LAND TRANSFORMATION IN THE KARKLOOF CATCHMENT BETWEEN 1944 AND 1999: TOWARDS A DATABASE FOR FUTURE PLANNING.

By

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ABSTRACT

Land transformation in the Karkloof Catchment (KwaZulu-Natal, South Africa) between 1944 and 1999 was examined. No research had previously been undertaken to quantify and obtain an understanding of these changes and their effect on the landscape. The study provides a valuable spatial and descriptive database, which could assist in future planning and in an improved management of the catchment. Land category maps and associated databases for 1944 and 1999 were produced by interpreting 1944 and 1996 aerial photographs and using a Geographical Information System (GIS). Land management changes were established primarily by interviews with land-owners. Property ownership and extent were ascertained and mapped in GIS by utilising and adapting existing GIS databases, by interviews with land-owners, and by undertaking title deed searches and by analysis of property Grant outlines and diagrams. Natural grasslands have decreased significantly, being lost mostly to exotic afforestation and marginally to commercial cultivation. Forest and woodland have increased marginally, as has exotic vegetation. Subsistence cultivation has been reduced significantly with very little being undertaken in 1999. Farm dams have increased in number and size. Extraction of indigenous timber from the Karkloof Forest has ceased. Soil erosion, which was detremined by summing the surface area of soil erosion gullies (bare soil area), has decreased. Property numbers have increased, whilst property sizes have decreased. Ownership has moved away from the predominantly 'Private Individual' ownership category towards 'Private Companies and Trusts' and towards large corporate companies. Reduction in farm size has contributed to maximisation of land use, which has often impacted negatively on natural resources. Land-owners are however becoming more environmentally conscious. More sustainable farming methods are being practised. Catchment management bodies have been established. Traditional land use types such as agriculture are slowly declining, whilst recreational, residential and tourism ventures are on the increase. Demand for land and its products will continue to increase and more pressure will be exerted on natural resources. Ways to live with nature, sensitively balancing development against the environment will need to be found. Recommendations have been made regarding the further application of the study, particularly the GIS database, catchment management bodies and integrated catchment management, property size and land use types. Various conservation recommendations are also given.

PREFACE

The work described in this dissertation was carried out in the Centre for Environment and Development, School of Applied Environmental Sciences, University of Natal, Pietermaritzburg, from August 1997 to March 2000. The work was undertaken on a part-time basis, under the supervision of Drs J. E. Granger and T. R. Hill, School of Applied Environmental Sciences. The format adopted for this dissertation is a departure from the conventional style, in that the literature review forms part of the discussion. This has been done intentionally, in order to lead the reader into each section, with the necessary background provided.

These studies represent original work by the author and have not otherwise been submitted in any form, in part or in whole, for any degree or diploma to any other University. Where use has been made of work by others this is duly acknowledged in the text.

Signed:.....

V.D. Weyer

17 March 2000

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There are many persons and institutions without whose help this study would not have been possible and to whom I am indebted for guidance and assistance: the land-owners of the Karkloof Catchment, particularly those interviewed (Appendix 7. (p.142)) who freely gave of their time and knowledge; the Wildlife and Environment Society of Southern Africa, particularly Keith Cooper and Richard Hunt for their encouragement and support; Kelson Camp of the KwaZulu-Natal Department of Agriculture, Natural Resources Section, Cedara for providing information on Bioresource Units, which related to the climate of the catchment; Shaun Moodley of the Computing Centre for Water Research (CCWR), Pietermaritzburg, who provided additional rainfall and temperature data; the staff at the Surveyor-General's office in Pietermaritzburg, particularly in the Deeds and Map Counter offices, who provided assistance with tracing property ownership and size in 1944; the iNdlovu Regional Council, Geographical Information Systems Department, who provided many of the GIS databases that were used as base and background information to the study (Appendix 6. (p.141)); Toni Bodington, (Cartographic Unit, Department of Geography, University of Natal, Pietermaritzburg), who compiled the location of the study area map; Sue Davies who proof read the final document; my two supervisors, Drs J.E. Granger and T.R. Hill for their valuable input into the study as well as their guidance and support throughout; Jon Marshall of Environmental Planning and Design, for his support since the start of the project in 1997 and for the use of his computer equipment (scanner, digitizer, CD writer and colour printer) which was selflessly made available whenever required.

Lastly, my family who have had to endure much over the duration of the project and especially my husband Mark, who has offered generous support throughout.

CHAPTER 1: INTRODUCTION

1.1. THE IMPORTANCE OF LAND AND ITS TRANSFORMATION

Most people live on the land, from the land and with the land. Land has always been a source of minerals, fertilisers and non-renewable energy; an influence on climate; a source of fresh water; a source of biodiversity; a source of food, fibre, agricultural and forestry products, and renewable energy; a biological system for recycling waste; a living and working space for man, meeting also recreational and infra-structural needs and requirements (Friedheim & Kassam 1994). Land as an entity is generally finite, while the natural resources it supports can vary over time according to management conditions and uses (Olembo 1994). Turner & Meyer (1994) recognise that human actions rather than natural forces are the source of most contemporary change in the states and flows of the biosphere. For much of human time, the modification of the earth by human actions involved mainly impacts on the soil and biotic resources central to the agricultural base. Land transformation did not abate, but rather accelerated and diversified with the onset of the Industrial Revolution, the globalisation of the world economy, and the expansion of population and technological capacity.

Fresco (1994) states that the forces driving change of land use are complex and act at various scales with differential rates of change. Turner & Meyer (1994) predict that the global demand for the products of the land is likely to continue accelerating, and that the capacity of the land, and of the environment more generally to sustain that demand will remain an issue of fundamental importance. Environmental change does not necessarily mean environmental degradation but changes in the land have often been perceived as improvements by some or all land users. Studies of land transformation are essential to understanding why changes have occurred, projecting future changes, evaluating the available resource base and the demand placed on it and in assessing the consequence of change on the environment.

1.2. DEFINITION OF LAND TRANSFORMATION

Turner & Meyer (1994) divide land transformation into two linked components: those of land use and land cover change. The term 'land use' denotes the human employment of land. Land use change may involve either a shift to a different use or an intensification of an existing one.

Examples of land use types identified in this study include 'Exotic Vegetation - Managed', 'Exotic Vegetation - Wild', 'Exotic Vegetation - Human Habitation', 'Cultivation - Commercial', 'Cultivation - Subsistence', quarry, farm dams, buildings and main roads. 'Land cover', a concern principally of the environmental sciences, denotes the physical state of the land. It embraces the quality and type of surface vegetation, of water and of earth materials. Land cover types identified in this study include forest, woodland and grassland. Land cover changes fall into two types, conversion and modification. The former is a change from one class of land cover to another. The latter is a change in condition within a land cover category, such as the thinning of a forest or a change in its composition. Land use and land cover are interconnected, influencing one another. For the purpose of this study, the term, 'land categories' has been used to represent both land use and land cover. Changes in land management have been identified and have been discussed separately, although such changes are linked to and affect land use and land cover. This was necessary for describing and distinguishing between spatially mapped changes and descriptive changes. Ownership and extent of properties have been investigated, as it was felt that this would have had a strong correlation and influence on land categories and land management.

1.3. IMPORTANCE OF THE KARKLOOF CATCHMENT

Water is a scarce and unevenly distributed national resource (Anon. 1998). Increasing water demands, reductions in water yield and deteriorating water quality are amongst the most pressing environmental issues facing the people of South Africa (Anon. 1996a). The need for the integrated management of all aspects of water resources and where appropriate, the delegation of management functions to a regional or catchment level is acknowledged (Anon. 1998). Based on the dominant types of problems, water use and sub-catchment characteristics, the Department of Water Affairs and Forestry and Umgeni Water recognises the Mgeni Catchment as comprising six sub-catchment Management Units (Anon. 1996a). These Management Units are: Midmar, Albert Falls, Nagle, Henley-Pietermaritzburg, Valley of a Thousand Hills and Durban. The Karkloof Catchment falls within the Albert Falls Management Unit (Figure 1.1. (p.4)).

The Mgeni Catchment is one of the most developed catchments in South Africa, providing water to over 3.5 million people and supporting an area which is responsible for approximately 65% of the total economic production in KwaZulu-Natal (Anon. 1996a). The Mgeni Catchment supplies a total naturalised incremental Mean Annual Runoff of 732 million m^3 per year, where naturalised incremental Mean Annual Runoff is referred to by Anon. (1996a) as the total water available from that Management Unit under pristine conditions, not including the inflow from any upstream Management Units. The Albert Falls Catchment supplies 125 million m^3 of this per year. This is 17% of the total for the Mgeni Catchment. The Albert Falls Catchment is 726 km^2 in extent, while the Karkloof Catchment, as delineated in this study, covers 383 km^2. Thus, the Karkloof Catchment's contribution to the naturalised incremental Mean Annual Runoff of the Albert Falls Catchment and subsequently the Mgeni Catchment is likely to be considerable.

Apart from the importance of the Karkloof Catchment in supplying water, it is an important farming area of KwaZulu-Natal. Soils with a high cropping potential occur extensively throughout and mean annual rainfall is high and reliable (777 mm to 1152 mm). The catchment is thus well suited to cultivation of a variety of crops, to dairy farming and to timber production. The area is highly valued in terms of its natural habitats and the ability of these to support a large number and variety of flora and fauna (K. Cooper, 1999, pers. comm.). Of particular importance is the Karkloof Forest. Moll (1976) states that the Karkloof Forest and adjacent grassland would be a suitable representative area to the vegetation type, 'Mistbelt Themeda-Aristida Grassland and Podocarpus Forest'. Cooper (1985) states that by far the most important private forest for conservation in the 'Mist-Belt Mixed Podocarpus Forest' category in KwaZulu-Natal, is the Karkloof Forest. The natural vegetation and the rural farming activities impart a high visual quality and unique character to the landscape, which attracts visitors to the area. Consequently in recent years there has been an increase in tourism ventures and the development of small-holdings as independent country residences, share-block weekend second homes, and country guest houses and restuarants. Examples of these include Mbona Estate, Thistledown Country House, Leopard's Bush Nature Reserve, Yarrow small-holdings and Halliwell developments. These developments have contributed to the area aquiring many of the characteristics for which the Midlands Meander of KwaZulu-Natal has become well known, and as a result the major road network has subsequently become incorporated as the eastern sector of the Midlands Meander route (Appendix 1. (p.136)).

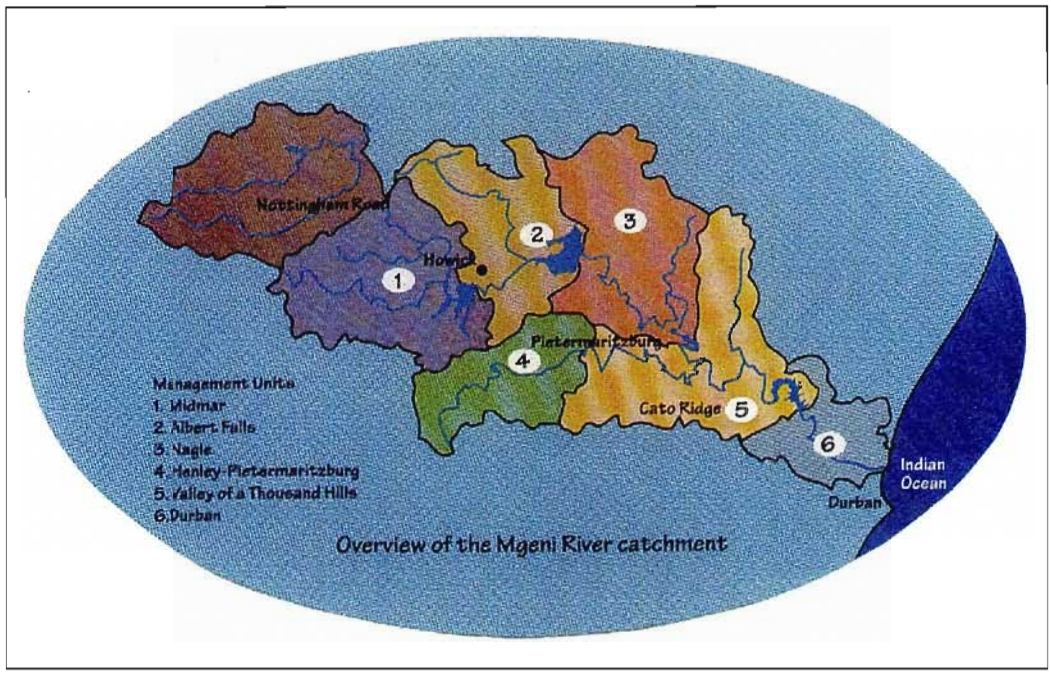

Figure 1.1. The Six Sub-catchment Management Units of the Mgeni Catchment (Anon. 1996b)

1.4. OBJECTIVES OF THE STUDY

Between 1944 and 1999 land within the Karkloof Catchment has been transformed profoundly by man's activities. Although land transformation also occurred prior to 1944, transformation was only examined between 1944 and 1999 as these years are closest to when the earliest (1944) and latest (1996) aerial photographs of the entire catchment were flown. No research has previously been undertaken to quantify and obtain an understanding of these changes and their effect on the landscape. With the need to optimise land use and the increased pressure being placed on natural resources, future planning and improved catchment management has become paramount. This study provides valuable baseline information and an insight into the past and present state and functioning of the catchment. Such information could provide a valuable tool, which could assist in improved management and the formulation of future land use plans for the catchment.

The five objectives of the study were:

1. To provide a biophysical description of the Karkloof Catchment, an historical overview and an examination of integrated catchment management. This was essential to provide background information for understanding the dynamics of the catchment as well as land transformation.

2. To quantify land transformation, which included changes in land categories, land management, property ownership and extent. Of particular importance was the loss of natural grasslands to exotic afforestation. It has been estimated that well over 90% of Acocks's (1988) Veld Type, 'Natal Mistbelt Ngongoni Veld (45)', into which category the grasslands of the Karkloof Catchment fall, have been transformed, with 0.3% protected (Proclaimed Protected Areas) (Scott-Shaw 1999).

3. To provide an understanding of **why** significant changes identified have taken place and the consequences of these changes.

4. To make recommendations on **how** the catchment may be used and managed in the future so as to attain improved catchment functioning and a balance between development and the natural environment.

5. To provide a database, which would include: a) a spatial Geographical Information System (GIS) component, showing mapped land categories and their associated attribute data tables, which contain information on the nature of the mapped land categories; and b) a text component, which describes land transformation. The GIS component is intended to be dynamic in that it makes provision for additional detail to be supplemented to it and it may be used for further analysis and research. Such a database could be used by conservation and catchment management bodies such as the Karkloof Conservancy and Karkloof Catchment Management Forum for future planning and catchment management. Such information would be valuable in formulating future land use plans for the area.

CHAPTER 2: BIOPHYSICAL DESCRIPTION OF THE KARKLOOF CATCHMENT

2.1. LOCALITY AND EXTENT

The Karkloof Catchment is located north of Pietermaritzburg in the Province of KwaZulu-Natal, South Africa (Figure 2.1. (p.7)). Delineation of the catchment boundary from orthophotographs revealed that the catchment is 383 km^2 in extent. It is situated to the north-west of the Albert Falls Dam. It extends from six kilometres outside of Howick north to Mount West / Nottingham Road interchange on the N2 freeway. The old Curry's Post road which runs parallel and is two kilometres to the east of the N2 forms the western boundary of the catchment. The catchment lies between $29^0$14'S $30^0$03'E and $29^0$28'S $30^0$22'E and falls within the iNdlovu Regional Council. The boundary is located along watersheds of the Karkloof River, and its tributaries the Kusane and Mholweni and associated streams (Figure 2.2. (p.8)). The catchment commences at the junction of the Karkloof and Mgeni River, three kilometres upstream of the Albert Falls Dam.

2.2. TOPOGRAPHY

KwaZulu-Natal is bordered on the west by the Drakensberg escarpment and on the east by the Indian Ocean. The country descends from the Drakensberg to the sea in a series of distinct terraces, separated from each other by scarps, most of which face east or south-east (Rycroft 1942). The Karkloof Catchment is located on one of these terraces and is bounded by a scarp to the north. This scarp forms the Karkloof Range (Plate 1. (p.31)), which rises from the Karkloof Valley at an altitude of approximately 1100 m* to 1670 m on the plateau. At 1767 m Mount Gilboa forms the highest peak on the scarp. The Karkloof Range is part of a range of hills, which can be traced from Giant's Castle through Spion Kop, ending at the Blinkwater (Rycroft 1942). The range forms the main watershed of the area. The Karkloof River and its two tributaries, the Kusane and Mholweni, dissect the topography. Steep sided river valleys are created towards the south and north of the catchment, above the junction of the Karkloof and Mgeni Rivers and in the vicinity of the Sappi Forests (Pty) Ltd. property, 'De Magtenburg' and the farm, 'Sherwood'.

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* Altitudes are given as values above mean sea level

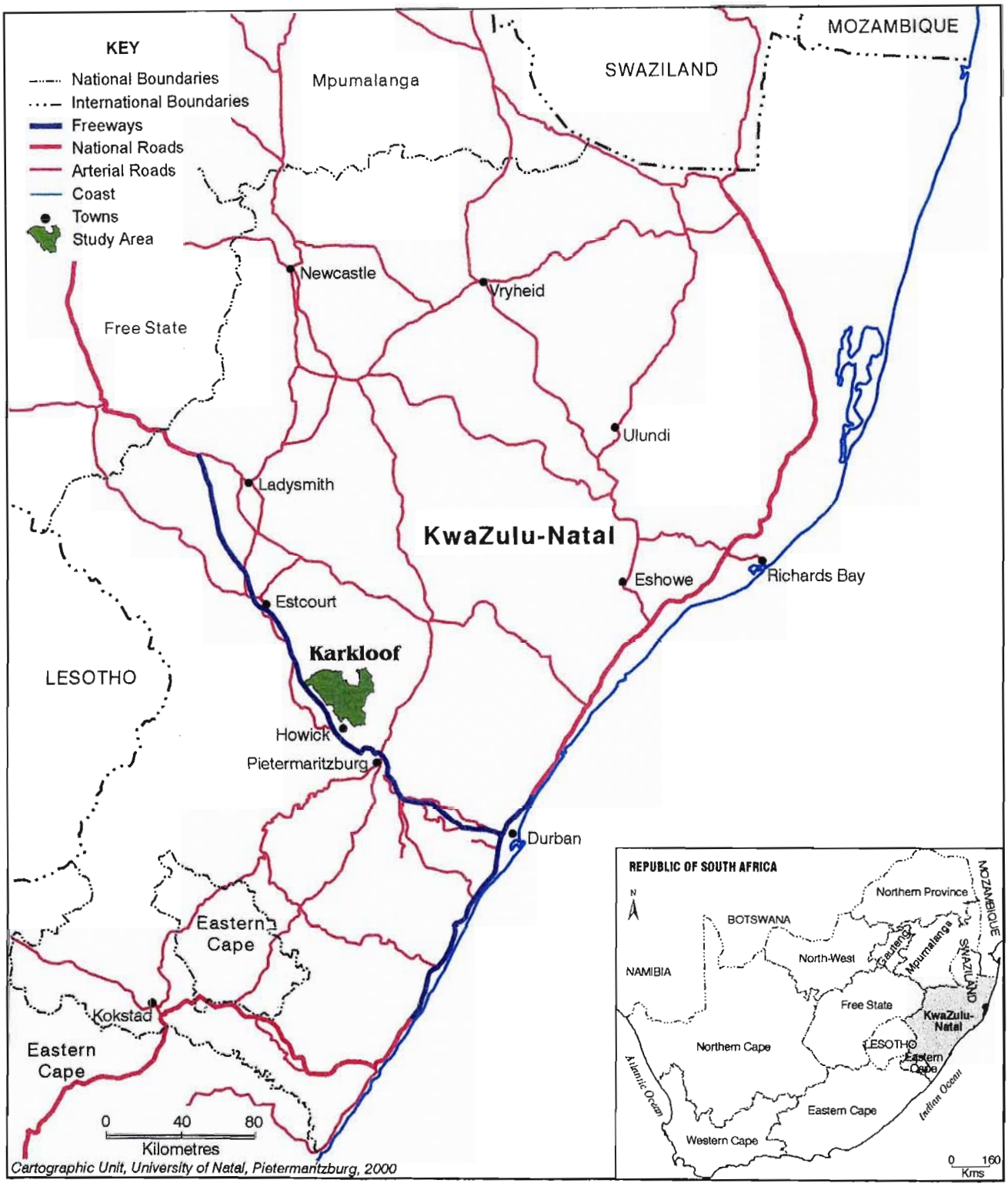
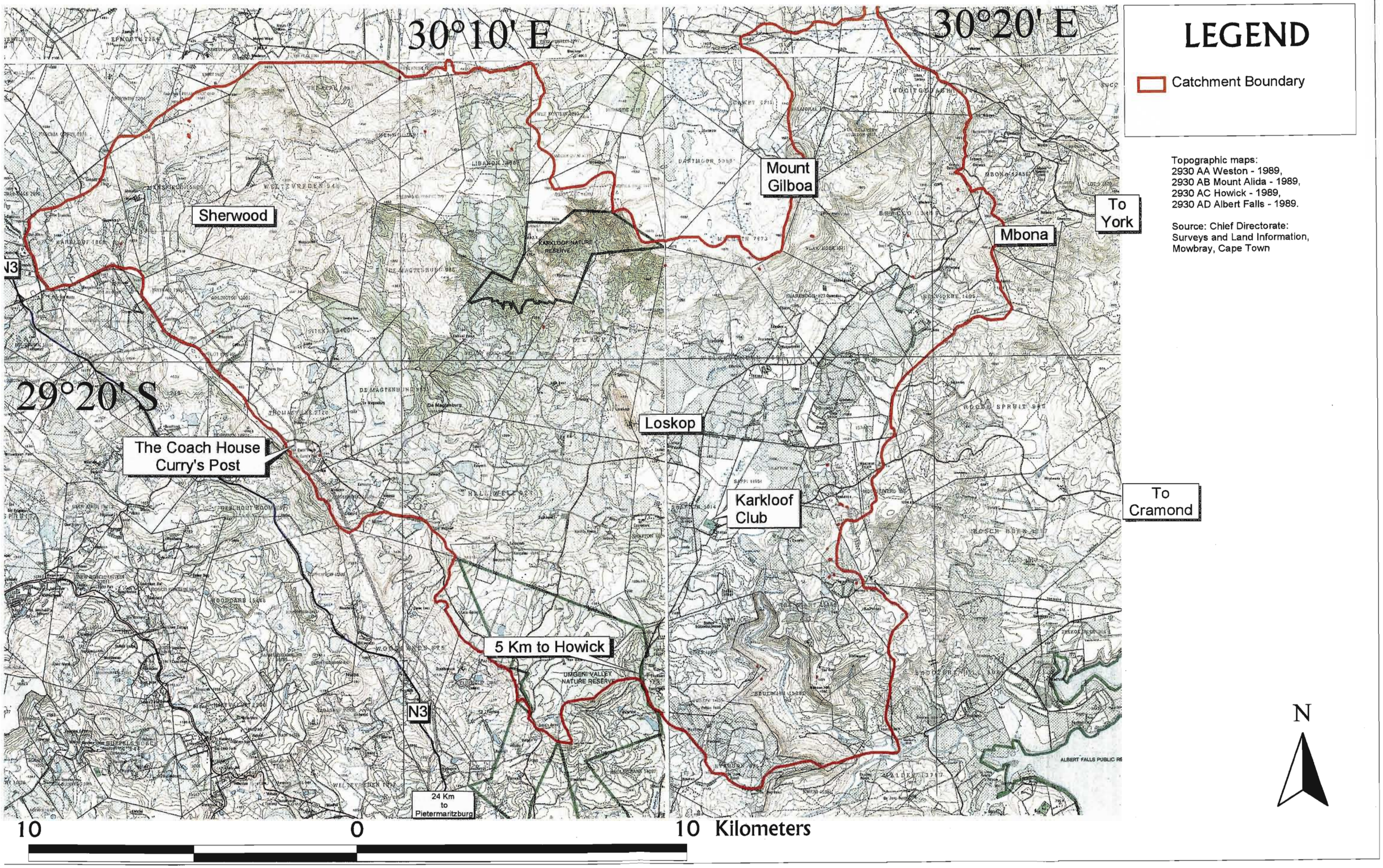


Figure 2.1. Location of the Study Area



igure 2.2. Boundaries of the Study Area

Topography is flat to gently rolling in the central reaches, particularly in the Karkloof Valley, close to the Karkloof Club and toward the west around the Tetworth area. Altitude in the Karkloof Valley is approximately 1100 m and rises to 1291 m toward Tetworth. Altitude increases gradually to the west, from an altitude of 1100 m to 1394 m at Curry's Post, and 1546 m at The Wold's in the extreme west. An isolated steep-sided rock outcrop, known as Loskop (Plate 2. (p.31)), occurs in the centre of the catchment. This dolerite sill has a north-west, south-east orientation and rises from an altitude of 1100 m to a small plateau of 1431 m. Contours defining the fundamental topographic features of the study area are shown in Figure 2.3. Topography of the Karkloof Catchment (p.10).

2.3. PRINCIPAL RIVER SYSTEMS

The Karkloof Catchment contains the Karkloof River and its two tributaries the Kusane (Plate 3. (p.32)) and Mholweni. These flow predominantly from north to south across the catchment. The Mholweni tributary starts in the north-east and joins the Karkloof River in the vicinity of Yarrow. The Kusane tributary rises in the west and joins with the Karkloof River in the vicinity of the Karkloof Club. The Karkloof River dominates the catchment, originating towards the north-west and flowing towards the south (Figure 2.4. (p.10)). The Karkloof River forms a steep river valley towards the west. This river valley branches towards the west and east in its upper extremity to form two smaller river valleys. As the topography becomes flatter towards the centre of the catchment, the Karkloof River and its Kusane tributary meander across the valley forming numerous wetlands and ox-bow lakes. Several waterfalls occur namely: the famous Karkloof Falls, located at the head of the valley to the south; Grey Mare's Tail, located to the north-east of the Karkloof Range and Horsetail Falls located to the north of the Karkloof Range. These waterfalls have formed as a result of underlying dolerite outcrops and Middle Ecca sandstone which offer greater resistance to erosion than various other rocks present (Rycroft 1942). The catchment is a closed entity being bounded by watersheds to the north, west and east. The Karkloof River flows out of the catchment to the south and flows into the Mgeni River, which then flows into the Albert Falls Dam.

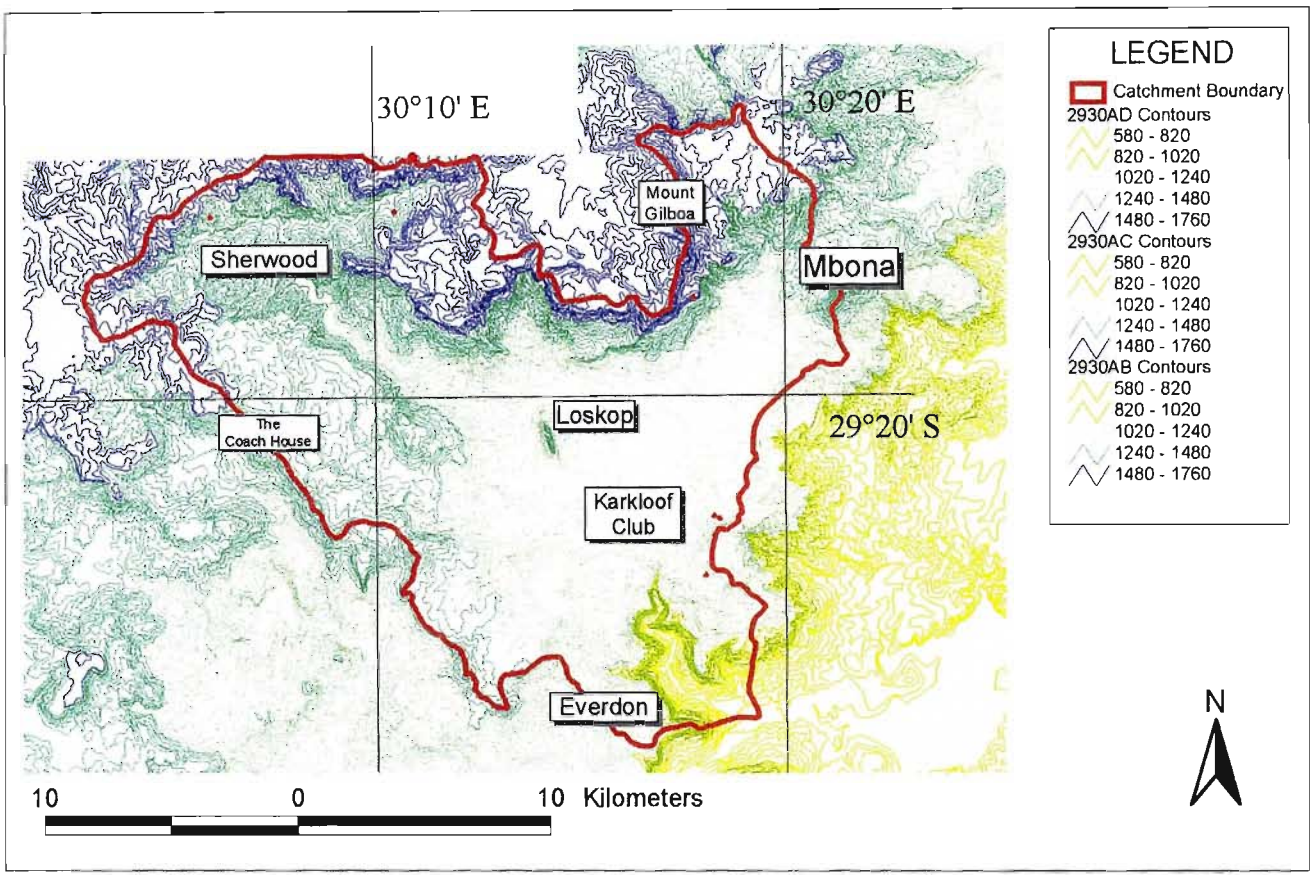


Figure 2.3. Topography of the Karkloof Catchment (contours shown in meters above mean sea level)

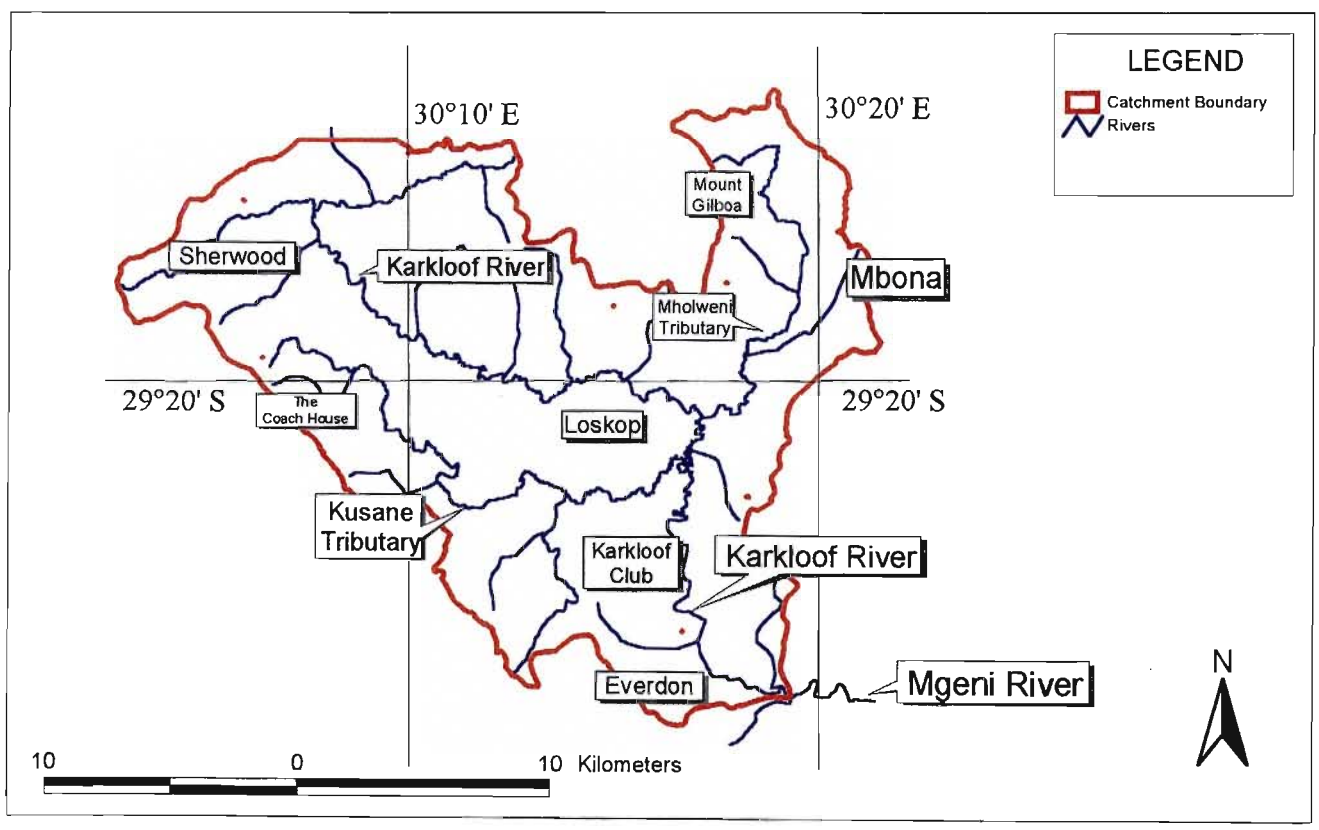


Figure 2.4. Principal River Systems of the Karkloof Catchment

2.4. GEOLOGY AND SOILS

According to Visser (1989) the geology of the Karkloof Catchment consists of horizontally-bedded sandstones, shales and mudstones belonging to the Beaufort and Ecca Series of the Upper Karroo System. Most of the Upper Karroo System has been intruded by dolerite dykes and sills. The Ecca Series occupies the majority of the catchment, whilst the Beaufort Series occurs mainly to the north and north-west. The rocks of the Ecca Series consist of blue and grey shales and sandstones. Resting on the Ecca Series are the mudstones, shales and sandstones of the Beaufort Series and these are generally purplish-red.

Scotney (1970) produced detailed soil maps at a scale of 1:50 000 for the Howick Extension Area. Soils were described mostly to the soil series level and these were then grouped into soil associations. MacVicar *et al.* (1977) later described a binomial system for soil classification in South Africa. This system employed two levels of classes, an upper or general level containing soil forms, and a lower, more specific one containing soil series. Most of the soil series described by Scotney (1970) were included and many of his soil associations fell within a common soil form. The binomial system for soil classification in South Africa was later revised to include in the classification only those classes which, on the whole, satisfactorily accommodate similar, naturally occurring, more or less uniform soil bodies (polypedons), and to exclude arbitrarily chosen classes (mainly texture) which continually cause uniform soil bodies to be split artificially by class boundaries (MacVicar *et al.* 1991). The soil series of the first edition, particularly those defined on the basis of texture, made up the majority of these arbitrary classes. Because of this, and because the information needed to define soil series classes to accommodate similar, more or less uniform soil bodies was not generally available, the 'series' category was omitted from the second edition. Instead the 'family', a category higher than the 'series' has become the lowest category. Notwithstanding the 'modernisation' of the classification system for South African soils since 1970, the soils of the Karkloof Catchment have been described within this dissertation according to Scotney (1970). This is because Scotney (1970): (1) included the Karkloof Catchment within his study area; (2) produced maps at a detailed scale; (3) described not just soil series, but rather associations of soil series, which often fell within a common soil form of MacVicar *et al.* (1977); and (4) he provided detailed explanations of soil association use-suitability and limitations.

Where the soil associations coincided with a soil form of MacVicar *et al.* (1977), the soil form's name has been included in parenthesis. Often the soil association comprises two soil forms, in which case both soil form names are given. These soil associations, miscellaneous land types, and their use-suitability and limitations are as follows:

1. 'A1 Balmoral-Farningham' association (Hutton form (MacVicar *et al.* (1977)) and 'B1 Farmhill-Griffin-Clovelly'association (Griffin and Clovelly form (MacVicar *et al.* (1977)). These are stable soils of very high potential for intensive arable use. They are suitable for a wide range of cash and fodder crops, vegetables, pastures, afforestation and supplementary irrigation. They are very low in plant nutrient status. The 'A1 Balmoral-Farningham' association occurs in isolated pockets mainly to the west of the catchment along the Karkloof River, whilst the 'B1 Farmhill-Griffin-Clovelly' association occurs extensively in the central flat areas of the catchment.

2. Cleveland soil series, belonging to the 'B2 Cleveland-Oatdale' association (Griffin and Clovelly form (MacVicar *et al.* (1977)). The series with adequate protection and corrective fertiliser treatment has moderate to high potential for arable use. It is suitable for a wide range of crops, afforestation and supplementary irrigation. It has a very low nutrient status, high erosion hazard especially on steep slopes and is prone to rapid structural degradation and loss of organic matter as a result of continued arable use. The 'B2 Cleveland-Oatdale' association occurs in isolated pockets on the hill slopes of the Karkloof River Valley, below the Karkloof Falls.

3. Oatdale soil series, belonging to the 'B2 Cleveland-Oatdale' association (Griffin and Clovelly form (MacVicar *et al.* (1977)). The series has low to moderate potential for arable use provided protection and corrective fertiliser treatment is adequate. It is suitable for trees and limited supplementary irrigation. It has very low nutrient status and shallow depths result in higher erosion hazard and lower availability moisture capacity than the Cleveland soil series.

4. 'C1 Katspruit-Dell' association (Katspruit form (MacVicar *et al.* (1977)). This association is unsuitable for arable use but may be used for the production of permanent pastures, preferably under sprinkler irrigation. It has very poor drainage, a potentially very high erosion hazard, unfavourable physical characteristics and compaction occurs under intensive grazing. 'C1 Katspruit-Dell' association occurs along minor riparian areas.

5. Alluvium (clayey) which belongs to the soil association, 'L1 River Alluvium', has limited potential for intensive arable use, but has potential for pasture and Poplar production, provided it has effective drainage. It has poor drainage, periodic flooding, mechanical limitations, silt deposition on fodder crops, the presence of *Moraea* spp. (Tulp), which are toxic to livestock if eaten, and is difficult to work when wet. 'L1 River Alluvium' association occurs along all major riparian areas.

6. Alluvium (sandy) which belongs to the soil association 'L1 River Alluvium' has moderately high potential for arable use for eg. Lucern, high producing pastures, vegetables and Poplars especially if irrigated. It is subject to excessive drainage, low available moisture capacity, occasional flooding and occurrence of weeds.

7. Alluvium (loamy) which belongs to the soil association, 'L1 River Alluvium', has high potential for intensive arable use, is well suited to a wide range of crops, pastures, intensive vegetable production, lucern, Poplars and irrigation. 'L1 River Alluvium' is subject to periodic flooding and the occurrence of *Moraea* spp.

8. The miscellaneous land type, 'M Hilly, steep and / or stony land' is generally regarded as non-arable and of low agricultural potential. It occurs extensively to the west and south-east of the catchment, along the Karkloof River Valley and above and below the Karkloof Forest or wherever topography is steep and rugged.

9. The miscellaneous land type, 'MF Indigenous Podocarpus Forests' has soils of very mixed origin which vary considerably in texture and depth. Outcrops of dolerite, Ecca and Beaufort sandstone are common. Forest soils reflect a lower degree of leaching than the adjacent grassland and are inherently more fertile than those of surrounding areas. 'MF Indigenous Podocarpus Forests' occurs along the extent of the Karkloof Forest.

All the associations, apart from 'L1 River Alluvium' are described as occurring in landscapes characterised by highly leached soils. 'L1 River Alluvium' and the miscellaneous land types occur in all landscapes.

Scotney (1970) states that, the highest agricultural potential for a wide range of crop, pasture and tree species lies with the highly leached soils despite their low inherent fertility.

2.5. CLIMATE

The Bioresource Programme of the Natural Resource Section of the KwaZulu-Natal, Department of Agriculture, at Cedara has mapped and described KwaZulu-Natal at three levels, which from the largest to the smallest are: the Bioresource Group (BRG), Bioresource Unit (BRU) and Ecotypes (Camp 1999a). These provide valuable information on the natural resources of an area. The BRU is of importance to the Karkloof Catchment, as rainfall and temperature of the catchment are described for the BRU. The BRUs of the Karkloof Catchment include: Vd4, Wd14, Wd9, Yd23, Zc6, Yd22, Yc11, VWb2, Yb8 and Vb12 (Figure 2.5. (p.15)).

2.5.1. Precipitation

Precipitation refers to rainfall, mist, hail and snow. These are discussed separately as follows:

1. Rainfall

Mean annual and mean monthly rainfall figures are given in climate tables for each BRU. The figures were determined in the following way: where rainfall stations were available, the initial rainfall data for a BRU were assigned from the best station available. In the absence of any stations, the average of the Computing Centre for Water Research (CCWR) 1' by 1' gridded mean annual rainfall within a BRU, was allocated. In areas where an abundance of stations with long records was available, the mean of the gridded mean annual precipitation values within a BRU was sometimes chosen as a representative average (Camp 1998). Table 2.1. (p.16) shows a summary of the mean annual and mean monthly rainfall figures for the BRUs of the catchment. The mean annual rainfall figures for the BRUs are illustrated in Figure 2.6. (p.15). As the source of the data varied, no calculations were made on the standard deviation, variance of the data and the number of years represented by the data for each BRU (K. Camp, 1999b, pers. comm.). In addition, data from two meteorological stations have been provided (Table 2.2. (p. 17)). This allows comparison and serves to provide some confidence in the validity of the BRU's data. The station, Hancock J Howick is located within BRU Zc6, whilst the station, Warren JAR Howick is located within BRU Yc11. Rainfall figures from both sources show little difference from one another.

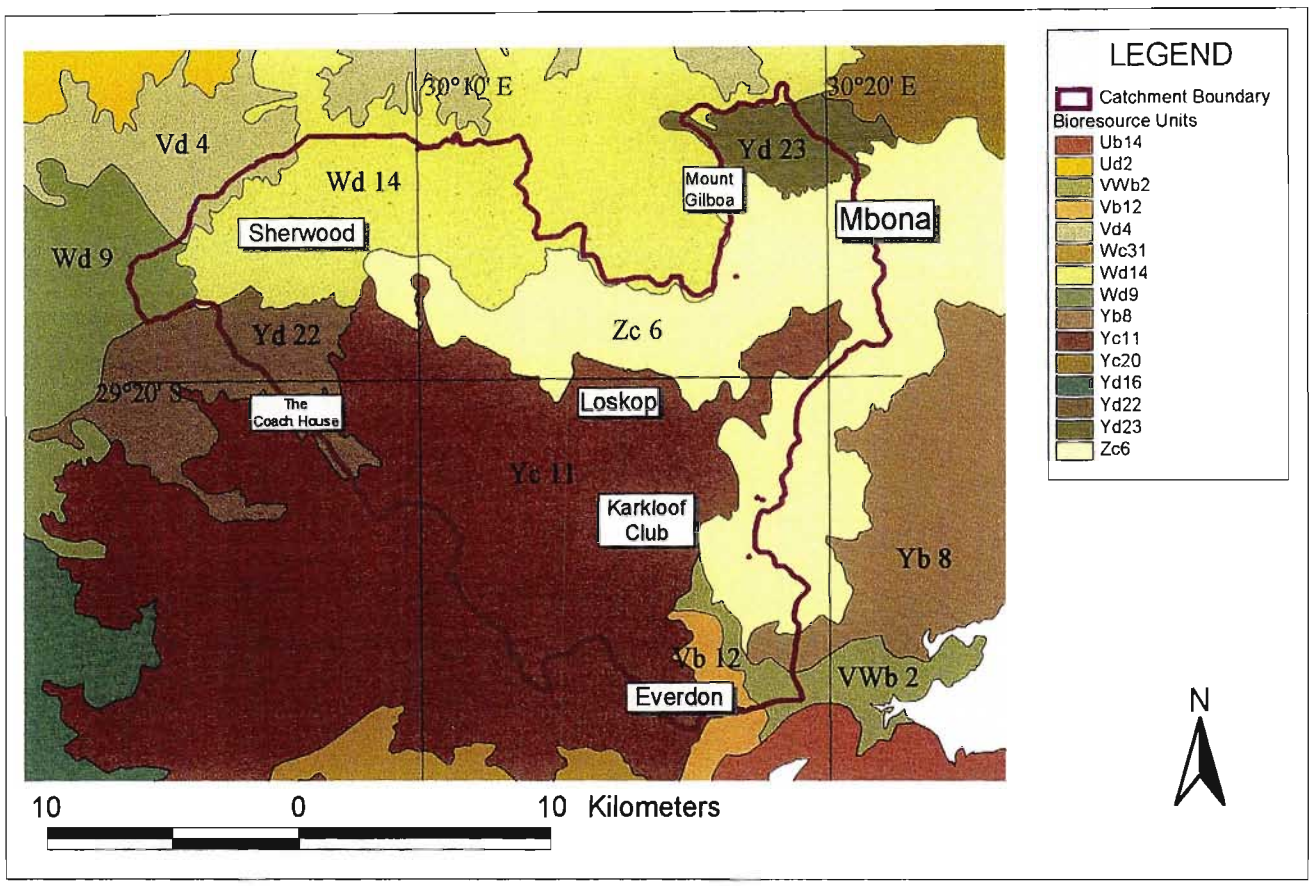


Figure 2.5. Bioresource Units of the Karkloof Catchment (Camp 1998)

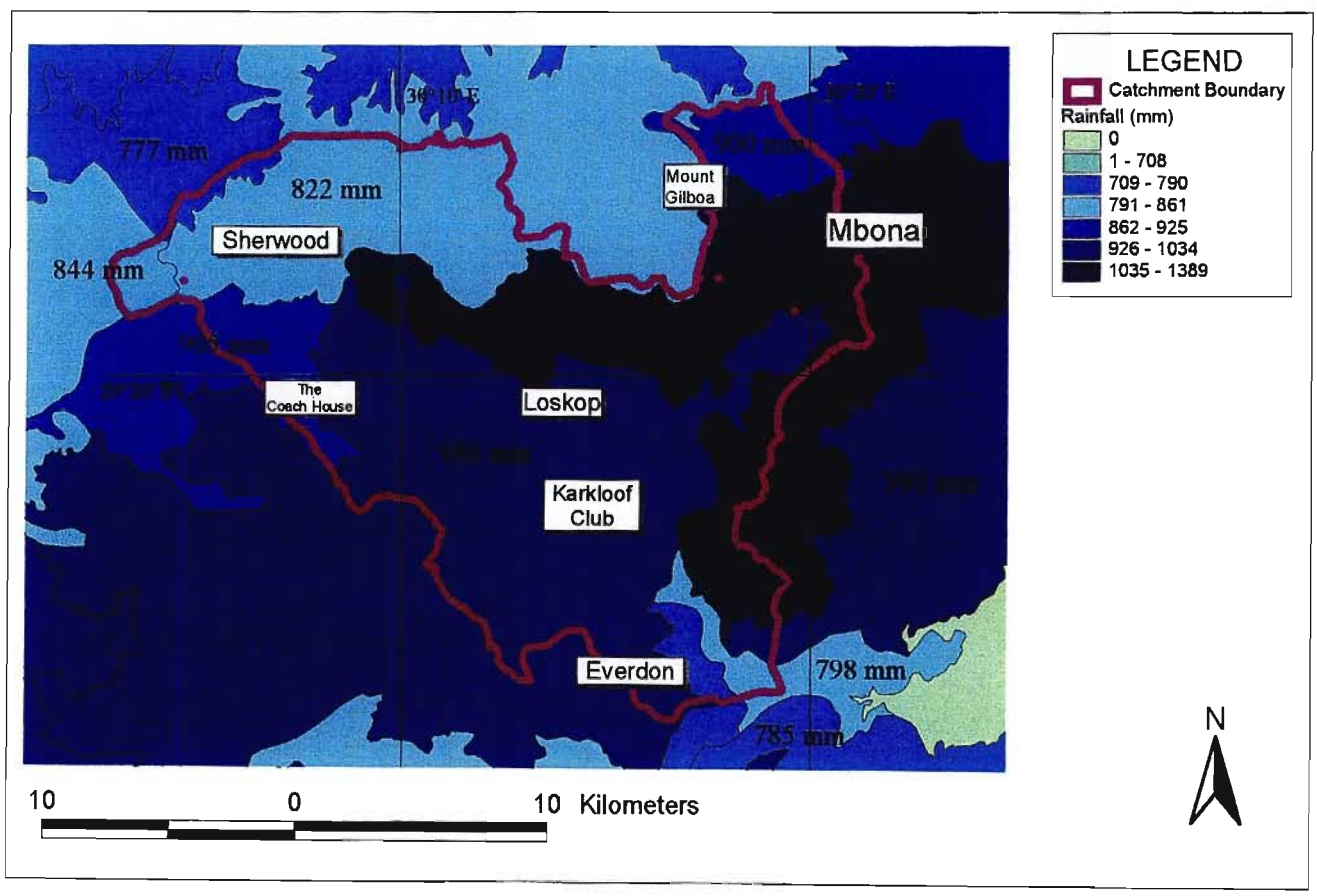


Figure 2.6. Pattern of Mean Annual Rainfall (mm) in the Karkloof Catchment (Camp 1998)

Table 2.1. Summary of Rainfall Data for the Bioresource Units of the Karkloof Catchment

BRU	Mean Annual (mm)	Mean Monthly (mm)											
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Wd14 - Sherwood	822	140	114	107	40	18	8	9	28	55	86	92	125
Wd9 - Nottingham Road	843	148	111	103	35	20	9	10	32	68	83	99	125
Yd22 - Curry's Post	905	152	134	112	54	22	11	12	29	45	78	114	142
Zc6 - Karkloof Forest	1153	184	165	144	69	29	16	18	36	70	110	143	169
Yc11 - Lidgetton	985	115	139	120	65	30	14	16	29	53	91	122	151
Yd23 - Gilboa	902	144	129	113	54	23	13	14	28	55	86	111	132
Vb12 - Howick Falls	786	119	123	96	53	23	12	17	21	40	67	87	128
VWb2 - Morton's Drift	798	121	125	98	54	23	12	17	21	41	68	88	130
Vd4 - Mount West	778	126	119	101	47	22	9	12	19	39	67	98	119
Yb8 - Albert Falls	992	147	154	125	59	17	12	13	32	70	92	118	153

Source: Bioresource Units - Climate Tables, Bioresource Programme, Natural Resource Section, Cedara, KwaZulu-Natal Department of Agriculture, 1999.

