from the Drakensberg, from which can be assumed that the occurrence of hail will be minimal in the greater part of the study area. The highest occurrence of hail is during November and December.

TABLE 2.3: INFORMATION FOR RAINFALL STATIONS IN THE STUDY AREA

Zone #	Years of data	Alt. (m.)	Lat / Long	M.A.P.	Station
360	23	1974	29° 00'S 29° 13'E	1510.8	Cathedral peak
371	41	1463	28° 57'S 29° 12'E	1300.0	Cathedral peak
372	73	1520	29° 10'S 29° 52'E	882.7	Lowland
375	53	1167	29° 01'S 29° 29'E	910.8	Heartsease
376	50	1280	28° 40'S 29° 02'E	998.6	Clifford Chamber
377	45	1130	28° 44'S 29° 21'E	740.9	Bergville
378	47	1220	28° 38'S 29° 27'E	707.8	Venterslaager
379	55	1768	28° 32'S 29° 00'E	766.3	Boschkloof
382	66	1769	27° 58'S 29° 08'E	694.5	Buckland Downs
383	49	1654	27° 28'S 29° 54'E	1006.1	Laingsnek
384	54	1219	28° 24'S 29° 37'E	850.0	Moorside
385	44	1158	28° 33'S 30° 25'E	762.9	Residence
386	45	594	28° 45'S 30° 27'E	644.8	Tugela Ferry
387	54	1167	28° 15'S 28° 58'E	908.5	Balbrogie
388	47	1295	28° 11'S 30° 09'E	794.5	Glencoe
526	53	1265	27° 46'S 30° 25'E	695.9	Waaioek

2.5.2 Temperature

Tables 2.4 & 2.5 give information for temperature figures in the different climate zones. According to Schulze & McGee (1978), temperature as such is not a significant factor in determining major regional differences in vegetation. It is however a basic climatological parameter, used as a control by which nature limits man's agricultural activities (Schulze 1982). What is important is the direct influence on water availability and thus temperature plays, on a meso- and microscale, a role in determining floristic variations.

It cannot be argued that temperature influences rate of plant growth and other physical processes, while certain plant mechanisms have adapted to seasonal and/or diurnal temperature fluctuations. Summer maxima and winter minima are regarded as more important in determining plant distribution (Schulze 1982, Schulze & McGee 1978)

Schulze (1982) pointed out that high and low temperatures are closely related to the physiographic divisions of Natal. According to this statement the low-lying areas will be characterised by higher temperatures, while the higher foothills and the high mountain areas will be characterised by relatively lower temperatures. Information regarding mean monthly maximum and minimum temperature data and temperature stations is given in Tables 2.4 & 2.5.

2.6. Vegetation

The veld types described by Acocks (1988) and vegetation types by Low and Rebelo (1996) are depicted in Figure 2.9 & 2.10 respectively. The main part of the study area is described by Acocks as Southern Tall Grassveld (#65), dominated by *Themeda* and *Hyparrhenia*. Altitude ranges from 600 to 1 350 m a.m.s.l., though below 1 050 m a.m.s.l. the veld is transitional to Valley Bushveld (#23).

Two variations are recognised in the Southern Tall Grassveld, namely Open Thornveld and Scrub Forest, both of which occur in the study area. The Open Thornveld is an open savanna of *Acacia sieberiana* in sourish mixed grassveld with patches of *Hyparrhenia* species. Erodible subsoil is present with shallow topsoil, causing severe erosion in some areas. Hillside and the deeper valleys have an *Acacia caffra* savanna, which is marginal to the Valley Bushveld. This savanna appears to be natural, but is slowly spreading up the valleys. The Scrub Forest is dominated by woody species and is present throughout the study area.

The Natal Sour Sandveld (Acocks #66) is present on poorly drained, shallow, sandy soils. It is generally a very open savanna of *Acacia sieberiana* in a poor sourveld. The Scrub Forest of the hills is similar to that of the Southern Tall Grassveld, but rather more tropical. Granger (1996) described both these veld types as Natal Central Bushveld (#25), an open savanna with scattered *Acacia sieberiana* trees, a variable herbaceous layer and secondary grassland. Granger (1996) concluded that this vegetation type is highly transformed and poorly conserved and because of intensive grazing and fire, it requires careful management.