As the source of the data varied, no calculations were made on the standard deviation, variance of the data and the number of years represented by the data for each BRU.

Table 2.2. Rainfall (mm) Data for two Meteorological Stations in the Karkloof Catchment*

	Hancock J Howick[1]	Warren JAR Howick[2]
Month	**Rainfall (mm) mean ± s.d.**	**Rainfall (mm) mean ± s.d.**
January	212.7 ± 86.4	174.9 ± 66.2
February	175.0 ± 81.1	132.4 ± 55.6
March	152.9 ± 99.6	127.4 ± 60.2
April	85.2 ± 56.5	75.5 ± 34.8
May	35.3 ± 43.5	27.3 ± 21.6
June	15.9 ± 33.0	5.6 ± 5.6
July	20.0 ± 23.8	8.1 ± 12.8
August	34.0 ± 30.1	27.4 ± 24.4
September	72.0 ± 54.6	62.2 ± 43.9
October	105.4 ± 48.3	90.8 ± 44.0
November	151.3 ± 53.9	121.5 ± 36.8
December	175.51 ± 72.7	143.4 ± 67.2
Total	1235.3 ± 683.5	996.4 ± 473.1

* Data compiled by the School of Bioresources Engineering and Environmental Hydrology (BEEH), University of Natal, Pietermaritzburg and the Computing Centre for Water Research (CCWR).

[1]Station I.D. 0269410; 29°20'S 30°14'E; 1100 m a.m.s.l. altitude; rainfall data for 1954-1982 (29 years) (Public appeal data (Dent, *et al.* 1989)).

[2]Station I.D. 0269446; 29°26'S 30°15'E; 1132 m a.m.s.l. altitude; rainfall data for 1971-1982 (12 years) (Public appeal data (Dent, *et al.* 1989)).

The Karkloof Catchment falls within the summer rainfall area of South Africa. The catchment receives on average between 777 mm mean annual rainfall (MAR) in the north-west on top of the scarp situated at an altitude of 1603 m and 1152 mm MAR directly below the scarp situated at an altitude of 1300 m extending along the Karkloof Forest from west to east and south along the eastern border of the catchment. Mean Annual Rainfall decreases to the north-west around the farm, 'Sherwood' and to the south-east along the valley of the Karkloof River which starts in the vicinity of the Karkloof Falls. The decrease in rainfall in the north-west may be attributed to the fact that the area lies on the leeward side of the escarpment and is thus in the rain shadow area. The occurrence and location of the high MAR is attributed to the rising ground of the Karkloof Range and cool air above the forest causing precipitation (Rycroft 1942). The highest rainfall months are December, January and February. The lowest rainfall months are June and July. The rainfall season starts in October and extends to March. Heavy afternoon summer thunderstorms are a common occurrence.

2. Mist

Thick mists (Plate 4. (p.32)), occur frequently towards the north of the catchment, particularly in the vicinity of the Karkloof Forest and as altitude increases. These mists occur in summer and can develop rapidly. The mists are most frequent during afternoons, evenings and early mornings, and may sometimes last for several days (Rycroft 1942). Scotney (1970) states that besides providing moisture, mist also has the effect of reducing evaporation and increasing humidity. The climax *Podocarpus* forests bear testimony to this. In winter, the drainage of cold air often causes mist in the valleys.

3. Hail and snow

Thunderstorms, often accompanied by hail, are particularly common in early summer. Scotney (1970) states that the regular snowline for the Howick Extension area is at an altitude of 1524 m and that one or more falls can be expected above this altitude during the winter months. The altitude at the top of the Karkloof Range is 1670 m. Rycroft (1942) states that, occasionally snow falls on the summit of the Karkloof Range and on the forest itself.

2.5.2. Temperature

Mean annual and mean monthly temperature figures are given in climate tables for the BRUs. Table 2.3. (p.20) shows a summary of the mean annual and mean monthly temperature figures for the BRUs of the Karkloof Catchment. The mean annual temperature figures for the BRUs are visually displayed in Figure 2.7 (p.21). Camp (1998) states that according to Schulze (1982) temperature correlates well with latitude and altitude, both of which can be determined with accuracy. The very poor network of temperature-measuring points in KwaZulu-Natal means that interpolation between sites is imperative. Thus, the average of the 1' by 1' gridded values of minimum, maximum and mean monthly means of daily temperature within a BRU were used as the best approximation available. As with the rainfall data, standard deviation, variance of the data and the number of years represented by the data were not determined for each BRU (K. Camp, 1999b, pers. comm.). In addition, data from one meteorological station have been provided (Table 2.4. (p.22)). This allows comparison with data contained in Table 2.3. and serves to provide some confidence in the validity of the BRU's data. The station, De Jong Ranch Howick, is located within BRU Vb12. Temperature data from both sources show little difference from each another.

Mean annual temperature decreases to the north-west of the catchment, in the vicinity of the farm, 'Sherwood' and increases towards the south-east, in the Karkloof River Valley, which starts in the vicinity of the Karkloof Falls. Mean annual temperatures of the BRUs range from 14.6 ^{0}C towards the north-west, to 18.2 ^{0}C towards the south-east. June and July are the coldest months of the year, whilst January and February are the hottest. The highest monthly maximum temperature of 27.7 ^{0}C is for January from BRU VWb2 - Morton's Drift. The lowest monthly minimum temperature of 3 ^{0}C is for July from BRU Wd9 - Nottingham Road.

Various factors affect temperature and these include:

1. Insolation

Rycroft (1942) states that slopes which face the sun i.e. the north and west facing slopes, experience a higher air and soil temperature than south and east facing slopes.

Table 2.3. Summary of Temperature Data for the Bioresource Units of the Karkloof Catchment

BRU	Mean Annual (°C)	Mean Monthly (°C)											
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Wd14 - Sherwood	14.6	18.2	18.1	17.1	14.8	12.6	10.2	10.2	11.9	13.9	14.8	15.9	17.6
Wd9 - Nottingham Road	14.7	18.5	18.4	17.3	14.9	12.5	10.0	10.0	11.8	14.0	15.0	16.2	17.9
Yd22 - Curry's Post	14.9	18.6	18.6	17.5	15.1	12.8	10.3	10.4	12.1	14.2	15.2	16.3	18.0
Zc6 - Karkloof Forest	16.1	19.4	19.5	18.6	16.4	14.2	11.8	11.8	13.5	15.3	16.1	17.2	18.8
Yc11 - Lidgetton	15.9	19.7	19.6	18.6	16.2	13.7	11.1	11.2	12.9	15.0	16.2	17.3	19.0
Yd23 - Gilboa	14.6	18.1	18.1	17.0	14.8	12.6	10.1	10.2	11.9	13.9	14.7	15.8	17.5
Vb12 - Howick Falls	17.2	20.8	20.9	20.0	17.6	15.2	12.7	12.7	14.3	16.2	17.4	18.5	20.2
VWb2 - Morton's Drift	18.2	22.1	22.1	21.2	18.7	15.8	13.0	13.1	15.1	17.3	18.5	19.7	21.5
Vd4 - Mount West	14.6	18.4	18.3	17.2	14.8	12.4	9.9	10.0	11.8	13.9	15.0	16.2	17.8
Yb8 - Albert Falls	17.8	21.6	21.6	20.7	18.3	15.6	12.9	13.0	14.9	17.0	18.1	19.2	21.0

Source: Bioresource Units - Climate Tables, Bioresource Programme, Natural Resource Section, Cedara, KwaZulu-Natal Department of Agriculture, 1999.

As the source of the data varied, no calculations were made on the standard deviation, variance of the data and the number of years represented by the data for each BRU.

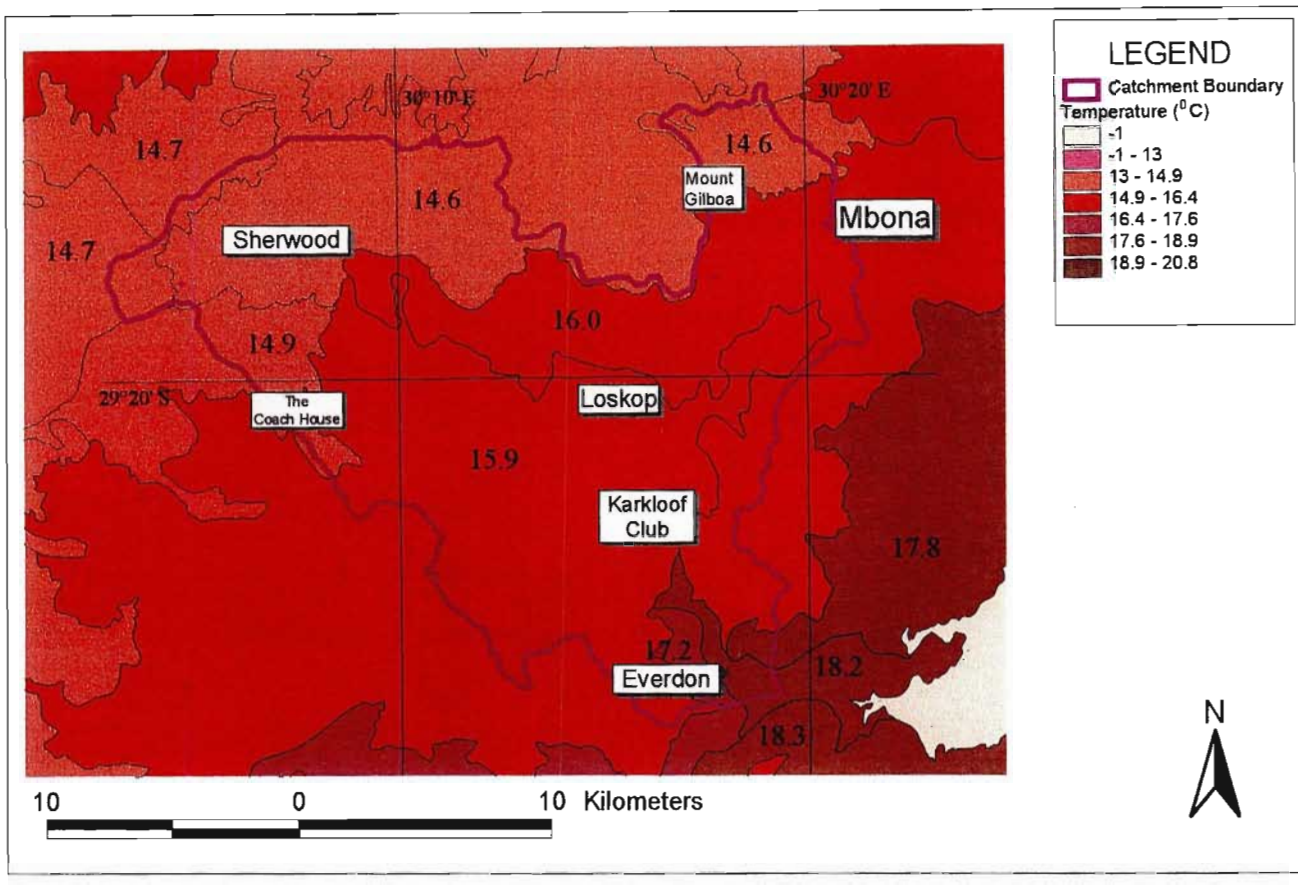


Figure 2.7. Pattern of Mean Annual Temperature (°C) in the Karkloof Catchment (Camp 1998)

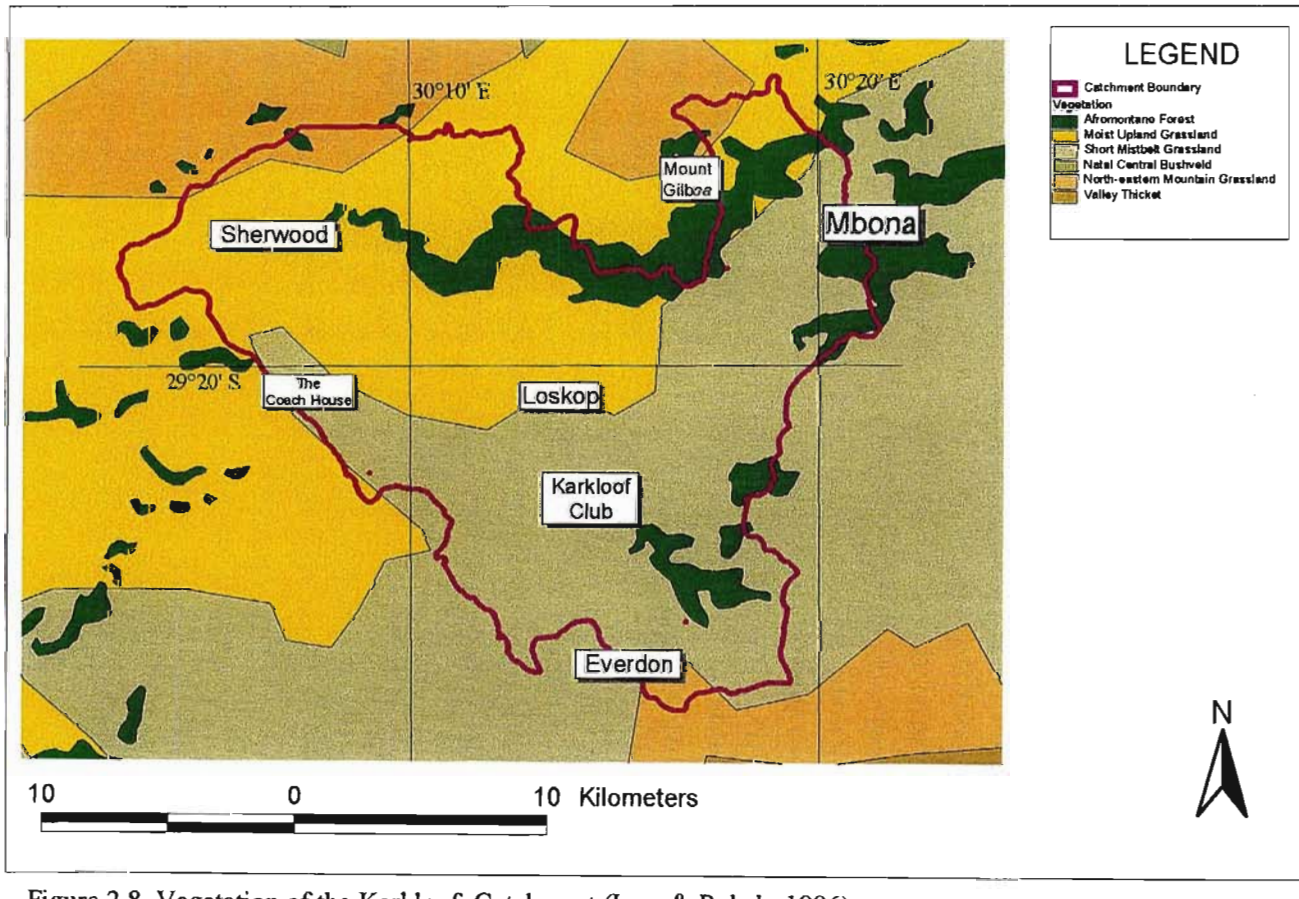


Figure 2.8. Vegetation of the Karkloof Catchment (Low & Rebelo 1996)

Table 2.4. Temperature (^{0}C) Data for one Meteorological Station in the Karkloof Catchment*

	De Jong Ranch Howick[3]	
Month	**Max - mean**	**Min - mean**
January	26.1	15.0
February	27.0	15.4
March	26.0	14.2
April	24.5	12.1
May	21.7	9.5
June	19.5	6.8
July	19.4	6.7
August	20.6	8.1
September	22.0	9.8
October	22.9	10.9
November	23.9	12.6
December	26.0	14.3

* Data compiled by the School of Bioresources Engineering and Environmental Hydrology (BEEH), University of Natal, Pietermaritzburg and the Computing Centre for Water Research (CCWR).

[3]Station I.D. 0269477; 29°27'S 30°16'E; 1082 m a.m.s.l. altitude; temperature data for 1975-1988 (14 years) (Department of Agriculture).

Standard deviations for data from this station were not available.

2. Temperature Inversion

During the winter months when winds are less frequent than during the summer, the atmosphere is relatively calm and the cold air from the hills sinks into the valleys, producing an inversion of temperature. As the cold air tends to sink, it flows out of the tributary valleys into the main valleys, which are at a lower level. The tributary valleys are therefore usually warmer (Rycroft 1942).

Frost as a result of temperature inversions is very common on the Karkloof Flats, which occur at altitudes that are lower than that of the main areas of indigenous forest. Scotney (1970) stated that frost is experienced throughout the Howick Extension Area, but is most severe at altitudes above 1524 m.

3. Wind

Winds have a strong influence on temperature. During winter, following a fall of snow on the Drakensberg, or a very cold period, a cold wind may blow for several days from a southern or south-western direction. At the end of winter or at the beginning of spring the 'Bergwinds' are common. These winds from the north and north-west are hot and dry because as they descend from the high altitudes of the Drakensberg mountains down to the sea, the air becomes compressed and heated. The 'Bergwinds' often blow for two or three days in succession. The Karkloof Forest which is situated on the south-east facing slopes of the Karkloof Range is not affected by 'Bergwinds', whilst the Sherwood and Weltevreden areas which face north-west, and are on the leeward side of the range are affected (Rycroft 1942).

2.6. THE INFLUENCE OF TOPOGRAPHY, RIVER SYSTEMS, GEOLOGY, SOILS AND CLIMATE ON THE NATURAL VEGETATION OF THE CATCHMENT

Complex interactions occur between topography, river systems, geology, soils and climate, which determine their very nature. Underlying geology and climate influence the type and depth of soils, which are formed and the topography created. In turn, especially when pronounced, topography can influence climate at a local level. Location and extent of river systems are also influenced by topography and climate and river systems also play a roll in soil formation. Thus topography, river systems, geology, soils and climate, individually or collectively, influence the location and formation of natural vegetation.

To the north of the Karkloof Catchment, extensive areas of steep south-facing slopes occur. These slopes receive less insolation than do north-facing slopes and are thus cooler and moister. This is reversed in the Northern Hemisphere. The rising topography of the Karkloof Range, which forces air to rise and cool, contributes to the area receiving the highest mean annual rainfall of the catchment (1152 mm). The rising topography and increased altitude also assist in the formation of mist.

Soils in the area as described by Scotney (1970) reflect a lower degree of leaching than the adjacent grasslands and are inherently more fertile than those of surrounding areas. The area is not affected by 'bergwinds', which blow from the north and north-west. All the above factors create a favourable habitat for the formation of indigenous forests. The spread of indigenous forests into neighbouring areas is limited by unfavourable environmental conditions such as, shallow less fertile soils and hot drier conditions. Fire also limits the spread of the indigenous forests. The steep slopes of the Karkloof Range afford protection from fires, whilst neighbouring areas are frequently subjected to fire, making such areas unsuitable for the establishment of indigenous forest.

To the north-west of the Karkloof Catchment the topography is rugged and deeply incised by the Karkloof River. A low mean annual rainfall (822 mm) is received, which can be attributed to the area being located on the leeward side of the escarpment, in the rain shadow area. Mean annual temperatures are also cooler (14.6 ^{0}C). Soils as described by Scotney (1970) are non-arable and of low agricultural potential, being often stoney and shallow. This area does not favour the formation of indigenous forests, but rather grasslands described by Low & Rebelo (1996) as, 'Moist Upland Grassland'.

Towards the south and south-east of the catchment the topography becomes flat to gently rolling. Mean annual rainfall is higher (966 mm) than to the north-west of the catchment. Mean annual temperatures are also higher (15.9 ^{0}C) and the agricultural potential of the soils improves. This area favours the formation of, 'Short Mistbelt Grassland' (Low & Rebelo 1996). It is stated by Low & Rebelo (1996) that this vegetation type requires higher mean annual rainfall and temperatures than 'Moist Upland Grassland'. This area is more suited to 'Short Mistbelt Grassland' than is the area to the north-west of the catchment.

At a more detailed level, micro-climates may be influenced by topography, river systems, geology, soils and climate. These micro-climates create unique vegetation habitats. For example, hygrophilous grasses tend to develop where soils are moist or waterlogged. Valley vegetation may differ from surrounding areas, due to the unique micro-climate created by an absence of frost and by increased temperatures.

This is evident in the valley below the Karloof Falls, where Forest and Woodland have formed compared to grassland, which has formed on the adjacent high lying plateau.

Indigenous forest may develop in isolated hollows, within other vegetation types, as these areas are protected from harsh climatic conditions and are moist.

2.7. FLORA

The vegetation of South Africa was studied and mapped by J.P.H. Acocks and the publication in 1953 of 'Veld types of South Africa', which included a vegetation map followed. Acocks mapped and described the vegetation of South Africa in terms of the agricultural potential of the vegetation, whereas the map should have rather been structured for more than agricultural planning. Since Acocks's work approaches to and concepts in vegetation classification have changed markedly and a considerable amount of new information has been collected. These shortcomings, as well as there having been no new or updated maps of the vegetation of South Africa since 1953, lead to Low & Rebelo (1996) producing a vegetation map and guide of South Africa, Lesotho and Swaziland. Low & Rebelo (1996) described and mapped four vegetation types, which lie within the Karkloof Catchment (Figure 2.8. (p.21)). These vegetation types are units of vegetation, which would have occurred today, were it not for man-made transformations. The four vegetation types are:

1. 'Afromontane Forest' (Plate 5. (p.33)). This extends along the Karkloof Range from west to east and southwards along the eastern boundary of the catchment. It occurs on south-facing ridges and in ravines where moisture is higher and the maximum effect of the south-westerly and south-easterly wind-driven rains is apparent. It is significant that the Karkloof Forest occurs almost precisely along the delineated west to east extent of 'Afromontane Forest' in the catchment. The area also receives considerable rainfall (1152 mm mean annual rainfall), which is a requirement of 'Afromontane Forest' distribution. It is thought that the 'Afromontane Forest' would certainly spread into grasslands were it not for fires. The majority of the Karkloof Forest in fact occurs in habitats relatively safe from fires such as on steep slopes. Trees can be up to 30 m or 40 m tall and distinct strata of emergent trees, canopy trees, shrub and herb layers are present.

Tree species include: *Podocarpus latifolius, P. falcatus, Trichocladus ellipticus, Rhus chirendensis, Curtisia dentata, Calodendrum capense, Apodytes dimidiata, Halleria lucida, Ilex mitis, Kiggelaria africana, Nuxia floribunda, Xymalos monospora, Rapanea melanophloeos* and *Ocotea bullata*. Shrub and Climber species include: *Maytenus heterophylla, Scutia myrtina, Carissa bispinosa, Secamone alpinii, Canthium ciliatum, Rhoicissus tridentata, Zanthophyllum capense* and *Burchellia bubalina*. Typical grasses, herbs and ferns include: *Oplismenus hirtellus, Stipa dregeana, Centella asiatica, Cyperus albostriatus, Polypodium polypodioides, Polystichum luctuosum, Streptocarpus rexii* and *Plectranthus* spp. Approximately 16.4% (of 792 km^2) of 'Afromontane Forest' in KwaZulu-Natal and 17.6% (of 5877 km^2) in southern Africa is conserved. Levels are deemed as having the status of 'well conserved'.

Cooper (1985) undertook a survey of the conservation status of indigenous forests in the former Provinces of Transvaal, Natal and Orange Free State of South Africa. He classified the Karkloof Forest as an example of 'Afromontane Forest' of the sub-type, 'Mist Belt Mixed Podocarpus Forest'. Especially relevant is Cooper's (1985) comment that the Karkloof Forest is by far the most important private forest in the 'Mist Belt Mixed Podocarpus Forest' category. He considered it important not just for its size, but also because it afforded a suitable habitat for numerous birds, animals and plant species, which were listed as rare, threatened or endangered in South Africa. Cooper (1985) recommended that the forest and adjoining grassland should constitute one of the top conservation priorities for KwaZulu-Natal. A preliminary checklist of plants (Appendix 2. (p.137)) occurring on the farm 'Ehlatini', located in the Karkloof Forest was prepared (Cooper & Moll 1967). Although the list was prepared only for 'Ehlatini', species cited in the list may be said to be representative of the greater Karkloof Forest.

2. 'Moist Upland Grassland' (Plate 6. (p.33)). This extends throughout most of the catchment, but is more extensive towards the north-west in the vicinity of the farms 'Sherwood' and 'Weltevreden', and to the north-east along the Karkloof Range to Mount Gilboa. 'Afromontane Forest' is scattered within the grassland. The climatic requirements of this vegetation type include: mean annual rainfall between 650 mm to 1000 mm, and mean annual temperatures between -3 ^{0}C to 40 ^{0}C, with an average of 16 ^{0}C.

This vegetation type is often evident on disturbed, ploughed or heavily overgrazed and degraded sites, indicating the secondary status of many of the representative plant communities. Poor grazing management of these grasslands encourages an increase of unpalatable grasses, such as *Aristida junciformis* and the invasion of herbaceous weeds. The vegetation type may be termed, 'sourveld'. Scott (1947) states that in sourveld the majority of the grasses become unpalatable for livestock on reaching maturity. Palatable material is thus only available during the growing season. This has limitations for livestock grazing and production within the area. Dominant grass species include: *Themeda triandra* (high to very high grazing value), *Heteropogon contortus* (average to high grazing value), *Tristachya leucothrix* (variable grazing value), *Eragrostis curvula* (average grazing value under natural conditions) and *Elionurus muticus* (very low grazing value). Grazing value stated is that assessed by van Oudtshoorn (1992). Diagnostic herbaceous species include: *Walafrida densiflora, Cucumis zeyheri, C. hirsutus, Berkheya onopordifolia, Spermacoce natalensis, Kohautia cynanchica, Tephrosia macropoda, T. multijunga, Conyza obscura, Corchorus confusus, Phyllanthus glaucophyllus, Richardia brasiliensis, Gomphrena celosioides, Aster bakerianus, Alysicarpus rugosus, Helichrysum coriaceum* and *H. rugulosum*. Tree and shrub species include: *Maytenus heterophylla, Zanthoxylum capense, Ziziphus mucronata, Rhus rehmanniana* and *Acacia sieberiana*. These occur on sheltered sites, rocky hills and ridges. Approximately 7.5% (of 13800 km^2) of 'Moist Upland Grassland' in KwaZulu-Natal and 2.5% (of 44012 km^2) in southern Africa is conserved. Levels are deemed as having the status of 'poorly conserved'. In fact only one large significant remnant patch of this grassland type occurs on the farm 'Sherwood' in the north-west of the catchment. Small scattered remnant patches also occur, mainly near the Karkloof Forest and at Mount Gilboa. Much of the 'Moist Upland Grassland' which would have occurred today in the Karkloof Catchment, has been destroyed largely by exotic afforestation.

3. 'Short Mistbelt Grassland'. This extends across the remainder of the catchment to the south. The vegetation is dense *Themeda triandra* dominated grassland. *Aristida junciformis* is dominant in areas disturbed by intensive agriculture. The climatic requirements of this vegetation type include mean annual rainfall between 900 mm to 1200 mm, and mean annual temperatures between -2 ^{0}C to 38 ^{0}C, with an average of 17 ^{0}C.

Dominant grass species include: *Monocymbium ceresiiforme* (low grazing value), *Trachypogon spicatus* (average to low grazing value), *Tristachya leucothrix* (variable grazing value), *Eragrostis racemosa* (low grazing value) and *Diheteropogon amplectens* (average to high grazing value). Grazing value stated is that assessed by van Oudtshoorn (1992). Approximately 2.5% (of 4537 km^2) of 'Short Mistbelt Grassland' in KwaZulu-Natal and 2.4% (of 4814 km^2) in southern Africa is conserved. Levels are deemed as having the status of 'poorly conserved'. Conservation status is lower than that of the 'Moist Upland Grassland' type. Much of the 'Short Mistbelt Grassland' which would have occurred today in the Karkloof Catchment, has been replaced by intensive cultivation and exotic afforestation.

4. Small sections of 'North-eastern Mountain Grassland' are shown to extend slightly into the catchment towards the north-west and south-east. This grassland contains many endemic plant species. Approximately 3.9% (of 10 968 km^2) of 'North-eastern Mountain Grassland' in KwaZulu-Natal and 7.4% (of 41 905 km^2) in southern Africa is conserved. In the Karkloof Catchment, limited small isolated patches of this vegetation type remain. This may be attributed to the small sections, which would have occurred in the catchment and the destruction of these areas by the establishment of exotic afforestation.

The poor conservation status of the grasslands in the Karkloof Catchment is a cause for concern. Such poor status is further exacerbated because although fragmented pockets of the grassland types still remain, the condition of many of these, especially in terms of palatable grass species composition, is poor. Thus its conservation status is far more threatened than is spatially shown. It is further estimated by Scott-Shaw (1999) that well over 90% of Acocks's (1988) Veld Type, 'Natal Mistbelt Ngongoni Veld (45)', into which category the grasslands of the Karkloof Catchment fall, has been transformed, with only 0.3% protected (Proclaimed Protected Areas). Scott-Shaw (1999) rated the Veld Type as being one of the most threatened Veld Types in KwaZulu-Natal, stating that a disproportionately high number of threatened plants occur in only a few Veld Types which typically have high rainfalls and mild temperatures. Such environments also attract intensive crop farming and habitation.

2.8. FAUNA

A list of fauna present in the Karkloof area was compiled by the KwaZulu-Natal Nature Conservation Service (Appendix 3. (p.138)), but is considered to be an under-representation of fauna in the area (S. Kruger, 1999, pers. comm.). The number of species recorded in each major category are as follows: Class: Amphibia (Amphibians) - 15; Class: Annelida (Worms) - 15; Class: Insecta, Order: Diptera (Flies) - 22, Order: Lepidoptera (Butterflies) - 104, Order: Mecoptera (Hangingflies) - 4, Order: Odonata (Dragonflies) - 9; Class: Mammalia (Mammals) - 24; Class: Onycophora (Velvet worms) - 1; Class: Osteichthyes (Bony fish) - 3; Class: Reptilia, Order: Sauria (Lizards) - 10, Order: Serpentes (Snakes) - 17. Of the Butterflies the 'Scarce Scarlet' (*Bowkeria phosphor borealis*) and 'Karkloof Blue' (*Orachrysops ariadne*) are considered 'Rare' (Henning & Henning 1989). The 'Karkloof Blue' is found at the farm 'The Start' near the Karkloof Falls. This important butterfly is endemic to KwaZulu-Natal and until it was recently discovered near Eshowe, was only found in the Karkloof District (S. Lu, 1999, pers. comm). The 'Scarce Scarlet' is also found near the Karkloof Falls. Of the mammals, the Oribi (*Ourebia ourebi ourebi*) and Rough-haired golden mole (*Chrysospalax villosus villosus*) are considered 'Vulnerable', whilst the Blue duiker (*Philantomba monticola bicolor*), African weasel (*Poecilogale albinucha*) and Samango monkey (*Cercopithecus mitis labiatus*) are considered 'Rare' (Smithers 1986). Not included in the species list prepared by KwaZulu-Natal Nature Conservation Service, but noted by Cooper & Moll (1967) as occurring on the farm 'Ehlatini', located in the Karkloof Forest are: Vervet monkey (*Cercopithecus aethiops*), Tree dassie (*Dendrohyrax arboreus*) and Rock dassie (*Procavia capensis*). Mountain reedbuck (*Redunca fulvorufula*), Grey rhebok (*Pelea capreolus*), Serval (*Felis serval*), Black-backed Jackal (*Canis mesomelas*), Caracal (*Felis caracal*) and Bushpig (*Potamochoerus porcus*) have been observed on land adjacent to the Karkloof Nature Reserve (Anon. 1993). The annual Karkloof Conservancy game count in 1998 recorded the following mammals on farms throughout the catchment: 7 Oribi, 365 Reedbuck, 169 Duiker, 66 Bushbuck, 128 Blesbuck, 45 Hares and 89 other game (C. Goble, 1999, pers. comm.).

Most Inland Mist-Belt forests in KwaZulu-Natal are not particularly rich in birds but the Karkloof Forest is an exception (Cooper & Moll 1967). A list of species recorded in the Karkloof Nature Reserve (Appendix 4 (p.139)) was prepared by the KwaZulu-Natal Nature Conservation Service (14/10/1996).

Scrutinising this bird list, revealed that the following species may be categorised as follows: Endangered: Wattled Crane (*Bugeranus carunculatus*); Vulnerable: Cape Vulture (*Gyps coprotheres*), Martial Eagle (*Polemaetus bellicosus*), Stanley's Bustard (*Neotis denhami*), Cape Parrot (*Poicephalus robustus*), Ground Hornbill (*Bucorvus leadbeateri*); Rare: White Stork (*Ciconia ciconia*), Striped Flufftail (*Sarothrura affinis*) (Brooke 1984). The list contains 184 bird species, which is a considerable number. As the list is a representation of bird species only of the Karkloof Nature Reserve, bird species found in the entire Karkloof Catchment may be far more extensive and significant. From the above it can be seen that the Karkloof area, particularly the Karkloof forest area is of great faunal importance.

Plate 1. View of the Karkloof Range, taken from the top of Mount Gilboa, looking towards the south-east. Note the indigenous forest on the south-facing slope of the Range (Oct. 1997)

Plate 2. View of Loskop, looking towards the north, showing the Karkloof Flats in the foreground and the Karkloof Range in the background behind Loskop. Newly planted maize in the foreground (Nov. 1998)

Plate 3. The Kusane, a tributary of the Karkloof River. Riparian Wattle is present along the tributary. This is visible in the background of the photograph (Oct. 1997)

Plate 4. Thick mist over the Karkloof Flats, below the Karkloof Forest (Oct. 1997)

Plate 5. The Karkloof Forest, Afromontane Forest (Low & Rebelo 1996). The forest is seen from the top of Mount Gilboa, looking south-east. Note the abrupt margins of the forest, a feature of regular burning of the adjoining grasslands (Oct. 1997)

Plate 6. Moist Upland Grassland (Low & Rebelo 1996). View looking towards the east, as seen from the approach road to 'Sherwood' farm, located in the north-west of the catchment (Oct. 1998)

CHAPTER 3: HISTORICAL OVERVIEW OF THE KARKLOOF CATCHMENT WITH PARTICULAR RELEVANCE TO LAND TRANSFORMATION

Early, Middle and Late Stone Age people inhabited the Karkloof Catchment, prior to the arrival of Iron Age people. The Early Stone Age is described as being from older than 1 million years to approximately 200 000 years ago, whilst the Middle Stone Age is from approximately 200 000 years to approximately 25 000 years ago. The Late Stone Age is from approximately 25 000 years ago to colonial times (Whitelaw 1999). Early, Middle and Late Stone Age sites have been recorded in the catchment in the vicinity of 'Loskop', a hill which is located in the centre of the catchment, at Albert Falls Dam, on top of the Karkloof Range towards the north-west, and on the farm, 'Sherwood' in the north-west (G. Whitelaw, 2000, pers. comm.). As very little of the catchment has been surveyed, there may be many unrecorded sites, some of which may be of great scientific significance and worthy of conservation.

The Stone Age people lived primarily off indigenous animals and plants which were hunted and gathered, with the variety of foods eaten and the extent of exploitation of certain foods appearing to increase through the Early Stone Age to the Late Stone Age (Mazel 1989). The Late Stone Age people lived in rock shelters, and probably in temporary encampments out in the open. It has been hypothesised, on the basis of an analysis of the seasonal movements of large antelope, that food resources would have been exploited on a seasonal basis by hunter-gatherers (Mazel 1989). The Drakensberg would have been occupied in summer and the thornveld and coastal areas during winter, and the Midlands would have been traversed along the ridges rather than in the valleys. Moll (1976) assumes that their effect on the vegetation was to maintain open grassland at the expense of woody plant communities such as forest. This was achieved by setting fire to the vegetation as an aid to hunting and probably to maintain the plants they exploited.

Approximately 2000 - 1500 years ago, the Iron Age people entered KwaZulu-Natal (Mazel 1989). In the Karkloof Catchment an Early Iron Age site, dated to approximately 650 - 800 AD was recorded in the vicinity of Albert Falls Dam.

Late Iron Age sites have been recorded in the vicinity of 'Mbona', located in the north-east of the catchment, with numerous sites recorded on the farm, 'Sherwood', located in the north-west and in the Umgeni Valley in the south (G. Whitelaw, 2000, pers. comm.). As was stated previously, because very little of the catchment has been surveyed, there may be many unrecorded sites, some of which may be of great scientific significance and worthy of conservation. Whitelaw (1999) describes the Early Iron Age as extending from 400 to 1000 AD and the Late Iron Age as extending from 1000 AD to colonial times.

The Iron Age people practised metallurgy and were agropastoralists i.e. they husbanded domestic live stock and cultivated crops. This necessitated a settled, village way of life instead of the nomadic patterns of the Stone Age (Maggs 1989). Diet was based on agriculture and pastoralism with some supplementary hunting, fishing and gathering of wild plants and shellfish. Several grain crops were grown, and domesticated animals such as cattle, sheep, goats and dogs were kept. Decorated pottery was made, which is considered a hallmark of these early settlements. These people would have required wood for building structures, fuel for fires and their metal works, grazing for their livestock and would have moved their livestock with the seasons, between higher and lower altitudes (G. Whitelaw, 2000, pers. comm.). In winter, cattle would have been moved into the lower warmer valleys, whilst in summer, when temperatures were higher and grazing pastures much improved the cattle would have been moved onto the upper grasslands. Grasslands would have been burnt to supply green grazing for their stock (G. Whitelaw, 2000, pers. comm.). Moll (1976) states that this practice initiated a change in the grassland species composition, *Themeda triandra* being replaced by *Aristida junciformis*. Cultivation sites were frequently moved, as under intensive cultivation with no rest period, the soil fertility soon declined (Moll 1976). This resulted in the continual clearing of small patches of primary vegetation and of its gradual replacement by secondary vegetation. Such a practice would encourage *Aristida junciformis*, *Eragrostis curvula* and *Hyparrhenia hirta* grassland formation, and *Acacia* scrub development.

It is stated by Wright (1989), when he examined political transformation south of the Thukela in the late 1810s and early 1820s that the Wushe chiefdom occupied the Mngeni Valley, north of present day Pietermaritzburg. This chiefdom was subsequently forced to flee after it was attacked and defeated by the migrating Thembu chiefdom.

A major battle took place at the foot of the hill 'Loskop', situated in the centre of the Karkloof Catchment on the farm, 'Loskop' (F. Prins, 2000, pers. comm.). In turn the Thembu chiefdom was forced to migrate further due to the approaching Zulu. Wright (1995) states that, contrary to early historical accounts, the Zulu were not the main agents of the upheavals, which took place south of the Thukela. These upheavals were caused mainly by migrant groups such as the: Ngwane, Thembu, Chunu, Memela and Nhlangwini. These groups were not 'refugees' and neither these groups nor the Zulu devastated or depopulated the region south of the Thukela as many historians have recorded. After these migrations the major powers between the Thukela and the Mzimkhulu were the three Zulu satellite chiefdoms: the Sithole, the Mkhize and the Cele, together with the Ngwane chiefdom in the north-west and the relocated Chunu chiefdom in the south. Between them they dominated the whole region (Wright 1995). Whether the Karkloof Catchment was occupied at this time is however unknown. Ellis (1985) states that the estimate of the extent to which KwaZulu-Natal was depopulated is controversial, but according to evidence large areas were empty for most of the 1820s and 1830s.

The Boers arrived in KwaZulu-Natal from the Cape in 1837 (Ellis 1998). They defeated the Zulus in 1838 at the battle of Blood River and established the Republic of Natalia. The Boers were the first to subdivide land into private farms and to establish private land-tenure. Prior to this land had been communally held. Private farms enabled land-owners to exploit natural resources on their properties as they wished. Ellis (1998) states that the Boers were cattle ranchers. Wherever they set up a ranch their demands would be similar. They would have wanted timber as a building material, fuel for domestic use, game for meat, good grazing veld for their livestock and they would have cleared a patch of natural vegetation near the homestead, to plant crops for their own consumption. Very few Boers were agriculturists. They probably burnt pastures regularly to ensure suitable grazing and may have overgrazed areas. The period of Boer rule of KwaZulu-Natal came to an end with the British occupation of 1842. The Boers' defeat and the annexation of KwaZulu-Natal by Britain resulted in an exodus of Boers, so that by 1846 approximately 60 Trekker families remained, most of whom lived in Pietermaritzburg (Ellis 1985). In the Karkloof Catchment, names which include: Weltevreden, Welgevonden and De Magtenburg given to Boer farms still remain on the property grants of today.

Between 1849 and 1852, approximately 5000 immigrants arrived from Britain (Ellis 1985). Many settlers to the Karkloof organised their passage and obtained land by their own means, whilst others came out under immigration schemes. One particular scheme in the Karkloof, was that of Richard Hackett who offered thirty acres per person attached to a steerage passage, whilst an intermediate fare, with a forty acre bonus, amounted to £16. This scheme was not a success, mainly due to the allocation of small farms, which were not viable (Hattersley 1950). Ellis (1998) states that the settlers' interaction with the environment was minimal, during the initial years. Their early activities, during the 1840s included: hunting, pastoralism and subsistence farming. Chief exports included butter, ivory, ox and buffalo hides. The scale of production of these items was however small. By the 1850s activities included: stone quarrying, lime burning, the felling and sawing of timber in the Pietermaritzburg district, from the forests of the Dargle and Karkloof, also fishing and hunting, burning of bricks and cutting of reeds for thatching. Butter, hides and ivory were still exported. By the 1860s hunting had decimated much game. Ballard & Lenta (1985) state that the years of early colonisation (1843 - 1860) were difficult, as immigrants had trouble adjusting to the climate and soils, which differed from those which they had left behind. Farmers attempted to learn about the environment and its possibilities for agriculture through much experimentation, which more often than not resulted in failure. By the 1860s they had gained enough experience, and between 1860 and 1900 a variety of crops and livestock were firmly established in bioclimatic zones most suited to their development (Ballard & Lenta 1985). The Midlands Mist Belt was found suitable for maize cultivation, for dairy cattle and for the extensive grazing of cattle and sheep on the hilly and broken terrain.

As is suggested by the above information, land in the Karkloof Catchment has been transformed. This land transformation has often been a direct consequence of historical changes. Each historical time period has been unique, having different groups of people living in the area, with each group utilising and altering the environment in different ways to suit their specific needs. With the progression of time technology, mechanisation and transportation have improved, and economies and political circumstances have changed. All of these have also had an influence on land transformation.

Heydenrych (1985) states that prior to the construction of the railway between Durban and Pietermaritzburg the ox-wagon was the sole means of communication. Roads throughout the Midlands were little more than tracks and even though the railway reached Pietermaritzburg in 1880, extensions to Richmond and Greytown had to wait until the end of the century (Lambert 1987). With these improvements and changes, land use in the Karkloof Catchment intensified and diversified, with much land cover conversion and modification taking place.

Seeds of the Black Wattle (*Acacia mearnsii*) were introduced into KwaZulu-Natal and South Africa by John van der Plank in 1864 (Sherry 1968). The first Black Wattle plantations established in the Karkloof Catchment in 1876 were on Mr G. Sutton's farm, 'Everdon' located in the south of the catchment. The first tanning test with Black Wattle was carried out in 1884, at the request of Sir George Sutton, but the local demand for this bark was limited, and the average price attained was only £4 per ton, compared with quotations of £15 per ton for Australian bark on the London market. In 1886 a small shipment of bark was sent to England, and due to high freight charges only £11 per ton was realised. However, with the introduction of more reasonable freight charges, exportation of bark became more profitable. Hurwitz (1957) states that before 1904, no census data exists to give the area or position of wattle plantations, but by 1904 the pattern of the wattle belt in KwaZulu-Natal was already taking shape, with the central Midlands area emerging as one of the most important areas. The wattle industry expanded rapidly in the period 1926 - 1928. This was due to the encouragement given to producers by the high prices of wattle bark and extract. Despite a slump experienced in 1929, as a result of the economic depression, the wattle area in KwaZulu-Natal continued to increase (Hurwitz 1957). By 1953, the wattle export trade, at its peak was valued at £7,620,784 (Sherry 1968). Shaw (1952) states that the chief use of wattle was as a tanning agent in the leather industry with an important by-product being the timber which remains, which was often used for mine timber, firewood and for the manufacture of hard boards, paper, treated poles and charcoal. The Karkloof Catchment, particularly the area towards the Karkloof Forest, was considered ideal for wattle plantations (Scott-Shaw 1971). These areas were located at the ideal altitude, situated within the Mistbelt and received the required amount of rainfall at the correct time of year. Frosts and cold winds were also uncommon.

Scotney (1970) states that extensive cattle farming was confined to the Highland Sourveld, where land could be purchased at very low cost. The hardy Afrikander, initially introduced by the Boers, was the most popular cattle breed. In 1855 an epidemic of Lung Sickness (Bovine pleuropneumonia) swept through KwaZulu-Natal and did much to reduce the number of cattle and effect a general change from cattle to sheep farming. After 1855 the cattle population continued to increase despite recurrences of Lung Sickness and East Coast Fever. In 1896 an outbreak of Rinderpest almost halved European cattle holdings (Hurwitz 1957).

Sheep were initially introduced into KwaZulu-Natal by the Boers, when they trekked from the Cape (Sellers 1985). During the early 1850s sheep-farming was pursued only on a limited scale, as farmers engaged in pastoral farming preferred to accumulate large herds of cattle which were easier to manage and which did not require such careful supervision as sheep. With the epidemic of Lung Sickness (Bovine pleuropneumonia) in 1855 sheep farming became more popular, and better breeds were imported. Sellers (1985) states that experiments in various parts of KwaZulu-Natal were carried out to determine whether both the climate and grass coverage was suited to sheep. One such experiment was carried out by Edwin Parkinson of 'Shafton Grange' situated in the centre of the Karkloof Catchment. Parkinson achieved great success and stated that the climate and pasturage were well suited to sheep farming. The years 1860 - 1864 were prosperous years, however during the years 1864 and 1865 wet weather brought about illness amongst the sheep. This, as well as the prevailing economic depression, resulted in a decline in sheep farming (Sellers 1985). By 1877, sheep farming had recovered, the recovery being related to improvements in the prevention and treatment of diseases. The KwaZulu-Natal Midlands was an important sheep producing area in the early 1900s. However, with the expansion of dairying and wattle growing in this area, the sheep and wool industry shifted considerably to the northern districts of KwaZulu-Natal (Hurwitz 1957). Sellers (1985) states that grasslands were managed so as to attain suitable grazing grass by allowing sheep to graze continually on the grass in a specific area to prevent the grass from growing too tall and coarse, and by burning the grass usually before the spring rains, which encouraged the growth of green shoots early in the season. To overcome the autumn and winter feeding problem, grasslands were burnt in February and March.

New growth would develop on these areas in the late autumn, and this nutritious material would be relied on to carry the animals through late autumn and winter (Sellers 1985). It is stated by Everson (1999) that the use of fire to stimulate out-of-season growth in fire climax grasslands, into which category the grasslands of the Karkloof Catchment fall, is detrimental to the cover and species composition of the grasslands. Many of the more preferred species will in time be replaced by inferior species. Grassland deliberately burned early to produce grazing before the spring rains is often grazed heavily and continuously before it has produced much re-growth. This early continuous grazing has a dramatic effect on the vigour of the grasses and will drastically reduce the season's yields. The ability of these fire climax grasslands to resist invasion by pioneer species will consequently be reduced, and deterioration in species composition is certain to follow (Everson 1999).

Lambert (1987) attributes the start of dairy farming to a reduction in diseases in European-owned herds making the introduction of better breeds feasible. This reduction in disease was due to the wider use of fencing and the decreasing use of transport oxen in the 1890s. At the same time, farmers were finding it difficult to compete with the supply of cheap beef from Griqualand East and Barkly West. These developments encouraged them to turn to dairy farming. Dairy farming was also encouraged with the improvement in roads and transport methods. At the same time, the introduction of pasteurising, refrigeration and the centrifugal cream separator increased the chance of supplying milk, butter and cream throughout the colony (Lambert 1987). With the establishment of the Natal Creamery Ltd. and the Nel's Rust Dairies during the 1890s the dairy industry became firmly established (Hurwitz 1957). These factories produced creamery butter, manufactured cheese and organised the distribution of milk in urban areas, such as Pietermaritzburg. Areas served by railways and situated near the large towns developed into intensive fresh-milk producing zones (Hurwitz 1957). The extension of the railway line from Pietermaritzburg to Greytown in the early 1900s would have made the Karkloof Catchment a feasible area for fresh-milk production. Despite this dairy farming was undertaken to a limited extent. This may have been due to other farming types, such as wattle being more popular. In 1944 dairy farming was practised only by two brothers belonging to the Mackenzie family (A. Symons, 1998, pers. comm.).

The establishment of intensive market gardens and of wattle plantations and dairy farming created a need for seasonal, well-trained labour (Lambert 1987). Under the labour tenant system, which originated in the 19th century, black families living on white-owned land had to supply the land-owner with their labour for part of the year, at a non-existent or nominal wage. In return they were allowed to graze some stock and cultivate some land on the owners' farm - labour serving as a form of land-rent (Anon. 1985). Grazing and cultivation were at the discretion and restriction of the land-owner. Ballard & Lenta (1985) state that black farmers geared their production first to meet subsistence needs and second, to sell surpluses on the local internal markets of the colony, with only two crops, mostly maize and sorghum being grown and herds of cattle being kept. Lambert (1987) maintains that the restrictions placed on grazing were creating serious problems, as it was no longer possible to move herds between winter and summer grazing the optimum use of the veld was becoming a thing of the past. The result was overgrazing and destruction of the natural goodness of the grasslands. With overgrazing and the deterioration of the natural grasslands and the death of cattle during drought years, black farmers began building up goat herds. With the outbreak of Rinderpest from 1897 to 1898 many cattle were lost which relieved the pressure from overgrazing.

By 1944 farming activities undertaken by white land-owners in the Karkloof Catchment consisted of cattle farming, wattle plantations, extraction of indigenous timber and some dairy farming (A. Symons, 1998, pers. comm.) Sheep farming took place towards the north-west of the catchment (J. Coleby, 1998, pers. comm.). The black farm-employees practised subsistence cultivation and kept cattle and goats in areas permitted by the white land-owners.

CHAPTER 4: INTEGRATED CATCHMENT MANAGEMENT IN THE KARKLOOF CATCHMENT

Integrated Catchment Management may be defined as, "*an holistic approach to managing natural resources, human activity and their relationships within a river catchment, to ensure continued and co-ordinated use of these resources to the mutual benefit of humans and the natural environment*"(Anon. 1996a, pg. 9). Catchment management is based on viewing the entire catchment as a fundamental environmental unit and a common geographical definition of land and water use (Anon. 1996a).

There are two catchment management bodies, which are relevant to the integrated catchment management in the Karkloof Catchment, namely:

1. The Karkloof Catchment Management Forum

The need for the integrated management of all aspects of water resources and where appropriate, the delegation of management functions to a regional or catchment level so as to enable everyone to participate is recognised (Anon. 1998). In order to achieve the above objectives, provision is made for the establishment of catchment management agencies (CMAs) for water management (Anon. 1998). No CMAs have as yet been established in South Africa, although 22 Water Management Areas (WMAs) are proposed, three of these being situated in KwaZulu-Natal (A. Seetal, 1999, pers. comm). The proposed WMAs in KwaZulu-Natal are: the central Tugela area; Usutu to Umhlatuze in the north; and Umvoti to Umzimkulu in the south. The Karkloof Catchment falls within the Umvoti to Umzimkulu WMA (A. Seetal, 1999, pers. comm). It is proposed that Catchment Management Forums (CMFs) be established at the local level to provide a 'bottom up' management approach. A CMF is a non-statutory body with representative stakeholders at the local level. It functions to promote catchment management, to involve interested and affected parties and stakeholders in integrated natural resource management and to advise the catchment management agency. CMFs have no formal statutory power, but as a multiple grouping of stakeholders constitute a significant pressure group and this can exert considerable pressure on the CMA (A. Seetal, 1999, pers. comm.). The Karkloof Catchment Management Forum (KCMF) was formed at a workshop held at Umgeni Valley on 12 May 1998.

Representatives from the different interest groups in the catchment were elected onto the Forum at the workshop. The interest groups include: commercial agriculture, commercial forestry (including Sappi Forests (Pty) Ltd. and Mondi Ltd.), Department of Health, Department of Water Affairs and Forestry, Headwaters Association, Karkloof Irrigation Board, Karkloof Conservancy, KwaZulu-Natal Nature Conservation Service, Soil Conservation, Tourism, iNdlovu Regional Council, Umgeni Water, University of Natal, Wildlife and Environment Society of Southern Africa and Working for Water. The KCMF has since held several meetings. The exact aim, role and functioning of the KCMF is still relatively unclear and initial support has been gained slowly, however with time and experience this is expected to change. The KCMF may have considerable power as a result of local knowledge and as a pressure group and may influence decision making of the CMA.

2. The Karkloof Conservancy

A conservancy may be described as, "*A voluntary, co-operative environmental management of an area by that community and its user groups*" (Anon. 1992, pg. 1). Conservancies did not come about overnight, but followed an evolutionary path where both the farmer and the former Natal Parks Board, now the KwaZulu-Natal Nature Conservation Service, moved towards some form of co-operative environmental management. The first conservancy, the Balgowan Conservancy was established in 1978 (Anon. 1992). Today there are over 220 conservancies in KwaZulu-Natal, which manage both farm, urban and industrial areas (R. Badenhorst, 1999, pers. comm.). There are numerous advantages to conservancies, some of these include: wildlife increases, there is better general security, land-owners become more conscious of their wildlife, a closer community is formed, often solving community problems, fewer uncontrolled forest and veld fires occur. Conservancies are run by an elected chairman and steering committee and have their own constitutions. Guards are employed when required and members pay an annual levy (Anon. 1992). The Karkloof Conservancy was formed on 28 November 1997 with membership drawn from the Karkloof Catchment and adjacent outlying areas. Large companies such as Sappi Forests (Pty) Ltd. and Mondi Ltd., as well as owners of many small privately owned farms have membership of the conservancy (C. Goble, 1999, pers. comm.). As most farmers in the area support 'Envirowatch', a private sector farm security company, the Karkloof Conservancy is not involved with the security role that conservancies generally play (K. Cooper, 1999, pers. comm.). The Karkloof Conservancy is involved with mainly environmental education and the monitoring of wildlife populations.

To date three game counts, a water bird count and various environmental educational talks have been conducted. A crane count, a guinea fowl count and talks on raptors and the Cape Parrot are proposed. Counts are normally held during the school holidays, which enables school children to participate. The Karkloof Conservancy has also been active in promoting environmental education within the local farm schools. Attendance of the counts and talks has been very good and the activities of the Karkloof Conservancy are assisting in forming a closer community.

CHAPTER 5: MATERIALS AND METHODS

The process followed in determining land transformation in the Karkloof Catchment between 1944 and 1999 and the resultant products are summarised in Figure 5.1. (p.46). This should be referred to in conjunction with the text which follows.

5.1. GEOGRAPHICAL INFORMATION SYSTEM TECHNIQUES

Black and white panchromatic contact aerial photographs of the Karkloof Catchment were obtained from the Chief Directorate, Surveys and Land Information, Cape Town, for the years 1944 (job no. 60/44, scale 1:20 000 flown April 1944) and 1996 (job no. 985 G, scale 1:30 000 flown April 1996). Twenty-eight opaque film orthophotographs (scale 1:10 000, compiled from aerial photographs taken in 1981 and 1976) were obtained for most of the catchment from the Department of Land Affairs Directorate, Surveyor-General, Pietermaritzburg. Orthophotographs were not available for a small section of the upper north-west portion of the catchment (orthophotograph nos. 2930 AA 18 & 19). The unavailability was due to orthophotographs never having been compiled for the area.

The orthophotographs were used as a base over which drafting film was laid. The use of orthophotographs was preferred, as they are rectified photographs, which have had height, tilt/tip, lens and paper distortions removed. Opaque film orthophotographs and drafting film were the preferred paper medium as both are not prone to stretching and distortion with moisture changes. Drawing mistakes are also easy to correct. The orthophotographs and overlaying drafting film were positioned on top of a light table. Aerial photographs for 1944 and 1996 were manually, visually, photo-interpreted with the aid of a light magnifying glass. Features of importance were hand-traced using a drafting pen onto the drafting film. When interpreting features, it was imperative that consistency in the interpretation was attained, as it is here that considerable errors of judgement may occur. To verify consistency, adjacent orthophotographs were checked to see that features followed from one on to another. Corresponding 1944 and 1996 film overlays were also examined, to establish that there were no major discrepancies in features.

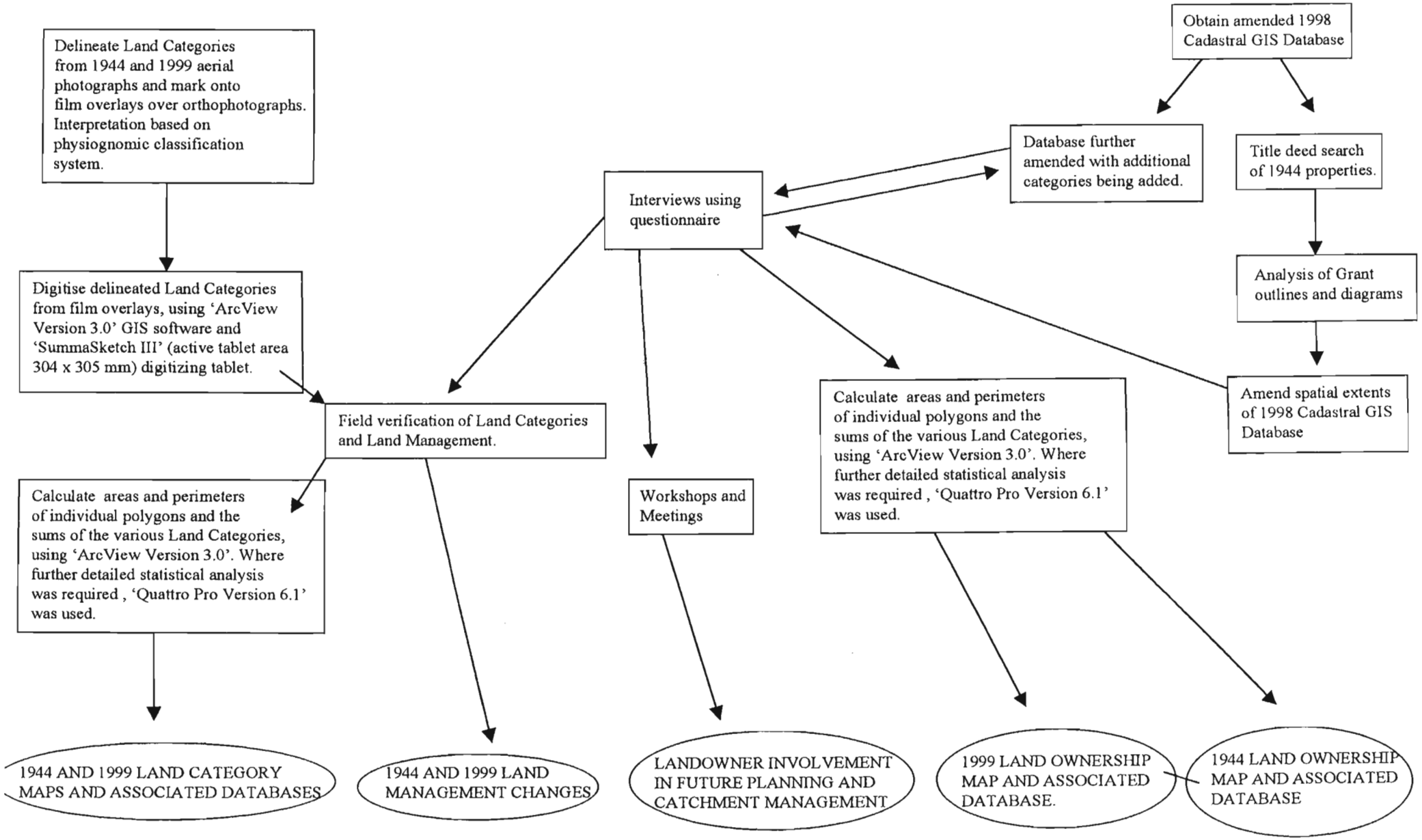


Figure 5.1. Steps to Determine Land Transformation and the Resulting End Products Provided

Where discrepancies such as variation in feature size and type and varying location were found, these were checked and where necessary corrected. Aerial photographs were interpreted according to a physiognomic-structural vegetation classification system developed by Granger (undated), which was based on a scheme proposed by Edwards (1983). Physiognomy is defined as, 'the appearance, especially the external appearance, of the vegetation, partly resulting from, but not to be confused with, structure and function.....' (Fosberg 1967 in Edwards 1983). Vegetation structure is defined as, 'the organisation in space of the individuals that form a stand (and by extension a vegetation type or a plant association)' and the 'primary elements of structure are growth-form, stratification and coverage' (Danserau 1957 in Edwards 1983). Granger's classification system incorporates growth-form, stratification (height) and coverage (also known as projected canopy cover (PCC) and crown:gap ratio) (Appendix 5.(p.140)). Projected canopy cover of the upper stratum is defined as the vertical projection of the crown or shoot area of the plant onto the ground (Edwards 1983 in Granger undated). The amount of cover contributed by the canopy stratum can also be expressed as a ratio between the mean diameter of the crown to the distance between crowns. This is termed crown:gap ratio (Edwards 1983 in Granger undated). Granger's system comprises eight primary categories, 66 secondary categories and over 1000 possible 'real' categories at the tertiary level. The level of detail used is dependent on the requirements of the study and on time constraints. As this study is intended to provide a database of selected features for future planning and catchment management, a large number of categories were identified, with provision being made for these in the Geographical Information System (GIS) database. This is to allow flexibility for updating the database by catchment users and thus to ensure that the database remains dynamic over time. Due to time constraints and this dissertation being a course work Masters and not a full Masters dissertation, data for many of these categories has however not been inserted. For the purpose of this study data has predominantly been inserted to the primary category level. Other information has been added such as: habitat moisture regime for grassland and 'Exotic Vegetation - Wild'; timber species for 'Exotic Vegetation - Managed' and degrees of erosion. The eighth primary category, 'Exotic Vegetation' was omitted and three 'Exotic Vegetation' categories were added, namely: 'Exotic Vegetation - Managed', 'Exotic Vegetation - Wild' and 'Exotic Vegetation - Human Habitation'. This was done to create a distinction between exotic vegetation, which was 'wilfully' planted and that, which has 'escaped' and invaded indigenous areas.

Other primary categories were added for land use types not termed indigenous vegetation. These included: 'Cultivation - Commercial', 'Cultivation - Subsistence', rock outcrops, erosion, quarry, farm dam, buildings and main roads. Definitions of the physiognomic categories are contained in Appendix 5. (p.140).

Control points were marked onto each 1944 and 1996 film overlay, by dividing the orthophotograph map area into nine uniform squares. Control points were situated at the intersections and corners of the squares. Latitude and longitude were noted for each intersection and corner. These points were then translated into decimal degrees by dividing the minute value by 60 and multiplying by 100. The degree value remained unchanged. The division of 60 was used as there are 60 minutes in every degree. All longitudes (y) were given a negative value, due to being located in the southern hemisphere. Latitudes (x) were given a positive value. The annotated film overlays with marked control points were then secured separately onto the active tablet area of a digitising tablet ('SummaSketch III', active tablet area - 304 x 304 mm) with masking tape. Using the GIS software package 'ArcView, Version 3.0' a 'project' file with two 'views', Land Categories 1944 and Land Categories 1999 were created. View properties for each 'view' were set to: *map units - decimal degrees and distance units - metres*. No projection was set. This was so that data created could be projected to the required projection at a later stage. This was advantageous as it allows compatibility with other digital databases, attained from other sources with varying projections. Various 'theme' files and their corresponding 'attribute tables' with 'fields' were created for 1944 and 1999 (Table 5.1. (p. 49)). Prior to digitising, each annotated map was registered according to the geographic space in the 'view'. This was achieved by transferring the ground co-ordinates for the control points that were identified into the 'ArcView Version 3.0' GIS software. The digitiser setup from the 'view' menu was initiated, the digitizer puck icon was activated and the puck was used to click on four previously marked corner control points. The points were clicked in a clockwise direction. The x and y decimal degree values for each control point were entered. If error limits of 0.010 or less were achieved the map was registered. Digitising was undertaken in absolute (digitising) mode and commands of 'ArcView Version 3.0' were accessed by relative (mouse) mode. Digitising was undertaken on one digitising 'theme' for 1944 and 1999, respectively.

Table 5.1. Theme Files and Corresponding Attribute Table Fields for Land Categories in 1944 and 1999

THEME	ATTRIBUTE TABLE - FIELDS
Forest	shape, id, code, area, perimeter
Thicket	shape, id, code, area, perimeter
Shrubland	shape, id, code, habitat moisture regime, under storey code, area, perimeter
Woodland	shape, id, code, habitat moisture regime, under storey code, area, perimeter
Grassland	shape, id, code, species, habitat moisture regime, managed, area, perimeter
Herbland	shape, id, code, under storey code, area, perimeter
Forbland	shape, id, code, area, perimeter
Exotic Vegetation - Managed	shape, id, code, species, status, area, perimeter
Exotic Vegetation - Wild	shape, id, code, species, status, habitat moisture regime, area, perimeter
Exotic Vegetation - Human Habitation	shape, id, code, area, perimeter
Cultivation - Commercial	shape, id, code, crop type, status, area, perimeter
Cultivation - Subsistence	shape, id, code, crop type, status, area, perimeter
Rock Outcrops	shape, id, code, area, perimeter
Erosion	shape, id, code, area, perimeter
Quarry	shape, id, area, perimeter
Farm Dam	shape, id, area, perimeter
Buildings	shape, id, code, area, perimeter
Main Roads	shape, id, area, perimeter

Large entire areas with multiple land category features within were digitised. Individual land categories were then 'cut' and 'pasted' onto their own 'themes' of forest, grassland etc. This method ensured digitised features occurred exactly adjacent to one another with no gaps in between. Areas, perimeters and properties of individual polygons for each land category of forest, grassland etc. were calculated after the field verification, as described in 5.2. and questionnaires and interviews, as described in 5.4 below had been completed. Areas and perimeters were calculated via running an 'ArcView - Avenue' script called 'calcapl.ave'. The script worked only when the 'theme' was active, the 'attribute table' of the 'theme' was open, the 'field' 'area' was selected and when the 'view' had been projected. The land category features were initially digitised with the map units - decimal degrees and distance units - metres. The Surveyor-General 1998 property cadastral database used was also supplied with the map units - decimal degrees and distance units - metres. The area and perimeter calculation worked only when the 'view' properties were altered to: Projection - Transverse Mercator; Spheroid - Clarke 1880 and Central Meridian - 31^0 East. The projection type was chosen as it was the same as that of the Orthophotographs (Gauss Conform Projection) from which the land categories were digitised. 'ArcView Version 3.0' does not support the Spheroid - WGS84, which is now widely used. Areas and perimeters calculated were therefore not compliant with this spheroid type. However, as the land category maps were digitised and the Surveyor-General 1998 property cadastral database was supplied with the map units - decimal degrees and distance units - metres, with no projection or spheroid specified, by using 'ArcView Version 3.2.' these maps could be projected to this spheroid and areas and perimeters may be calculated according to this spheroid type, should this be required. Total areas of all polygons in each land category and for all properties of 1944 and 1999 were attained by using the 'attribute table' function, 'statistics' from the field menu. For the 'statistics' function to work, the 'field' area had to be highlighted and numerated. Area statistics attained other than total area included: numbers of polygons, mean area, maximum area and minimum area of polygons, range, variance and standard deviation of data. Where land categories had been separated into other categories such as: habitat moisture regime, timber species and degrees of erosion, these were simply totalled. Where further statistical analysis was required 'Quattro Pro Version 6.1.' was used for manipulation and analysis.

Various GIS digital data sets were obtained from Government bodies, organisations and from individuals. These were obtained to provide background descriptive information on the study area and to provide a base on which to build new information. A list containing information such as: database name, description, method and scale of capture, date of capture, source of data / acknowledgement and usage in this dissertation is included as Appendix 6 (p.141).

5.2. FIELD VERIFICATION OF LAND CATEGORIES AND LAND MANAGEMENT

Although the 'view' titled 'Land Categories 1999', had been dated 1999 it was initially created by manually, visually, photo-interpreting 1996 aerial photographs. The initial land categories mapped in GIS were therefore 1996 land categories. Field verification was therefore necessary to update the 1996 land category map to a 1999 version. As the study area is large (383 km^2) it was not possible to check every area mapped. Key areas which were accessible or visible from the road, were chosen and field checked. Particular attention was paid to checking natural grasslands, dairy pastures and crops, as these look fairly similar on the aerial photographs. Timber species were determined for the land category, 'Exotic Vegetation - Managed', as this level of detail was not discernible from the scale of aerial photographs. Field checking was carried out through the duration of the study, with final field checking being done in September and October 1999. Field verification was also undertaken as a means of checking land category assumptions made from examining the 1944 aerial photographs and to verify and determine current and past land management not discernible from the aerial photographs.

5.3. TITLE DEED SEARCH

Determination of changes in property ownership and extent between 1944 and 1999 was considered important as it could reflect the fragmentation of land and reduction in farm size, which is strongly correlated with changes in land categories and land management. An amended 'ArcView Version 3.0' GIS digital database of the 1998 cadastral boundaries for the Karkloof Catchment was obtained from the iNdlovu Regional Council, who obtained the database from the Surveyor-General, Pietermaritzburg, South Africa. Amendments made to the database included the input of ownership names and property details, which were obtained from title deed searches undertaken in July 1999. These amendments were effected by the iNdlovu Regional Council, GIS Department.

The spatial extents of properties was not altered in any way, as no spatial changes had taken place since the original creation of the database in 1998 (K. Sivenandan, 1999, pers. comm.). The database was used with a new 'attribute table' being created. 'Fields' such as identity, property name, grant number, sub. number, farm name, owner type, owner name, area and perimeter were added (Appendix 9. (p.144)). No GIS digital data was available for 1944 cadastral boundaries. Therefore, a list was made of all the property names and grant numbers within the catchment in 1999 and those that were known to exist prior to any consolidation taking place. The list was compiled from the amended 1999 GIS cadastral boundary database as well as from the 1:50 000 Topographical maps of the area. The corresponding deeds registers of these were investigated in the Deeds Office, Surveyor-General, Pietermaritzburg. Grants were traced to 1944. Properties stemming from these grants existing in 1944 were noted. Details such as: owners name, date acquired and date disposed of, sub. number and registered area when given, were noted. The acquired date given was sometimes before 1944 and sometimes after, as the nearest available date to 1944 was recorded. Other available dates were often too far from 1944 or simply not available. This can be attributed to people owning land for the duration of their lifetime this often being for 70 years or more, as well as properties being subdivided and then sold only some years later. Only the change in ownership and not the original subdivision is often recorded in the deeds register. Ownership of one property could not be determined as no records were available in the deeds register. This is marked as unknown. Grant outlines and grant diagrams of the determined 1944 properties were examined in the Plan Safe, of the Surveyor-General, Pietermaritzburg, South Africa. These were compared with the amended digital database of the 1999 cadastral boundaries. This database was used as a base from which to create a 1944 cadastral boundary digital database. Original reference points of the 1944 properties, which could be seen on the grant outlines and diagrams, were also visible on the 1999 properties. These were used as a guide to recreate the extents of the 1944 properties. In cases where the properties of 1944 did not resemble those in 1999 and no reference points were available, best approximations were made. Amendments to the digital database of the 1999 cadastral boundaries were made and the 1944 cadastral boundary digital database was created. A new corresponding attribute table was created with 'fields': identity, property name, grant number, owner name, date acquired and disposed of, sub. number, registered area when available, owner type, area and perimeter (Appendix 9. (p.144)).

5.4. QUESTIONNAIRE AND INTERVIEWS

Formal interviews, with the aid of a questionnaire, were conducted with land-owners in the Karkloof Catchment. Land-owners were interviewed individually. This was found to be highly productive as participants were not influenced by others, which often occurs in group interviews or workshops. Also participants were more willing to share their personal feelings and experiences. Interviews were conducted at the homes or places of work of land-owners. As land use in the catchment is mixed, respondents were selected to represent the major land use categories which included: commercial timber plantations (large-scale corporate and small-scale private), commercial cultivation (mainly dairy pastures and annual crops), beef farming on natural grassland, pig farming, environmental conservation and tourism ventures. Land-owners whose families had owned land in the catchment for generations often from the 1850s and 1860s were considered important, due to their knowledge of early land use and land management, particularly in 1944. Seven such land-owners were interviewed. Participants were also selected to represent each of the four principle geographical sectors of the catchment, namely: the southern, the central, the north-western and the north-eastern sectors. Nineteen land-owners in total were interviewed during October, November and December 1998 (Appendix 7. (p.142)). The questionnaire used is qualitative and subjective, being open to differential interpretation. The questionnaire structure and the manner in which it was presented provided answers to questions and also information that could not have been obtained via any other method. Insight was provided into the quantitative data gathered in the GIS mapping procedure. Questions asked and information obtained included: the verification of 1944 and 1999 property ownership and size; the establishment of changes in land management practices; the verification of the extent and presence of alien vegetation invasion; an understanding of how participants perceived alien vegetation invasion's correlation to land use and land management changes, and finally how participants viewed their involvement in future planning and catchment management (Appendix 8. (p.143)). During the interview process, participants were informally asked for any background information on the Karkloof Catchment and to verify 1944 and 1999 land categories. Relevant annotated film overlays, corresponding orthophotographs and aerial photographs were shown to participants. Participants were asked to verify the annotated features of 1999 and where possible those of 1944. The use of orthopohotographs and aerial photographs helped to stimulate discussion and trigger participants' memory, although often the imagination was also triggered.

However as this flaw was anticipated, care was taken to analyse comments carefully so as to extract only information that was purely factual and relevant.

5.5. WORKSHOPS AND MEETINGS

Six workshops and meetings of the Karkloof Conservancy, the Karkloof Catchment Management Forum and the Albert Falls Management Unit of the Mgeni Catchment - Core Steering Group were attended (Appendix 7. (p.142)). The purpose of attendance was to gain an understanding on the functioning of these bodies, to determine stakeholder involvement in future planning and catchment management and to analyse how the data gathered in this dissertation could be used for the future planning and management of the catchment.

CHAPTER 6: RESULTS

6.1. CHANGES IN LAND CATEGORIES AND LAND MANAGEMENT BETWEEN 1944 AND 1999

6.1.1. Overview of Changes

Land categories in the Karkloof Catchment in 1944 and 1999 are shown in Figure 6.1. (p.57) and Figure 6.2. (p.58) respectively. Total areas of each category and the percentage of the total catchment area which they occupied, together with changes in area are given in Table 6.1. (p.59). The proportions of the Karkloof Catchment occupied by each land category in 1944 and 1999 are presented as percentage values in Figure 6.3. (p.60). Two complementary methods of describing change in area expressed as a percentage are presented in Table 6.1. (p.59). The first statistic describes the change in area of each land category between 1944 and 1999 as a percentage of the total catchment area. This statistic has been provided because:

- it has been used in a number of references, which have been used as background for this study and so direct comparisons can be made between these other studies and this one. This is particularly important in the case of the thesis produced by Rivers-Moore (1997) who carried out a very similar kind of study in the Midmar Catchment, which adjoins the Karkloof Catchment along its western boundary;
- it is a statistic which is used in the software package called 'FRAGSTATS' (McGarigal *et al.* 1995) which was developed to quantify landscape structure. Although 'FRAGSTATS' was not applied in this study, one of the objectives of the study was to produce a database which could be used for further analyses of landscape features in the Karkloof Catchment should this be required. A reading of the 'FRAGSTATS' manual has left me with the opinion that this might be a suitable software package for any further analyses. Hence the data which I have developed and analysed can be submitted to 'FRAGSTATS' routines with no additional calculations having to be carried out;
- many people tend to think of changes in landscape features in terms of this statistic. This may be edifying for them but it may also be misleading. In instances where it is misleading it is only by comparing the value of this statistic with the second statistic that the misconception is likely to become apparent.

The second statistic describes the change in the area of each land category between 1944 and 1999 as a percentage of the area occupied by each category in 1944. The importance of the need to consider this statistic can be gauged from situations where, for example, the area occupied by a particular category in 1944 was small relative to the total catchment area and where the area may not have changed very much by 1999. By simply expressing such change as a percentage of the total catchment area the change might seem rather insignificant but where the category is an important one say for nature conservation the use of the second statistic could reveal a more profound picture. An example of this would be the category, 'Exotic Vegetation – Wild', whose area relative to the total catchment area increased between 1944 and 1999 by only 2.0%, however relative to its area present in 1944 there was a profound increase of 397.3% in the category.

Important land category changes include the following:

- a major loss of grassland has occurred in which most of these areas have been replaced by 'Exotic Vegetation - Managed' and to a lesser extent by 'Cultivation - Commercial';
- 'Forest' and 'Woodland' have increased marginally;
- 'Cultivation - Subsistence' has been reduced significantly, with very little being undertaken in the catchment in 1999;
- 'Farm dams' have increased in number, as well as in size.

Important land management changes include the following:

- extraction of indigenous timber from the Karkloof Forest has ceased;
- the frequency of grassland burning has decreased, although areas which receive the highest mean annual rainfall, situated to the north and north-east of the catchment are still burnt annually;
- in 1944 firebreaks were created by burning strips of vegetation without any prior preparation or by hoeing an edge approximately 0.5 m wide on either side of a vegetation strip and then burning between the hoed edges. The hoeing of edges often caused soil erosion. In 1999 firebreaks were mostly created by first spraying a 'tracer break' approximately 0.3 m wide on either side of a vegetation strip and then burning between the 'tracer breaks';
- responses from interviews revealed that grasslands were generally overgrazed in 1944 and moderately grazed in 1999;

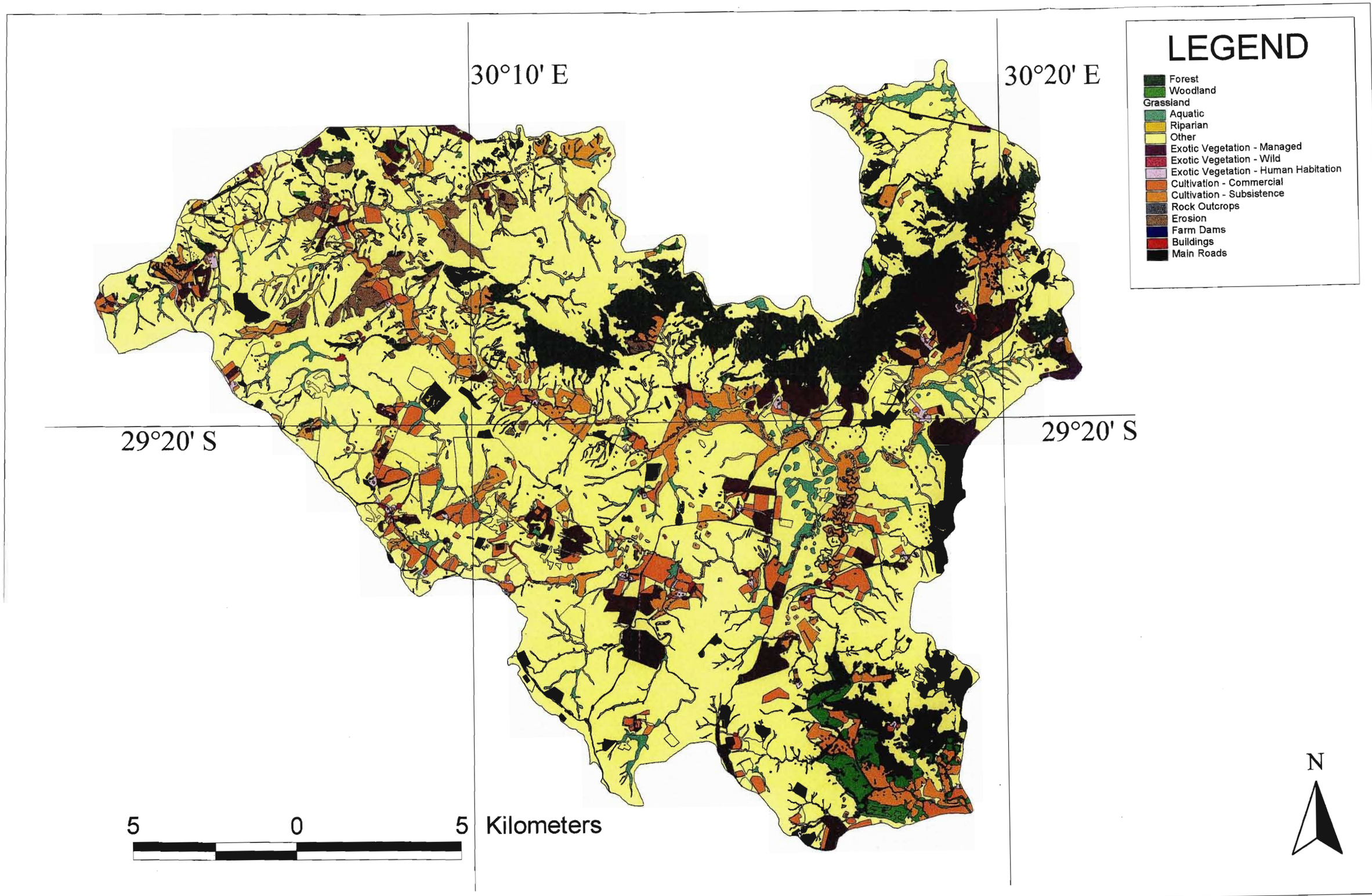


Figure 6.1. Land Categories in the Karkloof Catchment in 1944

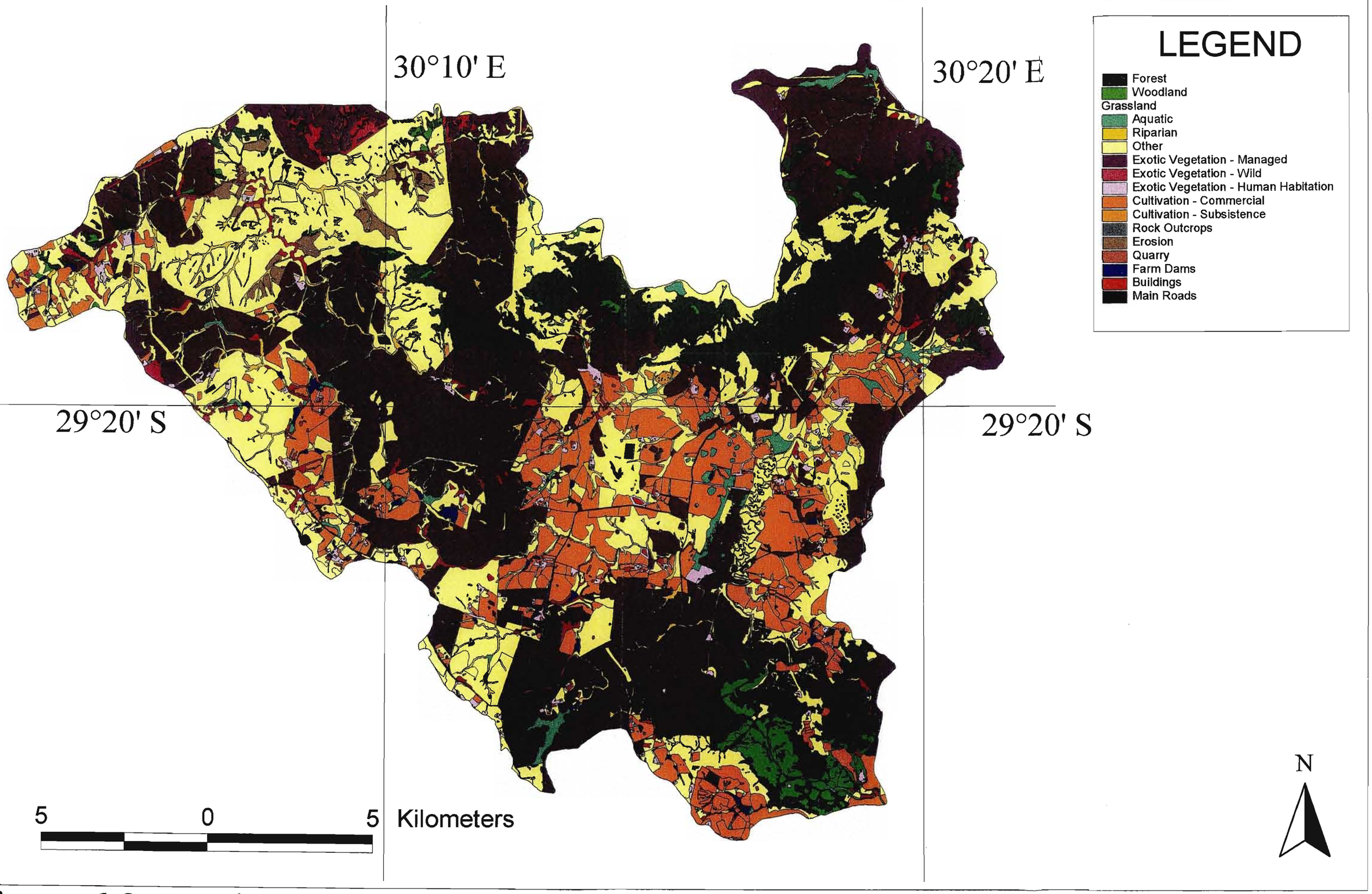


Figure 6.2. Land Categories in the Karkloof Catchment in 1999

Table 6.1. Total Areas for 1944 and 1999 Land Categories

Note: Area shown in km^2. Negative (-) values represent a decrease. Positive (+) values represent an increase.

	1944	1944	1999	1999	1999-1944	1999-1944	1999-1944
Land Category	**Area**	**% of total catchment**	**Area**	**% of total catchment**	**Area change**	**% Change[1]**	**% Change[2]**
Forest	37.91	9.9	39.57	10.3	1.65	0.4	4.4
Woodland	6.29	1.6	7.66	2.0	1.37	0.4	21.7
Grassland Total	**264.22**	**68.9**	**122.62**	**32.0**	**-141.60**	**-37.0**	**-53.6**
Aquatic	7.59	2.0	4.74	1.2	-2.85	-0.7	-37.6
Riparian	14.09	3.7	13.32	3.5	-0.78	-0.2	-5.5
Other	242.54	63.3	104.56	27.3	-137.98	-36.0	-56.9
Exotic Vegetation - Managed Total	**26.34**	**6.9**	**138.71**	**36.2**	**112.38**	**29.3**	**426.7**
Acacia spp.	23.89	6.2	14.20	3.7	-9.69	-2.5	-40.6
Eucalyptus spp.	1.82	0.5	29.27	7.6	27.45	7.2	1508.5
Populus spp.	None	None	0.25	0.1	0.25	0.1	-
Pinus patula	None	None	58.87	15.4	58.87	15.4	-
Other *Pinus spp.*	0.63	0.2	35.10	9.2	34.47	9.0	5475.2
Quercus spp.	None	None	0.14	0.0	0.14	0.0	-
Unknown	None	None	0.90	0.2	0.90	0.2	-
Exotic Vegetation - Wild Total	**1.94**	**0.5**	**9.66**	**2.5**	**7.71**	**2.0**	**397.3**
Riparian	1.21	0.3	3.25	0.8	2.04	0.5	168.4
Other	0.73	0.2	6.41	1.7	5.68	1.5	776.4
Exotic Vegetation - Human Habitation	1.94	0.5	5.63	1.5	3.69	1.0	190.3
Cultivation - Commercial	12.29	3.2	50.55	13.2	38.25	10.0	311.2
Cultivation - Subsistence	23.00	6.0	0.48	0.1	-22.52	-5.9	-97.9
Rock Outcrops	0.10	0.0	0.07	0.0	-0.04	-0.0	-36.3
Erosion Total	**6.78**	**1.8**	**3.46**	**0.9**	**-3.32**	**-0.9**	**-49.0**
Severe	4.40	1.1	1.26	0.3	-3.14	-0.8	-71.3
Moderate	2.27	0.6	1.16	0.3	-1.10	-0.3	-48.7
Slight	0.11	0.0	1.03	0.3	0.92	0.2	824.6
Quarry	None	None	0.02	0.0	0.02	0.0	-
Farm Dams	0.09	0.0	2.32	0.6	2.23	0.6	2503.1
Buildings	0.89	0.2	1.10	0.3	0.21	0.1	23.4
Main Roads	1.48	0.4	1.52	0.4	0.03	0.0	2.3
ACTUAL TOTAL	383.28	100.0	383.33	100.0	0.06	0.0	11414.8
ROUNDED TOTAL	383.00	100.0	383.00	100.0	0.00	0.0	11414.8

[1] Values represent change in area of each land category between 1944 and 1999 as a percentage of total catchment area.

[2] Values represent change in area of each land category between 1944 and 1999 as a percentage of their area that was present in 1944.

Because only a 0.01% difference was calculated between the total catchment area of 383.28 km^2 for 1944 and 383.33 km^2 for 1999, this was regarded as being an insignificant difference. Hence the catchment area for both years was rounded off to 383.00 km^2.

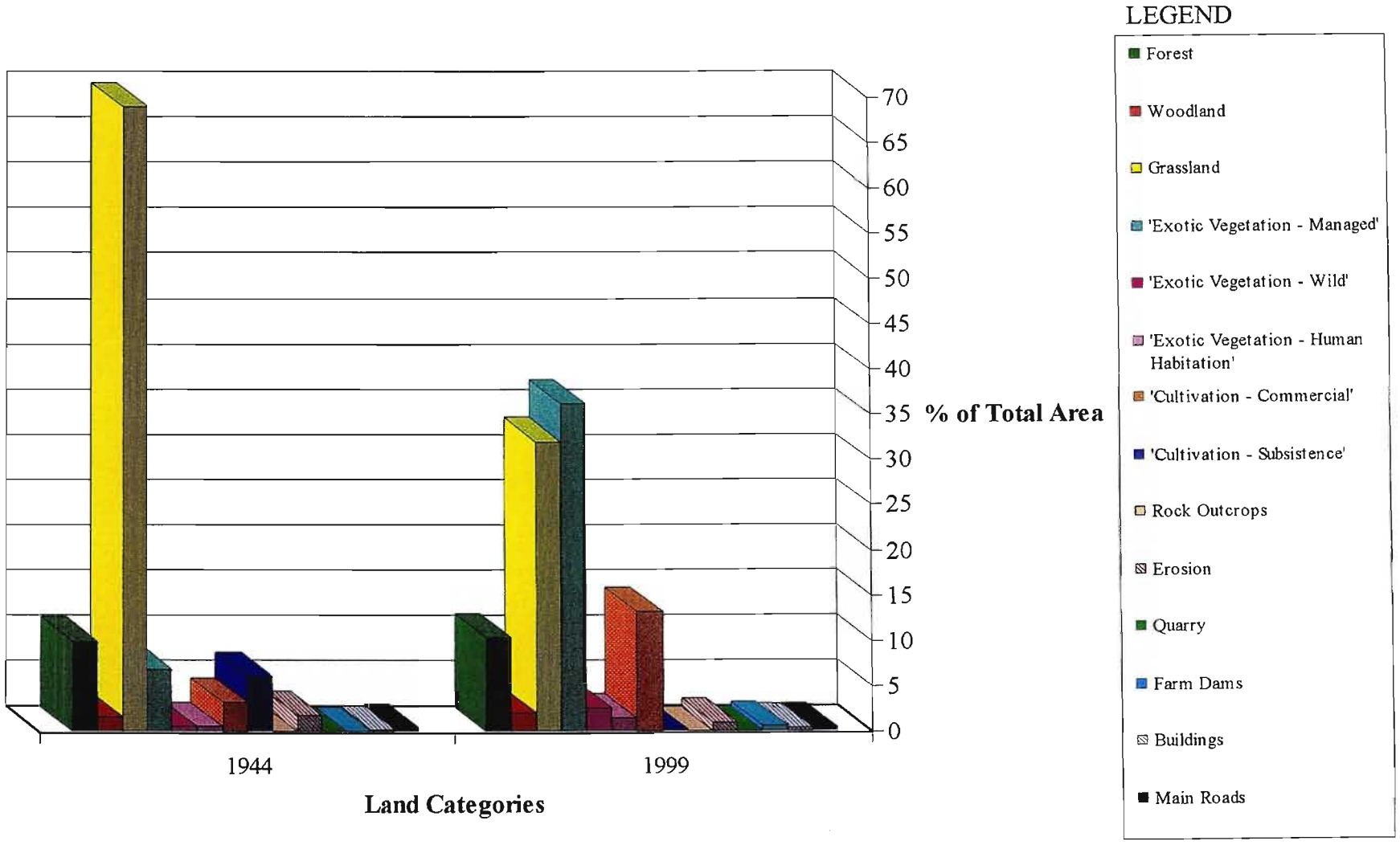


Figure 6.3. Bar chart showing the proportions of the different Land Categories in the catchment, as a percentage of the total area of the catchment in 1944 and 1999

- a perception by interviewees that the grazing quality of grasslands has generally improved. However, it was found that interviewees' perception of grazing quality is based more on total phytomass present rather than on the species composition of the grasslands. Extensive areas of *Aristida junciformis,* an unpalatable grass species were noted on farms visited during the study and from interpretation of the 1996 aerial photographs. *A. junciformis* produces a different texture and tone of colour on the landscape compared with *Themeda triandra*. The presence of large quantities of *A. junciformis* indicates that grassland species composition is poor;
- 'soil erosion', which refers to clearly discernible erosion gullies, has decreased;
- in 1944 'Exotic Vegetation - Managed' was planted directly adjacent to indigenous forests. This trend has continued and intensified;
- 'Exotic Vegetation - Managed' and 'Cultivation - Commercial' is being planted more in marginal areas, due to the competition for land and the need to maximise land use;
- in 1944 damaged grassland and forest areas were planted to 'Exotic Vegetation - Managed', in an effort to stabilise these areas;
- timber plantations of *Acacia* spp. are highly invasive: invading riparian areas extensively if not correctly managed;
- little effort was made in 1944 to control alien invasive plants and soil erosion associated with 'Exotic Vegetation - Managed' and 'Cultivation - Commercial'. In 1944 weeds were perceived as not that plentiful and erosion was perceived as being not a significant problem;
- alien vegetation was found to be associated with various land use practices, such as: the clearing of land for new or repeated cultivation; new planting or re-planting of timber; the disturbance of natural areas due mostly to overgrazing and erosion, and the abandonment of land;
- farmers in the catchment are gradually converting to 'no till' farming in an effort to reduce soil erosion and weed growth and to maintain soil moisture;
- extensive 'Cultivation - Subsistence' was taking place in 1944 in marginal areas, such as adjacent to steams and rivers and within indigenous forest. No 'Cultivation - Subsistence' was found to be taking place in 1999 on these areas identified in 1944. Environmental damage from 'Cultivation - Subsistence' was considerable.

Changes in land categories and land management are dealt with in more detail in the pages which follow.

6.1.2. Forest and Woodland

Indigenous forest increased slightly from 37.91 km^2 in 1944 to 39.57 km^2 in 1999: an increase of 4.4%. However, relative to the total area of the catchment (383 km^2) this represents an increase of only 0.4% for this vegetation type.

Woodland also increased: from 6.29 km^2 in 1944 to 7.66 km^2 in 1999: an increase of 21.7%. Relative to the total catchment this represents an increase of only 0.4%.

Woodland areas present in 1944 and identified during the course of this study within or adjacent to large patches of forest, had become sufficiently dense to warrant their classification in 1999 as forest. Grassland patches present within or adjacent to large patches of forest in 1944 developed into woodland by 1999. Areas which were significantly disturbed, mostly by 'Subsistence - Cultivation' in 1944 and which were located adjacent to or near to forest areas, developed into 'Woodland' by 1999. Between 1944 and 1999 large blocks of forest expanded, while small isolated patches of both forest and woodland either decreased in size or were obliterated by 1999. Figure 6.6. (p.64) which illustrates the situation in the vicinity of the farms 'Everdon' and 'The Start' in 1944 and 1999, is a typical example of these vegetation changes. 'Land Transformation Representative Areas' have been used to show the various land transformations of 1944 and 1999 in greater detail. Figure 6.4 and 6.5 (p.63), shows the location of these areas within the catchment.

Extraction of indigenous timber from the Karkloof Forest still occurred in 1944 and Rycroft (1942) stated that from about 1845 onwards the forest suffered severely from extensive felling. He observed that many trees, principally *Podocarpus* spp. had been felled and that in several parts the devastation was still continuing. An indigenous timber mill existed in 1944 on the farm, 'The Forest' and timber was felled until 1955, when the timber mill was sold, dismantled and removed (P. Burdon, 1998, pers. comm.).