TABLE 2.4: GENERAL INFORMATION FOR TEMPERATURE STATIONS IN STUDY AREA

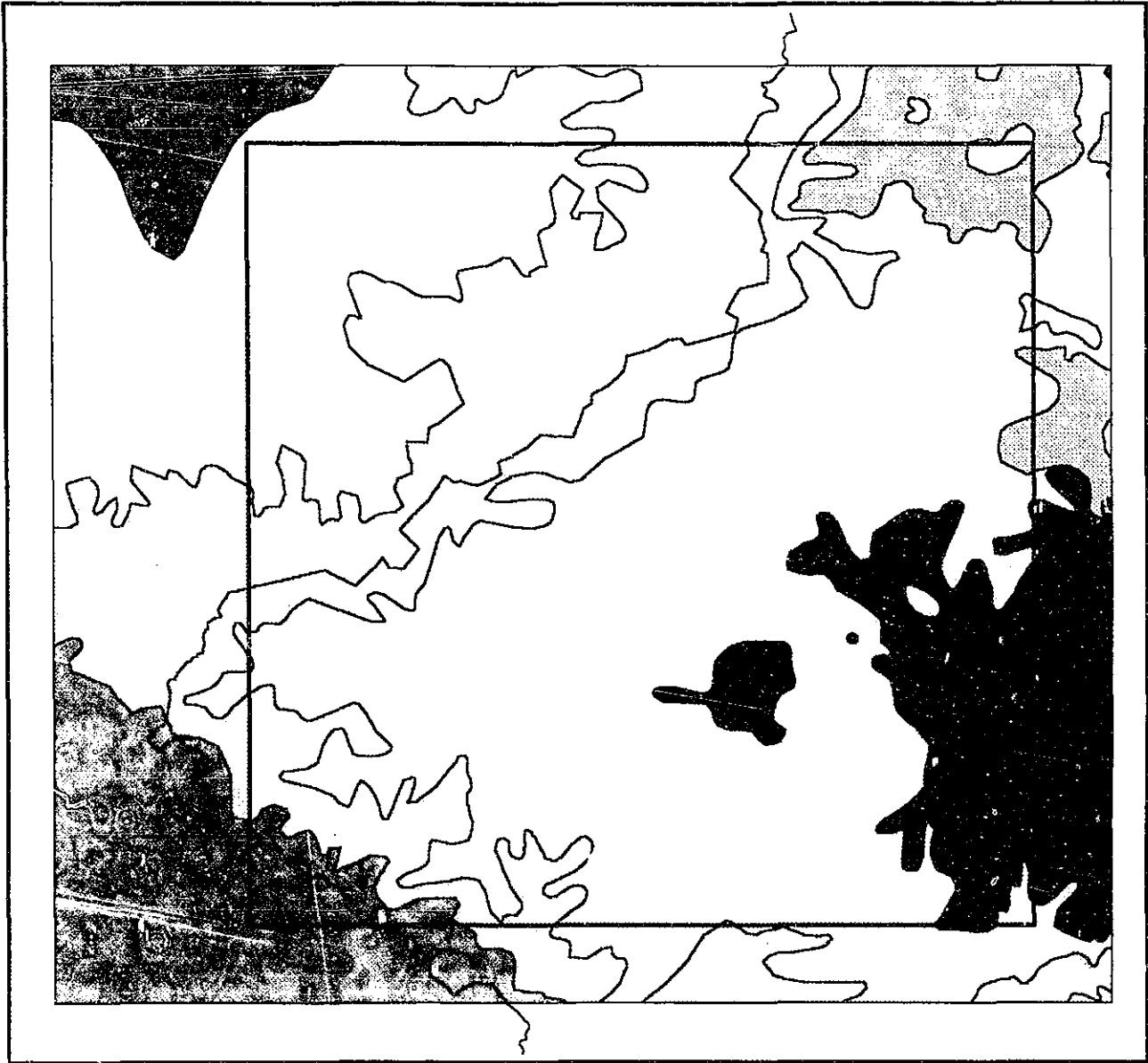
Zone		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
360	Max	21.4	21.1	20.5	18.9	16.6	14.5	14.6	16.9	19.6	20.0	20.3	21.3
	Min	12.6	12.5	11.9	9.5	7.5	5.4	5.0	6.3	8.1	9.2	10.3	11.8
371	Max	25.9	25.5	24.3	21.9	20.4	18.4	18.8	19.8	22.8	22.4	24.7	25.3
	Min	14.1	4.2	13.0	9.6	6.2	3.5	3.8	5.4	8.7	9.8	11.7	13.2
372	Max	25.9	6.5	5.2	2.6	21.3	19.5	20.0	22.0	25.1	23.8	23.9	26.5
	Min	13.1	3.2	10.8	7.0	1.7	-2.2	-2.4	0.0	5.5	9.7	10.5	11.9
375	Max	32.1	3.1	0.8	8.6	26.1	23.4	23.8	25.6	27.0	29.2	31.0	32.3
	Min	15.3	5.4	13.1	9.2	4.5	0.2	0.7	4.2	8.0	11.1	13.0	14.6
376	Max	30.7	30.8	8.5	6.5	24.1	22.2	22.5	24.9	7.1	28.3	30.0	31.6
	Min	15.5	5.8	14.4	0.7	6.7	4.2	4.0	6.7	8.8	12.2	13.3	14.8
377	Max	30.6	1.2	0.3	28.9	26.7	24.8	25.2	26.8	7.9	29.8	30.4	31.4
	Min	14.9	15.4	3.4	9.3	3.3	0.6	0.4	3.1	7.2	10.7	12.4	14.1
378	Max	30.7	30.8	8.5	6.5	24.1	22.2	22.5	24.9	7.1	28.3	30.0	31.6
	Min	15.5	5.8	4.4	0.7	6.7	4.2	4.0	6.7	8.8	12.2	13.3	14.8
379	Max	26.5	4.7	25.1	21.3	18.2	16.2	16.5	18.4	3.0	24.1	24.4	26.7