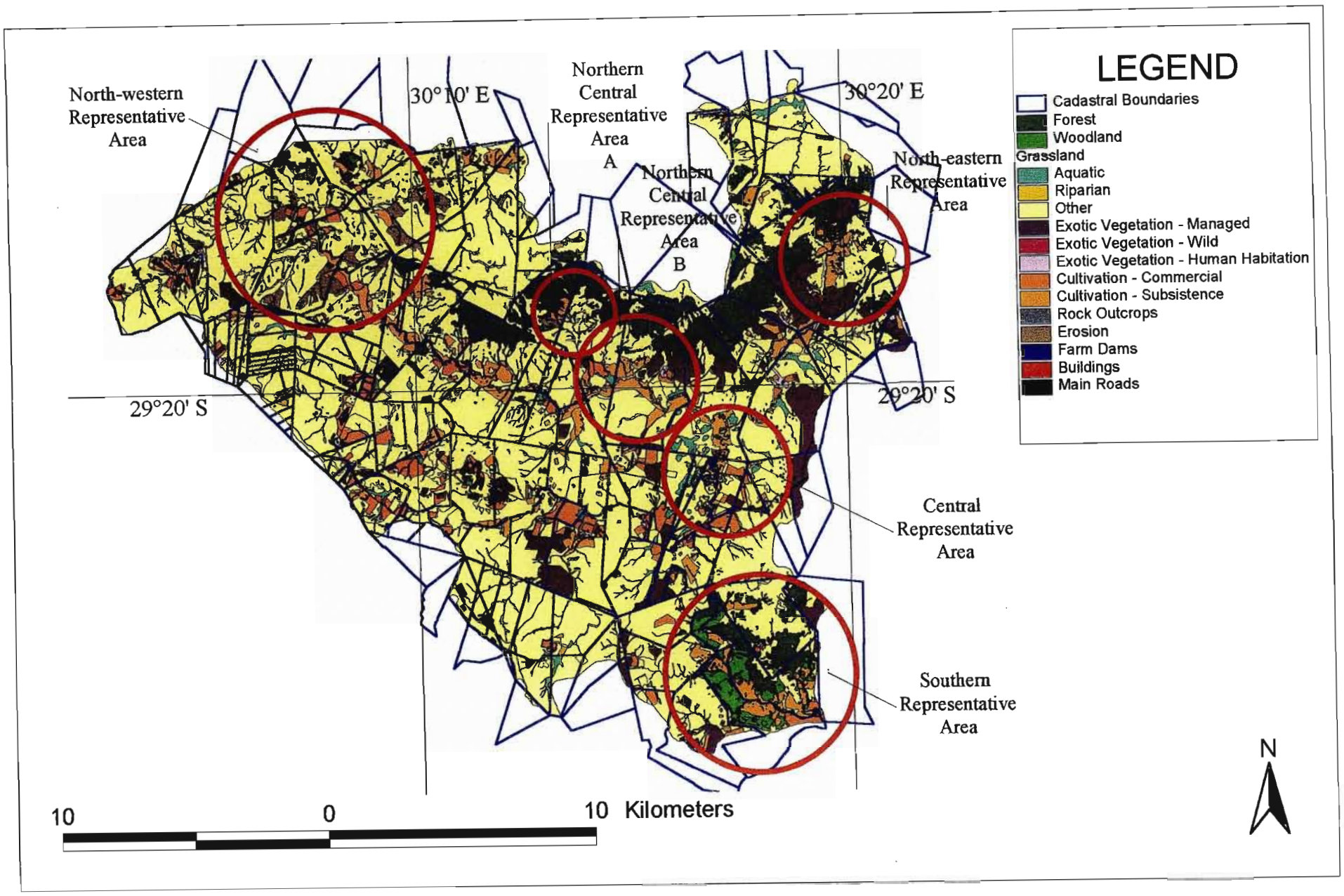


Figure 6.4. Location of Land Transformation Representative Areas in 1944

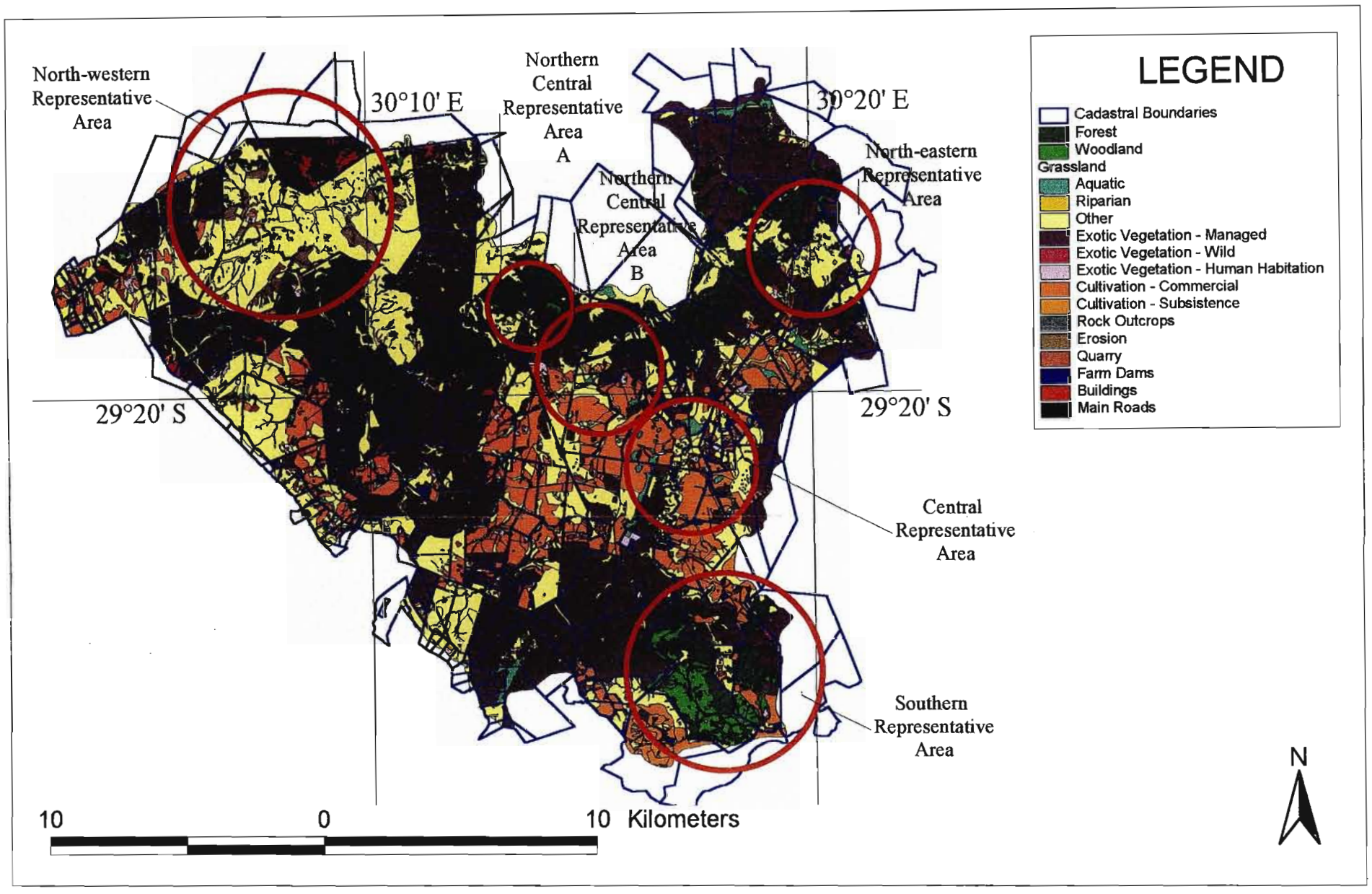
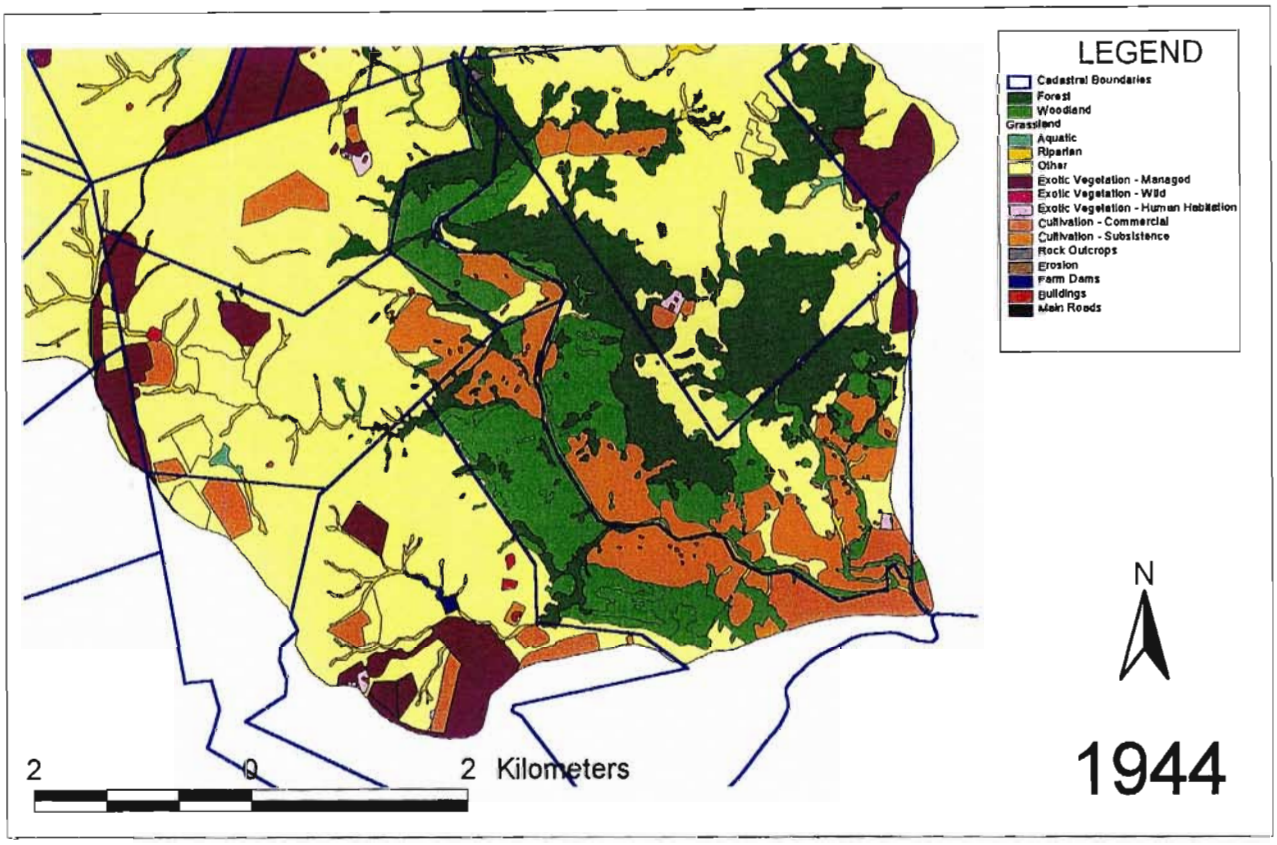


Figure 6.5. Location of Land Transformation Representative Areas in 1999



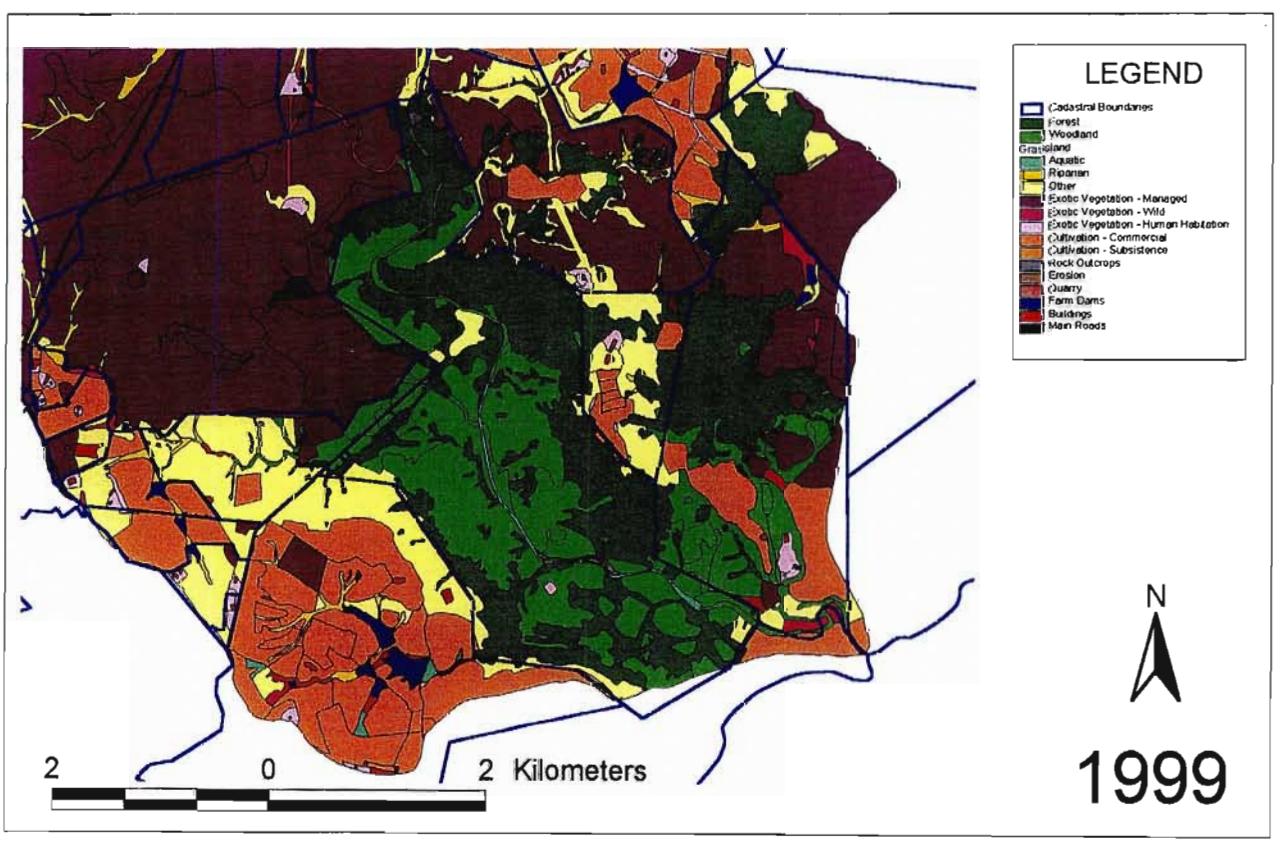


Figure 6.6. Southern Representative Area

A timber mill (Plate 7. (p.96)) also existed in 1944 on the farm 'Colbourne', which was owned by Walter Joseph Gower Shaw at that time (P. Shaw, 1998, pers. comm.). Austin Symons, son of Roydon Symons, who owned the original farm 'Shafton', remembers oxen and sleds being used extensively to extract timber from the forest and water-powered timber mills being used to cut up the timber. These mills existed on the farms: 'Shawswood', 'Colbourne' and 'Spitzkop'. (A. Symons, 1998, pers. comm.). Austin Symons's uncle, Bryan Symons, who owned the farm 'Spitzkop' in 1944, sold timber of indigenous species to the Union Government. 'Yellowwood' was the main timber extracted. Bryan Symons's neighbour, Harold Strapp, who exploited indigenous forests on the farm 'Rockwood' also supplied timber to Bryan Symons. The timber was used for railway sleepers and as structural timber for houses. The extraction of indigenous timber by white sawyers ceased in the 1960s (A. Symons, 1998, pers. comm.). However, logging paths and saw-pits are still easily found within the forest. A logging path (Plate 8. (p. 96)), saw-pits and the foundations of a timber mill (Plate 9. (p. 97)), were observed on the farm 'Ben Eden'. The mill was removed in the 1960s when the felling of indigenous timber ceased. (G. Boyd, 1998, pers. comm.).

6.1.3. Grassland and Erosion

Over the period under consideration in this study, the total area under grassland declined from 264.22 km^2 in 1944 to 122.62 km^2 in 1999: a decline of 141.60 km^2 or 53.6% of what was present in 1944. This is a decline of 37.0% in the area occupied by grassland in the catchment. This is a considerable loss of an important resource. The component details of this decline in grassland are given in Table 6.1. (p.59).

The loss of grassland is plainly obvious when comparing Figures 6.7. (p.66) and 6.8. (p.66). Most of this loss of grassland is due to its extensive replacement by 'Exotic Vegetation - Managed' and to a lesser extent by 'Cultivation - Commercial' [Figures 6.1. (p.57) and Figure 6.2. (p.58)]. A representative area, which illustrates these patterns of loss in more detail, occurs in the vicinity of the farms, 'Gartmore' and 'Loskop' (Figure 6.9. (p.67)).

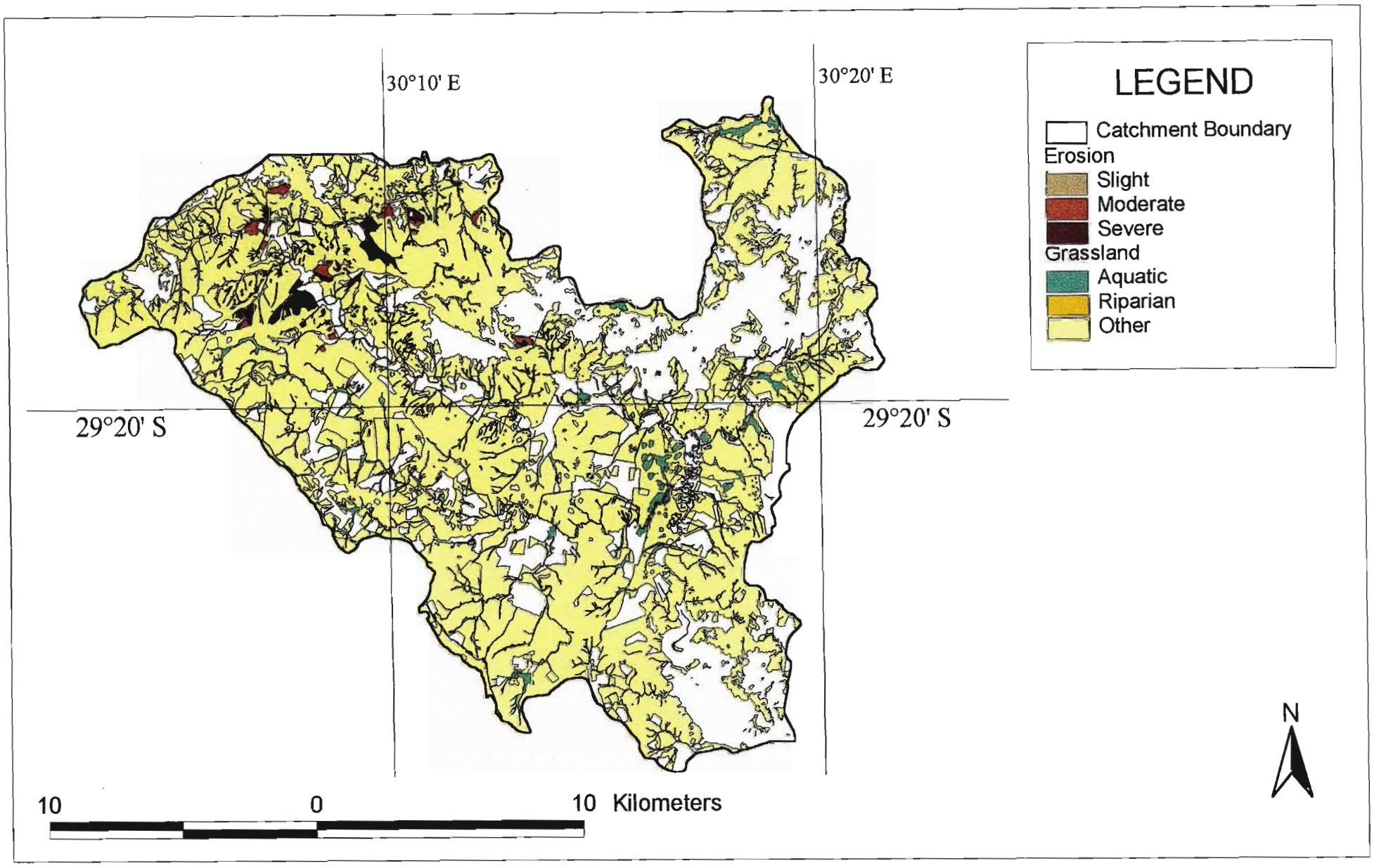


Figure 6.7. Extent of Grasslands and Erosion in 1944

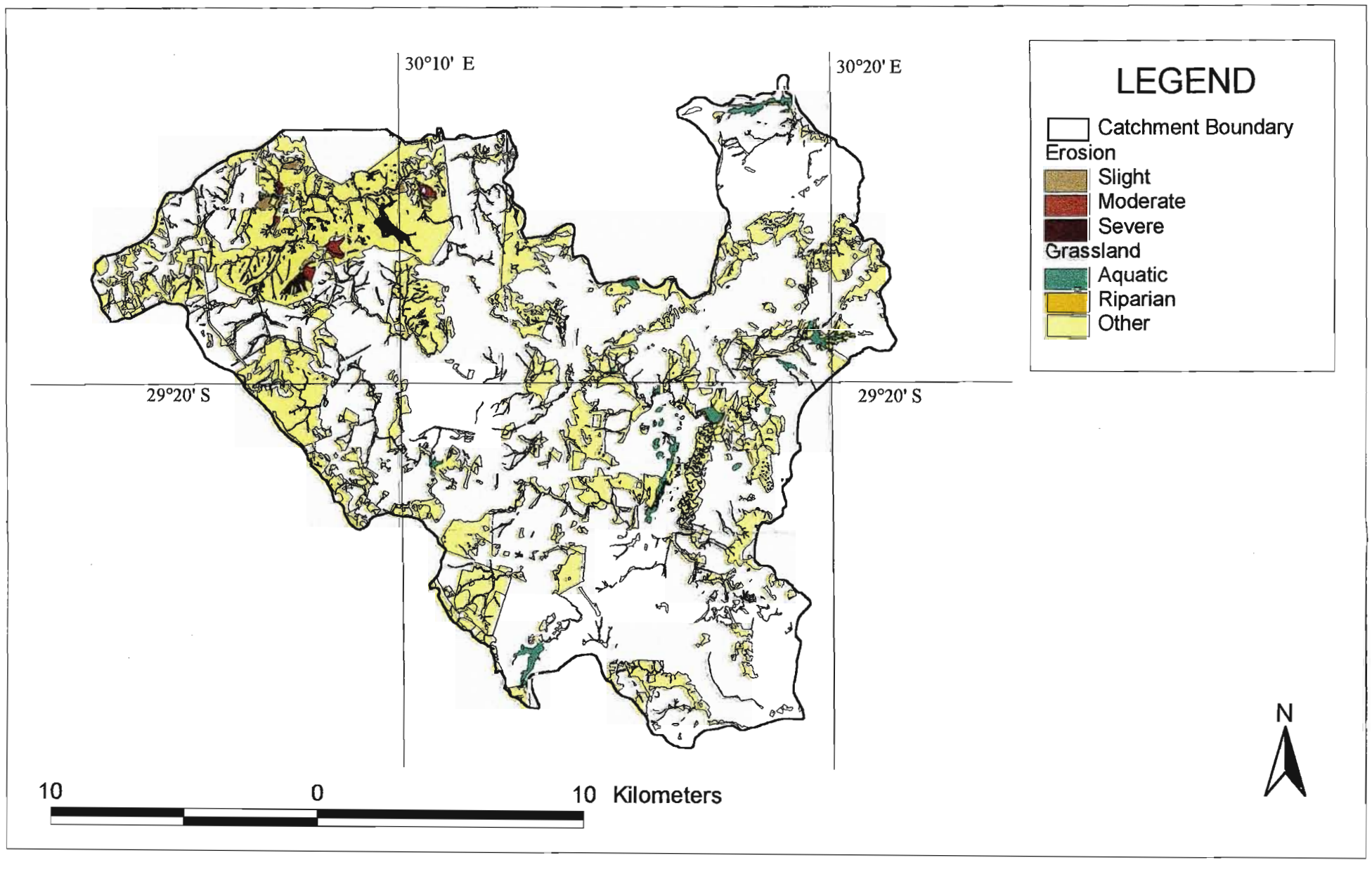
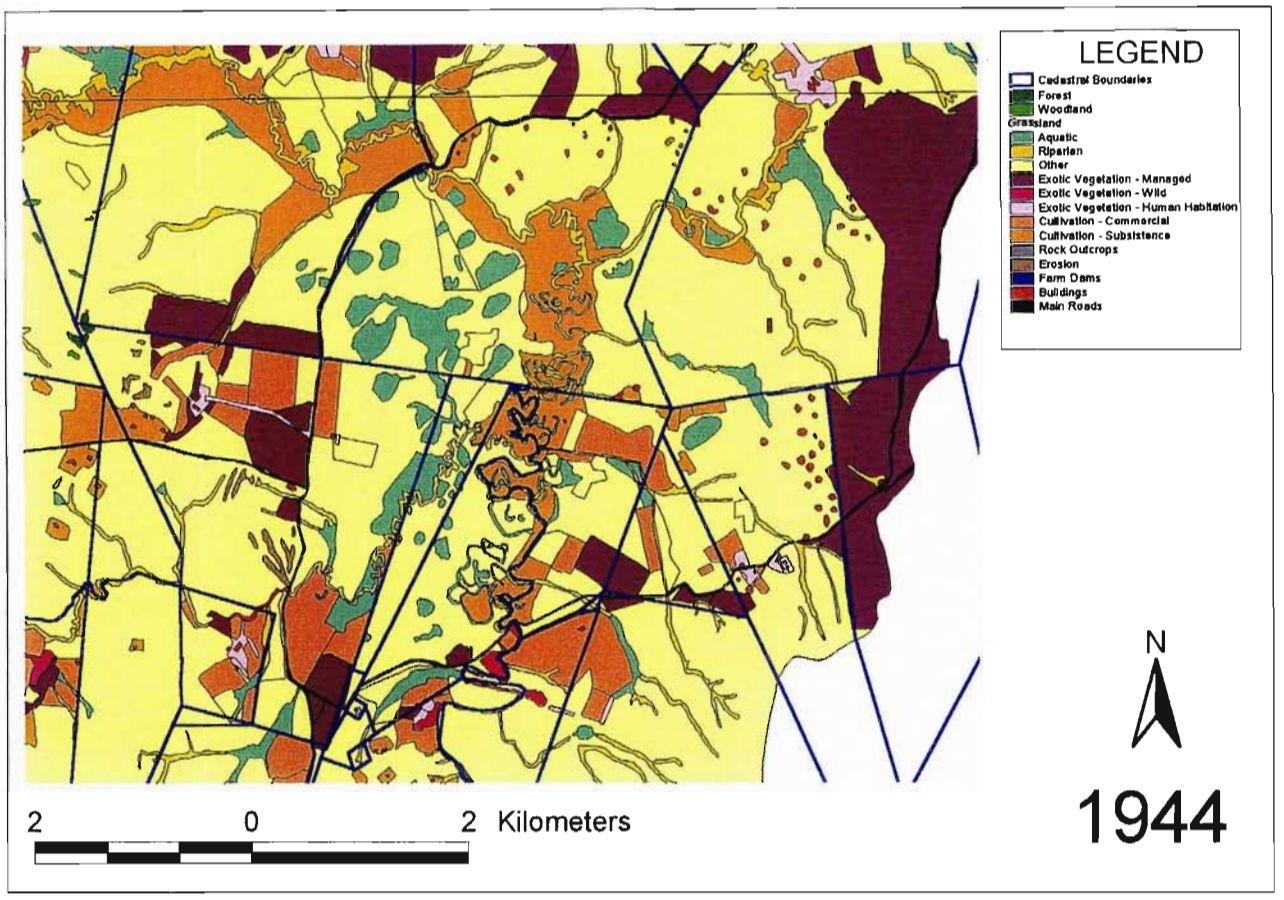


Figure 6.8. Extent of Grasslands and Erosion in 1999



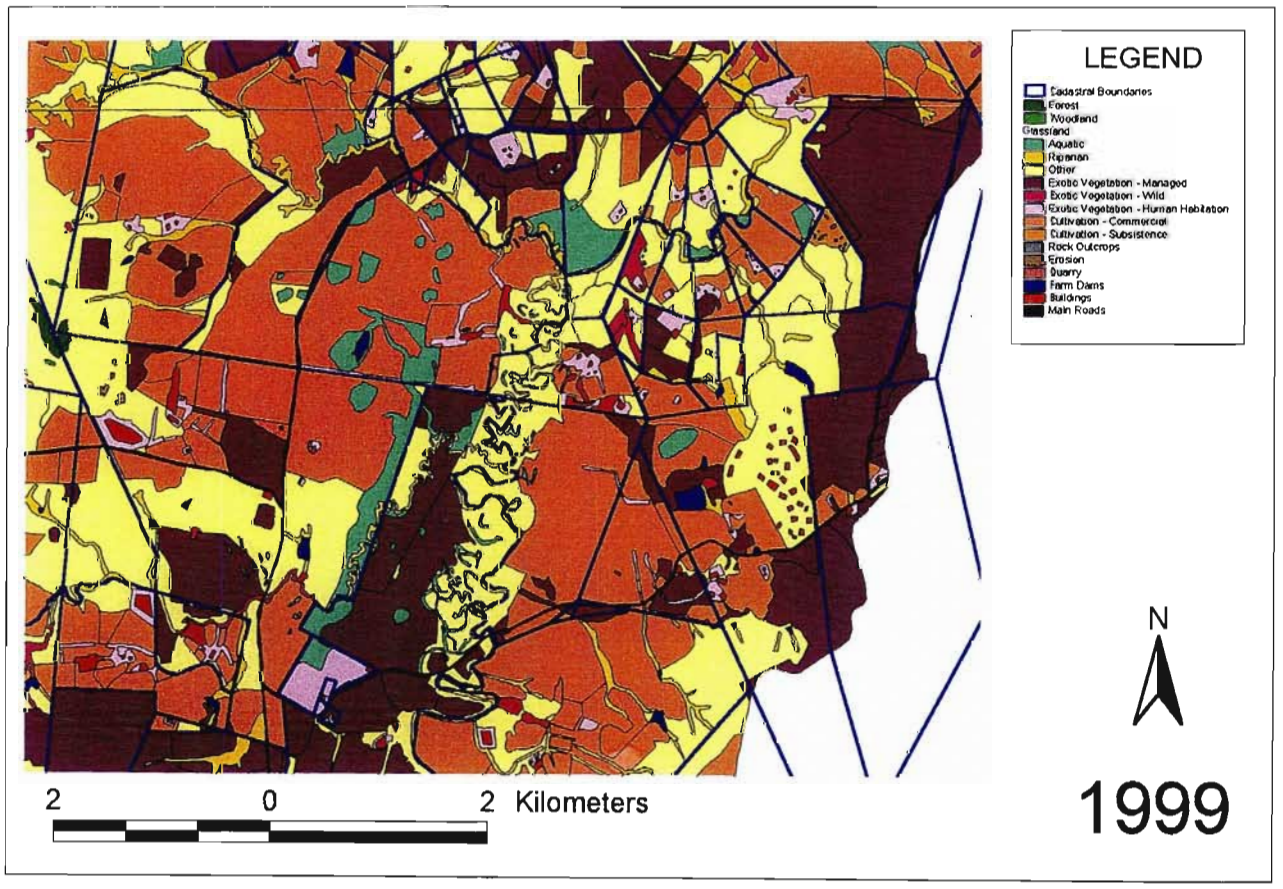


Figure 6.9. Central Representative Area

Particularly noteworthy in this area is the decreases in riparian and aquatic grassland between 1944 and 1999. Many aquatic grassland areas have completely disappeared, whilst surviving areas have become smaller in extent.

Responses by interviewees revealed that both in 1944 and 1999, firebreaks often follow features such as ridges, rivers, cliffs and roads but they also sometimes follow boundaries of properties, homesteads, timber plantations and cultivated fields. Currently, firebreaks are often burnt along the edges of an indigenous forest to prevent natural or anthropogenic fires from damaging the forest. Some property owners still prefer to hoe breaks adjacent to an indigenous forest rather than burn such boundaries. In 1944, firebreaks were created by burning strips of vegetation without any prior preparation or by hoeing an edge approximately 0.5 m wide on either side of a vegetation strip, and then burning between the hoed edges. The hoeing of edges often accelerated soil erosion (R. Pott, 1999, pers.comm.). Firebreaks in 1999 were mostly created by first spraying a 'tracer break' approximately 0.3 m wide on either side of a vegetation strip and then burning between the 'tracer breaks'. The 'tracer breaks' were created by spraying the grassland when it is still green with a dilute solution of a herbicide such as 'Garlon * 4'. Currently, a few land-owners still burn strips of vegetation directly, without creating 'tracer breaks'. However, this is not common and is dependent on the farm and fire and erosion hazard involved. Firebreaks were, and are, usually burnt annually.

Responses from the interviewees revealed that most grasslands were burnt every year throughout the catchment in 1944, usually to attain a green spring 'flush'. Currently however, grasslands in areas of low rainfall (822 mm - 905 mm mean annual rainfall), which are situated mainly to the north-west of the catchment (Figure 2.6. (p.15)), are burnt on a rotational basis every two to three years. While grasslands in areas of high rainfall (1152 mm mean annual rainfall), situated to the north-east are burnt annually where the condition of the grass warrants the frequent burn. High rainfall and high summer temperatures promote rapid growth. Unless the resultant material is removed through grazing or mowing it remains to form a moribund canopy in late autumn and winter which must then be removed usually by burning. If not removed this accumulated material leads to a decline in shade-intolerant grass species such as *Themeda triandra* and of grass basal cover in general.

Areas of the catchment that do not experience the extreme high or low rainfall (986 mm mean annual rainfall) are burnt on a rotational basis every two years, or only when required, depending on the moribund condition of the grass. Areas that are well grazed or mown for hay are not burnt. Large grassland areas within the indigenous forest are burnt on a rotational basis every three years, whilst the smaller areas are not usually burnt. These areas are burnt to control invasive alien vegetation (M. Hunt, 1998, pers. comm.). Wetland areas are burnt infrequently (C. MacGillivray, 1998, pers. comm.).

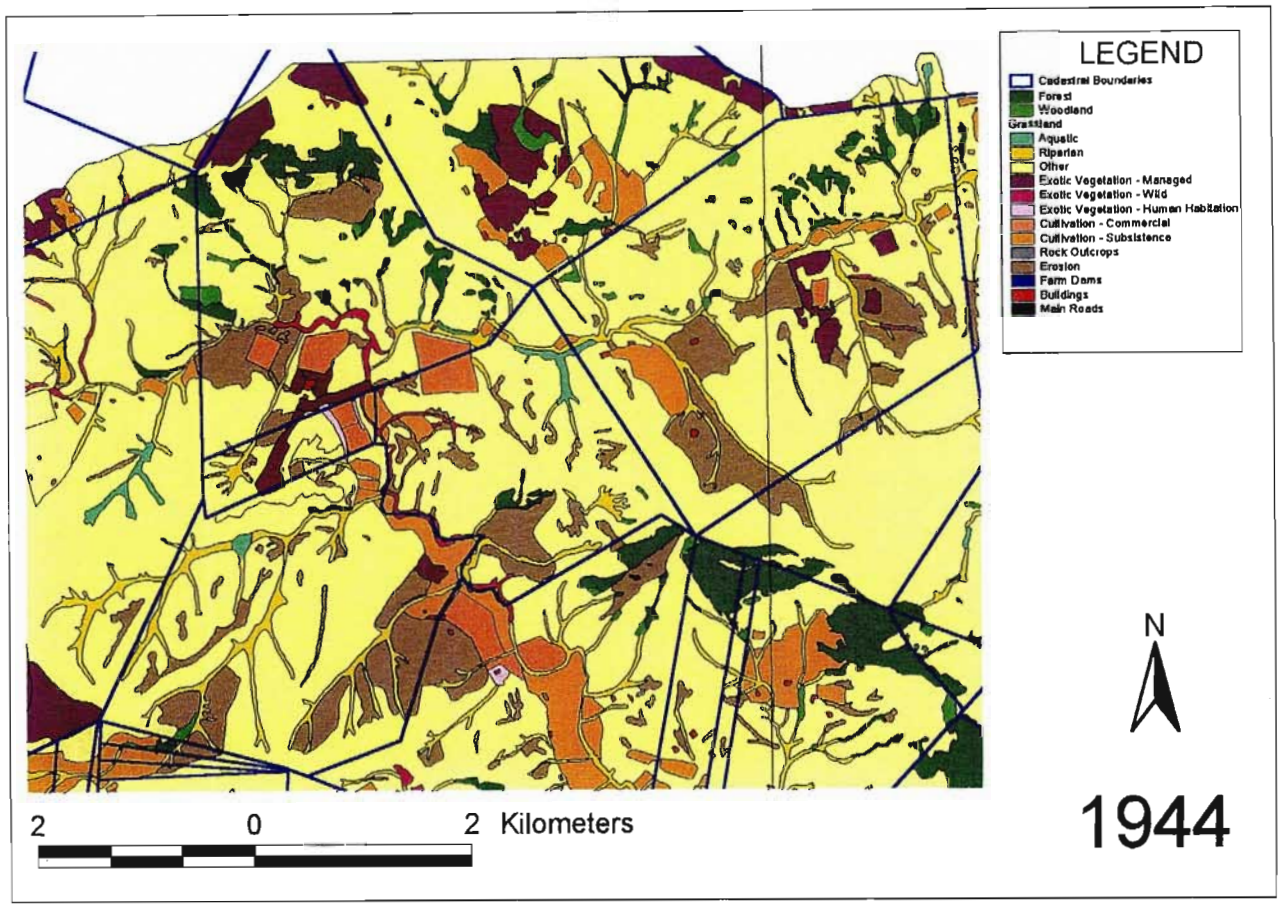
The interviews also revealed that in 1944 grasslands throughout the catchment were grazed heavily, mostly by subsistence cattle owned by the black farm-employees. Today, farm-employees keep very few cattle, as there is less reliance on cattle for subsistence. In 1944, white farm-owners kept small numbers of beef cattle, sheep and horses. Some dairy-cows were kept, but dairy farming was not profitable as it was difficult to transport milk and dairy products to commercial markets (A. Symons, 1998, pers. comm.).

Sheep were more prevalent in the north-west of the catchment (J. Coleby, 1998, pers. comm. & R. Pott, 1999, pers. comm.). Sheep farming was discontinued in this part of the catchment in the 1960s, due to the occurrence of Foot Rot (*Fusobacterium necroforum*) and the area being too wet for sheep. It was also difficult to bring sheep-shearers into the then remote area (J. Coleby, 1998, pers. comm.). Many land-owners in the catchment did not allow goats to be kept by their employees (P. Burdon, 1998, pers. comm.). Today grasslands are grazed mainly by commercial beef cattle and to a lesser extent by cattle owned by farm-employees. Farmers who practice mixed land use do not allow the cattle to graze the grasslands for long periods, but rather restrict grazing for two to three months of the year during spring and summer. The grassland is also rested every alternate year. Grasslands are grazed according to the condition of the grass. Grasslands in poor condition, with bare soil patches and an abundance of *Aristida junciformis* present, are grazed infrequently. The most extensive grassland area to the north-west of the catchment on the farm, 'Sherwood' is predominantly cattle farmed, although some game farming has recently been started.

Most interviewees believed that the grazing quality of the grassland had improved since 1944. This improvement was thought to be as a result of fewer cattle per unit area and improved management practices (P. Coleby, 1998, pers. comm.). Grazing quality in 1944 was apparently very poor on steep areas, such as at Mount Gilboa, where sheep were also present, while on the farm 'Rockwood', extensive overgrazing by cattle owned by farm-employees apparently occurred. It should however, be noted that interviewees perceived grazing quality as being based more on total phytomass present rather than on the species composition of the grasslands.

Extensive dense areas of *Aristida junciformis,* an unpalatable grass species, were noted on many farms visited during this study. These areas were also clearly distinguishable in the 1996 aerial photographs, where *A. junciformis* produces a different texture and colour tone compared with *Themeda triandra*. The presence of *A. junciformis* indicates that grassland species composition is poor, which will reduce grazing value. Very little *T. triandra* and approximately 80% *A. junciformis* grassland was present on the farm, 'Denleigh', (R. Stubbs, 1998, pers. comm.). The largest remaining grassland area, that of 'Sherwood' farm, also had an abundance of *A. junciformis* present. No attempt was however made to map the extent of these two grass species as it was felt that such an exercise would be beyond the requirements of this study.

The term 'Erosion', was detremined by summing the surface area of soil erosion gullies (bare soil area) that could be discerned on the 1944 and 1996 aerial photographs. This feature has decreased from 6.78 km^2 in 1944 to 3.46 km^2 in 1999: a reduction of 3.32 km^2 or 49.0%. However, relative to the total area of the catchment, this represents a decline of only 0.9%. The component details of this decrease are given in Table 6.1. (p.59). The overall decrease and thus improvement in 'Erosion' is shown in Figure 6.7. (p.66) and Figure 6.8. (p.66). An example area, located in the vicinity of the farm, 'Sherwood' is shown in Figure 6.10. (p.71). Some 'Erosion' areas which were visible in 1944 have since been planted to exotic afforestation and were classified as, 'Exotic - Vegetation Managed' in this study. These areas were not visible in 1999 and this has thus had an influence on the above results.



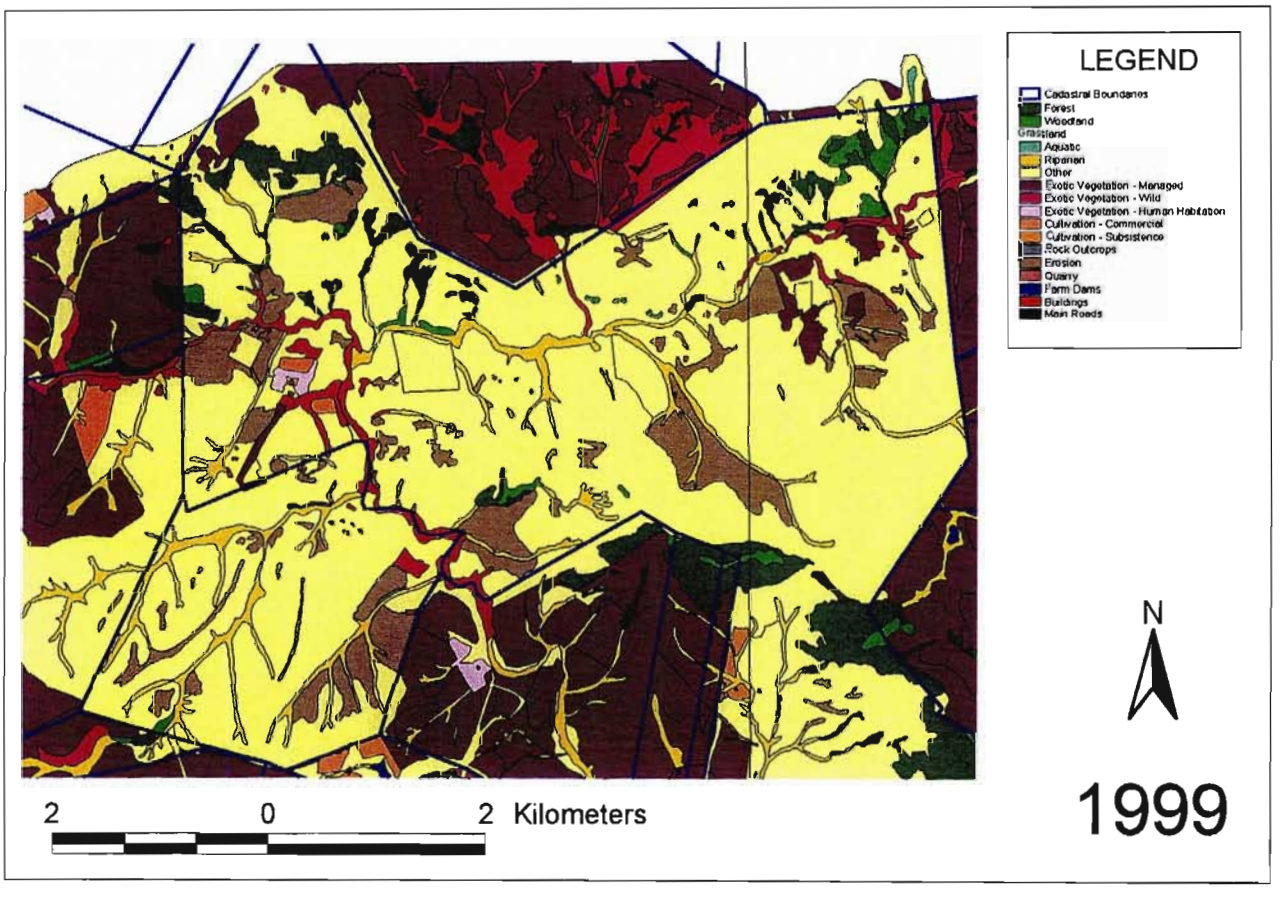


Figure 6.10. North-western Representative Area

In 1944 and 1999 'Erosion' was concentrated in the north-west sector of the catchment, particularly on the farm, 'Sherwood'. Topography in this area is fairly steep and rugged, with soils being described by Scotney (1970) as a miscellaneous land type, 'Hilly, steep and / or stoney land'. The farm has been owned by the same family since 1850, being passed down to subsequent generations. In the interview with the Colebys, the present owners, it was stated that in 1944 there was much evidence of erosion on the farm, which was the result of cattle movement, bad ploughing, use of ox-wagons and overgrazing. Today erosion on the farm has decreased considerably (P., J. & A. Coleby, 1998, pers. comm.).

Other long-time residents of the catchment were interviewed also and were asked: whether there used to be or are any significant eroded areas, what in their opinion the cause of the erosion was and whether the eroded areas had decreased over time? Respondents with farms in the steep and rugged areas of the catchment commented that there was considerable erosion in 1944 and stated that this erosion has decreased over time. The erosion was attributed to the use of ox-wagons particularly for indigenous timber extraction and to overgrazing mainly from subsistence owned cattle and from subsistence cultivation on steep slopes and in marginal areas (P. Burdon & J. Hancock, 1998, pers. comm.). Severely eroded areas were often planted to exotic timber to help stabilise the erosion (J. Hancock, 1998, pers. comm.). Farmers whose farms were located in the flatter areas of the catchment reported no or very little erosion in 1944 and currently (B. Mackenzie, A. Symons & P. Shaw, 1998, pers. comm.). Interviewed residents of the catchment, who have not lived long in the area, also noted a general improvement in erosion.

6.1.4. Exotic Vegetation

The total area of 'Exotic Vegetation - Managed' has increased from 26.34 km^2 in 1944 to 138.71 km^2 in 1999: an increase of 112.38 km^2 or 426.7%. This is an increase of 29.3% relative to the total area of the catchment. The Timber species composition has also changed significantly between 1944 and 1999. Figure 6.11. (p.73) illustrates the proportions of the different timber species grown in the catchment, as a percentage of the total area under afforestation in 1944 and 1999.

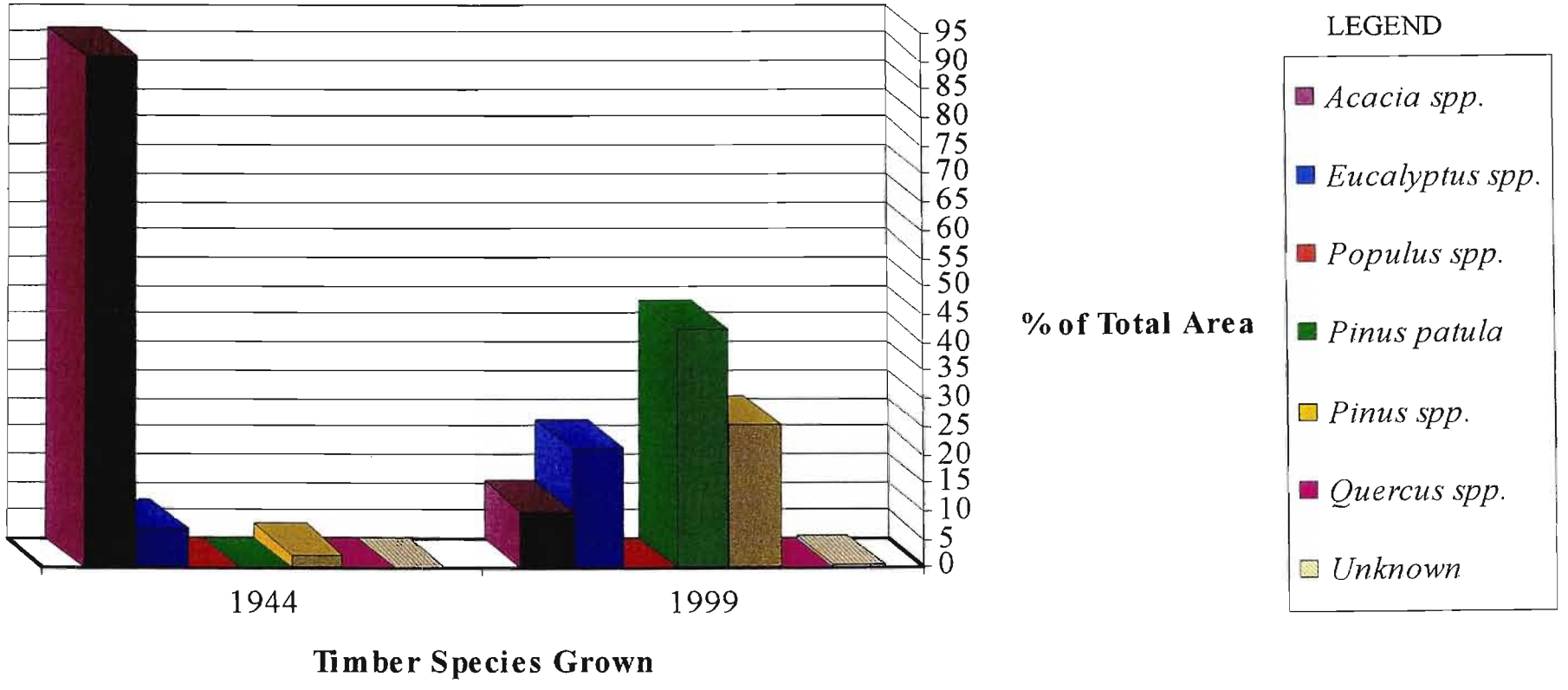


Figure 6.11. Proportional occurrence of different 'Exotic Vegetation - Managed' timber species grown in the catchment, as a percentage of the total area under afforestation, in 1944 and 1999

Table 6.2. shows the areas of the timber species for 1944 and 1999 and their proportion of the total area under afforestation in 1944 and 1999. *Acacia* spp. has decreased significantly and has been replaced mainly by *Pinus patula*, followed by other *Pinus* spp. and then by *Eucalyptus* spp. Although *Quercus* spp. were found around homesteads in 1944, none were commercially cultivated. Species types that could not be determined due to the timber plantation being felled or recently abandoned at the time of field verification have been termed 'unknown'.

It was mentioned in Section 6.1.3., 'Exotic Vegetation - Managed' has replaced grasslands extensively. This may be seen by comparing Figures 6.1. (p.57) and 6.2. (p.58).

Table 6.2. Proportions of Various Timber Species as a Percentage of the Total 'Exotic Vegetation - Managed' Area in the catchment in 1944 and 1999

Note: Area shown in km^2.

	1944	1944	1999	1999
Land Category	**Area**	**% of total area under afforestation**	**Area**	**% of total area under afforestation**
Exotic Vegetation - Managed				
Acacia spp.	23.89	90.7	14.20	10.2
Eucalyptus spp.	1.82	6.9	29.27	21.1
Populus spp.	None	None	0.25	0.2
Pinus patula	None	None	58.87	42.4
Other *Pinus* spp.	0.63	2.4	35.10	25.3
Quercus spp.	None	None	0.14	0.1
Unknown	None	None	0.90	0.7
TOTAL	26.34	100.0	138.71	100.0

The details of the extent and pattern of various timber species in the catchment in 1944 and 1999 are shown in Figure 6.12. (p.75) and Figure 6.13 (p.75) respectively. In 1999, *Pinus patula* predominates the north and north-west of the catchment. *Eucalyptus* spp. and other *Pinus* spp. are concentrated in the central areas and to the south of the catchment. *Acacia* spp. are grown in the north of the catchment below and adjacent to the Karkloof Forest. Many plantations of *Acacia* spp. present in 1999 were present in more or less their same locations in 1944. Timber plantations in 1944 consisted of a few scattered blocks, with most of them being concentrated in the north-east below the Karkloof Forest. As mentioned previously *Acacia* spp. was the main timber species grown.

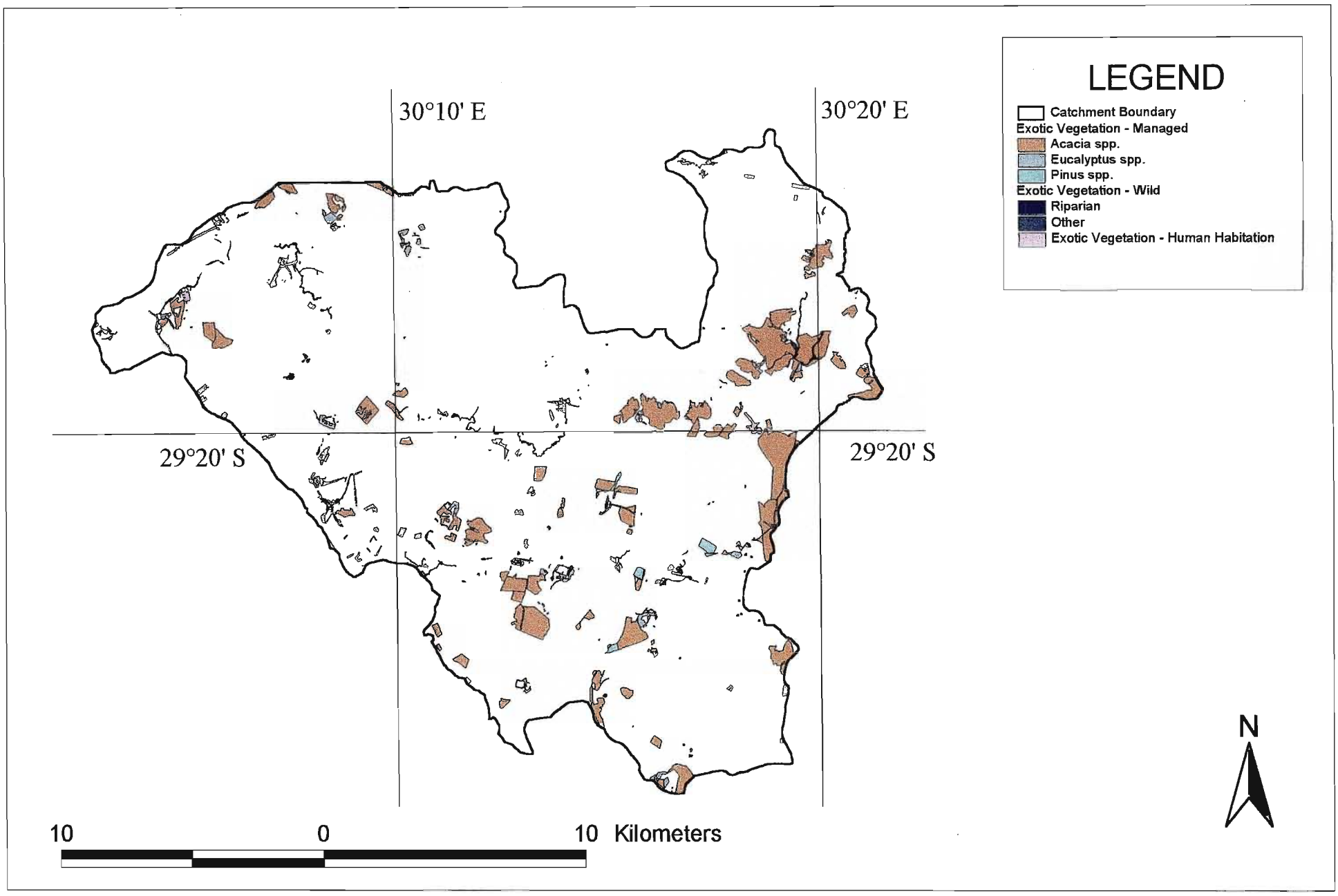


Figure 6.12. Extent of Exotic Woody Vegetation in 1944

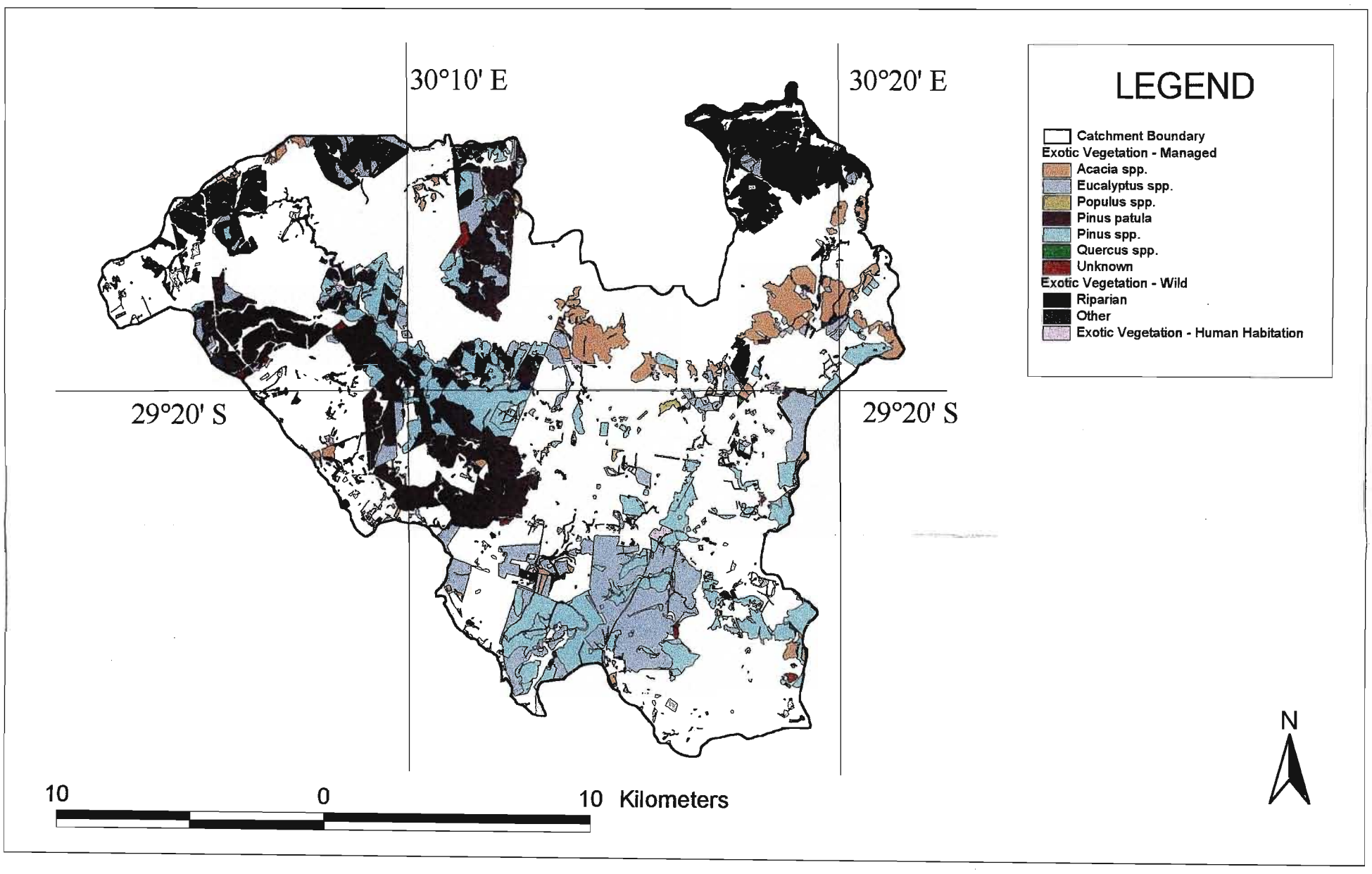


Figure 6.13. Extent of Exotic Woody Vegetation in 1999

The increase in 'Exotic Vegetation - Managed', has resulted in former relatively small discreet blocks of plantations becoming large contiguous blocks.

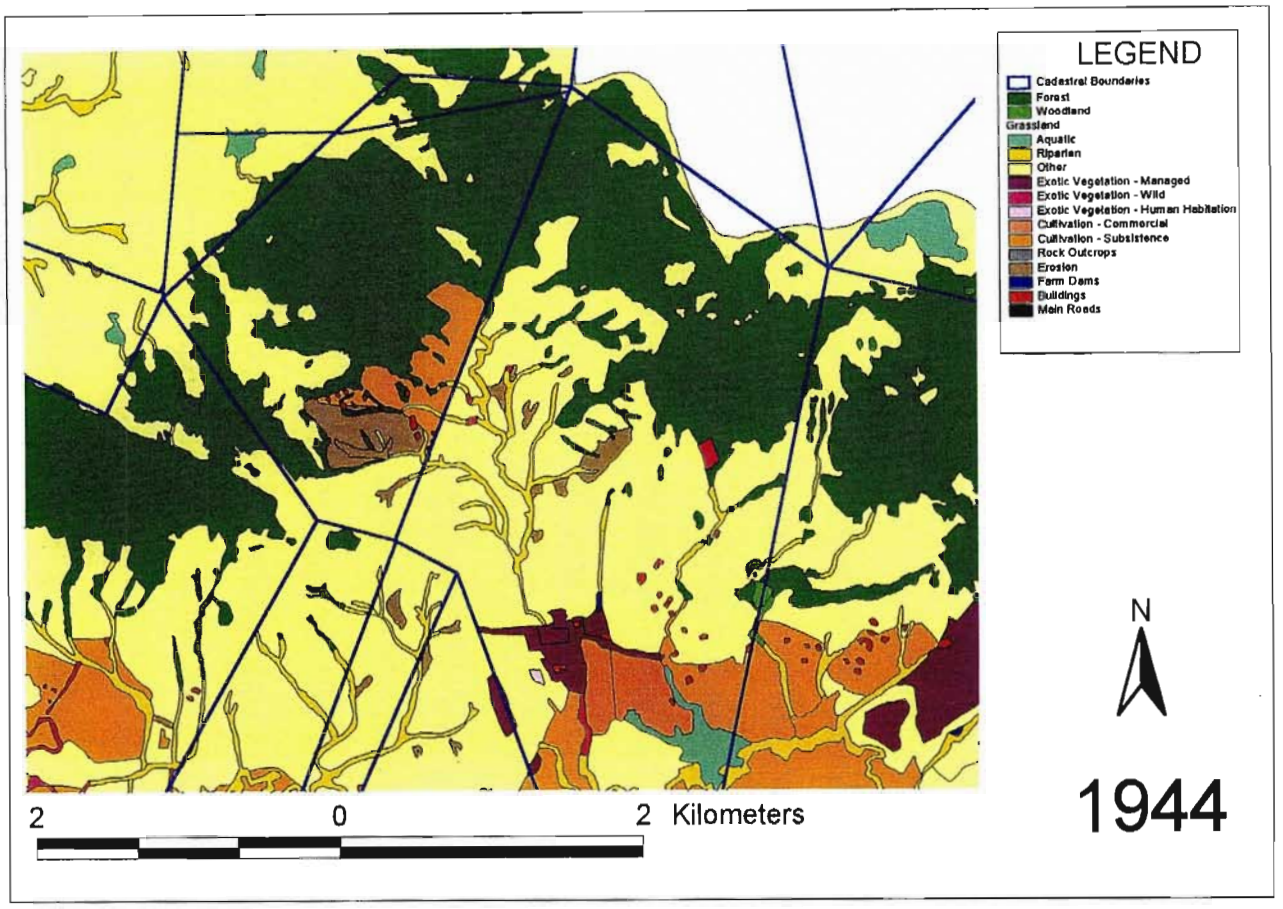
In 1944 many exotic timber plantations were planted up to the boundaries of the Karkloof Forest. This practice has continued and intensified with the expansion of exotic afforestation (Plate 10. (p. 97)). It is estimated from observation of Figure 6.1. (p.57) and Figure 6.2. (p.58), approximately 70% of the Karkloof Forests' perimeter in 1999 is bounded directly by exotic timber plantations, as opposed to only approximately 20% in 1944. No attempt has been made to measure the amount of forest adjoining plantations, as it was felt that this was beyond the requirements of this study.

Interviewees believed that the most suitable areas for timber production were planted first. In 1944 timber plantations existed in areas highly suitable to timber growth, particularly Wattle (*Acacia* spp.) and areas to which it was relatively easy to gain access. Such areas were close to main roads and mostly flat, apart from areas planted below the Karkloof Forest. Due to easy availability of land, there was little competition from other land uses for the land and there was no need to plant marginal areas. With the decline in the beef price from R5 to R3/kg in 1989/1990 and the failure since of the price to recover, many grassland cattle farms have been sold and converted to exotic timber (P. Coleby, 1998, pers. comm.). Mondi Ltd. purchased the properties that it currently owns between the years 1975 and 1989 (D. Alborough, 1999, pers. comm.). Sappi Forests (Pty) Ltd. purchased its properties in 1993 (C. Boake, 1999, pers. comm.). With the increase in population and the improvement in mechanisation, demand for land has increased. Today, timber plantations tend to be planted more and more in marginal areas, such as: on steep slopes, along drainage lines, rocky and shallow soils and close to indigenous forests. Such areas are often difficult to gain access to and are chosen as they are not suited to other land uses. Access is not a limitation as mechanisation and transport have improved.

In 1944 timber was harvested using mainly oxen to extract the timber, sledges to remove the bark and ox-wagons for transport (A. Symons, 1998, pers. comm.). Although oxen are capable of working in areas inaccessible to many modern vehicles, harvesting is time-consuming, so that areas easier to gain access to became favoured for afforestation. Grassland areas adjacent to indigenous forest, that were overgrazed and exhausted of cultivated soil, were planted to timber plantations. One such area was on the farm, 'Spitzkop' (J. Hancock, 1998, pers. comm.). This area is shown in Figure 6.14. Northern Central Representative Area A (p.78). Figure 6.15. North-eastern Representative Area (p.79), which is an area located in the vicinity of the farm, 'Braco' shows timber plantations within the indigenous forest in 1944 and 1999. These plantations were planted after much indigenous forest in the area had been extracted. It is unknown whether the damage to the indigenous forest was a result of 'slash and burn' subsistence cultivation or due to the commercial extraction of indigenous timber. Damage to this area occurred prior to 1944.

The area occupied by 'Exotic Vegetation - Wild' increased from 1.94 km^2 in 1944 to 9.66 km^2 in 1999: an increase of 7.71 km^2 or 397.3%. Relative to the total area of the catchment this is an increase of only 2.0%. The component details of this increase are provided in Table 6.1. (p.59).

The extent of 'Exotic Vegetation - Wild' in 1944 and 1999 is shown in Figures 6.12. (p.75) and 6.13. (p.75). A comparative examination of Figure 6.1. (p.57) and Figure 6.2. (p.58) shows as to be expected, 'Exotic Vegetation - Wild (Riparian)' in 1999 frequently occurring downstream of timber plantations which existed in 1944. An example of this, located in the vicinity of the farm, 'Sherwood' is illustrated in Figure 6.10. North-western Representative Area (p.71). 'Exotic Vegetation - Wild (Other)' frequently occurs in areas that have suffered some sort of disturbance, such as the abandonment of a homestead or a damaged eroded area. Abandoned timber plantations have increased in size by 1999.



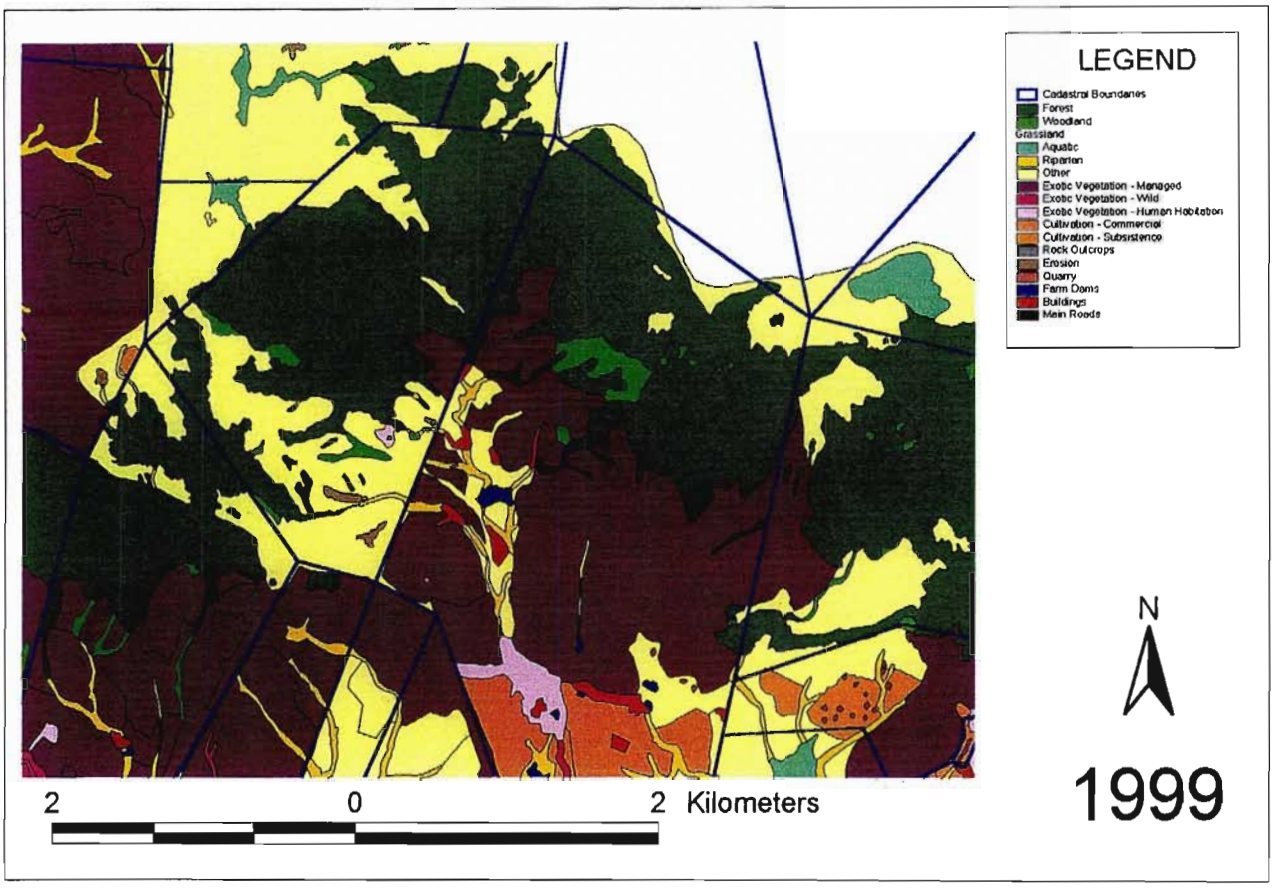
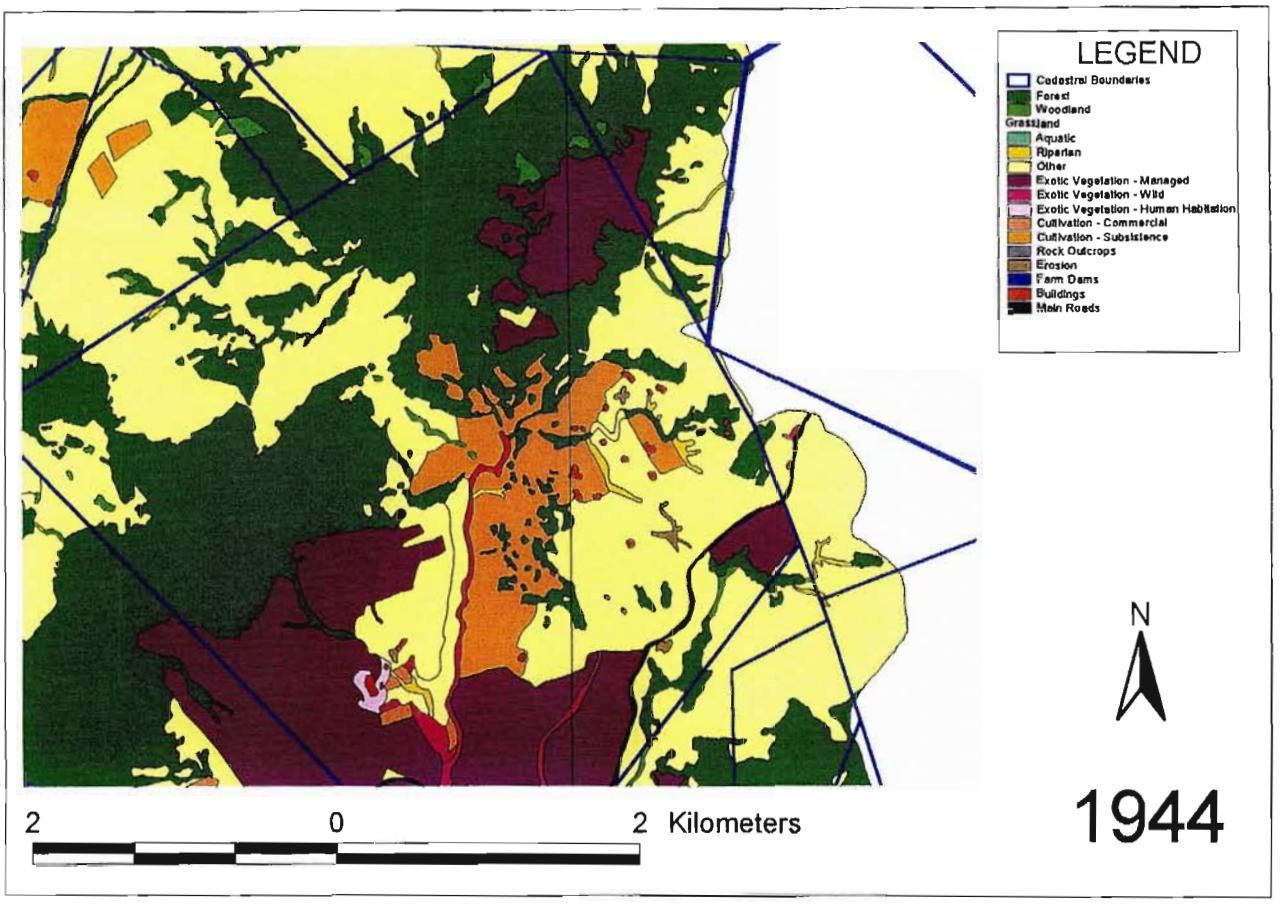


Figure 6.14. Northern Central Representative Area A



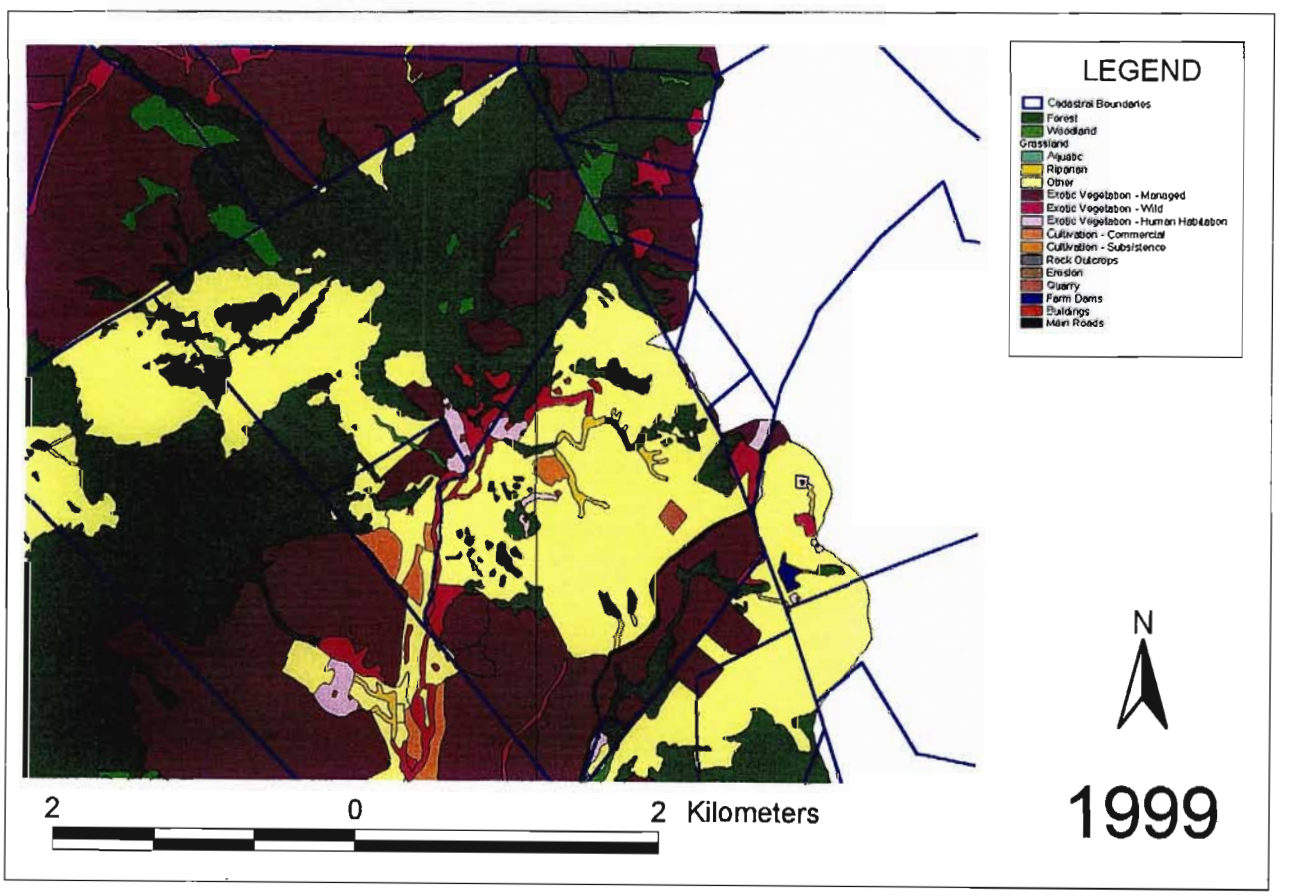


Figure 6.15. North-eastern Representative Area

According to interviewees and from interpretation of 1944 aerial photographs, most plantations in 1944 consisted of *Acacia* spp., whilst in 1999 plantations consisted of mostly *Pinus* spp, especially *Pinus patula*. *Acacia* spp. were observed to be highly invasive, invading riparian areas extensively if not correctly managed. Little effort was made to control encroachment of planted timber species into neighbouring areas or to control weed infestation of felled areas in 1944. Today, greater effort is made, with control consisting of manual and chemical eradication. In 1944 it was felt that control was not necessary as weeds were not that plentiful nor were they a significant problem (P. Shaw, A. Symons & P. Coleby, 1998, pers. comm.).

Respondents also noted the presence of alien vegetation in 1999, particularly *Acacia* spp. in riparian habitats. American Bramble (*Rubus cuneifolius*) was noticed along road edges, in drainage lines and on elevated mounds where birds often sit. Bug Weed (*Solanum mauritianum*) was evident along margins of timber plantations and Scotch Thistle (*Cirsium vulgare*) was noted in cultivated lands. Manual and chemical methods of eradication are used, depending on the weed type and its location. Manual eradication methods are preferred.

People's perceptions of alien vegetation and its correlation to changes in land use practices were ascertained from interviews. The presence of weeds was perceived to be associated with various land use practices such as: the clearing of land for new or repeated cultivation; new planting or re-planting of timber; the disturbance of natural areas due mostly to overgrazing and erosion and the abandonment of land. Land that was previously used for timber plantations and planted with *Acacia* spp. but that had since been abandoned, has *Acacia* spp. seedlings constantly germinating. A particular problem area was noted on the farm, 'Ben Eden', which was once planted with *Acacia* spp. The spread of alien vegetation was observed to be slow at first, but was seen to rapidly increase if not managed and controlled. The rate at which alien vegetation spreads is thought to be related to the favourable climate and the spread increases during the summer months. It was observed that the Rameron Pigeon (*Columba arquatrix*) which feeds off the fruit of Bug Weed (*Solanum mauritianum*) is responsible for assisting in the spread of the weed. Water, especially streams and rivers (Plate 11. (p. 98)), was seen to play a large role in translocating the seeds of weeds. Management upstream was thus considered important. The presence of weeds was less noticeable in 1944 than in 1999.

Some respondents felt that the lack of weeds in 1944 was attributable to the frequent annual burning and the general overgrazing of the grasslands, which destroyed saplings before they could establish. Timber plantations were also relatively limited and new in 1944, which meant that their seeds had not had much time to spread and establish.

The area occupied by 'Exotic Vegetation - Human Habitation' increased from 1.94 km^2 in 1944 to 5.63 km^2 in 1999: an increase of 3.69 km^2 or 190.3%. This is an increase of only 1.0% relative to the total area of the catchment. Areas allocated to this category include situations where exotic and perhaps some indigenous species were planted for aesthetic value and for the provision of windbreaks. Prior to 1944, farmers planted small patches of timber species adjacent to their homes in an effort to see which species did best, so as to justify commercial cultivation (P. Coleby, 1998, pers. comm.). With the subdivision of land, additional buildings have been constructed, each having exotic vegetation planted nearby. This has resulted in a related increase in 'Exotic Vegetation - Human Habitation'.

6.1.5. Cultivation

The category 'Cultivation - Commercial' increased from 12.29 km^2 in 1944 to 50.55 km^2 in 1999: an increase of 38.25 km^2 or 311.2%. Relative to the total area of the catchment this is an increase of 10.0%.

As was stated in Section 6.1.3. 'Cultivation - Commercial' replaced grasslands marginally, including riparian and aquatic grasslands. This may be seen by comparing Figure 6.1. (p.57) with Figure 6.2. (p.58). A representative area of this trend occurs in the vicinity of the farms, 'Gartmore' and 'Loskop', shown in more detail in Figure 6.9. Central Representative Area (p.67). The extent and distribution of 'Cultivation - Commercial' within the catchment in 1944 and 1999 is shown in Figure 6.16. (p.82) and Figure 6.17. (p.82) respectively.

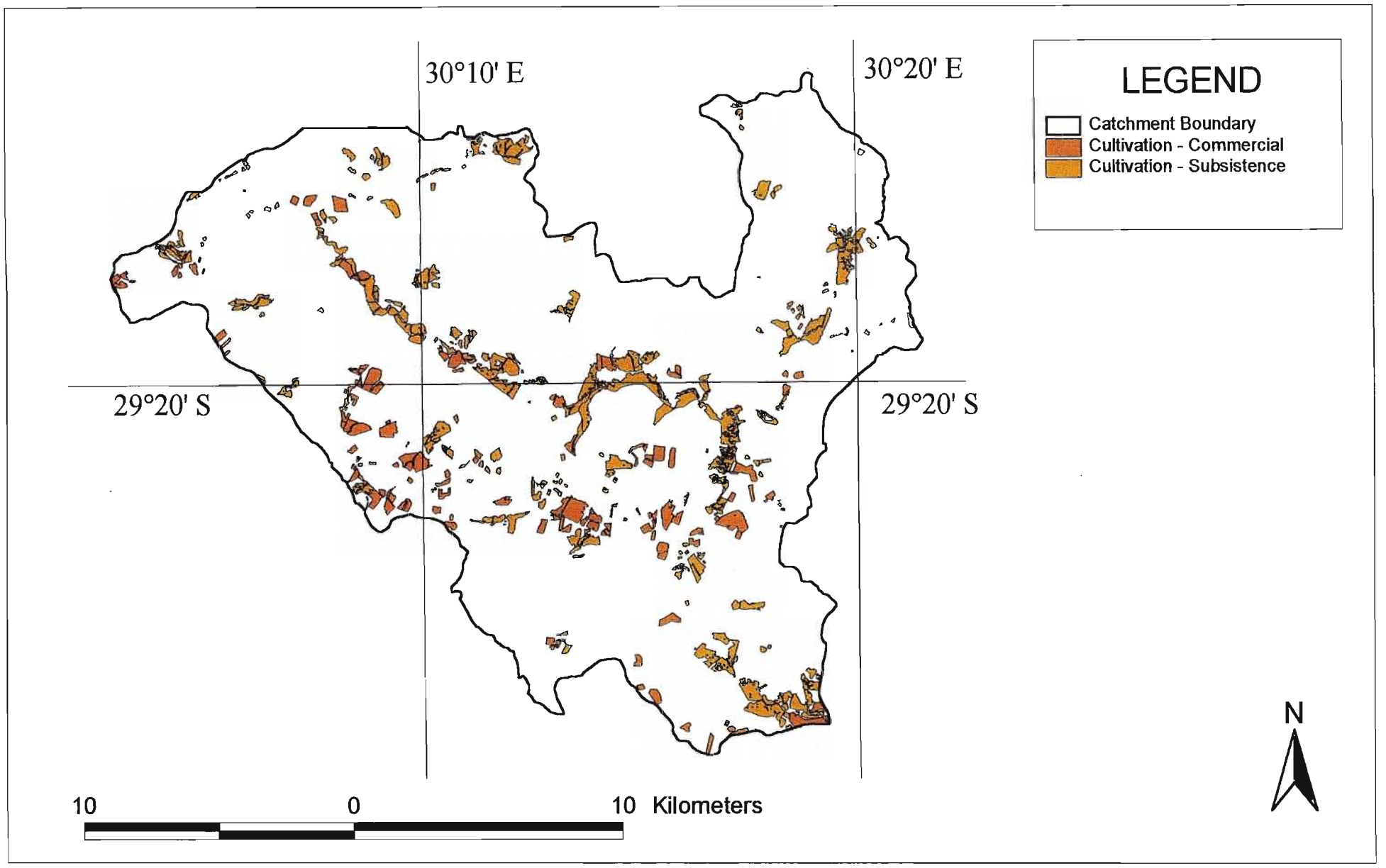


Figure 6.16. Extent of Commercial and Subsistence Cultivation in 1944

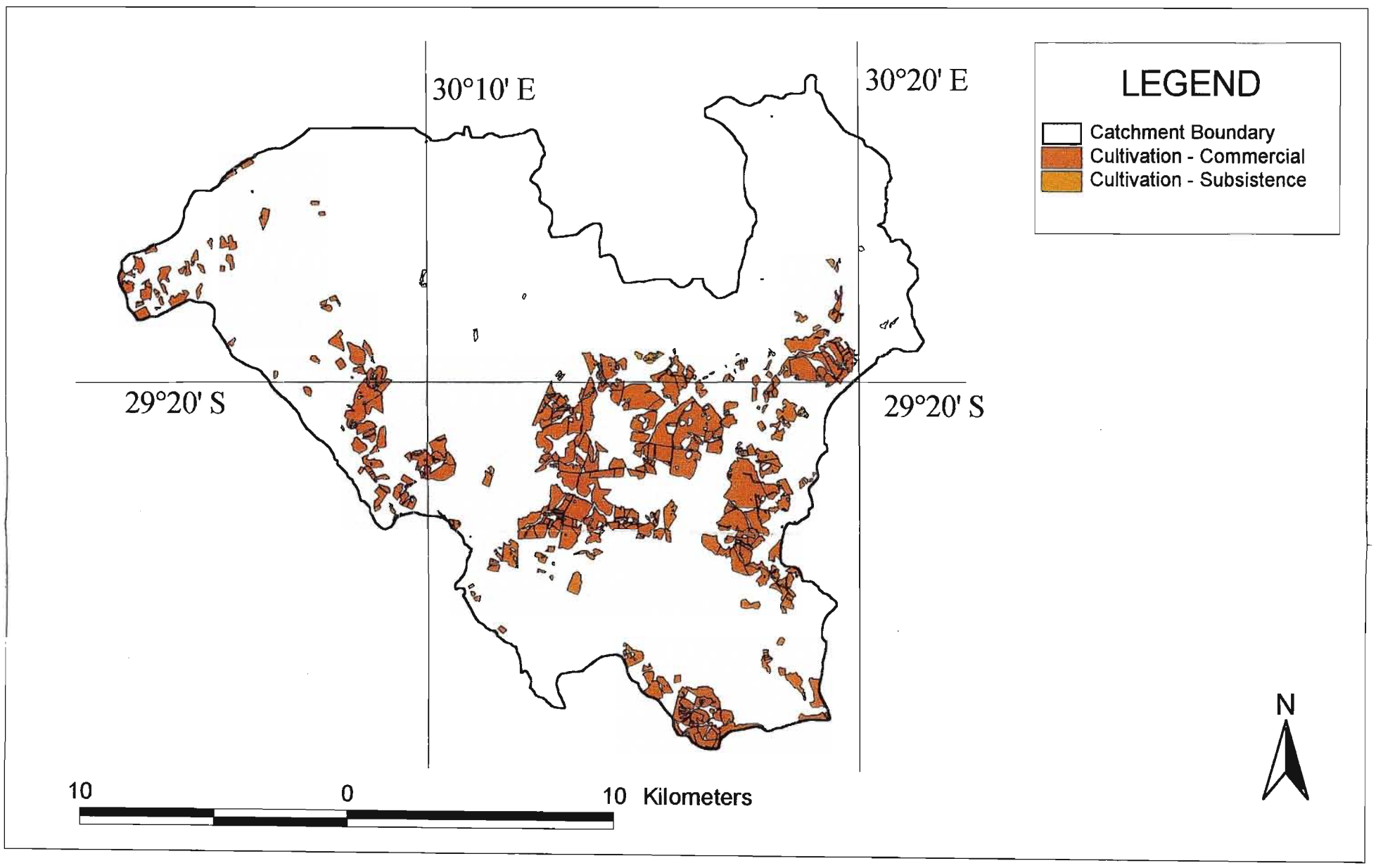


Figure 6.17. Extent of Commercial and Subsistence Cultivation in 1999

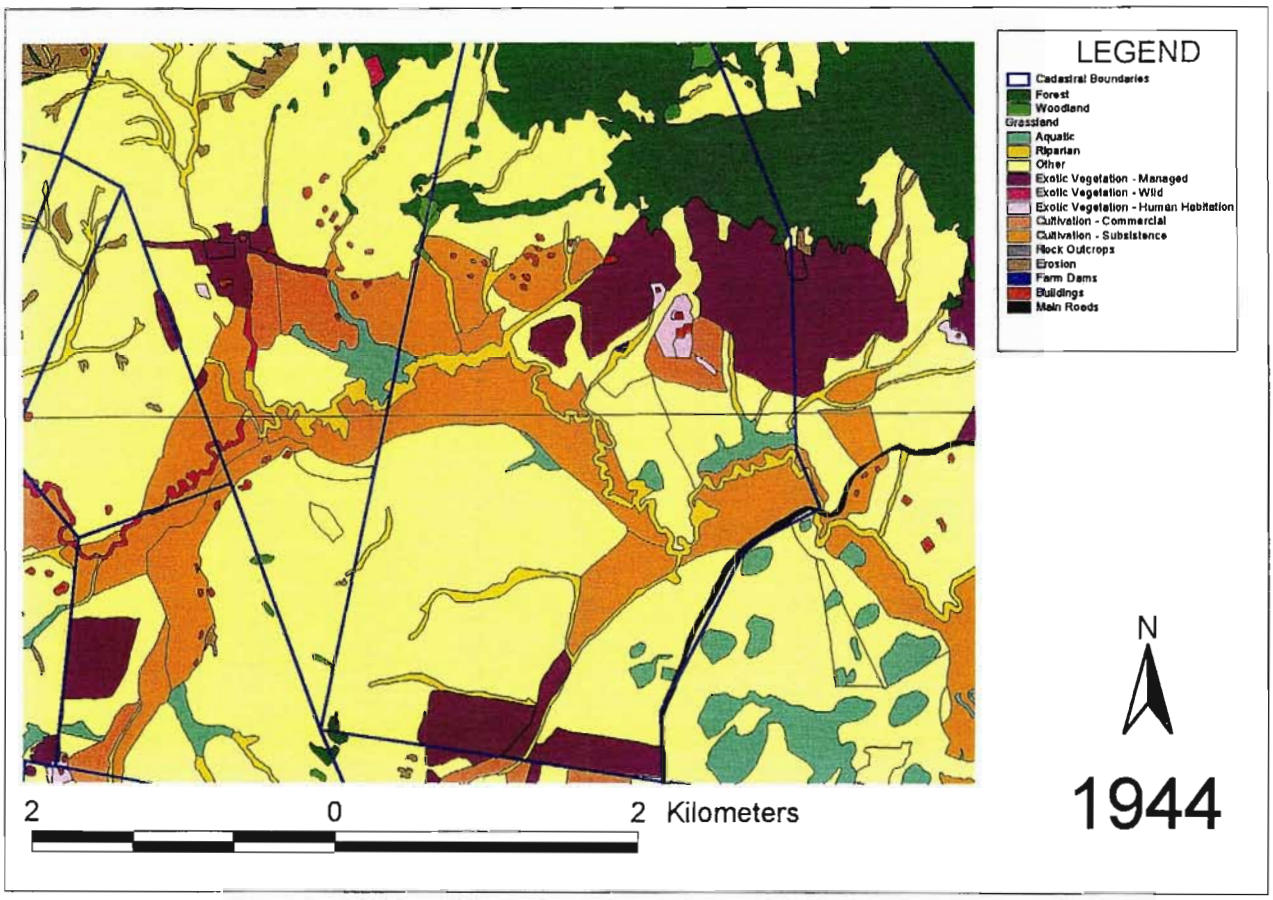
In 1944 'Cultivation - Commercial' areas were scattered throughout the catchment, being located mostly close to white farmers' houses. The cultivated lands were small, as their main purpose was to supply sufficient vegetables for the consumption of the farmer's family (A. Symons, 1998, pers. comm.). Fertilisers were not commonly used and mechanisation and transport were limited making the commercial production of crops unsustainable thereby limiting their extent (P. Burdon, 1998, pers. comm.). Oxen were used to plough the lands, which made it difficult and uneconomical to plough large areas. The first lorry, owned by Roydon Symons and Campbell Gower Shaw, was brought into the catchment in 1930 (A. Symons, 1998, pers. comm.). In 1999 'Cultivation - Commercial' extended across the central areas of the catchment and mostly where the land is relatively flat with fairly good soils. For the purpose of this study, pastures, fruit trees and crops have been grouped under the single heading 'Cultivation - Commercial'. In 1944 'Cultivation - Commercial' comprised mainly: crops of maize, beans and vegetables (A. Symons, 1998, pers. comm.). Dairy farming was undertaken only by the Mackenzie family, thus the occurrence of pastures in general was minimal. By 1999 'Cultivation - Commercial', comprised mainly pastures and crops. Avocados (*Persea americana*) are grown in the southern parts of the catchment, whilst a few small areas of Kiwi-fruit (*Actinidia chinensis*) may be found in the north-east, below the Karkloof Forest.

Results from interviews show that 'Cultivation - Commercial' farming in 1944 was not undertaken on any marginal sites, where a marginal site refers to a site not considered optimum for cultivation. Little attempt was made to control the spread of weeds and soil erosion from ploughed bare lands. Weeds were not an issue and little gully erosion occurred because cultivation was almost exclusively confined to flat areas and even then large portions were left undisturbed. With increased demand for land and for the production of food, marginal areas particularly sloping ground and areas in close proximity to riparian and aquatic grassland areas were observed to be cultivated by 1999. The areas in close proximity to riparian and aquatic grassland are however, seldom ploughed and mostly are planted with perennial pasture grasses such as Kikuyu (*Pennisetum clandestinum*). Kikuyu is also known to increase the level of soil protection to a greater extent than natural grassland. Farmers in the catchment are moving towards 'no-till' farming in an effort to reduce weed growth and soil erosion and maintain soil moisture.

'Conventional' and 'no-till' cultivation areas of nine farms in the Karkloof Valley were compared (T. Matchett, 1998, pers. comm.). It was found that 70% of the total area under maize (*Zea mays*) and soya beans (*Glycine max*) on these farms was 'no-till' cultivation. 'No till' farming involves planting directly into the remnant mulch from the previous season's crop, without first plouging (tilling) the field. The conviction being that the mulch acts as a protective layer reducing erosion, maintaining soil moisture and limiting weed growth. 'No till' farming is particularly important in marginal, sloping areas. The rotation of maize and soya beans is usually practised. Contour ploughing, to reduce soil erosion is also practised. This practice however was not undertaken in 1944. Weeds in 1999 were controlled by chemical and manual methods, depending on the type of weed and its location.

The area of 'Cultivation - Subsistence' has decreased from 23.00 km^2 in 1944 to 0.48 km^2 in 1999: a decrease of 22.52 km^2 or 97.9%. Relative to the total catchment area this is a decline of 5.9%.

The extent and distribution of all 'Cultivation - Subsistence' within the catchment in 1944 and 1999 is shown in Figures 6.16. (p.82) and 6.17. (p.82) respectively. Extensive 'Cultivation - Subsistence', which included the ploughing of land adjacent to and within riparian and aquatic grassland areas was taking place in 1944. These areas were favoured by the black farm-employees, due to the availability of moisture and the higher fertility of the soil, which favoured the growth of crops. Detailed maps of example areas within which this unit occurred are shown in Figure 6.9. Central Representative Area (p.67), which is an area located in the vicinity of the farms, 'Gartmore' and 'Loskop' and Figure 6.18. Northern Central Representative Area B (p.85), which is an area located in the vicinity of the farms, 'Colbourne', 'Tullamore' and 'Spitzkop'. Figures 6.4. and 6.5. (p.63), respectively show the location of these areas within the catchment. In 1944 areas conforming to the characteristics of 'Cultivation - Subsistence' occurred in areas directly adjacent to and within indigenous forest [Figure 6.6. (p.64) and Figure 6.15 (p.79)]. Rycroft (1942) states that the high humus content of the forest soils, the good moisture content and the favourable mico-climate attracted the black farm-employees to these areas.



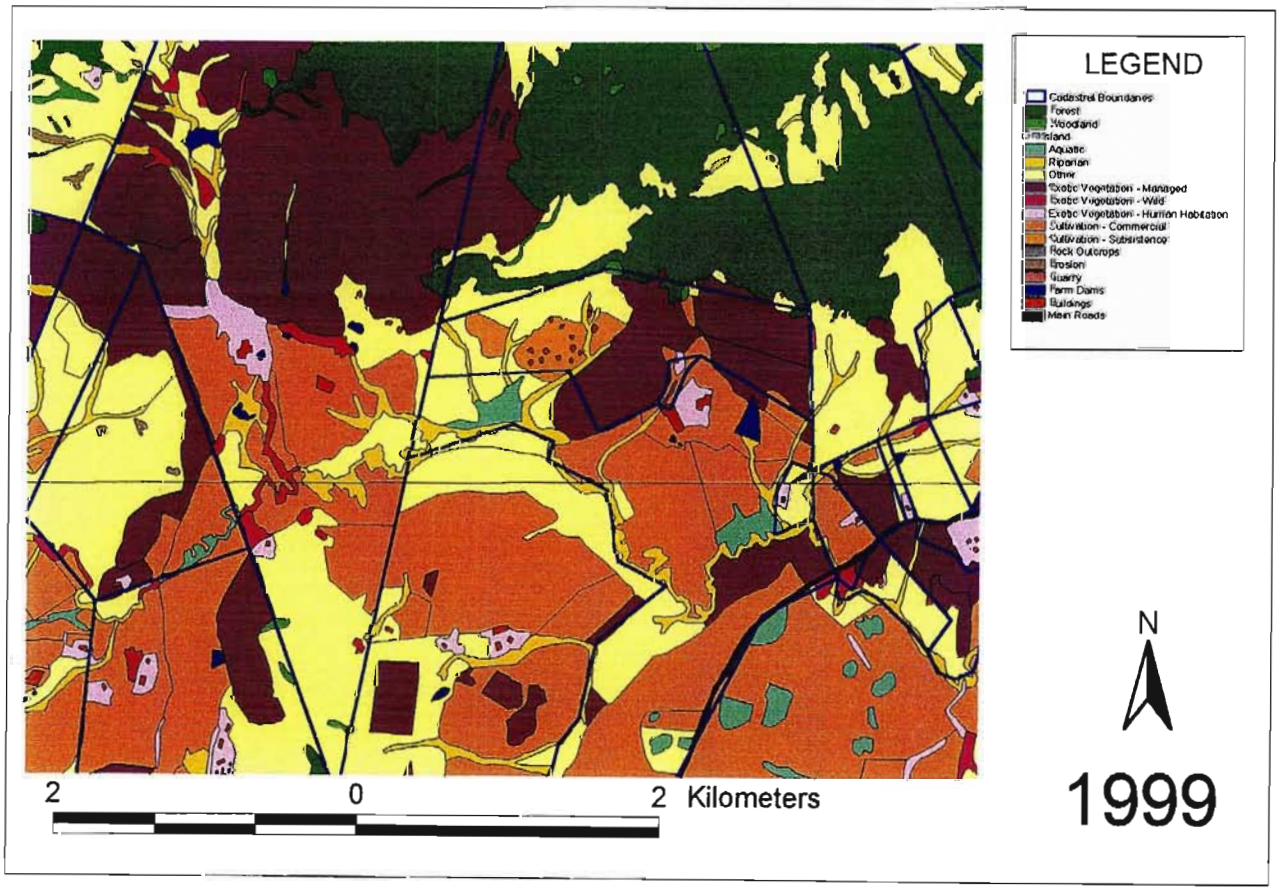


Figure 6.18. Northern Central Representative Area B

Initially small portions but later larger portions of the forest margins were opened up and planted with corn and maize. When the soil became exhausted from over-cropping fresh land was sought, either by moving to another place on the margin or by extending into the forest. Occasionally small portions were cleared well within the forest, each year being enlarged (Rycroft 1942). Mrs Joan Hancock, who came to live on the farm, 'Spitzkop' in 1952, recalls 'slash and burn' subsistence cultivation taking place in the nearby forest (J. Hancock, 1998, pers. comm.). 'Slash and burn' subsistence cultivation also took place in the indigenous forest of the farm, 'The Forest', until the late 1950s when the then owner of the property banned the practice (P. Burdon, 1998, pers. comm.). Rycroft (1942) states that these practices had been abandoned in some, but not all parts due to the strict supervision by several of the forest owners at that time.

In 1999 no areas classifiable as 'Cultivation - Subsistence' were seen in any of the areas which were identified as such in 1944. It is thought that the decrease in this category can be linked to the gradual abolishment of the farm labour tenancy system. Starting in the 1920s, and gathering momentum in the 1950s and 1960s, the State sought first to control and limit but then to eliminate labour tenancy on South African farms. In 1964, the 1936 Development Trust and Land Act was further amended to empower the Minister of Bantu Administration to abolish entirely or to limit the system of labour tenancy in any one district of the country, by proclamation (Anon. 1985). The labour tenant system originated in the 19th century. Under this system, black families living on white-owned land supplied the land-owner with their labour for part of the year, at a non-existent or nominal wage, in return for the right to graze some stock and cultivate some land on the owner's farm - labour serving as a form of land-rent. During the period when they were not working for the land-owner, many tenants supplemented their income by becoming short-term migrant workers in industry or on the mines (Anon. 1985). Responses to the interviews revealed that some farmers in the catchment had labour tenants on their properties in 1944, whilst other farmers had permanent full-time employees. Farmers, who had labour tenants, permitted them to live on the farm, provided they supplied labour for six months of the year. Each kraal, which consisted of a group of huts was allowed its own field and permitted to keep 10 cattle (A. Symons, 1998, pers. comm.). Farmers often supplied rations, dip for the cattle and would plough the fields using their oxen. Mostly maize was grown, along with some vegetables.