	Min	13.0	1.8	10.7	6.4	3.7	1.2	2.0	2.4	4.3	7.8	9.3	11.6
382	Max	24.3	23.3	21.6	9.9	14.0	14.1	14.1	17.1	9.7	22.2	22.6	24.0
	Min	11.4	1.0	10.0	7.0	1.0	0.7	0.7	2.4	4.9	8.1	9.3	10.7
383	Max	24.5	4.0	23.2	1.5	19.0	16.4	16.4	19.1	1.4	23.1	23.0	24.4
	Min	11.6	10.9	9.4	5.4	1.2	-2.2	-2.1	0.9	4.4	8.3	9.5	11.1
384	Max	30.7	0.8	8.5	6.5	24.1	22.2	22.5	24.9	7.1	28.3	30.0	31.6
	Min	15.5	15.8	4.4	0.7	6.7	4.2	4.0	6.7	8.8	12.2	13.3	14.8
385	Max	29.6	9.2	27.5	25.9	23.0	20.7	20.9	23.8	6.4	27.3	28.8	29.7
	Min	16.9	6.6	15.2	1.7	6.4	3.1	2.9	6.6	10.3	13.1	14.7	16.1
386	Max	31.2	0.2	29.0	7.0	24.2	21.3	21.0	23.9	26.3	28.1	28.9	30.4
	Min	16.2	6.1	4.8	0.8	5.2	0.8	0.8	4.2	7.9	12.2	14.2	15.8
387	Max	26.5	25.6	5.6	3.4	21.8	18.3	18.2	21.1	1.6	24.3	25.5	26.3
	Min	15.4	15.0	14.1	0.4	7.7	4.7	4.4	8.1	9.3	11.7	13.9	14.3
388	Max	27.5	27.0	5.6	4.4	22.0	19.5	19.6	22.4	24.6	26.1	26.6	27.4
	Min	14.8	14.7	3.3	10.0	5.8	2.4	2.4	5.2	8.2	11.6	12.8	14.0
526	Max	29.1	29.4	28.4	26.2	23.1	20.3	20.6	23.7	6.0	26.4	28.7	29.6
	Min	16.1	6.4	4.8	11.5	7.8	4.3	4.8	7.4	0.8	12.3	14.4	15.9