No weed or soil erosion control was practised. Because marginal areas, which often consisted of areas close to streams and rivers as well as areas on steep slopes were cultivated, soil erosion was often extensive (J. Hancock, 1998, pers. comm.). Using oxen to plough steep slopes meant that it was difficult to plough up hill. Ploughing was thus started at the top of the slope and moving downwards: across the contour. This resulted in lifting of the soil from the top and moving it slowly down the slope, which ultimately removed the topsoil, rendering the field infertile and useless (P. Coleby, 1998, pers. comm.). Infertile fields were abandoned and the process re-started in new areas. 'Cultivation - Subsistence' was observed to be minimal by 1999, due to farm-employees not being dependent on subsistence agriculture. Small vegetable gardens were maintained, close to houses and a few cattle were also kept (Plate 12. (p. 98)).

6.1.6. Farm Dams

The total area occupied by farm dams has increased from 0.09 km^2 in 1944 to 2.32 km^2 in 1999: a substantial increase of 2.23 km^2 or 2503.1%. Relative to the total area of the catchment this is an increase of 0.6%.

Other noteworthy changes in this category over the period considered in this study are: mean dam size in 1944 was 4236 m^2, whereas in 1999 it was 11 936 m^2: an increase of 181.8%. The number of dams has increased from 21 in 1944 to 194 in 1999. This represents an increase of 823.8%. The increase in the number of dams is a reflection of the subdivision of farms, with every new farm requiring its own independent water supply.

6.2. CHANGES IN LAND OWNERSHIP BETWEEN 1944 AND 1999

6.2.1. Overview of Property Size and Land Ownership Changes

Selected statistics for 1944 and 1999 property sizes are given in Table 6.3. (p.90) The number of properties has increased from 191 in 1944, to 308 in 1999: an increase of 61.3%. Correspondingly, property size has decreased from a mean property area of 2.70 km^2 (n = 191) in 1944 to 1.59 km^2 (n = 308) in 1999. This is a decrease in the mean area of 1.11 km^2 or a 41.1% decrease in the mean property area that was present in 1944. The largest property in 1944, the farm 'Braco' owned by Campbell Gower Shaw was 15.46 km^2. The largest property in 1999 was 31.33 km^2 being the farm, 'Sherwood' owned by Morton Estates / Coleby family.

This exceptionally large property however, is the result of the consolidation of smaller properties, located adjacent to one another, which were owned by the family since 1944 and this does not represent a trend applicable to other properties in the catchment. The smallest property size in 1944 was 0.014 km^2, whilst in 1999 it was 0.003 km^2.

Total areas of land ownership categories in 1944 and 1999 are given in Table 6.4. (p.90). The proportion of the various land ownership categories as a percentage of the total area of all properties, defined by the extent of their cadastral boundaries in 1944 and 1999, are also given. Summing the areas of all properties revealed a difference in total area of 5% between 1944 and 1999. This difference is due to entire properties being selected for each time period, even though some property boundaries extended outside of the catchment boundary and the properties differed in size and extent between the two time periods. Figures 6.19. (p.91) and 6.20 (p.91) show the distribution and extent of the land ownership categories in the catchment in 1944 and 1999, respectively. In 1944 ownership of land in the catchment consisted mostly of: 'Private - Individuals' (95.8%), 'Private - Trusts/Trustees' (2.3%) and the 'Union Government' (1.9%) making up the remainder. In 1999 the largest ownership categories were 'Private -Individuals' (36.6%), 'Private - Pty Ltd' (17.5%), 'Private Trusts/Trustees' (10.9%), Sappi Forests (Pty) Ltd. (17.0%) and Mondi Ltd. (9.2%). Ownership moved away from the predominant 'Private - Individuals', mainly towards 'Private Pty Ltd', 'Private Trusts/Trustees' and large corporate companies such as Sappi Forests (Pty) Ltd. and Mondi Ltd., who together own 26.2% of the catchment. The term 'Private' refers to small scale farms which may be: Incorporated (Inc.), Proprietary Limited (Pty Ltd), Closed Corporation (CC), in the name of a Trust/Trustee, in the name of an Administrator, clubs and individual owners. The term 'Private' was used in order to draw a distinction between large corporate companies such as Sappi Forests (Pty) Ltd. and Mondi Ltd. and the small scale enterprises.

6.2.2. Property Size and Land Ownership in 1944

Land ownership and property sizes in 1944 are shown in Figure 6.21. (p.92). Each property has been assigned an identity number, which corresponds to the table in Appendix 9. (p.144). This table contains information such as: property name, grant number, sub. number, owner name, date acquired and date disposed of, registered area if available, owner type, area shown in square meters and perimeter shown in metres.

Many properties often adjacent to one another, were owned by the same individual or members of the same family. Operational farm sizes were thus much bigger than the registered properties. No consolidation of properties had taken place by 1944. Original Grants had merely been subdivided.

6.2.3. Property Size and Land Ownership in 1999

Land ownership and property sizes in 1999 are shown in Figure 6.22. (p.93). Each property has been assigned an identity number, which corresponds to the table in Appendix 9. (p.144). This table contains information such as: property name, grant number, sub. number, farm name if available, owner type, owner name, area shown in square meters and perimeter shown in metres. Sappi Forests (Pty) Ltd. and Mondi Ltd. together own 26.2% of the catchment and the properties they own are adjacent to one another.

Ownership of adjacent properties by the same 'Private - Individual' or family is minimal, when compared to 1944. Many of the original grants have been consolidated to form new grant numbers and property names by 1999. Consolidation normally occurred when one individual or family owned a number of adjacent properties and wished to unite / consolidate the properties or when a neighbour wished to buy and incorporate adjacent pieces of property.

Table 6.3. Statistics for 1944 and 1999 Property Sizes

Note: Area in km^2. Negative (-) values represent a decrease. Positive (+) values represent an increase.

	1944	1999	1999-1944
Statistics			**Change**
n	191	308	117
Total area	516.33	490.31	-26.02
Mean area	2.70	1.59	-1.11
Largest area	15.46	31.33	15.87
Smallest area	0.014	0.003	-0.011
Range	15.44	31.33	15.88
Variance	9.597×10^{12}	6.89167×10^{12}	-2.70501×10^{12}

Table 6.4. Total Areas for 1944 and 1999 Land Ownership Categories

Note: Total area of each owner category in km^2.

	1944	1944	1999	1999
Owner Category	**Area**	**% of total area of all properties**	**Area**	**% of total area of all properties**
State - KZNNCS	0.00	0.0	7.90	1.6
State - Union Government	9.84	1.9	0.00	0.0
Religious	0.02	0.0	0.02	0.0
Mondi Ltd	0.00	0.0	44.96	9.2
Sappi Forests (Pty) Ltd	0.00	0.0	83.47	17.0
Sappi Forests leased	0.00	0.0	1.02	0.2
Private - Inc.	0.00	0.0	1.74	0.4
Private - Pty Ltd	0.00	0.0	85.71	17.5
Private - CC	0.00	0.0	12.06	2.5
Private - Trusts/trustees	11.65	2.3	53.57	10.9
Private - Administrators	0.00	0.0	9.61	2.0
Private - Clubs	0.00	0.0	0.03	0.0
Private - individuals	494.63	95.8	179.50	36.6
Unknown	0.19	0.0	10.72	2.2
TOTAL	516.33	100.0	490.31	100.0

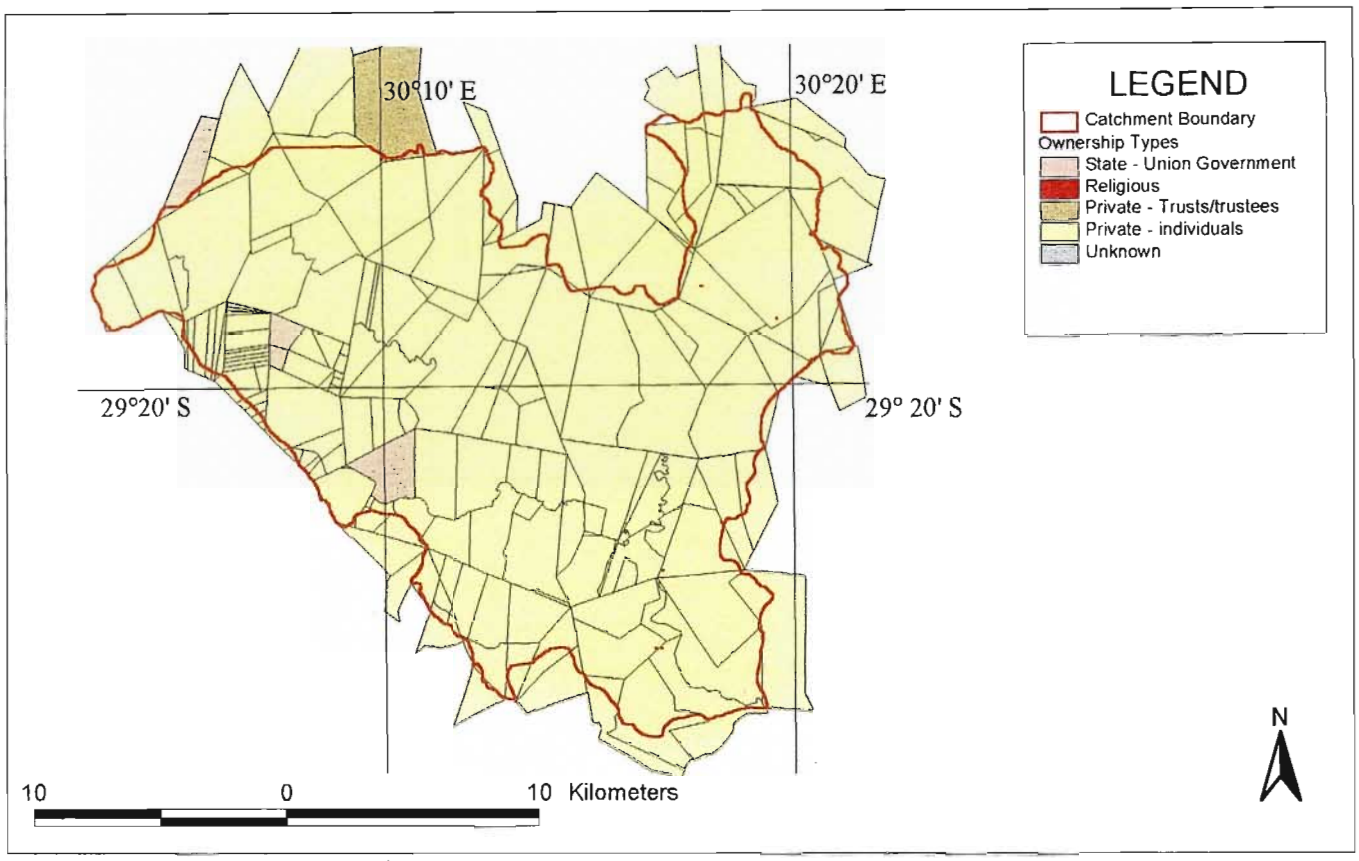


Figure 6.19. Land Ownership Categories in 1944

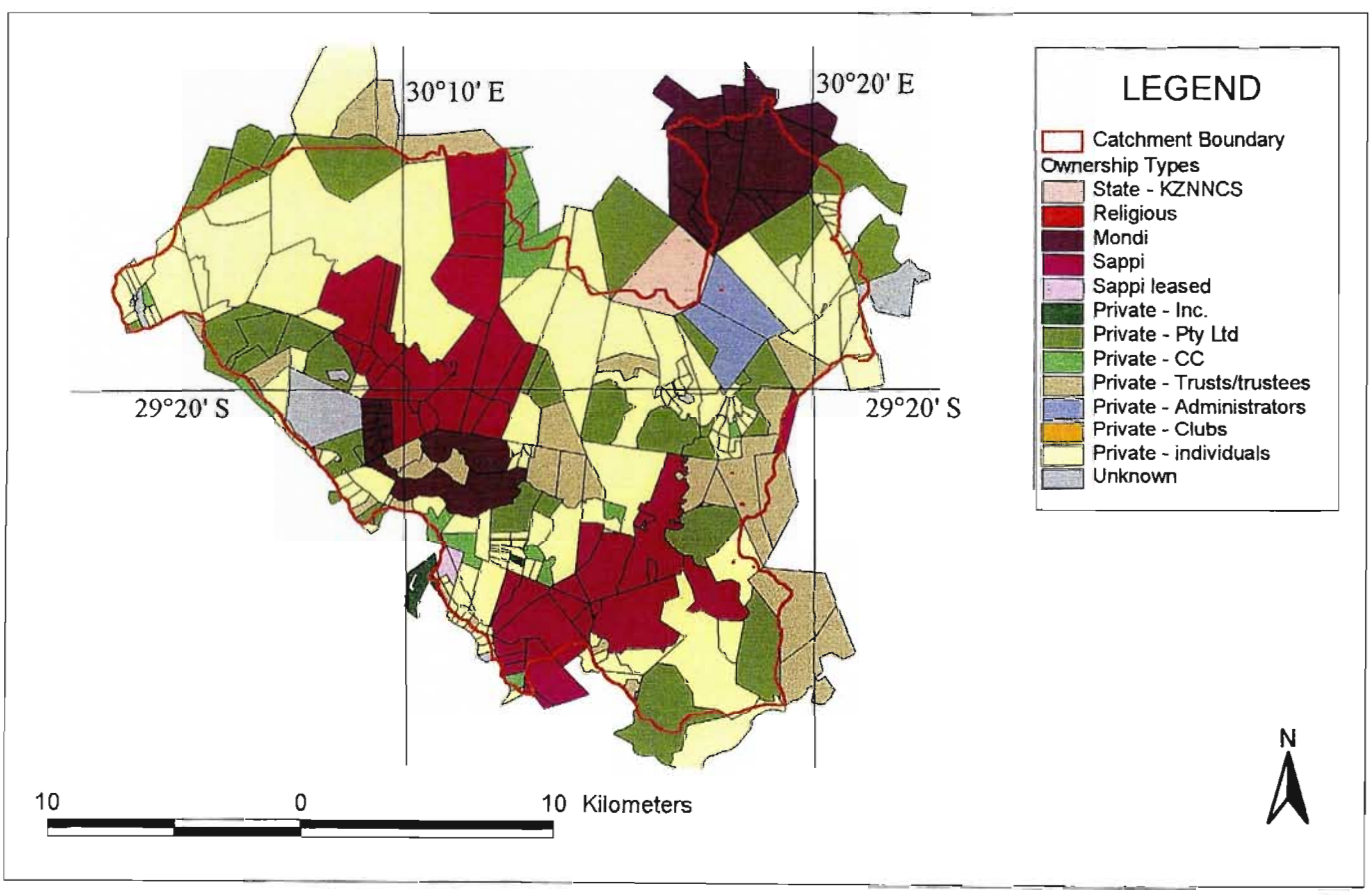


Figure 6.20. Land Ownership Categories in 1999

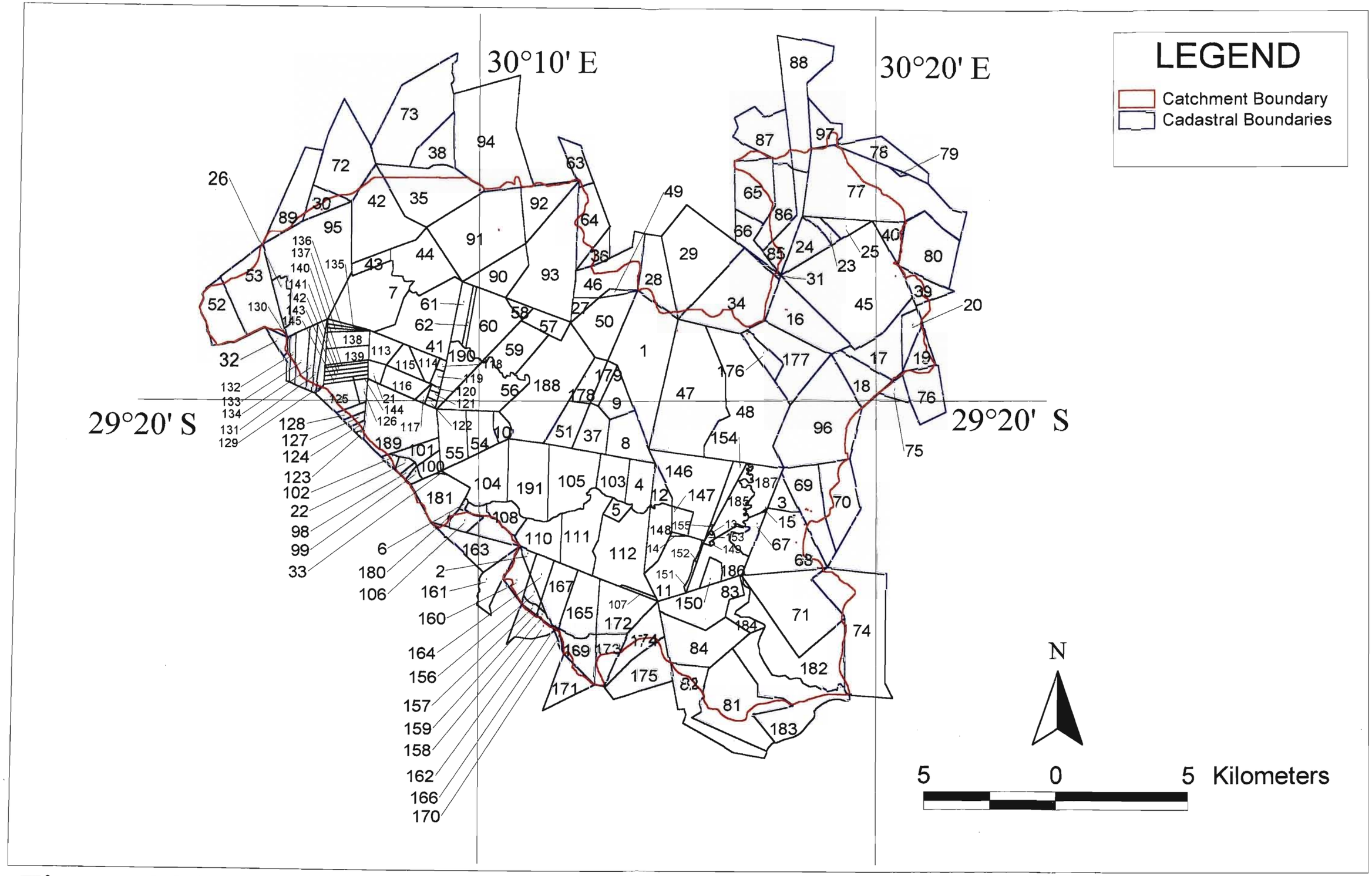


Figure 6.21. Land Ownership and Property Sizes in 1944

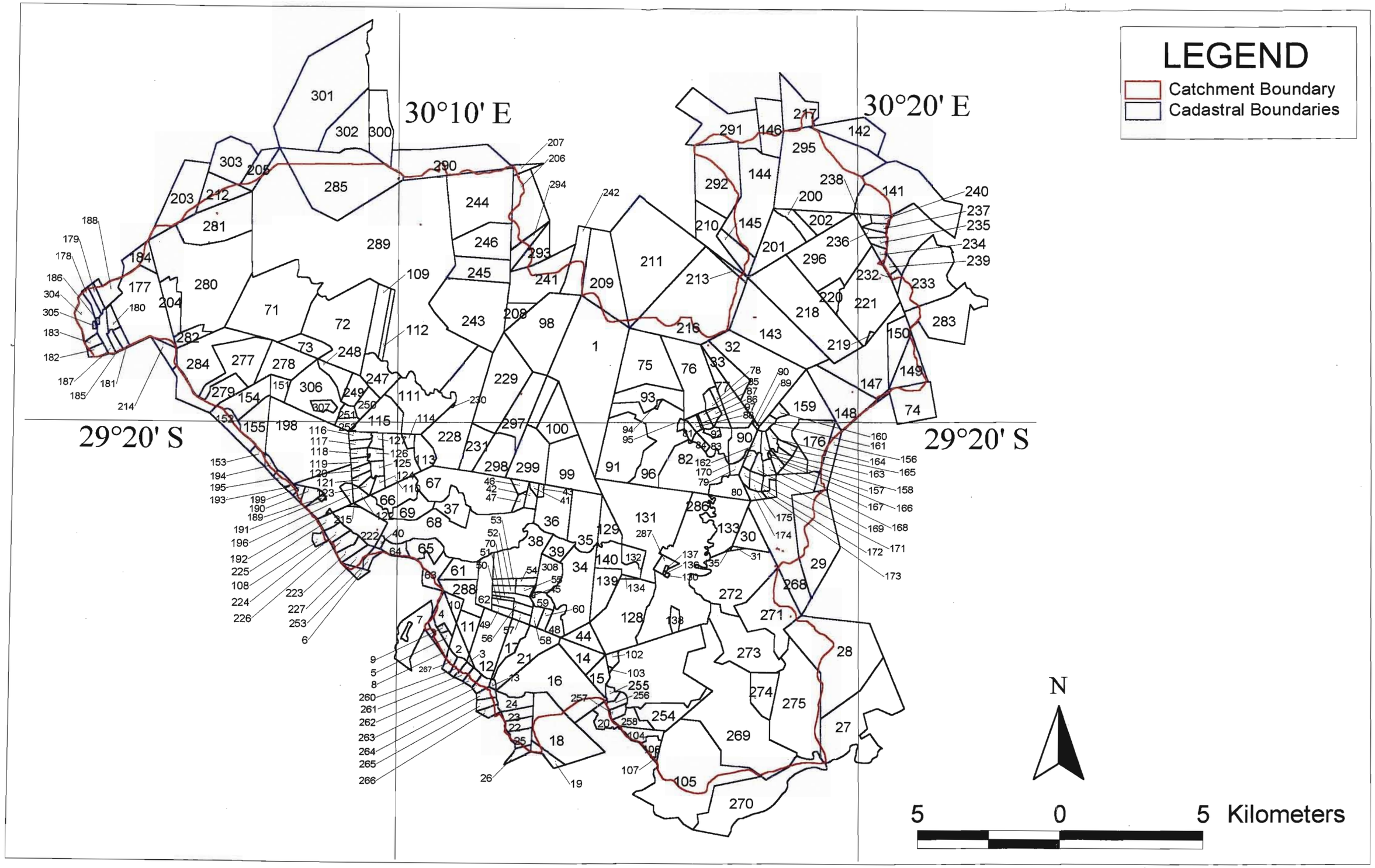


Figure 6.22. Land Ownership and Property Sizes in 1999

6.3. LAND OWNERS' INVOLVEMENT IN FUTURE PLANNING AND CATCHMENT MANAGEMENT

Interviewees were asked how they perceived their involvement in the future planning and management of the Karkloof Catchment. It emerged that 84.2% (n = 19) were interested in conserving and improving the environment. This is evidenced by the trend towards 'no till' farming and the support given to the activities of the Karkloof Conservancy and Karkloof Catchment Management Forum. Many saw themselves as the 'care-takers' of the land for future generations. Respondents felt that funding is required for catchment management and conservation initiatives. Farmers are currently subjected to considerable economic constraints. This is mainly due to: imported dairy products and beef and chicken competing on the local markets; lack of farming subsidies, which overseas farmers have and which make them highly competitive; low milk and beef prices and the decline of the Eastern forestry markets. These economic constraints have resulted in farmers currently having very little spare cash available for catchment management and conservation. How catchment management should be undertaken was of great concern to farmers and many comments and suggestions were made by respondents during interviews. These included:

- planning and management should not be prescribed or dictated;
- land-owners should be influenced slowly by positive example;
- land-owners should view the Karkloof Catchment Management Forum as a body offering an opportunity to be proactive and as a means by which they could communicate their needs;
- land-owners should not criticise one another, but should work together;
- the varying land use in the catchment has historically created suspicion and antagonism amongst land-owners, as each land use has its own unique requirements and issues which often conflict with those of other land uses. This issue should be addressed;
- co-operation should be practised amongst all land-owners on a positive constructive basis, taking into consideration economic needs of farmers and their employees;
- conservation and economic needs should be balanced in a manner that is not to the detriment of one or the other;
- the Karkloof Catchment Management Forum should respect the views and livelihoods of land-owners, be considerate, offer constructive criticism and have a give and take attitude specially when relating to long time land-owners;

- those who have conserved indigenous vegetation areas and who have large extents on their farms should be given recognition and be compensated;
- owners/caretakers of the catchment should be compensated for improvements in the catchment, which benefit downstream users (particularly cities). Compensation should be financial or in the form of other incentive benefits such as tax relief;
- present land use should not be altered too much;
- future planning and management should be sensitive to past land use practices. Changes to land use practices should not be expected to occur overnight, as the economic impacts of such rapid change could be disastrous;
- it is far more difficult for small-scale farmers to change than it is for large-scale farmers to do so. Large-scale farmers are more adaptable to change as they are not dependent on single small land holdings;
- catchment management should be conducted using individual personal interviews. Large public meetings are not favoured due to dominant opinions being expressed and dictated;
- catchment management should examine the broad issues and not concentrate just on single issues;
- the objective of the Forum should be clearly defined and communicated;
- the Forum should be professionally run, as people need to see where and how their money is to be spent;
- select projects should be chosen as a start to catchment management. Such projects would win support by example.

Many land-owners expressed the opinion that the area has great potential for tourism, but that this could only be realised if land-owners worked together, possibly developing joint ventures, and linking with tourism development. Due to potential security risks, land-owners expressed a concern regarding the use of 'outside labour' working on their farms, as may sometimes occur with projects such as, the 'Working for Water' initiative. 'Outside labour' is viewed as any labour not employed by a particular farm-owner or labour from areas outside the catchment. Many felt that the sensitive upper catchment area should be retained for conservation purposes. It was suggested that the economics of the various land use options be investigated. One respondent stated that in the long term what suits the environment best is what suits the people best.

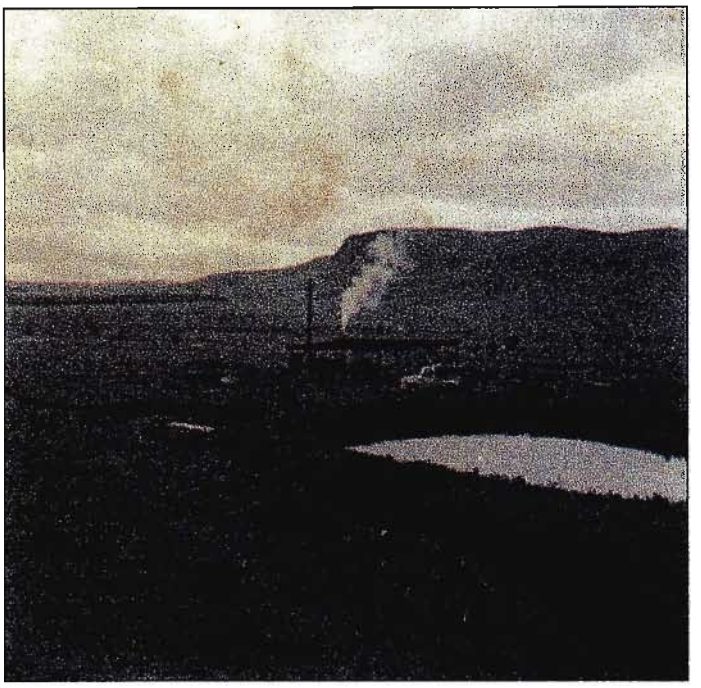


Plate 7. A timber-mill, located on the farm, 'Colbourne'. The mill was used to process indigenous timber extracted from the nearby Karkloof Forest (Source: P.Shaw 1998) (Estimated date of photograph 1950)

Plate 8. An indigenous timber logging path found on the farm, 'Ben Eden', located below the Karkloof Forest. Note the width and depth of the path, a result of extensive use and the erosive action of water run-off channelled down the path, particularly during heavy rains (Nov. 1998)

Plate 9. Remnant foundations of an indigenous timber mill, found on the farm, 'Ben Eden', located below the Karkloof Forest (Nov. 1998)

Plate 10. Exotic timber plantations which directly adjoin the Karkloof Forest. View from the De Magtenburg road looking north towards the Karkloof Forest (Dec. 1997)

Plate 11. Water plays a large role in translocating weed seeds. Note the presence of American bramble (*Rubus cuneifolius*) along this drainage channel, which runs through cultivated lands, located to the west of the Karkloof Club. Photograph taken along the road leading to the Karkloof Club, looking north (Nov. 1998)

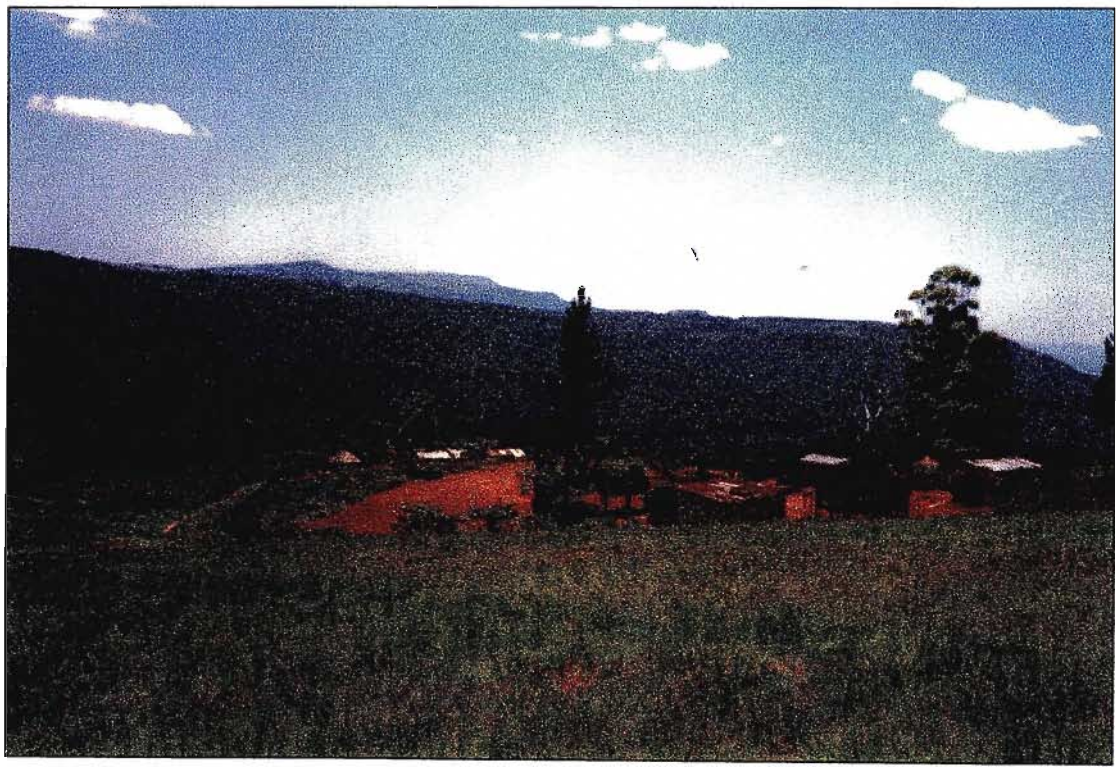


Plate 12. Farm-employee accommodation on the farm, 'The Forest', showing minimal subsistence cultivation (Nov. 1998)

CHAPTER 7: DISCUSSION AND INTERPRETATION OF MAIN FINDINGS

The principle findings of this study are that between 1944 and 1999 there has been:

- an increase in numbers of properties and a decrease in property size;
- indigenous ecosystems have been transformed which includes: marginal increases in forest and woodland, extensive loss of natural grasslands to exotic afforestation, fragmentation of ecological habitat and an increase in alien invasive vegetation;
- an increase in numbers and size of farm dams has occurred.

These findings are discussed further, and explanations of why changes have occurred and the consequences of these changes to the environment are offered.

7.1. PROPERTY NUMBERS AND SIZES

This study has found that between 1944 and 1999 numbers of properties have increased, and that the size of properties have decreased. The increase in numbers of properties may be attributed ultimately to population growth between 1944 and 1999 which has led to more people demanding their own land. This increased need for individual ownership of properties has resulted in extensive subdivision of large properties, which existed in 1944. In turn this has created small farm/property sizes. Small farm size determines the nature of land use and management. Individual farmers have to produce more from less land and therefore must optimise land use. Often optimisation, where the highest crop production levels are attained from the most suitable farmable areas, is not sufficient for the farmers' needs and they then tend to maximise land use, utilising every available space of the farm. This often impacts negatively on natural resources when farming is extended directly adjacent and into many of these areas. This problem is more severe when small farms have extensive natural areas, which again further reduces the land available for production. Many farms within the catchment, particularly those adjacent to the Karkloof Forest face this problem, with around half the farm occupied by indigenous forest with only half available for production. This trend is discernible in Figure 6.5. (p.63), where property boundaries have been superimposed on the land categories.

Clay *et al.* (1994) state that large holders of land are often more able than small-holders are, to maintain traditional fallowing practices and to set aside large areas for non-food uses that help control soil loss and fertility depletion. Small holders of land, which have lower production, are closer to the margin of financial failure and at greater risk should portions of their holdings fail to produce adequate yield. Small-holders often need more careful farm management with the related improvements in productivity. Although mean property size in the catchment has decreased, two large timber companies namely Sappi Forests (Pty) Ltd. and Mondi Ltd. have bought up many discrete properties that were adjacent to one another. Together they own 26.2% of the catchment. These individual adjacent properties are farmed as large land-holdings, with land use and management accordingly being influenced. Large land-holdings are more resilient to change, because they are not dependent on single small-holdings for their income; they contain larger farmable areas and therefore it should be easier to set aside marginal or sensitive areas for conservation purposes; they have the benefit of shared farming resources and access to technological advancements. The large property sizes of 1944 exerted less pressure on the natural resources than the small property sizes of 1999. Many properties, which were usually adjacent to one another were owned by the same individual or members of the same family. Operational farm sizes were thus much bigger than those that were registered. This had certain advantages such as the sharing of farming equipment and resources and the obvious fact of an increased area available for shared farming, all of which advantages has largely been lost today.

Legislation has also influenced farm size. In 1944 no legislation existed which regulated farm size (J. Milton, 2000, pers. comm). Farms were subdivided according to the requirements of the farm-owner and his family. Subdivision of farms was based mainly on the number of sons who were to inherit the property from their father (F. Marais, 1999, pers. comm.). This resulted in farm sizes becoming increasingly smaller with each new generation. Unusually small property sizes in 1944, such as those owned by Samual Stead, which are part of Lot 67, located to the north-west of the catchment, are thought to be the result of farm subdivisions of the Hackett Immigration Scheme of the 1840s and early 1850s. Samual Stead is reported to have ridden across these farms some time after the Hackett immigration, only to find most of them abandoned (Hattersley 1950). It is thought that Stead may have later purchased these properties.

Other small properties in 1944 were the result of subdivisions made in drawing up a will, or prior to death so as to ensure that family members did not quarrel over their inheritances. These properties, although shown as individual units, were nevertheless often managed as one farm.

Immediately prior to 1970 the demand for rural residential land (small-holdings) increased markedly, mainly because people at that time had become more affluent and wanted to move out of the big towns into the country, or wished to acquire second holiday homes. Land-owners took advantage of this opportunity to acquire capital by disposing of portion or even entire land-holdings, often at higher prices than would have been realised if the land had been sold *en bloc* for agricultural purposes (Anon. 2000a). This led to the further creation of small farms. This trend was perceived as a threat to the viability of commercial farms and thereby future national food security in South Africa, where fragmented land-holdings became too small to sustain the farmer, leading to over exploitation of land (Anon. 1970). The promulgation of the Subdivision of Agricultural Land Act (Act 70 of 1970) was intended to combat the creation of uneconomic farming units through subdivision, which in their turn, could give rise to over-utilisation of the land, resulting in higher levels of soil erosion (Fuggle & Rabie 1992). It was stipulated that agricultural land could not be subdivided unless the Minister of Agriculture consented to such subdivision (Anon. 1970). Applications for subdivision were evaluated on the basis of what constituted an economically viable unit so that farmers could secure an acceptable income from the farming operation (Anon. 2000a). The economic farming unit was determined by a number of factors such as: the farming activity, local farming conditions (soils, climate and vegetation), available arable land and economic viability (K. Camp, 1999b, pers. comm). However, despite these requirements, in some districts the Subdivision of the Agricultural Land Act (Act 70 of 1970) stipulated that the minimum farm size should be 20 acres. This was found to be problematic as most land units of this size or smaller, unless intensively farmed, are not economically viable and the legislation, although well intended, in many instances did not serve its intended purpose. Land within the Karkloof Catchment falls within the planning category of, 'Reserved for Agriculture'. This category applies to all land not zoned for other uses in terms of the Natal Planning Ordinance 27 of 1949 as amended (M. Puttick, 2000, pers. comm.). Thus the area was subject to the Subdivision of Agricultural Land Act (Act 70 of 1970).

The repeal of the Subdivision of Agricultural Land Act (Act 70 of 1970) is currently being proposed, primarily to promote farming among previously disadvantaged small-scale farmers. Concern that this will result in a serious loss of land of high agricultural value and conservation-worthyness has been expressed by numerous stakeholders (Anon. 2000a). Though it has been stated that supplementary legislation in the form of the proposed Planning and Development Act and the Environmental Conservation Act (Act 73 of 1989) will offer adequate legal protection against land degradation, the implementation of these Acts and the judgement values of those assessing applications may be of concern. Any further reduction in farm sizes will again influence the choice of land use and land management and may exert even greater pressure on natural resources.

7.2. TRANSFORMATION OF INDIGENOUS ECOSYSTEMS

7.2.1. Forest and Woodlands

The Forest Commission in 1880 estimated the Karkloof Forest to be 323.68 km^2 (32 368 ha) (Foucade 1889 and Bews 1913 in Rycroft 1942). Some 62 years later, in 1942 Rycroft estimated the extent of the forest to comprise probably only a quarter of the original (80.92 km^2 or 8092 ha). That the forest may have declined by 242.76 km^2 (24 276 ha) between 1880 and 1942, a relative change of 75% implies a profound change in a major ecosystem in the catchment.

The combined area for forest and woodland in 1944 as determined from this study is 44.20 km^2 (4420 ha). This is almost half the extent estimated by Rycroft (1942). While a decrease in the extent of indigenous forest by 242.76 km^2 (24 276 ha) (Foucade vs. Rycroft) between 1880 and 1942, a period of 62 years (a decline rate of c 392 ha yr^{-1}) is startling (a subjective comparison with the work of Von Breitenbach (1968) revealed that such rates of decline are not recorded even for the Knysna Forest, which has long been exploited extensively), the apparent decrease of 36.72 km^2 (3672 ha) between 1942 (Rycroft) and this study (1944) – a mean annual rate of 1224 ha, verges on the unbelievable!

This aparent rate of decline becomes even less credible when it is appreciated that human population in the catchment at around this time was low, also, since most forests between 1942 and 1944 occurred on white owned farms and this was during the Second World War when many potential vigorous exploiters of forest would probably have been involved in the war effort in some way or another. Furthermore, at that time, modern equipment such as chain saws, which would be necessary to achieve this rate of reduction, did not exist. Hence it seems reasonable to conclude that Rycroft's estimate of the extent of indigenous forest in 1942 was far too generous and likewise the same can be concluded for Foucade's extent. Such shortcomings can be ascribed to the lack of small-scale maps, e.g. 1:50 000, at the time of both Foucade and Rycroft's surveys.

It is significant that in the 55 years between 1944 and 1999, the area of forest and woodland combined has not continued to decrease as apparently occurred between 1880 and 1942, but rather has increased by 3.02 km^2 (302 ha). Rivers-Moore (1997) in his examination of changes in land use in the Midmar Catchment, which adjoins the Karkloof Catchment's western boundary, also noted a slight increase in the size of indigenous forest between 1944 and 1996. The increase in forest and woodland between 1944 and 1999 in the Karkloof Catchment is ascribed to the following:

1. In 1944 'Cultivation - Subsistence' was taking place in a number of locations within and adjacent to the indigenous forest. A typical area of such a situation is shown in Figure 6.6. (p.64). These areas have since been abandoned and over the 55 year period have slowly been re-colonised by grasses followed by small trees. These areas have been classified in this study as woodland areas by 1999.
2. Fire has undoubtedly played a considerable role in limiting the expansion of forest and woodland. This study has shown that grasslands have generally been burnt less frequently than they were in 1944. Land use immediately adjacent to forest was mainly classified as 'Exotic Vegetation - Managed' in 1999. Such areas are not burnt and as they consist of large, solid areas, they act as a 'fire-break', preventing most grass fires from burning up to and into the indigenous forest. This reduction in fire frequency and the occurrence of fire has allowed large forest patches to increase outwards, it has allowed woodland areas within or adjacent to large patches of forest to succeed to forest, and grassland patches within or adjacent to large patches of forest to succeed to woodland.

Rycroft (1942) stated that grass fires generally attack forest margins, although severe fires have been known to burn through forests. While severe fires may burn through very small forest patches, that this also occurs in the case of large blocks of indigenous forest needs to be challenged. Rycroft (1942) stated that a fire, which originated near Mooi River, during the winter of 1878, swept in a south-easterly direction on past the Karkloof Forest, and through part of it, until it eventually reached the Umgeni River. He stated that in many places the forest was severely burned. This statement is considered misleading in that while this fire may have burnt through small patches of forest and places in larger patches where they were narrow, it is untenable that the fire would have run through large blocks of forest such as today form part of the Karkloof Forest. The presence of large areas classified as, 'Exotic Vegetation - Managed' adjacent to indigenous forest would have inhibited such fires and prevented them from causing extensive damage to forest. Rycroft (1942) stated that if there is no recurrence of fire there is a good change of the forest regaining its former territory. If on the other hand, fires recur every year, there is no likelihood that this succession will take place. Rycroft (1942) noted that during 1941, there was only one locality where fire had not extended right up to the forest margin. This may have been due to owners of large farms being engaged in one way or another with the World War Two effort and having little time and resources available for fire management. Rycroft (1942) stated that if protected in the future, the marginal community of forest would assist in bringing about conditions suitable for the germination and growth of important timber species. On the other hand if the area was unprotected, fire would destroy the marginal community, and probably damage some of the trees on the edge. Rycroft (1942) stated that this was happening year after year in most parts of the forest, with the margins retreating every time. The 'fire-break' effect from the presence of the category classified as 'Exotic Vegetation - Managed' and a reduction in frequency of grassland burning noted in 1999 has therefore contributed to the protection of the marginal community thus enabling expansion of the forest. In presenting this hypothesis due cognisance is taken of the fact that no empirical data describing the rate of succession of fire prone forest margin communities for forest yet exists.

3. In 1944 indigenous timber was still being extracted from the forest. This has ceased since the 1960s. Areas that were previously damaged have been allowed to recover, with gradual succession to forest occurring.

The close proximity of 'Exotic Vegetation - Managed' to the indigenous forest in 1944 has been observed and the trend is seen to continue and intensify by 1999. The affect of this on the indigenous forest, apart from the resultant reduction in fire has however not been investigated in this study.

7.2.2. Grasslands

Grasslands within the catchment have decreased significantly with 141.60 km^2 being lost between 1944 and 1999: a loss of 53.6% of the grassland area that was present in 1944. Grasslands have been replaced mainly by, 'Exotic Vegetation - Managed' and marginally by 'Cultivation - Commercial'. Rivers-Moore (1997) reported a similar loss of 46.4% between 1944 and 1996 in the grassland area that was present in the adjacent Midmar Catchment in 1944. Grasslands were also lost mainly to exotic afforestation.

The loss of grassland habitat is significant and a cause for considerable concern. Of the estimated 20 300 species of vascular plants which occur in southern Africa, at least 3378 species are exclusively grassland species (Siegfried 1989). An examination of the vegetation maps of southern Africa prepared by Acocks (1953) and Low & Rebelo (1996) showed that these grasslands occur mostly in the South African Provinces of: Free State, North-West, Gauteng, Mpumalanga, Eastern Cape and KwaZulu-Natal. Hence a decline in the extent of natural grasslands in KwaZulu-Natal is likely to lead to a decline in the sectivity of the indigenous plants which characterise this vegetation type. Scott-Shaw (1999) noted an association between ecosystems, as classified in his study and the number of all threatened plants ($n = 344$). The 'Grassland' ecosystem was found to contain the highest representation of threatened plants (58.4%), relative to its land area proportion of 6.2%. Scott-Shaw (1999) further examined the association between his classified grassland types and the number of threatened species and noted that the category, 'Mistbelt Grassland', into which category the grasslands of the Karkloof Catchment fall, as having an apportionment of 26.4%, which is the highest of all his grassland types. Scott-Shaw (1999) also rated Acocks's (1988) Veld Type, 'Natal Mistbelt Ngongoni Veld (45)', into which category the grasslands of the Karkloof Catchment fall, as being one of the most threatened Veld Types in KwaZulu-Natal, with > 90% transformed and 0.3% protected (Proclaimed Protected Areas).

He stated that this Veld Type should have a high conservation priority and that further loss may result in the loss of threatened plant species. Low & Rebelo (1996) described and mapped four vegetation types, which occur in the Karkloof Catchment. Three of these: 'Moist Upland Grassland', 'Short Mistbelt Grassland' and 'North-eastern Mountain Grassland' are included in the Grassland Biome. Two of these units dominate the catchment area: 'Moist Upland Grassland' and 'Short Mistbelt Grassland'.

Approximately 7.5% of 'Moist Upland Grassland' in KwaZulu-Natal and 2.5% in southern Africa is conserved, whilst approximately 2.5% of 'Short Mistbelt Grassland' in KwaZulu-Natal and 2.4% in southern Africa is conserved (Low & Rebelo 1996). The Grassland Biome is considered to have an extremely high biodiversity: second only to the Fynbos Biome! This poor conservation status and high biodiversity of the Province's grasslands has lead to a request by the KwaZulu-Natal Nature Conservation Service for a moratorium to be placed on any further transformation (where new ground is to be broken) of Mistbelt Grasslands (KwaZulu-Natal Nature Conservation Service 1999). This request was accepted by the KwaZulu-Natal Plantation Permit Review Panel on the 29 September 1999. The loss of grassland is of even greater concern, considering that most of the few remaining grassland areas are poor in grazing quality. Although interviewees perceived grazing quality as having improved since 1944, based mainly on an improvement in grass cover, large numbers of *Aristida junciformis*, an unpalatable grass species and very little *Themeda triandra* were noted on farms visited during the study. Although easily distinguishable in winter, the boundaries of communities distinctly dominated by these two species were not mapped because it was felt such an undertaking was beyond the scope of this study. Such information would nevertheless be very useful in further quantifying the loss of grasslands in the catchment and in the KwaZulu-Natal Midlands. In addition, the loss of grasslands to mainly one land use category; exotic afforestation and the resultant fragmentation of the grasslands has implications for the biodiversity status of the Karkloof Catchment. Armstrong *et al.* (1998) states that exotic afforestation affects all three components of biodiversity, namely: composition, structure and function, and that a critical issue is the cumulative landscape-level transformation. From examination of Figure 6.2. Land Categories in the Karkloof Catchment in 1999 (p.58) it is clear that exotic afforestation occupies the greatest area of the catchment relative to other individual land use categories (36.2%) thus its cumulative impact on biodiversity could be considerable.

This study has shown that 37.6% of the aquatic grassland area and 5.5% of the riparian grassland area that was present in 1944 had been lost between 1944 and 1999. The loss in areas of riparian and aquatic grasslands was determined from observation of open water, wet areas and hygrophilous grasses, which could be discerned in the 1944 and 1996 aerial photographs.

The decrease in aquatic and riparian grassland may be attributed to:

1. Categories 'Exotic Vegetation - Managed', 'Exotic Vegetation - Wild' and 'Cultivation - Commercial' have replaced or have encroached into riparian and aquatic grasslands. An example of such a loss to 'Cultivation - Commercial' is shown in Figure 6.9. Central Representative Area (p.67).
2. The increase in farm dams within the catchment has contributed towards a reduction in streamflow, ultimately reducing wetland areas. Tarboton & Schulze (1990) state that the then present farm dams in the adjacent Midmar Catchment reduced the potential streamflow into Midmar Dam by 13%. Dams within the Karkloof Catchment may exert similar reductions in potential streamflow.
3. The categories 'Exotic Vegetation - Managed', 'Exotic Vegetation - Wild' and 'Cultivation - Commercial' use more water than indigenous vegetation. This is exacerbated by the extraction of water for the irrigation of crops. Mature Pine and Eucalypt forest types are estimated to cause 30 to 40 mm change in annual water yield per 10% of the catchment subject to change in cover (Bosch & Hewlett 1982 in Scott & Smith 1997). For example, the clearfelling of mature Pine forest occupying 20% of a humid grassland catchment could be expected to increase streamflow by 60 to 80 mm. Reductions in water yield will reduce streamflow and ultimately impact on wetlands by decreasing their area.

Aquatic and riparian grassland areas perform many valuable functions. Kotze and Breen (1994) cite the functional values of wetlands, which benefit society as for example:

1. Hydrological values (water purification; streamflow regulation, including flood attenuation and baseflow augmentation; and groundwater discharge and recharge).
2. Erosion control value.
3. Ecological value (maintenance of biotic diversity through the provision of habitat for wetland-dependent fauna and flora).

Any decrease in aquatic and riparian grassland areas will result in the subsequent loss of many of the above benefits.

In 1944 extensive areas of 'Cultivation - Subsistence', consisting mostly of annual crops, such as maize and some vegetables, was taking place within and adjacent to aquatic and riparian grassland areas. In 1999 'Cultivation - Commercial', in the form of mostly perennial pastures was found to be taking place adjacent to these areas. It is thought that the impact from 'Cultivation - Subsistence' on aquatic and riparian grassland areas would be far greater than that from 'Cultivation - Commercial'. Kotze and Breen (1994) stated that the level of impact on wetlands from pasture production is less severe than from cropland production as pastures provide better vegetation cover for the soil. If pastures are perennial then the impact of soil erosion is likely to be reduced further, because perennial plants require the soil to be disturbed and exposed less. Also, commonly grown perennial pasture species tend to have higher wetland tolerance than most crops and annual pastures, which means that there is less need to drain such wet areas.

7.2.3. Habitat Fragmentation

Habitat fragmentation is defined as the progressive division of large, comparatively homogeneous tracts of habitat or vegetation type into a heterogeneous mixture of much smaller patches as a result of disturbances, including human activity (Reed *et al.* 1996 in Winter 1999). Examination of Figure 6.2. (p.58) shows that forest, woodland and grassland areas have become highly fragmented.

No detailed analysis of the extent and nature of fragmentation was undertaken as it was considered beyond the scope of the study. However, a database created by this study does allow for such detailed analysis at a later stage.

Nevertheless, at this stage the extent and nature of fragmentation within the Karkloof Catchment is of importance because fragmentation affects biodiversity. Fragmentation studies may include the analysis of vegetation patch size, shape, density and numbers of various patch types; connectivity between patches; landscape structure; edge affects; species composition and diversity.

Such studies would provide an indication of the current status of biodiversity within the catchment and would contribute to an understanding of the biodiversity status of the KwaZulu-Natal Mistbelt as a whole.

In her study of Mistbelt Grassland fragmentation in the Mvoti Vlei Conservancy, which is situated adjacent to the north-east of the catchment, Winter (1999) observed similarly, that the Mvoti Vlei Conservancy area is highly fragmented. The additional fragmentation of the Karkloof Catchment could have implications for the biodiversity status of the KwaZulu-Natal Mistbelt. Fragmentation studies of the Karkloof Catchment will provide valuable base information, which will allow the importance of the remaining vegetation patches to be assessed. Future linkages between patches as well as other conservation strategies may then be proposed. This would ultimately aid in the overall conservation and general improvement of the ecology within the catchment and surrounding area.

7.2.4. Alien Invasive Vegetation

The total area of the category, 'Exotic Vegetation - Wild' has increased by 7.71 km^2, which between 1944 and 1999 is an increase of 397.3% in the area of 'Exotic Vegetation - Wild' that was present in 1944. This increase may be due to:

1. Timber plantations, classed as 'Exotic Vegetation - Managed', which existed in 1944, have been abandoned and are classed as 'Exotic Vegetation - Wild (Other)' in 1999. Many of these areas have increased in size by 1999, due to self-sown timber species being allowed to establish and mature on plantation margins. This is normally controlled when a plantation is actively managed, with weed control programmes aimed at preventing the spread of the timber species into adjacent areas.
2. In 1944 timber plantations were far less extensive than in 1999 and in 1944 were a relatively new form of land use. This meant that timber plantations had not yet produced sufficient quantities of seed relative to the prevailing seed dispersal affects. Macdonald & Jarman (1985) stated that plantations tend to form seed source centres. With the increase in the total extent of timber plantations within the catchment and the passage of time between 1944 and 1999 sufficient amounts of seed have been produced relative to dispersal affects and timber species have spread into adjacent areas.

3. The planting of timber plantations close to streams and rivers in 1944 has hastened the spread of timber tree species to downstream areas (Figure 6.10. (p.71)). Water is observed to be a translocating agent of seeds. In 1999, the practice of planting close to rivers was still observed in many parts of the catchment, although efforts are being made to remove timber from riparian areas and to plant away from streams and rivers with each new timber planting (C. Boake & R. Pott, 1999, pers. comm.).

4. Timber species such as, *Acacia* spp. which were more common in 1944 and *Pinus patula*, which was more common in 1999, spread and invade natural areas more than other timber species. Campbell (1993) notes that Wattle seeds are long-lived and may remain dormant in the soil for up to 100 years. This dormancy may be broken when the grassland is burned and the seed coat cracks, with the seed germinating during subsequent rains. Macdonald and Jarman (1985) similarly state that *Acacia mearnsii* seed can remain viable for up to 40 years and that *Pinus patula* has a high potential rate of spread.

5. Disturbed areas are more susceptible to invasion from 'Alien Invasive Vegetation' than pristine natural areas. With increased changes in land use and land use practices there has been a related increase in disturbed areas and a subsequent increase in invasion from 'Alien Invasive Vegetation'.

6. Grasslands were burnt more frequently and were overgrazed in 1944 than is the case in 1999. This is thought to have controlled the growth and spread of 'Alien Invasive Vegetation' in 1944, as seedlings were prevented from establishing themselves due to being destroyed or damaged by fire or grazing.

'Alien Invasive Vegetation' poses numerous threats to indigenous ecosystems, these include:

1. The habitat for indigenous species is destroyed, which is a threat to the natural levels of biodiversity.

2. 'Alien Invasive Vegetation' use more water than the indigenous vegetation they replace (van Wilgen 1997). Sufficient water is essential for ecosystems to function correctly. Any decrease in water will adversely affect the functioning of ecosystems.

3. Flow of water is hampered, often resulting in flooding.

4. The landscape is aesthetically spoilt. The replacement of indigenous vegetation by alien species of greater size and density will result in screening and masking of views at least at short to intermediate ranges (Versveld & van Wilgen 1986 in Bainbridge 1990).

5. Some plant species, such as *Acacia mearnsii* once established in heavy densities will exclude all other plants resulting in soil erosion from lack of sufficient ground cover.

Removal of 'Alien Invasive Vegetation' is highly advantageous in reducing or eliminating these threats. Economic advantages such as: increased farmable areas and increased water flows are an added incentive for removal.

7.3. INCREASE IN NUMBERS AND SIZE OF FARM DAMS

The study has shown that farm dams within the catchment have increased in number and size between 1944 and 1999. The increase in the numbers of dams may be directly related to the increase in numbers of properties within the catchment, which is a reflection of intensive subdivision of large farms. Each property requires its own supply of water for crop production. The increase in dam size may be attributed to the need to optimise land use on the resultant smaller property sizes found in 1999.

The increase in numbers and size of dams, as mentioned in Section 7.2.2. has contributed towards a reduction in streamflow, ultimately reducing wetland areas within the catchment. Tarboton & Schulze (1990) found that the then present farm dams within the adjacent Midmar Catchment reduced the potential streamflow into Midmar Dam by 13%, while an increase of 75% in the area under farm dams within the catchment, would reduce the median annual streamflow into Midmar Dam by 5%. Farm dams also impacted on the temporal nature of streamflow into Midmar Dam, by attenuating the seasonal streamflow variability in dry years and increasing streamflow in wet months, due to the high rainfall being more effective on an increased surface water area (Tarboton & Schulze 1990). Further increases of numbers of farm dams within the Karkloof Catchment may be expected to exert similar impacts on stream-flow rates, which will affect water availability in Albert Falls Dam and the Mgeni Catchment as a whole.

CHAPTER 8: CONCLUSIONS AND RECOMMENDATIONS

8.1 GENERAL CONCLUSIONS

In the 55 years between 1944 and 1999, land within the Karkloof Catchment has been transformed profoundly by man's activities. Pivotal to this transformation has been the increase in the number of properties caused by the subdivision of agricultural land and the resultant decrease in the size of individual properties. Farmers have had to produce more from less land and have therefore had to optimise land use. Often optimisation, where the best crop production levels are attained from the most suitable farmable areas, is not sufficient and farmers have then tended to maximise land use, utilising every available space of the farm. This has often impacted negatively on natural resources. The planting of marginal areas to short-term rotational crops such as maize and soya-beans, and to timber plantations has increased.

One of the more serious transformations that has taken place is the substantial decrease in natural grassland (141.60 km^2 being lost), which has been lost mostly to exotic afforestation and marginally to commercial cultivation. This loss is cause for concern, particularly as similar losses to the KwaZulu-Natal Mistbelt Grasslands have been reported by others (Low & Rebelo 1996, Rivers-Moore 1997 & Scott-Shaw 1999). Grasslands in KwaZulu-Natal and its neighbouring regions are known to contain a high representation of threatened plants relative to other ecosystems, and the category, 'Mistbelt Grassland', into which category the grasslands of the Karkloof Catchment fall, is described as having the highest apportionment of threatened species of all grassland types (Scott-Shaw 1999). Furthermore grasslands contribute considerably to the numbers of estimated species of vascular plants which occur in southern Africa (Siegfried 1989). Any decrease in the extent of grassland may result in a decrease in the numbers of threatened plant species as well as a decrease in the numbers of estimated species of vascular plants which occur in southern Africa. Grasslands, once lost, may never be re-established in their former state, because the conditions under which they became established, especially climate were very different to those which occur today.

The study has also shown a marginal increase in forest and woodland, which is of importance as large losses of indigenous forest were thought to have occurred prior to 1944 (Rycroft 1942).

Rivers-Moore (1997) noted a similar increase in the size of indigenous forest in the adjacent Midmar Catchment.

A consequence of the noted land transformation is the related increase in alien invasive vegetation, which has increased particularly with disturbances to the land and the establishment of exotic afforestation. With the increase in the number of properties within the catchment, there has been a related increase in the numbers of farm dams, and farm dam size has also increased because of the need to optimise land use. It seems logical to conclude that this may well have contributed to a reduction in water quantity in streams and rivers and has diminished the extent of wetlands within the catchment.

Land-owners within the catchment are becoming more environmentally conscious, despite increasing economic and other pressures. Farmers are moving towards more sustainable farming methods such as 'no till' farming. Catchment management bodies such as the Karkloof Conservancy and the Karkloof Catchment Management Forum have been established and are increasingly becoming well supported. There is a movement away from traditional land uses such as agriculture, towards recreational, residential and tourism ventures.

Undoubtedly demand for land and its products will continue to increase and more pressure will be exerted on the natural resources of the catchment. The ability of the catchment to sustain this continued pressure will ultimately depend on land-owners constantly finding ways to live with nature, sensitively balancing development against the environment.

8.2. SIGNIFICANCE AND FURTHER APPLICATION OF THE STUDY

The study has quantified and provided an understanding of land transformation and the resultant significant consequences to the environment within the Karkloof Catchment. This baseline information and insight provides a valuable tool which will assist in improved environmental management and the formulation of future land use plans of the catchment. A spatial (GIS) and descriptive database has been created for 1944 and 1999.

The provision of the 1944 database is of particular importance. It is stated by Swetnam *et al.* (1999) that historical perspectives increase our understanding of the dynamic nature of landscapes and provides a frame of reference for assessing modern patterns and processes. Scientists and managers alike are increasingly using environmental history as a 'base datum' for understanding and managing ecosystems (Swetnam *et al.* 1999). Environmental history may be used to determine the range and variability of ecological processes and structures during times when ecosystems were less affected by humans. Reference conditions may be used, along with current condition assessments, social and economic considerations and other practical constraints, for the setting of achievable and sustainable management goals (Swetnam *et al.* 1999). Reference conditions are useful for deciding upon ecologically justifiable goals for restoration programs.

The databases provided for 1944 and 1999 in this study may be utilised by various conservation and catchment management bodies and individuals. Such utilisation may include:

1. Detailed analysis of habitat fragmentation, which will reflect biodiversity status within the catchment. Winter (1999) used 'ArcView Version 3.1.' to calculate for each fragment namely: area (ha), perimeter (m) and nearest neighbour distances (m), from which a variety of metrics and statistics were calculated for each individual patch and for the Mistbelt Grassland patch type as a whole. 'ArcView Version 3.1.' was also used to examine what predominant land use contrast existed around each patch. 'FRAGSTATS', a computer program was then used to quantify the landscape structure. The GIS database created and statistics attained in this study are suitable for such analyses.
2. Detailed mapping and analysis of grassland species composition, which will contribute to a deeper understanding of the significance of the loss of grasslands in the catchment and the KwaZulu-Natal Midlands as a whole.
3. Temporal vegetation changes between 1944 and 1999, which this study shows may be further analysed. Future changes may be recorded. The analysis of these changes may broaden current understanding of vegetation change and its influencing factors.
4. The progress of conservation initiatives, such as the removal of 'Invasive Alien Vegetation' from the catchment may be mapped. This will assist in the improved management of such initiatives.

5. The GIS database may be utilised in environmental planning work. The 1999 land category map may be overlayed with other GIS databases such as: soils, topography, hydrology, infrastructure and climate, to determine the most suitable areas for various land uses. In this way a future land use plan of the catchment may be created.
6. At the detailed farm level, land categories provided may be further divided to assist in farm conservation projects and general farm management.
7. Water quantity models for 1944 and 1999 land categories may be produced using the created 1944 and 1999 land category maps. These will provide insight into the effect that various land use and land cover types have on water utilisation.

The Karkloof Catchment Management Forum has recognised the value of the study to their work and has stated that the database will be particularly useful in determining current environmental problems and in formulating future conservation initiatives and a land use plan (K. Cooper, 1999, pers. comm.). On completion of this dissertation, its database will be made available to the Karkloof Catchment Management Forum and other conservation and catchment management bodies and individuals who may request its use. The database has been structured so as to be dynamic, allowing for future updating and editing by future users.

It is my sincere hope that the knowledge gained from this study and the provision of the GIS database will be further utilised by others in a positive and constructive manner, which will benefit the environmental and socio-economic status of the Karkloof Catchment and its surrounds.

8.3. CATCHMENT MANAGEMENT BODIES AND INTEGRATED CATCHMENT MANAGEMENT

Following the 1994 elections and change of Government, South Africa has seen many changes. Much new legislation relating to the environment has been promulgated. Stakeholder involvement and the need to facilitate participation from everyone is embodied in much of this legislation. The need for the integrated management of all aspects of water resources and where appropriate, the delegation of management functions to a regional or catchment level is recognised (Anon. 1998).

The two primary catchment management bodies relevant to integrated catchment management in the Karkloof Catchment include the Karkloof Catchment Management Forum and the Karkloof Conservancy. Integrated management by stakeholders at a local level has numerous advantages. Stakeholders invariably have different backgrounds, education, life experiences, goals and objectives. The pooling of these results in the mixing and exchange of ideas and a more holistic management approach. Differences of opinion are detected at an early stage with potential problems being dealt with. Knowledge and resources are shared, communication is improved and the community may be strengthened. The Karkloof Catchment has many varying land uses, which have historically created suspicion and antagonism amongst land-owners. An integrated management approach may assist in broadening understanding of the various land uses and associated problems and issues, which may help relieve suspicion and antagonism. Integrated management by stakeholders at a local level does have certain disadvantages. Stakeholders often do not have the skills or expertise necessary for management and planning. There is also the danger that vocal and dominant individuals or stakeholders may influence decisions. The Karkloof Catchment Management Forum and Karkloof Conservancy have no statutory powers or legal backing: participation in the Forum and Conservancy and adherence to decisions made is purely voluntary. Appropriate management and direction of these bodies is of paramount importance to their success. Good management and sound direction could enhance relations and promote sustainable catchment management, whilst poor management and direction could have the reverse effect.

The following recommendations which may assist in achieving appropriate management and direction of catchment management bodies are suggested:

1. The Karkloof Conservancy's role in promoting environmental education should be enhanced. Environmental education helps change people's perception of the environment and awareness is created on the values and sensitivities of the environment.
2. As no statutory or legal backing exists to enforce catchment management and conservation, it is important that support is voluntarily obtained. Stakeholders should be able to see the effect of their actions and should want to make appropriate change. Various starter projects, such as the clearing of 'Invasive Alien Vegetation' from riparian zones may be initiated. These, if managed and undertaken correctly, will show results and will win support.

3. The running of catchment management bodies should be undertaken in a professional manner. Poor management will lead to dissatisfaction and loss of interest, which will reduce chances of success.

4. Necessary expertise should be obtained when necessary, stakeholders should not attempt to undertake everything themselves. The use of outside expertise will assist in strengthening catchment management, will promote environmental education and will further empower stakeholders. It will also help focus catchment management and ensure that the broader integrated picture is considered as opposed to much too specific issues.

5. Funding for catchment management is a major issue, with no real solutions available at present. Farmers are currently subjected to considerable economic constraints and do not have available funding for catchment management. Funding from the Private and Government sectors will need to be acquired. Methods such as raising funds by levying water tariffs to those that benefit from improved catchment management (particularly cities) should be investigated. Land-owners that conserve and improve catchment functioning should be compensated. Compensation may be in the form of incentives such as tax relief and subsidies.

Involvement of stakeholders at the local level in integrated catchment management will ensure that they 'buy in' to any decisions taken or strategies proposed, and they accept future land use plans and catchment management proposals.

8.4. PROPERTY SIZE AND LAND USE TYPES

The study has found that as a result of extensive subdivision of agricultural land, property numbers have increased, whilst property sizes have decreased between 1944 and 1999. Small farm sizes were seen prior to 1970 to be a threat to the viability of commercial farms and the future national food security in South Africa. In response the Subdivision of Agricultural Land Act (Act 70 of 1970) was promulgated and was intended to combat the creation of uneconomic farming units, which in their turn, could give rise to over-utilisation of the land, resulting in higher levels of soil erosion (Fuggle & Rabie 1992). The repeal of this Act is currently being proposed.

It has been stated that supplementary legislation in the form of the proposed Planning and Development Act and the Environmental Conservation Act (Act 73 of 1989) as amended will offer adequate legal protection against land degradation due to uneconomic small farming units (Anon. 2000a). The implementation of these Acts and the judgement values of those assessing applications may however be of concern. Further reduction in farm sizes is expected to affect land use and land management accordingly and may exert even greater pressure on natural resources. The type of land use found on small properties influences the severity of this pressure. Intensive farming systems, such as exotic afforestation, crops, dairy, pigs, poultry and the breeding of pedigree livestock often result in maximisation of land use and rely heavily on production from arable land. This puts considerable pressure on the natural resources. Scotney (1970) states that intensive farming systems, however provide the best economic possibilities. Extensive farming systems such as beef and / or sheep rely almost entirely on production from the natural grassland (Scotney 1970). However, these systems exert less pressure on natural resources. Intensive farming systems although exerting greater pressure on natural resources, are more able to provide a living from smaller property sizes than extensive farming systems, which require greater expanses of land to be profitable. Extensive farming on small pieces of land may result in the need to over stock in order to be economic, thus resulting in overgrazing and degradation of natural grassland areas. In recent years land use within the catchment has moved away from these traditional farming practices towards tourism, recreational and residential land uses. Such uses may exert less pressure on natural resources and make the use of smaller property sizes more economical.

A distinction needs to be made between future land use types and property size. It is recommended that restrictions be placed on the further subdivision of properties, which are to be used for farming practices, as further reductions in farm sizes will exert greater pressure on natural resources and place considerable economic pressure on farmers to make a living. Subdivision of properties for alternative land use types such as, tourism, recreation and residential activities should be evaluated on a 'case-by-case' basis. Although these land use types require less land to be economic and place less pressure on natural resources, the cumulative impact of large groupings of these in close proximity to one another could be considerable.

The Karkloof Catchment is a valuable natural asset with high visual appeal. Care should be taken not to destroy this with over development of the area as has happened in many other parts of South Africa, for example the Cathkin Valley, in the KwaZulu-Natal Drakensberg. Studies which may include an overall visual analysis; visual and environmental impact assessments of individual proposals; investigation of the overall carrying capacity and agricultural and environmental potential of the catchment, should be undertaken. This will inform decision making, ensuring that the best use is made of the land, and that sensitive high value areas are protected.

8.5. CONSERVATION RECOMMENDATIONS

The study has shown that there is a need for various conservation strategies within the catchment. Three of the most important strategies are, the creation of corridors / linkages between vegetation patches, the conservation of remaining grassland patches, the improvement of these patches and the removal of 'Invasive Alien Vegetation' from riparian and other sensitive areas.

8.5.1. Corridors / Linkages

Observation of Figure 6.2. (p.58) show that forest woodland and grassland areas have become highly fragmented. The extent and nature of this fragmentation was not investigated as it was considered beyond the scope of the study. Preliminary observation of Figure 6.2. does however highlight the need for the creation of corridors / linkages between vegetation patches.

East to west linkages in the upper catchment appear to be sufficient, whilst east to west linkages in the lower catchment and north to south linkages are lacking. It is recommended that the GIS database produced from this study be utilised to further investigate habitat fragmentation. Only then may detailed linkages between patches as well as other conservation strategies be proposed.

8.5.2. Grassland Conservation and Improvement

The significant loss of grasslands in the catchment and the KwaZulu-Natal Mistbelt as a whole is cause for much concern.

The moratorium on any further transformation (where new ground is to be broken) of Mistbelt Grasslands, which was accepted by the KwaZulu-Natal Plantation Permit Review Panel on the 29 September 1999 is fully supported. Grasslands once lost may never be re-established in their former state.

Efforts to improve grassland grazing quality are recommended. This will not only improve biodiversity in the area, but will also provide improved grazing for livestock and game, which will ultimately benefit farmers. Poor grazing quality is often associated with increases in *Aristida junciformis* and decreases in the more palatable grass species, *Themeda triandra*. One of the ways of improving grazing quality is to re-introduce *T. triandra* back into grassland areas. This in the past was most problematic, mainly due to the poor germination rate of seed. Everson (1994) states that from analysis of the fate of seeds of *T. triandra* between their production and establishment, the main constraints for seedling establishment were predation, low viability and poor germination. Research aimed at determining the feasibility of using seedlings, raised as 'grass plugs' (small grass plants) of various indigenous grass species including *T. triandra* for revegetating disturbed sites was undertaken by Dr J. E. Granger, School of Applied Environmental Sciences, University of Natal, Pietermaritzburg (Granger 1999). This research commenced in 1992. Success in improving the germination rate and in re-establishing *T. triandra* into disturbed sites has been achieved. Seeds are harvested and later germinated under controlled nursery conditions. Seedlings are then transplanted into seedling trays and allowed to grow into 'grass plugs'. These 'grass plugs' once sufficiently established, are planted out directly into the degraded grassland areas, without removing other grass species. The density of planting is dependent on the degree of degradation and the required coverage (J.E. Granger, 1999, pers. comm.). Only areas suited to *T. triandra* are planted. The availability of grass plugs was previously limited, however stock quantities are approaching sufficient numbers for commercial release. A trial, in a degraded grassland area was planted in January 2000 on the farm 'The Forest' located to the north-east of the catchment (Plate 13. (p123)) and (Plate 14. (p123)). Strips within the degraded grassland were sprayed with the herbicide 'Roundup ^{R}' and burnt only once the grass had died. This practise ensured that there was no root or canopy competition. The strips were positioned 1.5 metres apart from one another and 'grass plugs' were then planted into the strips with 30 cm planting spacings.

'Grass plugs' were mostly planted directly into the strips, whilst others were planted into a furrow within the strip that had been ripped with a tractor tine. After only two months, plants had grown to an average height of 30 cm and it is anticipated that these plants will produce seed this Spring (J.E. Granger, 1999, pers. comm.).

8.5.3. Removal of 'Alien Invasive Vegetation' and Rehabilitation

As discussed in Section 7.2.4. the presence of 'Alien Invasive Vegetation' poses numerous threats to indigenous ecosystems. Its removal from invaded areas is recommended. Macdonald and Jarman (1985) state that the Phillips' bioclimatic region: 'Mist Belt (3)', into which category the Karkloof Catchment falls has various habitats that are more prone to invasion of alien vegetation. These habitats include riverine habitat, forest gaps, forest ecotones and grassland. Taking these as well as other factors, as noted in this study into consideration, priority areas for removal within the catchment, ranked in order of importance are as follows:

1. Riparian areas, starting in the upper catchment. Failure to remove 'Alien Invasive Vegetation' from these areas first will render any eradication undertaken downstream useless, as the source of seeds will not have been removed.
2. Riparian areas, close to timber plantations, particularly *Acacia* spp. and *Pinus patula* plantations. These areas are seed sources and *Acacia* spp. and *Pinus patula* are known to be more invasive than other timber species.
3. All other riparian areas.
4. Disturbed areas, starting with those areas close to natural habitats, such as forest, woodland and grassland. These disturbed areas may include erosion gullies and abandoned plantations, fields and homesteads.
5. Disturbed areas, which may include any newly felled or planted timber plantation or any newly cultivated fields.
6. Roadside areas.

The Karkloof Catchment 'Working for Water' project, which functions to remove 'Alien Invasive Vegetation' from the catchment was initiated in 1998. It forms part of the National 'Working for Water' initiative which came about in September 1995, under the direction of Professor Kader Asmal, the then Minister of Water Affairs and Forestry (J. Symons, 2000, pers. comm.).

Work has since been undertaken in the following areas of the catchment:

- Mr Edwards's and Mr Plumley's properties (Mount West) - to the north-west;
- Mr M. Neilsen's, Mr J. Elliott's and Mr Folker's properties (Curry's Post) - to the north-west;
- Karkloof Nature Reserve - to the north;
- Mbona Estate - to the north-east;
- P. Goble's property - centre of the catchment, near 'Loskop' hill;
- Umgeni Valley Nature Reserve - to the south.

Whilst the removal of 'Alien Invasive Vegetation' is highly advantageous, often cleared areas are not rehabilitated, which leads to soil erosion. No rehabilitation has as yet taken place in the Karkloof Catchment (A. Govender, 2000, pers. comm.). Rehabilitation often involves the sowing of *Eragrostis curvula* 'Ermelo' seed to re-establish a vegetative cover (Granger 1999). Trials in the early 1970s demonstrated that *E. curvula* 'Ermelo' could be used to rapidly revegetate disturbed areas at low cost, also producing a dense cover. However, recent reassessments of several areas sown 25 years ago with *E. curvula* 'Ermelo' reveal negligible invasion of other grass species, while in some instances *E. curvula* 'Ermelo' is invading undisturbed grassland (Granger undated in Granger 1999). As stated in Section 8.5.2., research aimed at determining the feasibility of using seedlings, raised as 'grass plugs' (small grass plants) of various indigenous grass species including *Themeda triandra* for revegetating disturbed sites was undertaken by Dr J. E. Granger. These disturbed sites included cleared Wattle, Pine and Eucalyptus areas. A trial in the Kamberg Nature Reserve, KwaZulu-Natal Drakensberg, where *T. triandra* 'grass plugs' were planted into an area which had been cleared of self-sown Wattle, Pine and Eucalyptus, showed that after six months since planting in March 1995, 'grass plugs' were alive and had produced tillers following one of the coldest winters in that decade (Granger 1999). Further assessment in February 1998 revealed no significant change in survival with all plants having produced culms. It is recommended that methods described in Section 8.5.2. be applied to rehabilitating areas that have been cleared of 'Alien Invasive Vegetation'.

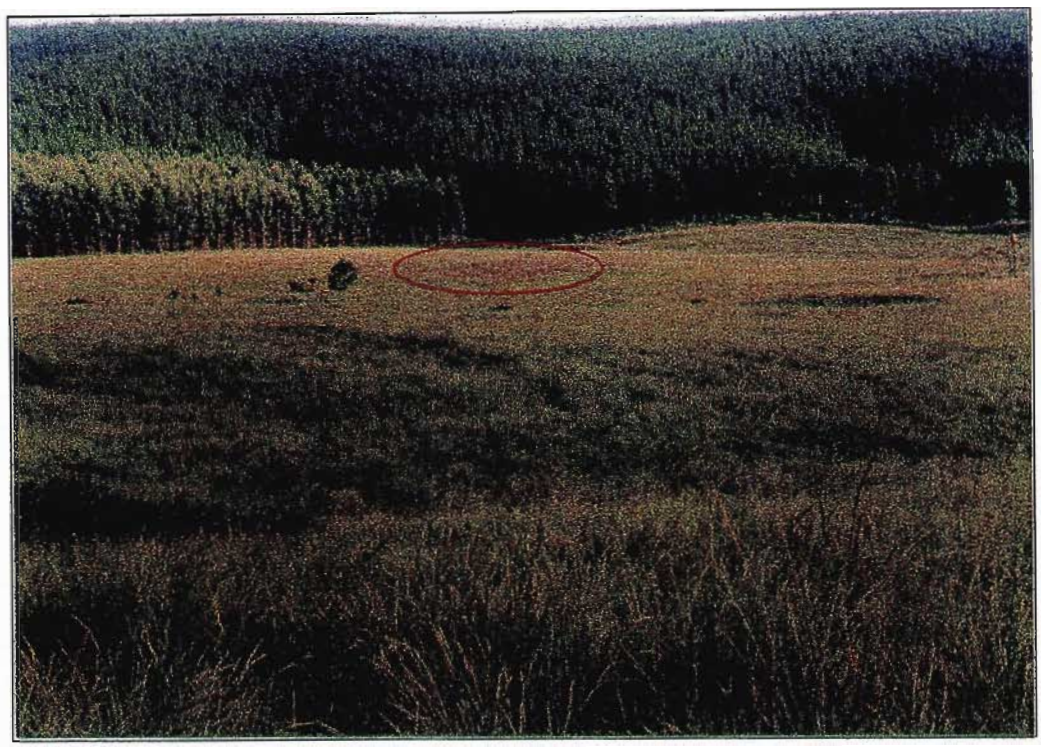


Plate 13. Location of the trial planting (ringed) of *Themeda triandra* 'grass plugs' on the farm 'The Forest' located in the north-east of the catchment (Source: J. E. Granger) (Mar. 2000)

Plate 14. *Themeda triandra* 'grass plugs' (arrow) were planted into treated strip areas (left). After only two months, plants had grown to an average height of 30 cm (right) (Source: J. E. Granger) (Mar. 2000)

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APPENDIX 1.

MIDLANDS MEANDER INFORMATION BROCHURE: ROUTE T1

(SOURCE: ANON. 2000b)

Welcome to

THE Midlands Meander

ROUTE T1

HILTON, MERRIVALE, HOWICK, CURRYS POST, KARKLOOF, MOUNT WEST

• OPEN DAILY • SELECTED OPENING TIMES
See entry for details
80% OF WORK IS MADE ON THE PREMISES

Immediately accessible from Pietermaritzburg, Route T1 includes several scenic waterfalls, the most spectacular of which is the Howick Falls. Plunging almost 100 metres to the gorge below, the Howick falls are known to the Zulu as 'kwaNogqaza' (the place of the tall one). The falls and surrounding 32 hectares were proclaimed a National Monument in 1951.

• *The spectacular Howick Falls is a natural wonder*

11 • HILTON COLLEGE

A drive through the grounds of this historic school reveals the cool splendour of Cape Dutch architecture spectacularly set on 3 500 acres of land overlooking the Karkloof Mountains. Indigenous forests, sandstone crags, the Umgeni River Valley and productive farmlands complete the unique environment in which 480-500 pupils are educated. Hilton College, Private Bag 6001 Hilton 3245. Tel: 0331-430100 Fax: 0331-430080 • Tel: 033-3430100 Fax: 033-3430080

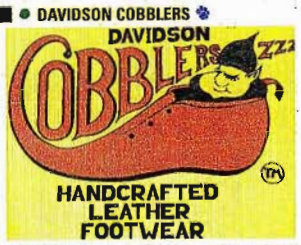
2 • FONTAINEBLEAU

Finally offering a chance to dine in style in the heart of the peaceful village of Hilton. Our A' La Carte menu offers a variety of exquisite international cuisine, also a terrace menu for light lunches. Accommodation also provided in our luxury garden bungalows, self-catering and room service provided. Tel: 0331-432077 Fax: 0331-432078 • Tel: 033-3432077 Fax: 033-3432078.

3 • HILTON HOTEL

The Hilton Hotel, with its imposing Tudor lines, is situated in the heart of the Natal Midlands, only 12 km from Pietermaritzburg, an hour's drive from Durban. This unique and special hotel offers comfortable en-suite accommodation, conference and wedding facilities, an enclosed pool area, bowling green and tennis court. Visit Champion's Restaurant for fine food and grills. Highly recommended!! Tel: 0331-433311 Fax: 0331-433722 • Tel: 033-3433311 Fax: 033-3433722 E-mail: hiltonhotel@alpha.futurenet.co.za

4 • DAVIDSON COBBLERS



Conveniently situated in the heart of the Hilton, we offer a unique range of OXFORD and DERBY foot-wear, authentically handstiched the original way. Our traditional classic designer styles ensure exclusivity! Open daily 9am-4pm (Mondays by appointment) 28 Acutt Rd, Hilton (behind Hilton Shell Garage). Tel/Fax: 0331-431055 • Tel/Fax: 033-3431055

5 • ST ANNE'S DIOCESAN COLLEGE

Stately buildings, dating from 1904, which include a Herbert Baker Chapel, are set in a tranquil beautiful 32 hectare estate. In the heart of Hilton, this boarding school for girls offers a unique educational and living experience. SCHOOL DATES: 1999 - Terms 3&4: 26 July - 23 Sept; 4 Oct - 28 Nov; 2000 18 Jan - 17 March; 4 April - 21 June; 18 July - 20 Sept; 3 Oct - 1 Dec. Private Bag 6002 Hilton 3245. Phone 0331-433300 • 033-3433300. E-mail: mist@stannes.org.za

8 • HILTON COTTAGE

Bed and breakfast for 2 in charming thatched rondavel with en-suite shower and toilet. Secure parking. Facilities include TV, electric blankets, heating, fridge, kettle and toaster. Healthy light breakfast served in the cottage. SATOUR accredited. 111 Cedara Road (R103 corner Annthia Road) Hilton 3245. Tel/Fax Heather or Graham at 0331-433174 • 033-3433174. E-mail: grahamat@mweb.co.za

9 • THE ROTUNDA

Begin your Midlands Meander at our unique stopover. Situated conviniently at the Cedara off-ramp off the N3 highway. • HILTON FARM STALL Fresh fruit and vegies. Other goodies too • HILTON BAKERY Fresh rolls, speciality breads and confectionery • HILTON GARDEN CENTRE For all your gardening needs • AFRICAN RHYTHM Lovely gifts. Arts and crafts. Tel: 0331-434205 • Tel: 033-3434205.

12 • TOUCHWOOD FLOWER FARM
Restaurant, Tea Garden and B&B

Close to Pietermaritzburg & Midmar Dam in a scenic setting. Fresh cut and dried flowers, gifts and novelties available. Meals and teas serves in a garden setting. B&B cottages. 10 mins from Hilton and St Annes College and Cedara. Open daily (except Monday) 9am-4:30pm. Contact Maurice & Fionna Burger. Tel: 033-3302215 Fax: 033-3306478 Cell: 082 807 7978.

13 • PEEL'S HONEY

Peel's honey and honey confectionery is synonymous with the Natal Midlands. Established in 1924, many generations have enjoyed our quality products, particularly the smooth creamy honey which is unique to the Natal mistbelt. We are situated right next to the N3. Take route 99 Southern Drakensberg and follow the signs. Tel/Fax: 033-3303762.

14 • SAKABULA GOLF CLUB

Sakabula Golf Club is a stunning, Par 73 golf course in the Midlands. The course is designed to enable golfers to enjoy the magnificent views of the Drakensberg as well as the exciting birdlife in and around the wetlands. Visitors are welcome. 92 properties surrounding the course are for sale. *Closed on Tuesdays.* Tel: 033-33067!

15 • WATERFALL RESTAURANT & NOGQAZA CRAFT

Open 7 days a week. 8am - 5pm
Tel: 033-3305733
Fax: 033-3307817

Situated metres from the stunning Howick Falls, we offer breakfasts, light lunches & fresh home-made cake. Ample seating indoors under thatch surrounded by beautiful hangings or outside under large shade trees. We cater for small and large groups. Visit Nogqaza Crafts for an exciting selection of arts, crafts, curios, ethnic clothing, jewellery, African music and books.

A classic collection of more than 400 pieces of old and new cottage furniture.

AT THE ROTUNDA IN HILTON

www.countryfurniture.co.za

Tel: 0331-431163 • 033-3431163

No. 10

6 • GATESIDE GUESTHOUSE

Richard and Debbie Blackburn warmly welcome guests to their home situated in Hilton with breathtaking views across pastures, picturesque dam, Table Mountain and city lights. Offering beautifully appointed en-suite rooms including 2 luxury self-contained suites. Full English/Continental breakfast and dinner by arrangement. Tel: 0331-431536 Fax: 0331-433506 • Tel: 033-3431536 Fax: 033-3433506 Cell: 083 546 3388. 11 Quarry Rd Hilton 3245.

7 • MAGNOLIA HOUSE

A warm welcome awaits you at the lovely Magnolia House which offers Bed and Breakfast accommodation in Hilton. Conveniently situated, it is close to schools, shops, restaurants and the Natal Railway Museum. Two suites have separate entrances, secure parking, TV and coffee or tea making facilities. Contact Jenny Watt. Tel/Fax: 0331-433998 • Tel/Fax: 033-3433998.

10 • COUNTRY FURNITURE WAREHOUSE

At the Rotunda in Hilton

• Over 400 pieces of old and new cottage furniture • Diningroom tables, chairs, sideboards, headboards, pedestals, TV cabinets, chests of drawers, dressing tables, bookcases, kists, desks, coffee tables • Country kitchen tables, storage units and accessories • Victorian bathroom washstands, baths and accessories • Fireplace surrounds, brass and copper ware • Oregon, yellowwood, oak, teak, satinwood • Open everyday. Tel: 0331-431163 • Tel: 033-3431163

11 • HI-FLY KITES

David and Nadia invite you to Hi-Fly Kites on WoodGrove Farm overlooking the beautiful Umgeni Valley. Hi-Fly Kites produces a range of quality kites for all ages. Open Friday and weekends 9am-4pm. We are usually in during week days but phone if coming especially. Tel/Fax: 033-3305746. E-mail: hifly@intekom.co.za

16 • THABO'S ANTIQUES

Come in and view our lovely range of Antiques and Cottage Furniture in Mohogany, Yellowwood, Walnut, Rosewood, Beachwood, Teak and Oak:- Tables, Wardrobes, Chairs, Dressing Tables, Kists, Beds, Hall Stands, Dressers, Linen Cupboards, Desks, Bookshelves and Smalls. Tel/Fax: 033-3302885 / 3307385.

17 • STOCKLANDS FARM GUEST HOUSE

Charming B&B accommodation in this Colonial Victorian farm house 1km from Howick. A warm and welcoming home offering tastefully decorated en-suite bedrooms. Stone walls and wide verandas add to the ambiance. A small hand milked jersey herd adds to the country atmosphere. A separate four bedroomed self catering cottage also available. Dinner on request. Children welcome. Contact Franklin Mooney Tel/Fax: 033-3304 or Cell: 082 459 1249 Box 1417 Howick 3290

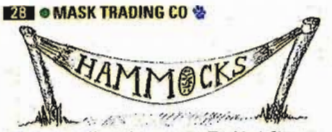
● UMGENI VALLEY NATURE RESERVE

0 ha valley-
shveld reserve.
uated north of
etermaritzburg,
m from Howick
the Karkloof
ad. Boasting:
206 bird species.
Antelope,
affe, zebra,
aller carnivores
d herbivores • Rustic camps strategically placed
pturing valley splendour • Six hiking trails
Children's holiday courses • Organised hikes
Conference facilities • Self catering cottages with
noramic views. • Magnificent scenery. P O Box 394,
wick 3290. Tel: 033-3303931 Fax: 033-3304576.

24 ● CRANFORD COUNTRY HOUSE

Cranford is fun, comfortable and affordably priced. Scrumptious teas, country pub lunches, gourmet dinners. Children very welcome. Charming rooms in stone and thatch cottages from R195pp. Try the cold draught in the Bent Arm Bar while the kids play on the junglegym. Country weddings and functions are our speciality. Self catering available from R120pp.
Contact Simon and Megan Kerr on
Tel: 033-3304308 Fax: 033-3305510.
Website: www.cranford.co.za
E-mail: simon@cranford.co.za

28 ● MASK TRADING CO



Colin and Jennifer welcome you to The Mask Shop. We have our own range of: • Handmade hammocks • Handmade afro-suite clothing & ponchos • African adornment & masks • Hats, birdfeaders, swings & hanging things • Artworks by Don Guy.
Open 7 days a week 9am-5pm. Telephone or fax: 033-3307343.

25 ● SITEKA LODGE

Siteka Lodge, situated on a 36 acre dam, an ideal haven for fishermen and birdwatchers. Luxury self catering accommodation provided with a choice of 2 thatched cottages or historic homestead. We are conveniently situated to the N3 and Meander. Easy access to restaurants, pubs, golf courses, private schools. Own airstrip. Facilities for mini conferences.
Tel/Fax: 033-3302073 Cell: 082 897 2996.

29 ● THATCHINGS

• Luxury guest house and small conference venue 2,5km from the N3 • 7 En-suite double bedrooms with TV • Fine food • Licenced • Enchanting gardens set in 135 acres of tranquillity • Fish in our trout dams • Conference facilities • Children welcome • Golf course minutes away • AA/SAA Accommodation Awards Semi-finalist • SATOUR Accredited.
Tel: 033-2636275 Fax: 033-2636276.
E-mail: thatchings@futurenet.co.za
Website: www.midlandsmeander.org.za/thatch/

● BROOKLANDS

ooklands is situated in the scenic Karkloof valley
ar the foot of the Kyber Pass. Our shop stocks:
Mens and ladies leather footwear • Handpainted
ramics • Jerseys • Belts • Hand and foot creams.
en daily from 8:30am-4:30pm.
ntact Gill or James Arathoon on Tel: 033-3302559.

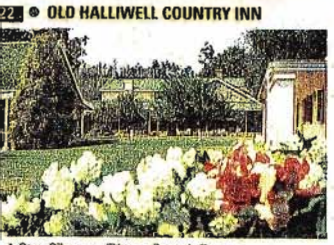
30 ● THISTLEDOWN COUNTRY HOUSE & INDIGENOUS NURSERY

tuated 20km
om Howick,
is haven of
anquility
estles on the
anks of the
konkwane
tream at
e foothills of
e indigenous
rests of the
arkloof Hills. Comfortable en-suite accommodation
nd fine cuisine are available. Bookings are essential.
elephone Norma Maguire on 033-3302629 or
82 4910533. For further information about the nursery,
hich specialises in indigenous plants, telephone
enny Shaw on 033-3303782 or 082 785 9275.

21 ● GROUNDCOVER

tuated on the Currys Post road, Groundcovers
eatherwork has become legendary on the Meander.
our restored settlers cottage you will discover:
A range of export quality boots, shoes and sandles
Leather briefcases, bags and accessories • Birdman
oundry bronze belt buckles • Local woodwork • Farm
roducts • Picnic site. Open daily 9-5. Contact Justin
nd Amanda. Tel: 033-3306092 Fax: 033-3304694.

22 ● OLD HALLIWELL COUNTRY INN



4-Star Silver • Fifteen Superb Rooms
Fine Dining in Old Fashioned Luxury • Meander
unches and Teas Daily • Golf, Fishing and Walks
Tranquil Surroundings. P O Box 201, Howick 3290.
el: 033-3302602 Fax: 033-3303430.
-mail: haliwell@PMB.lia.net

23 ● MULBERRY HILL GUEST & PANCAKE HOUSE

elax in a friendly atmosphere in tranquil surroundings
d enjoy home cooking, log fires and spacious en-suite
cilities at Currys Post, near Howick. Accessible to
ading KwaZulu-Natal Stud Farms, Golf Courses and
ivate Schools. Horse riding, Trout Fishing, Bird
atching and Nature walks. Light teas & lunches: daily
0am-5pm. Contact Linda and Hansen

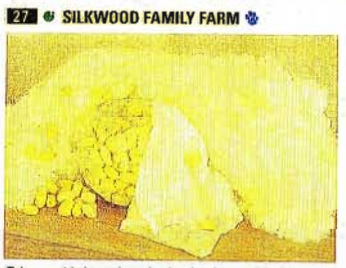
26 ● KINGDOM WEAVERS

Welcome to our farm 'Chebango' where local Zulu ladies weave cotton knit rugs. All our rugs are machine washable and hard wearing. We also make numnahs (saddle blankets). Situated 3km off Exit 125 on the Balgowan/Currys Rd. Handmade crafts also available. Open daily 9am-5pm. Contact Neil or Trish
Tel: 033-2344187 Fax: 033-2344187.
E-mail: kingdomweavers@futurenet.co.za
Website: www.kingdomweavers.co.za

30 ● HAWKSTON FARM

Muscovy cottage is a 3 bedroom, self catering (breakfast on request) thatched cottage situated in the Natal Midlands. Conveniently accessible to local schools for parents. The cottage overlooks a beautiful trout dam and golf, bird-watching, fishing and country walks in close proximity. Berg hikes and fishing trips organised on request. Contact Brenda or Harry Tountas.
Tel/Fax: 033-2636392 Cell: 082 926 8993.

27 ● SILKWOOD FAMILY FARM



Take a guided tour into the fascinating world of hand-processed silk. Luxurious hand made silk-filled products and silk articles for sale. Have a tasting of the Bellavista range of specialty cheeses. Enjoy a light

31 ● FEATURES OF FORDOUN

New on the Meander. A unique and distinctive gift and coffee shop with light lunches and a wide range of interior accessories. Stockists of "HOMEWORK" clothing. Also self-catering accommodation in 5 cottages.
Fly-fishing bookings R15 dams & 20k of river

STEEL TRACKS AND A FIRST ATTEMPT TO FLY

A magnet for the steam enthusiast, is the Natal Railway Museum. Situated in Hilton, this historic attraction is open from Tuesday to Thursday, as well as on most weekends.

Those interested in flying should visit the Goodman Household monument near Currys Post. Erected to commemorate the flight in a home built glider by Goodman Household in 1871, it records how he crashed, wrecking his glider and breaking a leg - thus ending what was almost certainly man's earliest attempt to fly in Southern Africa.

THAT SPECIAL DAY

The Midlands Meander is particularly popular for weddings - and with good reason. The region offers couples the choice of a wide range of delightful country settings for that very special occasion. There are several picturesque and historical churches on the Meander, many dating back to the 1880's, which provide a formal but relaxed setting for the exchange of vows.

In the immediate vicinity there are a host of country guest houses and traditional hotels perfect for a memorable reception, with a range of getaway opportunities on the doorstep for the honeymoon couple.

• A happy occasion at St. Andrews in Dargle

A number of the historic churches on the Meander have been declared national monuments, including some very well preserved Settler Churches, such as:

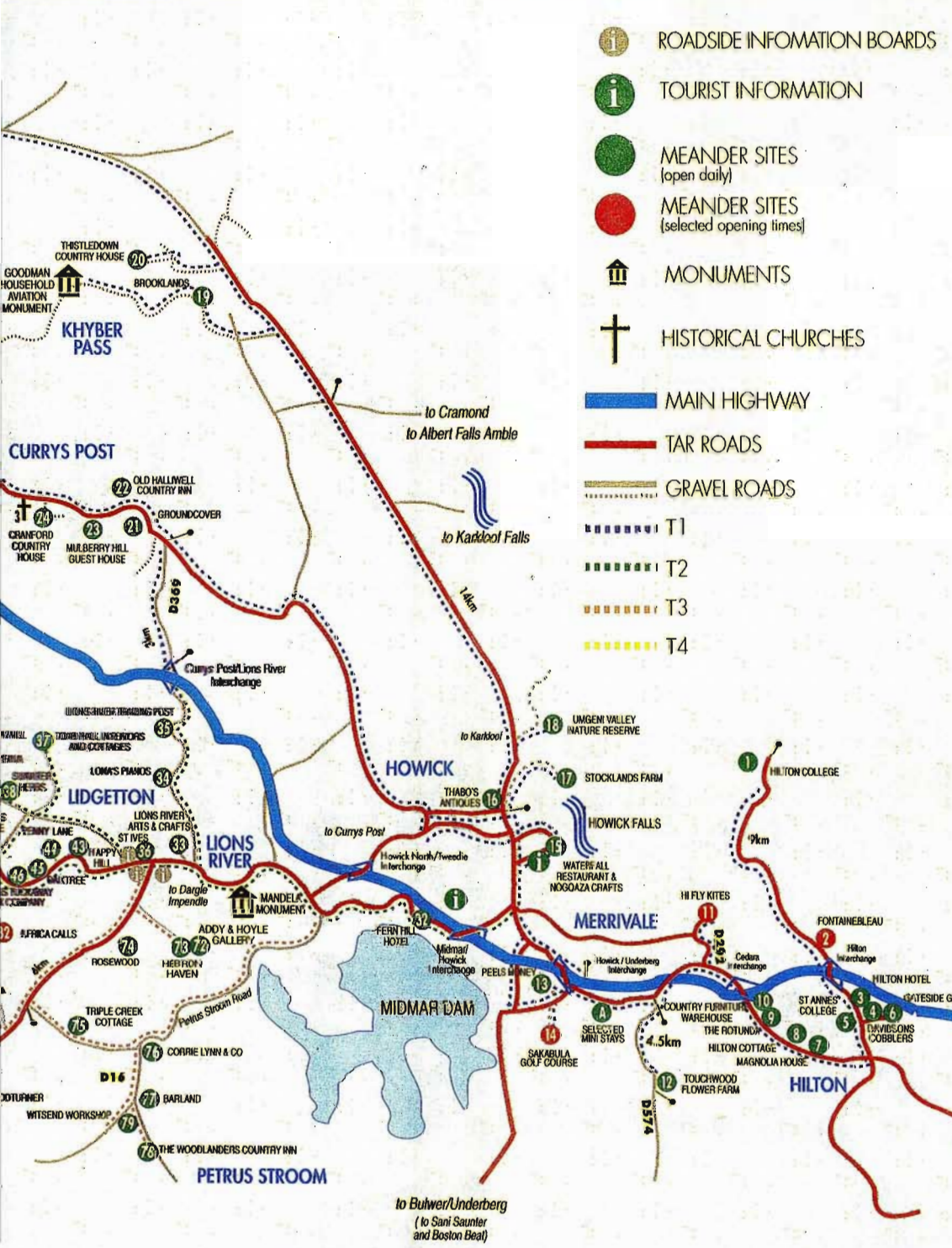
- St. John Gowrie, Nottingham Road . Built in 1885.
- St. Andrews, The Dargle. Built 1882
- St. Pauls, Currys Post. Established by Sgt M Curry in 1876.
- St. Matthews, Lidgetton.
- St. Lukes, Howick. First opened in 1869.

FUNCTIONS & CONFERENCES

From the sublime to the meticulous, the Midlands Meander is becoming increasingly popular for corporate functions - ranging from product launches and sales seminars to conferences and team building seminars.

CONFERENCE, WEDDING AND FUNCTION VENUES ON THE MIDLANDS MEANDER

59	Abberley Guest House	033-2344163
94	Bellwood Cottages	033-2636716
40	Caversham Mill	033-2344524
24	Cranford Country House and Wedding Centre	033-3304308
32	Fern Hill Hotel	033-3305071
116	Gleneagles Guest House	033-2632883
51	Granny Mouse Country House	033-2344071
118	Hall's Country House	033-2632696
43	Happy Hill Guest House	033-2341380
117	Hartford House	033-2632713
86	Hawtlee Country House	033-2636006
73	Hebron Haven Hotel	033-2344437
3	Hilton Hotel	0331-433311
33	Lions River Club	033-2341235
50	Lythwood Lodge	033-2344666
70	Nottingham Road Hotel	033-2636151
22	Old Halliwell Country Inn	033-3302602
44	Penny Lane Guest House	033-2344332
64	Rawdon's Hotel and Restaurant	033-2636044
115	Sierra Ranch	033-2631073
25	Siteka Lodge	033-3302073
120	Swiss Manor House	033-2632733
29	Thatchings	033-2636275
99	The Bend	033-2636441
103	The Outpost	033-2636836
78	The Woodlanders Country Inn	033-2344482



APPENDIX 2.