The Valley Bushveld (Acocks #23) is described as the vegetation that occurs in numerous river valleys draining into the Indian Ocean. These valleys are hot and receive less rain than the intervening ridges. In this dense bush there is less undergrowth and it includes few of the veld grasses and none in an important role, though shade grasses are plentiful. Lubke (1996) described this vegetation as the Valley Thickets (#5), vegetation with a closed canopy of dominant evergreen woody species up to six meter in height. These Thickets are invasive into savanna and grassland. A number of large reserves conserve these thickets, but they are under threat at locations where there is intensive, poorly managed farming.

TABLE 2.5: MEAN MONTHLY MAXIMUM AND MINIMUM TEMPERATURES FOR CLIMATE ZONES

Zone #	Alt. (m.)	Lat / Long	Station
360	1871	28° 59'S 29° 14'E	Cathedral Peak
371	1463	28° 57'S 29° 14'E	Cathedral Peak
327	1477	29° 23'S 29° 53'E	Aberdeen Angus S
375	1143	28° 55'S 29° 28'E	Athur's Seat
376	1200	28° 42'S 29° 14'E	Killarny, Bergville
377	1121	28° 24'S 29° 19'E	Avondale, Bergville
378	1200	28° 42'S 29° 14'E	Killarny, Bergville
379	1646	28° 10'S 28° 43'E	Rietkuil
382	1829	28° 17'S 29° 11'E	Harrismith (Bos)
383	1773	27° 21'S 30° 09'E	Wakkerstroom
384	1200	28° 42'S 29° 14'E	Killarny, Bergville
385	1060	28° 33'S 29° 47'E	Ladysmith (Con)
386	854	28° 51'S 30° 05'E	Weenen (TNK)
387	1402	28° 12'S 29° 58'E	Balbrogie
388	1247	28° 10'S 30° 14'E	Dundee
526	1257	27° 59'S 30° 01'E	Broadfields

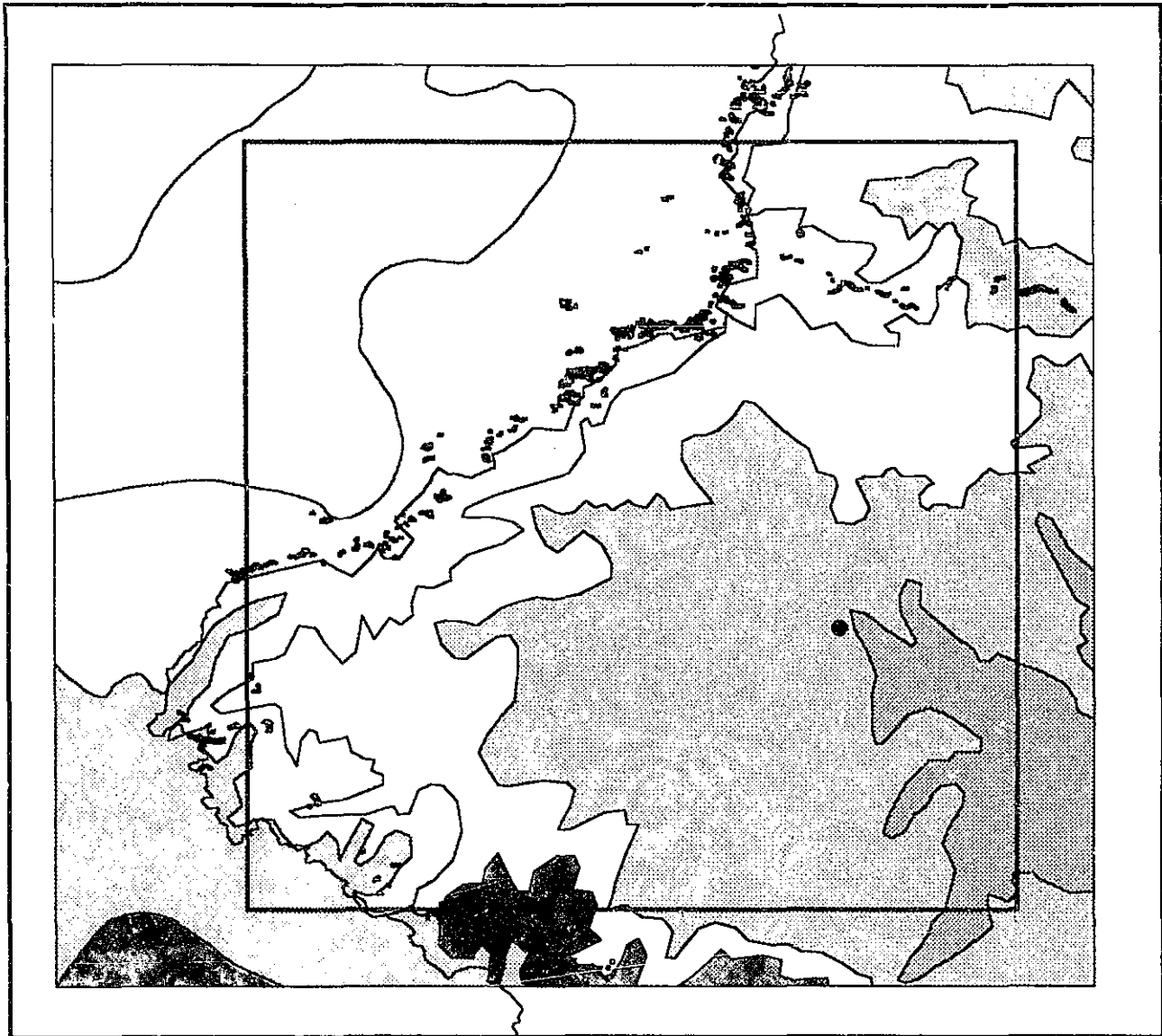
The Highland Sourveld and Dohne Sourveld (Acocks #44a & b) is the vegetation of the Drakensberg extending over the top of the escarpment. Forest and Sourveld variations are recognised. The forests are dominated by evergreen woody species like *Podocarpus* and *Leucosidea*. The Grassveld, which is presumed to replace these Forests is, in the more level parts, a pure grassveld, with some shrubiness on the mountain slopes. Grazing easily degrades the veld. Low and Rebelo (1996) divided this vegetation type into Wet Cold Highveld Grassland (Bredenkamp et. al. 1996a) (#41) and the Moist Upland Grassland (Bredenkamp et. al. 1996b) (#42), separated by altitude. Elements of the Afromontane Forests (Lubke & McKenzie 1996) (#2) are also included.



- Ladysmith
- Gridlines 28° - 29°S and 29° - 30°E
- ⚡ KwaZulu-Natal Boundary
- Acocks Veld Types**
- Cymbopogon - Themeda Veld (Sandy) (#48)
- Highland Sourveld and Dohne Sourveld (#44)
- Highland Sourveld to Cymbopogon - Themeda Transition (Eastern Free State Highveld) (#49)
- Natal Sour Sandveld (#66)
- Southern Tall Grassveld (#65)
- Themeda Veld to Cymbopogon - Themeda Veld Transition (Patchy) (#53)
- Themeda - Festuca Alpine Veld (#58)
- Valley Bushveld (#23)



Figure 2.9: Distribution of Acocks Veld Types in the study area and surrounding areas.



- Ladysmith
- Gridlines 28° - 29°S and 29° - 30°E
- ▬ KwaZulu-Natal Boundary
- Low and Rebelo Vegetation Types**
- Afromontane Forest (#2)
- ▨ Valley Thickets (#5)
- ▩ Natal Central Bushveld (#25)
- Moist Cool Highveld Grassland (#39)
- Moist Cold Highveld Grassland (#40)
- Wet Cold Highveld Grassland (#41)
- ▨ Moist Upland Grassland (#42)
- North-eastern Mountain Grassland (#43)
- ▨ Afro Mountain Grassland (#45)
- Alti Mountain Grassland (#46)



Figure 2.10: Distribution of the Low and Rebelo Vegetation Types in the study area and surrounding areas.

At altitude of higher than 1 750 m a.m.s.l., the Wet Cold Highveld Grassland (Bredenkamp *et. al.* 1996a) (#41) is present in the study area. Structurally this is classified as grassland, but a woody layer may form dense thickets in places. Occasional snow and frequent burning have a major influence on the vegetation. This veld type is well conserved in the Golden Gate National Park, though severe erosion can be observed in places.

The *Themeda - Festuca* Alpine Veld (Acocks #58) is present on the Drakensberg at altitude ranging from 1 850 to 2 150 m a.m.s.l. It is a short, dense grassveld, varying from sweet to mixed, dominated by *Themeda* with an admixture of the usual grassveld species. A form of fynbos is a natural part of this vegetation, especially on the eastern side of the Drakensberg. Elements of this Veld Type are present in three vegetation types described by Low and Rebelo (1996), namely South-eastern Mountain Grassland (Lubke *et. al.* 1996) (#44), Afro Mountain Grassland (Granger & Bredenkamp 1996a) (#45) and Alti Mountain Grassland (Granger & Bredenkamp 1996b) (#46).