A PRELIMINARY CHECKLIST OF PLANTS OCCURRING AT THE FARM, 'ETHLATINI' (SOURCE: COOPER & MOLL 1967)

APPENDIX I

A preliminary list of spermotophytes occurring at Ehlatini. This list is by no means complete and is merely an indication of what occurs in the area. It is our hope that any additional species will be collected and sent to the Natal Herbarium, Durban, and these additional names can be sent to The Secretary NFWS, P.O. Box 2985, Durban.

Genera have been arranged in order after Phillips and species are alphabetic.

. . . . . .

TAXACEAE

Podocarpus falcatus (Thunb.) R. Br. ex Mirb.
Upper canopy tree.
P. latifolius (Thunb.) R. Br.
Upper canopy tree.

GRAMINEAE

Panicum aequinerve Nees
Uncommon grass of the field layer, especially where the soil is moist and where the canopy has been disturbed.
Oplismenus hirtellus (L.) Beauv.
Common grass of the field layer, best developed where the canopy cover is least disturbed.
Setaria chevalieri Stapf
Uncommon grass of the field layer with a patchy distribution, most common where the canopy has been broken.
Potamophila prehensilis (Nees) Benth.
Locally common climbing herbaceous grass especially where the canopy has been disturbed and the forest is scrubby.
Ehrharta erecta Lam.
Uncommon grass of the field layer especially on disturbed margins in damp places.
Stipa dregeana Steud.
Uncommon, widespread grass of the field layer.
Brachypodium flexum Nees
Uncommon grass of the field layer, especially in damper situations where the canopy has not been too disturbed.

CYPERACEAE

Cyperus albostriatus Schrad.
Fairly common, widespread sedge of the field layer.
Mariscus riparius Schrad.
Rare herb especially on disturbed margins.
Schoenoxiphium caridoides C.B. Cl.
Uncommon in the field layer.
Carex cognata Kunth.
Uncommon in the field layer.
C. spicato-paniculata C.B. Cl.
Uncommon in the field layer.

LILIACEAE

Littonia modesta Hook.

Asparagus crispus Lam.
Uncommon in the rocky areas where the canopy has been disturbed.
A. falcatus L.
Rare canopy climber, usually in parts of the forest which had been cut for timber.
A. virgatus Baker
Fairly common in the field layer where the canopy has been disturbed.
Behnia reticulata Didr.
Rare herbaceous climber.

AMARYLLIDACEAE

Clivia miniata Regel
Rare herb in rocky areas.
Brunsvigia natalensis Bak.

VELLOZIACEAE

Vellozia talbotii Balf.
Occasional herb on steep banks.

IRIDACEAE

Dietes vegeta (L.) N.E. Br.
Rare herb of the field layer.
D. butcheriana Gerstner
Rare herb in the field layer.
Tritonia nelsonii Bak.
Rare herb.
Crocosmia aurea
Fairly common in disturbed areas where there is greater light penetration to the forest floor.

ORCHIDACEAE

Stenoglottis fimbriata Lindl.
Occasional lithophyte on forest floor.
Disperis fanniniae Harv.
Occasional herb in the field layer.
Mystacidium caffrum (Bol) Bol.
Occasional epiphyte on tree boles.
M. venosum Harv.
Occasional epiphyte on tree boles.

PIPERACEAE

Piper capensis L.f.
Occasional shrub.
Peperomia reflexa A. Dietr.
Fairly common epiphyte and lithophyte of the forest.

ULMACEAE

Celtis africana Burm. f.
Upper canopy tree.

MORACEAE

Ficus craterostoma Warb. ex Mild.
Strangling fig, eventually becoming a canopy tree.

URTICACEAE

Fleurya alatipes N.E. Br.
Rare herb in damp places - a "nettle".
F. mitis (E. Mey.) Wedd.

RANUNCULACEAE

Knowltonia bracteata Harv.
Herbaceous climber in secondary areas.

ANNONACEAE

Popowia caffra (Sond.) Benth..
Occasional canopy climber.

MONIMACEAE

Xymalos monospora (Harv.) Baill.
Upper canopy tree, especially on rocky areas.

LAURACEAE

Ocotea bullata E. Mey.
Rare upper canopy tree.
Cryptocarya myrtifolia Stapf
Fairly common upper canopy tree.
C. woodii Engl.
Sub-canopy tree especially on the margin.

SAXIFRAGACEAE

Choristylis rhamnoides Harv.
Occasional scandent shrub of the margin and sometimes a canopy climber.

ROSACEAE

Rubus rosaefolius L.
Woody climber to 10ft especially in gaps.
Prunus africanus (Hook. f.) Kalkm.
Rare upper canopy tree.

CONNARACEAE

Cnestis natalensis Planch. & Sond.
Canopy climber.

LEGUMINOSAE

Entada spicata (E. Mey.) Druce
Canopy climber.
Calpurnia aurea (Ait.) Benth.
Small tree up to 30ft common in gaps, and sometimes found on the margin.
Indigofera micrantha E. Mey.
Occasional small shrub of the field layer.
L. natalensis Bol.
Common, small shrub of the field layer.
Dalbergia obovata E. Mey.
Canopy climber and also a marginal shrub.

RUTACEAE

Fagara davyi Verdoorn
Occasional canopy tree, sometimes marginal.
Calodendron capense (L.f.) Thunb.
Upper canopy tree.
Vepris undulata (Thunb.) Verdoorn
Upper canopy tree
Clausena anisata (Willd.) Hook. f.
Common tree to 40ft in gaps and where the forest has been disturbed. Also on the margin.

MELIACEAE

Ptaeroxylon obliquum Radlk.

EUPHORBIACEAE

Drypetes gerrardii Hutch.
Rare canopy tree, especially at lower altitudes.
Micrococca capensis Prain
Common shrub (small) along rocky stream course.
Euphorbia kraussiana Benth.
Occasional herb of the field layer, especially where the soil is damp.

ANACARDIACEAE

Rhus chirindensis Bak. f.
Rare canopy tree, usually marginal.

AQUIFOLIACEAE

Ilex mitis (L.) Radlk.
Uncommon canopy tree, especially along stream banks.

CELASTRACEAE

Maytenus cymosus (Soland.) Excell
Small marginal tree.
M. mossambicensis (Klotzsch) Blakelock
Common undershrub.
M. nemorosus (E. & Z.) Marais
Small marginal tree.
Cassine papillosa (Hochst. ex Krauss) Kuntze
Rare shrub or sub-canopy tree.

ICACINACEAE

Apodytes dimidiata E. Mey. ex Arn.
Rare upper canopy tree, occasional or margin.

BALSAMINACEAE

Impatiens duthieae L. Bol.
Occasional herb especially in damp places.

RHAMNACEAE

Scutia myrtina (Burm. f.) Kurz.
Canopy climber and forest undershrub especially where there has been disturbances.
Rhamnus prinoides L'Hérit
Common marginal tree.

VITACEAE

Rhoicissus tomentosa (Lam.) Wild & Drummond
Canopy climber.

OCHNACEAE

Ochna arborea Burch. ex DC.
Occasional sub-canopy tree.
O. atropurpurea DC.
Small tree or shrub on the margin.
O. serrulata Hochst.
Occasional shrub.

VIOLACEAE

Rinorea angustifolia (Thou.) Baill.
Occasional sub-canopy tree.

FLACOURTIACEAE

Kiggelaria africana L.
Upper canopy tree.
Scolopia mundii (Eckl. & Zeyh.) Warb.
Upper canopy tree.
S. zeyheri (Nees) Harv.
Upper canopy tree but only in driest parts where the canopy is lower.
Trimeria grandifolia (Hochst.) Warb.
Dovyalis rhamnoides Harv.

ACHARIACEAE

Ceratiosicyos laevis (Thunb.) Meeuse
Rare herb.

THYMELAEACEAE

Peddiea africana Harv.
Undershrub.
Dais cotinifolia L.
Sub-canopy tree especially where the canopy has been disturbed.

BEGONIACEAE

Begonia sutherlandii Hook. f.
Common herb along moist, rocky stream courses.

OLINIACEAE

Olinia emarginata Burtt Davy
Occasional tree on the upper margin.

RHIZOPHORACEAE

Cassipourea gummiflua Tul.
Rare upper canopy.

COMBRETACEAE

Combretum kraussii Hochst.
Upper canopy tree.

ARALIACEAE

Cussonia chartaceae Schinz
Upper canopy tree, usually emergent.
C. spicata Thunb.
Rare tree, usually marginal.

MYRTACEAE

Eugenia zuluensis Dümmer
Common undershrub or small tree.

UMBELLIFERAE

Centella coriacea Nannfd.
Common herb in moist places.
Heteromorpha trifoliata (Wend.) Eckl. & Zeyh.
Marginal tree.

MYRSINACEAE

Rapanea melanophloeos (L.) Mey.
Common marginal tree.

EBENACEAE

Diospyros whyteana (Hiern,) F. White
Occasional small, subcanopy tree.
Euclea crispa (Thunb.) Guerke
Occasional tree on the upper forest margin.

OLEACEAE

Linociera foveolata (E. Mey.) Knobel
Rare canopy tree.
Olea capensis L.
Rare upper canopy tree.
Jasminum streptopus E. Mey.
Woody climber, marginal.

LOGANIACEAE

Nuxia floribunda Benth.
Occasional upper canopy tree.
Buddleia dysophylla (Benth.) Radlk.
Occasional canopy climber.
B. salviifolia (L.) Lam.
Common marginal tree.

APOCYNACEAE

Carissa bispinosa (L.) Desf. ex Brenan
Common undershrub.
Strophanthus speciosus (Ward & Harv.) Reber
Canopy climber.

ASCLEPIADACEAE

Secamone gerrardii Harv.
Rare canopy climber.
Riocreuxia tomentosa Decne.
Rare herbaceous climber, usually marginal.

VERBENACLAE

Clerodendrum glabrum E. Mey.
Marginal tree and also where the forest has been cut.

LABIATAE

Teucrium riparium Hochst.
Herb in disturbed areas.
Plectranthus ciliatus E. Mey. ex Benth.
Herb of the field layer.
P. dolichopodus Briq.
Herb of the field layer.
P. elegantulus Briq.
Herb of the field layer.
P. fruticosus L'Hérit.
Herb of the field layer.

SOLANACEAE

Solanum aculeatissimum Jacq.
Rare secondary plant.
S. mauritianum Scop.
Small tree, where the canopy has been disturbed.
Solanum cf. didymanthemum Dun.
Rare secondary plant

SCROPHULARACEAE

GESNERIACEAE

Streptocarpus gardeni Hook.
Lithophyte, especially along seasonal stream courses.
S. silvaticus Hilliard
Epiphyte on the lower bole of canopy tree, occasionally as a lithophyte.
S. grandis N.E. Br.
Herb of field layer.
S. fanniniae Harv. ex C.B. Cl.
Herb at stream edges.

ACANTHACEAE

Thunbergia natalensis Hook.
Herb of the field layer.
Justicia campylocantha T. Anders.
Occasional herb or shrub.

RUBIACEAE

Rothmannia globosa (Hochst.) Keay
Sub-canopy tree.
Canthium ciliatum (Klotzsch) Kuntze
Undershrub.
C. locuples (K. Schum.) Codd
Rare, subcanopy tree.
C. mund ianum Cham. & Schldl.
Marginal tree.
C. obovatum Klotzsch
Rare subcanopy tree.
C. pauciflorum (Klotzsch) Kuntze
Rare subcanopy tree.
Rothmannia capensis Thunb.
Canopy tree, usually marginal.
Gardenia thunbergia L.f.
Pavetta tristis Brem.
Undershrub.
P. lanceolata Eckl.
Undershrub.

CAMPANULACEAE

Lobelia decipiens Sond.
Herb of the field layer.

Some late additions:

CELASTRACEAE

Maytenus acuminata (L.f.) Loes.
Rare subcanopy tree, sometimes on the upper margin.

OCHNACEAE

Ochna natalitia Engl. & Gilg
Rare subcanopy tree.

FLACOURTIACEAE

Casearia gladiiformis Mast.
Fairly common canopy tree at lower altitudes.

APPENDIX 3.

SPECIES LIST OF FAUNA FOR THE KARKLOOF AREA, PREPARED BY KWAZULU-NATAL NATURE CONSERVATION SERVICE

(21/5/1999)

KwaZulu-Natal Nature Conservation Service

Requested by: John

Species at Location: Karkloof

Scientific Name	Common Name	Date Last Collected	Red Data Status	Endemicity KZN	Endemicity Near	Endemicity RSA	Restricted in KZN
Class: Amphibia	**Amphibians**						
Order: Anura							
Family Bufonidae							
Bufo gutturalis	Guttural toad			☐	☐	☐	☐
Bufo rangeri	Raucous toad			☐	☐	☑	☐
Family Heleophrynidae							
Heleophryne natalensis	Natal ghost frog	10/1/1984		☐	☐	☑	☐
Family Hyperoliidae							
Hyperolius marmoratus marmoratus	Painted reed frog	18/11/1977		☐	☑	☑	☐
Kassina senegalensis	Bubbling kassina			☐	☐	☐	☐
Family Microhylidae							
Breviceps verrucosus tympanifer	Plaintive rain frog	1/10/1983		☐	☐	☑	☑
Breviceps verrucosus verrucosus	Plaintive rain frog			☐	☐	☑	☐
Family Ranidae							
Arthroleptella hewitti	Natal chirping frog	7/1/1984		☐	☑	☑	☐
Cacosternum boettgeri	Common caco			☐	☐	☐	☐
Phrynobatrachus natalensis	Snoring puddle frog			☐	☐	☐	☐
Rana angolensis	Common river frog	7/1/1984		☐	☐	☐	☐
Rana fuscigula	Cape river frog			☐	☐	☐	☐
Strongylopus fasciatus fasciatus	Striped stream frog	1964		☐	☐	☐	☐
Strongylopus grayii grayii	Clicking stream frog	7/1/1984		☐	☐	☐	☐
Tomopterna natalensis	Natal sand frog			☐	☐	☐	☐

Species at Location: Karkloof

Scientific Name	Common Name	Date Last Collected	Red Data Status	Endemicity KZN	Endemicity Near	Endemicity RSA	Restricted in KZN
Class: Annelida	**Worms**						
Order: Oligochaeta							
Family Lumbricidae							
Allolobophora rosea				☐	☐	☐	☐
Bimastos eiseni				☐	☐	☐	☐
Dendrobaena octaedra				☐	☐	☐	☐
Dendrobaena rubida				☐	☐	☐	☐
Lumbricus castaneus				☐	☐	☐	☐
Lumbricus rubellus				☐	☐	☐	☐
Octolasion lacteum				☐	☐	☐	☐
Family Megascolecidae							
Amynthas divergens				☐	☐	☐	☐
Amynthas minimus				☐	☐	☐	☐
Family Microchaetidae							
Microchaetus caementerii				☑	☐	☑	☑
Microchaetus natalensis				☐	☐	☑	☐
Tritogenia karkloofia				☑	☐	☑	☑
Tritogenia lunata				☑	☐	☑	☑
Family Octochaetidae							
Dichogaster bolaui				☐	☐	☐	☐
Dichogaster saliens				☐	☐	☐	☐
Class: Aves	**Birds**						
Order: Charadriiformes							
Family Scolopacidae	Snipe & Waders						
Gallinago nigripennis	Ethiopian Snipe	2/1996		☐	☐	☐	☐

Species at Location: Karkloof

Scientific Name	Common Name	Date Last Collected	Red Data Status	Endemicity KZN	Endemicity Near	Endemicity RSA	Restricted in KZN
Order: Gruiformes							
Family Gruidae	Cranes						
Bugeranus carunculatus	Wattled Crane	6/1964		☐	☐	☐	☐
Grus carunculata	Wattled crane	2/1996	Endangered	☐	☐	☐	☐
Family Rallidae	Rails						
Sarothrura rufa	Redchested Flufftail	2/1996		☐	☐	☐	☐
Class: Insecta	**Insects**						
Order: Diptera	**Flies**						
Family Asilidae							
Bactria amastrus				☐	☐	☐	☐
Damalis femoralis				☑	☐	☑	☐
Damalis monochaetes				☐	☑	☐	☐
Dasophrys boslacus				☐	☐	☐	☐
Dasophrys crenulatus				☐	☐	☐	☐
Dasophrys loewi				☐	☑	☐	☐
Dasophrys nigroflavipes				☐	☐	☐	☐
Dasophrys oldroydi				☐	☐	☐	☐
Dasophrys tarsalis				☑	☐	☐	☐
Dasophrys umbripennis				☑	☐	☐	☐
Gonioscelis truncatus				☐	☐	☐	☐
Hypenetes stigmatias				☐	☐	☐	☐
Leptogaster maculipennis				☐	☐	☐	☐
Nannolaphria nigra				☐	☑	☐	☐
Neolophonotus hirsutus				☑	☐	☐	☐
Neolophonotus wroughtoni				☐	☐	☐	☐
Neomochtherus annulitarsis				☐	☐	☐	☐

Species at Location: Karkloof

Scientific Name	Common Name	Date Last Collected	Red Data Status	Endemicity KZN	Endemicity Near	Endemicity RSA	Restricted in KZN
Pegesimallus bulbifrons				☐	☐	☐	☐
Pegesimallus calvifrons				☐	☑	☐	☐
Rhabdogaster				☐	☐	☐	☐
Rhabdogaster nitidus				☐	☐	☐	☐
Synolcus dubius				☐	☐	☐	☐
Order: Lepidoptera (rhopalocera)	**Butterflies**						
Family Hesperiidae	Skippers						
Astictopterus inornatus	Modest Sylph	2/4/1984		☐	☐	☑	☐
Calleagris kobela	Mrs Raven's Flat	24/12/1994		☐	☐	☑	☐
Celaenorrhinus mokeezi mokeezi	Large Sprite	18/1/1972		☐	☑	☐	☐
Eretis umbra umbra	Small Marbled Elf	13/4/1980		☐	☐	☑	☐
Kedestes niveostriga	Dark Ranger	10/4/1985		☐	☐	☑	☐
Kedestes wallengrenii wallengrenii	Wallengren's Ranger	25/1/1977		☐	☐	☐	☐
Metisella metis paris	Gold-spotted Sylph	20/3/1991		☐	☐	☐	☐
Netrobalane canopus	Buff-Tipped Skipper	7/2/1897		☐	☐	☐	☐
Spialia spio	Mountain Sandman	2/4/1977		☐	☐	☐	☐
Family Lycaenidae	Blues, coppers and hairtails						
Actizera lucida	Rayed Blue	24/4/1980		☐	☐	☐	☐
Alaena amazoula amazoula	Yellow Zulu	1/1/1972		☐	☑	☑	☐
Aloeides aranda	Aranda Copper	25/1/1977		☐	☐	☐	☐
Aloeides penningtoni	Pennington's Copper	29/12/1951		☐	☐	☑	☐
Aloeides trimeni trimeni	Trimen's Copper	27/12/1928		☐	☐	☐	☐
Anthene definita definita	Common Hairtail	27/3/1987		☐	☐	☐	☐
Azanus natalensis	Natal Spotted Blue	27/12/1928		☐	☐	☐	☐
Bowkeria phosphor borealis	Scarce Scarlet	24/11/1962	Rare	☐	☐	☑	☐
Cacyreus lingeus	Bush Bronze	14/2/1981		☐	☐	☐	☐
Cacyreus marshalli	Common Geranium Bronze	26/12/1938		☐	☐	☐	☐

Species at Location: Karkloof

Scientific Name	Common Name	Date Last Collected	Red Data Status	Endemicity KZN	Endemicity Near	Endemicity RSA	Restricted in KZN
Cacyreus palemon palemon	Water Bronze	20/5/1980		☐	☐	☐	☐
Cacyreus virilis	Mocker Bronze	20/1/1917		☐	☐	☐	☐
Capys alphaeus extentus	Orange-banded Protea-butterfly	10/3/1953		☐	☐	☑	☐
Cupidopsis cissus	Common Meadow Blue	30/1/1952		☐	☐	☐	☐
Cupidopsis jobates jobates	Tailed Meadow Blue	12/1880		☐	☐	☐	☐
Durbania amakosa natalensis	Natal Amakosa Rocksitter	30/12/1980		☑	☐	☑	☑
Durbania limbata	Natal Rocksitter	17/3/1973		☐	☑	☑	☑
Euchrysops malathana	Common Smoky Blue	6/4/1980		☐	☐	☐	☐
Freyeria trochylus	Grass Jewel Blue	26/2/1985		☐	☐	☐	☐
Harpendyreus noquasa	Marsh Blue	6/4/1980		☐	☐	☑	☐
Lampides boeticus	Lucerne Blue	14/2/1979		☐	☐	☐	☐
Lepidochrysops procera	Potchefstroom Blue	4/1892		☐	☐	☑	☐
Leptotes pirithous	Common Blue	24/4/1988		☐	☐	☐	☐
Lycaena clarki	Eastern Sorrel Copper	26/12/1928		☐	☐	☑	☐
Myrina silenus ficedula	Common Fig-tree Blue	25/1/1960		☐	☐	☐	☐
Orachrysops ariadne	Karkloof Blue	2/4/1984	Rare	☑	☐	☑	☑
Pseudonacaduba sichela sichela	Dusky Blue	29/1/1917		☐	☐	☐	☐
Spindasis natalensis	Natal Bar	5/4/1992		☐	☐	☐	☐
Tarucus bowkeri bowkeri	Bowker's Blue	15/12/1975		☐	☐	☑	☐
Zintha hintza hintza	Hintza Blue	29/4/1980		☐	☐	☐	☐
Zizeeria knysna	Sooty Blue	13/4/1980		☐	☐	☐	☐
Zizina antanossa	Clover Blue	5/4/1965		☐	☐	☐	☐
Zizula hylax	Gaika Blue	1880		☐	☐	☐	☐
Family Nymphalidae (acraeinae)	Acraeas						
Acraea acara acara	Large Spotted Acraea	18/3/1993		☐	☐	☐	☐
Acraea boopis	Rainforest Acraea	25/2/1995		☐	☐	☐	☐
Acraea horta	Garden Acraea	28/8/1982		☐	☐	☐	☐
Acraea nohara nohara	Light-red Acraea	1880		☐	☐	☐	☐

Species at Location: Karkloof

Scientific Name	Common Name	Date Last Collected	Red Data Status	Endemicity KZN	Endemicity Near	Endemicity RSA	Restricted in KZN
Acraea petraea	Blood-red Acraea	10/4/1951		☐	☐	☐	☐
Acraea violarum	Speckled Red Acraea			☐	☐	☐	☐
Hyalites anacreon	Orange Acraea	18/3/1989		☐	☐	☐	☐
Hyalites cerasa cerasa	Tree-top Acraea	25/3/1972		☐	☐	☐	☐
Hyalites encedon encedon	Common Mimic Acraea	6/4/1980		☐	☐	☐	☐
Hyalites eponina	Dancing Acraea	24/4/1980		☐	☐	☐	☐
Hyalites rahira rahira	Marsh Acraea	4/4/1994		☐	☐	☐	☐
Pardopsis punctatissima	Polka Dot	18/3/1989		☐	☐	☐	☐
Family Nymphalidae (charaxinae)	Charaxes						
Charaxes druceanus druceanus	Silver-barred Charaxes	27/11/1993		☐	☐	☐	☐
Charaxes jasius saturnus	Foxy Charaxes	11/12/1972		☐	☐	☐	☐
Charaxes karkloof karkloof	Karkloof Charaxes	11/12/1972		☐	☐	☑	☑
Charaxes varanes varanes	Pearl Charaxes	3/4/1994		☐	☐	☐	☐
Charaxes xiphares penningtoni	Pennington's Forest-king Charaxes	20/3/1994		☑	☐	☐	☐
Family Nymphalidae (danainae)	Monarchs						
Amauris albimaculata albimaculata	Layman Friar	23/4/1993		☐	☐	☐	☐
Amauris echeria echeria	Chief Friar	6/4/1991		☐	☐	☑	☐
Amauris niavius dominicanus	Common Friar	13/5/1978		☐	☐	☐	☐
Amauris ochlea ochlea	Novice Friar	23/6/1976		☐	☐	☐	☐
Danaus chrysippus aegyptius	African Monarch	25/1/1977		☐	☐	☐	☐
Family Nymphalidae (nymphalinae)	Brush-footed butterflies						
Antanartia hippomene hippomene	Short-tailed Admiral	7/3/1979		☐	☐	☐	☐
Antanartia schaeneia schaeneia	Long-tailed Admiral	7/3/1979		☐	☐	☑	☐
Byblia anvatara acheloia	Common Joker	25/3/1972		☐	☐	☐	☐
Cymothoe alcimeda trimeni	Trimen's Battling Glider	20/3/1994		☐	☑	☑	☐
Hypolimnas anthedon wahlbergi	Variable Diadem	1/4/1994		☐	☐	☐	☐
Phalanta eurytis eurytis	Forest Leopard	6/5/1993		☐	☐	☐	☐

Species at Location: Karkloof

Scientific Name	Common Name	Date Last Collected	Red Data Status	Endemicity KZN	Endemicity Near	Endemicity RSA	Restricted in KZN
Precis archesia	Garden Commodore	1/4/1994		☐	☐	☐	☐
Precis ceryne ceryne	Marsh Commodore	18/3/1977		☐	☐	☐	☐
Precis octavia sesamus	Gaudy Commodore	1/4/1994		☐	☐	☐	☐
Precis orithya madagascariensis	Eyed Pansy	1/4/1994		☐	☐	☐	☐
Precis tugela tugela	Eared Commodore	1/4/1994		☐	☐	☐	☑
Family Nymphalidae (satyrinae)	Browns						
Aeropetes tulbaghia	Mountain Pride	7/3/1979		☐	☐	☐	☐
Bicyclus safitza safitza	Common Bush Brown	17/4/1988		☐	☐	☐	☐
Cassionympha cassius	Rainforest Brown	1/4/1994		☐	☐	☑	☐
Paralethe indosa albina	White-spotted Bush Beauty	1/4/1994		☐	☐	☑	☑
Pseudonympha magoides	False Silver-bottom Brown	20/2/1994		☐	☐	☑	☐
Pseudonympha varii	Vari's Brown	19/3/1995		☐	☐	☑	☑
Stygionympha scotina scotina	Eastern Hillside Brown	27/12/1928		☐	☐	☑	☐
Stygionympha wichgrafi williami	Wichgraf's Brown	13/4/1980		☐	☐	☑	☐
Family Papilionidae	Swallowtails and swordtails						
Papilio constantinus constantinus	Constantine's Swallowtail	25/1/1947		☐	☐	☐	☐
Papilio dardanus cenea	Mocker Swallowtail	27/3/1987		☐	☐	☐	☐
Papilio demodocus demodocus	Citrus Swallowtail	7/3/1979		☐	☐	☐	☐
Papilio echerioides echerioides	White-banded Swallowtail	18/3/1989		☐	☐	☐	☐
Papilio euphranor	Bush Kite Swallowtail	27/1/1986	Indeterminate	☐	☐	☑	☐
Papilio nireus lyaeus	Green-banded Swallowtail	14/2/1981		☐	☐	☐	☐
Papilio ophidicephalus ayresi	Ayres' Emperor Swallowtail			☐	☐	☑	☑
Papilio ophidicephalus phalusco	Emperor swallowtail	14/2/1979		☐	☐	☑	☑
Papilio ophidicephalus zuluensis	Zululand Emperor Swallowtail			☑	☐	☑	☑
Family Pieridae	Whites, yellows etc.						
Belenois aurota aurota	Brown-veined White	29/12/1928		☐	☐	☐	☐
Belenois zochalia zochalia	Forest White	28/8/1982		☐	☐	☐	☐

Species at Location: Karkloof

Scientific Name	Common Name	Date Last Collected	Red Data Status	Endemicity KZN	Endemicity Near	Endemicity RSA	Restricted in KZN
Colias electo electo	African Clouded Yellow	18/3/1989		☐	☐	☐	☐
Colotis eris eris	Banded Gold Tip	22/1/1918		☐	☐	☐	☐
Colotis euippe omphale	Smoky Orange Tip	27/1/1986		☐	☐	☐	☐
Dixeia charina charina	African Small White	23/4/1993		☐	☐	☐	☐
Dixeia pigea	Ant-Heap Small White	29/3/1953		☐	☐	☐	☐
Eurema brigitta brigitta	Broad-bordered Grass Yellow	29/4/1980		☐	☐	☐	☐
Eurema desjardinsii marshalli	Angled Grass Yellow	29/4/1980		☐	☐	☐	☐
Nepheronia argia varia	Large Vagrant	5/5/1979		☐	☐	☑	☑
Nepheronia argia variegata	Variegated Large Vagrant			☐	☐	☐	☐
Pontia helice helice	Meadow White	22/1/1918		☐	☐	☐	☐
Order: Mecoptera	**Hangingflies**						
Family Bittacidae							
Bittacus kimminsi				☐	☐	☐	☐
Bittacus nebulosus				☐	☐	☐	☐
Bittacus selysi				☐	☐	☐	☐
Bittacus walkeri				☐	☐	☐	☐
Order: Odonata	**Dragonflies**						
Family Chlorolestidae							
Chlorolestes fasciatus	Mountain sylph	1987		☐	☐	☐	☐
Chlorolestes tessellatus	Forest sylph	1993		☐	☐	☐	☐
Family Coenagrionidae							
Enallagmea glaucum	Common African blue	1987		☐	☐	☐	☐
Enallagmea subfercatum	Delicate mountain blue	1990		☐	☐	☐	☐
Family Lestidae							
Lestes virgatus	Smoky emerald damsel	1960		☐	☐	☐	☐

Species at Location: Karkloof

Scientific Name	Common Name	Date Last Collected	Red Data Status	Endemicity KZN	Endemicity Near	Endemicity RSA	Restricted in KZN
Family Libellulidae							
Orthetrum caffrum	Mountain marsh orthetrum	1989		☐	☐	☐	☐
Orthetrum robustum	Robust orthetrum			☐	☐	☐	☐
Orthetrum trinacria	Marsh orthetrum	1988		☐	☐	☐	☐
Family Platycnemididae							
Allocnemis leucosticta	Goldtail	1962		☐	☐	☐	☐
Class: Mammalia	**Mammals**						
Order: Artiodactyla							
Family Bovidae							
Ourebia ourebi ourebi	Oribi	1/5/1994	Vulnerable	☐	☐	☐	☐
Philantomba monticola bicolor	Blue duiker	1/5/1994	Rare	☐	☐	☐	☐
Redunca arundinum arundinum	Reedbuck	1/5/1994		☐	☐	☐	☐
Sylvicapra grimmia	Grey duiker	1/5/1994		☐	☐	☐	☐
Tragelaphus scriptus	Bushbuck	1/5/1994		☐	☐	☐	☐
Order: Carnivora							
Family Mustelidae							
Poecilogale albinucha	African weasel	19/12/1974	Rare	☐	☐	☑	☐
Order: Chiroptera							
Family Vespertilionidae							
Miniopterus fraterculus	Lesser long-fingered bat			☐	☐	☐	☐
Order: Insectivora							
Family Chrysochloridae							
Amblysomus hottentotus longiceps	Hottentot golden mole			☐	☐	☑	☐
Chrysospalax villosus villosus	Rough-haired golden mole		Vulnerable	☐	☐	☐	☐

Species at Location: Karkloof

Scientific Name	Common Name	Date Last Collected	Red Data Status	Endemicity KZN	Endemicity Near	Endemicity RSA	Restricted in KZN
Family Soricidae							
Crocidura cyanea infumata	Reddish-grey musk shrew			☐	☐	☐	☐
Myosorex cafer	Dark-footed forest shrew			☐	☐	☐	☐
Myosorex varius	Forest shrew			☐	☐	☑	☐
Order: Primates							
Family Cercopithecidae							
Cercopithecus mitis labiatus	Samango monkey		Rare	☐	☐	☐	☐
Order: Rodentia							
Family Gliridae							
Graphiurus murinus	Woodland dormouse			☐	☐	☐	☐
Family Muridae							
Aethomys chrysophilus chrysophilus	Red veld rat			☐	☐	☐	☐
Dasymys incomtus incomtus	Water rat		Indeterminate	☐	☐	☐	☐
Dendromus mystacalis jamesoni	Chestnut climbing mouse			☐	☐	☐	☐
Grammomys dolichurus dolichurus	Woodland mouse			☐	☐	☐	☐
Mastomys coucha coucha	Multimammate mouse			☐	☐	☐	☐
Mastomys natalensis natalensis	Natal multimammate mouse			☐	☐	☐	☐
Mus minutoides minutoides	Pygmy mouse			☐	☐	☐	☐
Otomys irroratus	Vlei rat			☐	☐	☐	☐
Otomys laminatus	Laminate vlei rat			☐	☐	☑	☐
Rhabdomys pumilio dilectus	Striped mouse			☐	☐	☐	☐
Class: Onycophera	**Velvet worms**						
Order: (Onycophora)							
Family Peripatopsidae							
Peripatopsis moseleyi				☐	☐	☐	☐

Species at Location: Karkloof

Scientific Name	Common Name	Date Last Collected	Red Data Status	Endemicity KZN	Endemicity Near	Endemicity RSA	Restricted in KZN
Class: Osteichthyes	**Bony fish**						
Order: Perciformes							
Family Centrarchidae							
Micropterus salmoides	Largemouth bass			☐	☐	☐	☐
Family Cichilidae							
Tilapia rendalli	Redbreast tilapia			☐	☐	☐	☐
Order: Salmoniformes							
Family Salmonidae							
Salmo trutta	Brown trout			☐	☐	☐	☐
Class: Reptilia	**Reptiles**						
Order: Sauria	**Lizards**						
Family Agamidae							
Agama aculeata distanti	Distant's ground agama	23/8/1984		☐	☐	☑	☑
Family Cordylidae							
Chamaesaura anguina anguina	Cape grass lizard	10/6/1980		☐	☐	☑	☐
Cordylus vittifer	Transvaal girdled lizard	15/6/1980		☐	☐	☐	☐
Pseudocordylus melanotus subviridis	Drakensberg crag lizard	11/11/1979		☐	☐	☑	☑
Family Gerrhosauridae							
Gerrhosaurus flavigularis	Yellow-throated plated lizard	8/2/1982		☐	☐	☐	☐
Tetradactylus seps	Short-legged seps			☐	☐	☑	☑
Family Scincidae							
Mabuya capensis	Cape skink	31/5/1979		☐	☐	☐	☐
Mabuya striata punctatissima	Speckled skink	23/8/1984		☐	☐	☐	☐
Mabuya varia	Variable skink	1/1989		☐	☐	☐	☐
Scelotes bourquini	Bourquin's dwarf burrowing skink	24/10/1964		☑	☐	☑	☑

Species at Location: Karkloof

Scientific Name	Common Name	Date Last Collected	Red Data Status	Endemicity KZN	Endemicity Near	Endemicity RSA	Restricted in KZN
Order: Serpentes	**Snakes**						
Family Atractaspididae							
Macrelaps microlepidotus	Natal black snake	14/12/1980		☐	☑	☑	☐
Family Colubridae							
Crotaphopeltis hotamboeia	Herald snake	10/6/1980		☐	☐	☐	☐
Dasypeltis inornata	Southern brown egg-eater	26/4/1982		☐	☐	☑	☐
Dispholidus typus typus	Boomslang	1987		☐	☐	☐	☐
Duberria lutrix lutrix	Common slug-eater	19/9/1976		☐	☐	☑	☐
Lamprophis inornatus	Olive house snake	3/2/1989		☐	☐	☑	☐
Lycophidion capense capense	Cape wolf snake	29/7/1984		☐	☐	☐	☐
Philothamnus hoplogaster	Green water snake	20/5/1976		☐	☐	☐	☐
Philothamnus natalensis occidentalis	Western Natal green snake	24/4/1981		☐	☐	☑	☐
Philothamnus semivariegatus	Spotted Bush Snake	15/5/1976		☐	☐	☐	☐
Psammophis crucifer	Cross-marked grass snake	26/8/1979		☐	☐	☐	☐
Psammophylax rhombeatus rhombeatus	Spotted skaapsteker	18/11/1978		☐	☐	☐	☐
Family Elapidae							
Hemachatus haemachatus	Rinkhals	6/3/1981		☐	☐	☐	☐
Homoroselaps lacteus	Spotted harlequin snake	31/5/1979		☐	☐	☑	☐
Family Leptotyphlopidae							
Leptotyphlops conjunctus conjunctus	Cape thread snake	19/9/1976		☐	☐	☑	☐
Family Typhlopidae							
Typhlops bibronii	Bibron's blind snake	21/3/1992		☐	☐	☐	☐
Family Viperidae							
Causus rhombeatus	Rhombic night adder	15/11/1992		☐	☐	☐	☐

APPENDIX 4.

LIST OF BIRD SPECIES RECORDED IN THE KARKLOOF NATURE RESERVE: PREPARED BY KWAZULU-NATAL NATURE CONSERVATION SERVICE (14/10/1996)

KARKLOOF NATURE RESERVE BIRD LIST 14.10.96

8	Dabchick *Tachybaptus ruficollis*	173	Hobby Falcon *Falco subbuteo*	362	Cape Parrot *Poicephalus robustus*
58	Reed Cormorant *Phalacrocorax africanus*	181	Rock Kestrel *Falco tinnunculus*	370	Knysna Lourie *Tauraco corythaix*
62	Grey Heron *Ardea cinerea*	192	Redwing Francolin *Francolinus levaillantii*	377	Redchested Cuckoo *Cuculus solitarius*
63	Blackheaded Heron *Ardea melanocephala*	196	Natal Francolin *Francolinus natalensis*	384	Emerald Cuckoo *Chrysococcyx cupreus*
81	Hamerkop *Scopus umbretta*	198	Rednecked Francolin *Francolinus afer*	386	Diederik Cuckoo *Chrysococcyx caprius*
83	White Stork *Ciconia ciconia*	199	Swainson's Francolin *Francolinus swainsonii*	391	Burchell's Coucal *Centropus burchellii*
94	Hadeda Ibis *Bostrychia hagedash*	200	Common Quail *Coturnix coturnix*	392	Barn Owl *Tyto alba*
102	Egyptian Goose *Alopochen aegyptiacus*	203	Helmeted Guineafowl *Numida meleagris*	393	Grass Owl *Tyto capensis*
104	Yellowbilled Duck *Anas undulata*	204	Crested Guineafowl *Guttera pucherani*	394	Wood Owl *Strix woodfordii*
105	African Black Duck *Anas sparsa*	207	Wattled Crane *Bugeranus carunculatus*	401	Spotted Eagle Owl *Bubo africanus*
116	Spurwinged Goose *Plectropterus gambensis*	208	Blue Crane *Anthropoides paradiseus*	405	Fierynecked Nightjar *Caprimulgus pectoralis*
118	Secretarybird *Sagittarius serpentarius*	221	Striped Flufftail *Sarothrura affinis*	410	Lesser Honeyguide *Indicator minor*
122	Cape Vulture *Gyps coprotheres*	231	Stanley's Bustard *Neotis denhami*	411	European Swift *Apus apus*
126	Black (Yellowbilled) Kite *Milvus migrans*	249	Threebanded Plover *Charadrius tricollaris*	412	Black Swift *Apus barbatus*
131	Black Eagle *Aquila verreauxii*	257	Blackwinged Plover *Vanellus melanopterus*	415	Whiterumped Swift *Apus caffer*
139	Longcrested Eagle *Lophaetus occipitalis*	258	Blacksmith Plover *Vanellus armatus*	416	Horus Swift *Apus horus*
140	Martial Eagle *Polemaetus bellicosus*	286	Ethiopian Snipe *Gallinago nigripennis*	417	Little Swift *Apus affinis*
141	Crowned Eagle *Stephanoaetus coronatus*	297	Spotted Dikkop *Burhinus capensis*	418	Alpine Swift *Apus melba*
148	African Fish Eagle *Haliaeetus vocifer*	349	Rock Pigeon *Columba guinea*	424	Speckled Mousebird *Colius striatus*
149	Steppe Buzzard *Buteo buteo*	350	Rameron Pigeon *Columba arquatrix*	426	Redfaced Mousebird *Urocolius indicus*
150	Forest Buzzard *Buteo trizonatus*	351	Delegorgue's Pigeon *Columba delegorguei*	427	Narina Trogon *Apaloderma narina*
152	Jackal Buzzard *Buteo rufofuscus*	352	Redeyed Dove *Streptopelia semitorquata*	429	Giant Kingfisher *Megaceryle maxima*
155	Redbreasted Sparrowhawk *Accipiter rufiventris*	354	Cape Turtle Dove *Streptopelia capicola*	431	Malachite Kingfisher *Alcedo cristata*
158	Black Sparrowhawk *Accipiter melanoleucus*	355	Laughing Dove *Streptopelia senegalensis*	435	Brownhooded Kingfisher *Halcyon albiventris*
160	African Goshawk *Accipiter tachiro*	356	Namaqua Dove *Oena capensis*	455	Trumpeter Hornbill *Bycanistes bucinator*
169	Gymnogene *Polyboroides typus*	359	Tambourine Dove *Turtur tympanistria*	460	Crowned Hornbill *Tockus alboterminatus*
172	Lanner Falcon *Falco biarmicus*	360	Cinnamon Dove *Aplopelia larvata*	463	Ground Hornbill *Bucorvus leadbeateri*

464 Blackcollared Barbet
Lybius torquatus

469 Redfronted Tinker Barbet
Pogoniulus pusillus

474 Greater Honeyguide
Indicator indicator

475 Scalythroated Honeyguide
Indicator variegatus

483 Goldentailed Woodpecker
Campethera abingoni

488 Olive Woodpecker
Mesopicos griseocephalus

489 Redthroated Wryneck
Jynx ruficollis

518 European Swallow
Hirundo rustica

520 Whitethroated Swallow
Hirundo albigularis

526 Greater Striped Swallow
Hirundo cucullata

529 Rock Martin
Hirundo fuligula

530 House Martin
Delichon urbica

536 Black Sawwing Swallow
Psalidoprocne holomelas

540 Grey Cuckooshrike
Coracina caesia

541 Forktailed Drongo
Dicrurus adsimilis

545 Blackheaded Oriole
Oriolus larvatus

547 Black Crow
Corvus capensis

548 Pied Crow
Corvus albus

550 Whitenecked Raven
Corvus albicollis

554 Southern Black Tit
Parus niger

565 Bush Blackcap
Lioptilus nigricapillus

568 Blackeyed Bulbul
Pycnonotus barbatus

569 Terrestrial Bulbul
Phyllastrephus terrestris

572 Sombre Bulbul
Andropadus importunus

577 Olive Thrush
Turdus olivaceus

579 Orange Thrush
Zoothera gurneyi

580 Groundscraper Thrush
Turdus litsitsirupa

581 Cape Rock Thrush
Monticola rupestris

582 Sentinel Rock Thrush
Monticola explorator

588 Buffstreaked Chat
Oenanthe bifasciata

589 Familiar chat
Cercomela familiaris

596 Stonechat
Saxicola torquata

598 Chorister Robin
Cossypha dichroa

601 Cape Robin
Cossypha caffra

606 Starred Robin
Pogonocichla stellata

613 Whitebrowed Robin
Erythropygia leucophrys

639 Barratt's Warbler
Bradypterus barratti

644 Yellowthroated Warbler
Seicercus ruficapillus

645 Barthroated Apalis
Apalis thoracica

648 Yellowbreasted Apalis
Apalis flavida

657 Bleating Warbler
Camaroptera brachyura

661 Grassbird
Sphenoeacus afer

667 Ayres' Cisticola
Cisticola ayresii

670 Wailing Cisticola
Cisticola lais

677 Levaillant's Cisticola
Cisticola tinniens

678 Croaking Cisticola
Cisticola natalensis

679 Lazy Cisticola
Cisticola aberrans

681 Neddicky
Cisticola fulvicapilla

686 Spotted Prinia
Prinia hypoxantha

690 Dusky Flycatcher
Muscicapa adusta

694 Black Flycatcher
Melaenornis pammelaina

700 Cape Batis
Batis capensis

708 Bluemantled Flycatcher
Trochocercus cyanomelas

710 Paradise Flycatcher
Terpsiphone viridis

712 Longtailed Wagtail
Motacilla clara

713 Cape Wagtail
Motacilla capensis

716 Grassveld Pipit
Anthus cinnamomeus

717 Longbilled Pipit
Anthus similis

718 Plainbacked Pipit
Anthus leucophrys

720 Striped Pipit
Anthus lineiventris

727 Orangethroated Longclaw
Macronyx capensis

732 Fiscal Shrike
Lanius collaris

736 Southern Boubou
Laniarius ferrugineus

740 Puffback
Dryoscopus cubla

744 Blackcrowned Tchagra
Tchagra senegala

746 Bokmakierie
Telophorus zeylonus

747 Gorgeous Bush Shrike
Telophorus quadricolor

748 Orangebreasted Bush Shrike
Telophorus sulfureopectus

750 Olive Bush Shrike
Telophorus olivaceus

751 Greyheaded Bush Shrike
Malaconotus blanchoti

758 Indian Myna
Acridotheres tristis

759 Pied Starling
Spreo bicolor

764 Glossy Starling
Lamprotornis nitens

769 Redwinged Starling
Onychognathus morio

774 Gurney's Sugarbird
Promerops gurneyi

775 Malachite Sunbird
Nectarinia famosa

783 Lesser Doublecollared Sunbird
Nectarinia chalybea

785 Greater Doublecollared Sunbird
Nectarinia afra

792 Black Sunbird
Nectarinia amethystina

793 Collared Sunbird
Anthreptes collaris

796 Cape White-eye
Zosterops pallidus

801 House Sparrow
Passer domesticus

804 Greyheaded Sparrow
Passer diffusus

807 Thickbilled Weaver
Amblyospiza albifrons

808 Forest Weaver
Ploceus bicolor

821 Redbilled Quelea
Quelea quelea

824 Red Bishop
Euplectes orix

827 Yellowrumped Widow
Euplectes capensis

828 Redshouldered Widow
Euplectes axillaris

831 Redcollared Widow
Euplectes ardens

832 Longtailed Widow
Euplectes progne

840 Bluebilled Firefinch
Lagonosticta rubricata

846 Common Waxbill
Estrilda astrild

850 Swee Waxbill
Estrilda melanotis

852 Quail Finch
Ortygospiza atricollis

857 Bronze Mannikin
Spermestes cucullatus

860 Pintailed Whydah
Vidua macroura

864 Black Widowfinch
Vidua funerea

869 Yelloweyed Canary
Serinus mozambicus

872 Cape Canary
Serinus canicollis

873 Forest Canary
Serinus scotops

877 Bully Canary
Serinus sulphuratus

884 Goldenbreasted Bunting
Emberiza flaviventris

Sources: P.B. Lowry
D.N. Johnson
P.L. Walker
J.S.B. Scotcher
A.N. Marchant
A. Stainthorpe
W. McCleland

APPENDIX 5.

A PHYSIOGNONMIC - STRUCTURAL VEGETATION CLASSIFICATION SYSTEM, ADAPTED FROM GRANGER (UNDATED), USED TO MAP THE VEGETATION OF THE KARKLOOF CATCHMENT

Table 1.

F - FOREST - Total tree cover > 0.1%; shrub cover <10% if 1m high			
Coverage 100 - 75% Crown:gap ratio 0 - 0.1	Continuous > 2ha	Forest Patches < 2ha	Forest Mosaic - very small clumps of forest interspersed with another community, usually grassland. Often associated with extensive areas of large boulders.
DOMINANT HEIGHT CLASS	Code:	Code:	Code:
Trees > 10m	F10 - Tall Forest	F20 - Tall Forest Patch	F30 - Tall Forest Mosaic
Trees 5 - 10m	F11 - Short Forest	F21 - Short Forest Patch	F31 - Short Forest Mosaic
Trees 2 - 5m	F12 - Low Forest	F22 - Low forest Patch	F32 - Low Forest Mosaic
T - THICKET - Total tree cover 1 - 20%, shrub cover > 10% & > 1m high			
	Coverage 100 - 10% Crown:gap ratio 0 - 2	Coverage 10 - 1% Crown:gap ratio 2 - 8.5	
DOMINANT HEIGHT CLASS	Code:	Code:	
Trees 5 - 10m & Shrubs 2 - 5 m	T10 - Short Dense Thicket	T20 - Short Patchy Thicket	
Trees 2 - 5m & Shrubs 1 - 5m	T11 - Low Dense Thicket	T21 - Low Patchy Thicket	
S - SHRUBLAND - Total tree cover < 0.1 %, shrub cover > 0.1% or tree cover up to 1% and shrub cover > 10% and 1m high (closed shrublands)			Other Coding to add: Habitat moisture regime (aquatic, aquatic-riparian, hygrophilous, hygrophilous-riparian, mesic and xeric). Simplified to riparian and other for mapping purposes; Under storey code - code upper storey first then put under storey code underneath as for grasslands etc.
	Coverage 100 - 10% Crown:gap ratio 0 - 2	Coverage 10 - 1% Crown:gap ratio 2 - 8.5	Coverage 1 - 0.1% Crown:gap ratio 8.5 - 30
DOMINANT HEIGHT CLASS	Code:	Code:	Code:
Shrubs 2-5m	S10 - High Closed Shrubland	S20 - High Open Shrubland	S30 - High Sparse Shrubland
Shrubs 1-2m	S11 - Tall Closed Shrubland	S21 - Tall Open Shrubland	S31 - Tall Sparse Shrubland
Shrubs 0.5 - 1m	S12 - Short Closed Shrubland	S22 - Short Open Shrubland	S32 - Short Sparse Shrubland
Shrubs < 0.5m	S13 - Dwarf Closed Shrubland	S23 - Dwarf Open Shrubland	S33 - Dwarf Sparse Shrubland

Table1. continued

W - WOODLAND - Wooded grassland, wooded herbland, wooded forbland			Other Coding to add: Habitat moisture regime (aquatic, aquatic-riparian, hygrophilous, hygrophilous-riparian, mesic and xeric). Simplified to riparian and other for mapping purposes; under storey code - code upper storey first then put under storey code underneath as for grasslands etc.
	Coverage 100 - 10% Crown:gap ratio 0 - 1	Coverage 10 - 1% Crown:gap ratio 2 - 8.5	Coverage 1 - 0.1% Crown:gap ratio 8.5 - 30
DOMINANT HEIGHT CLASS	Code:	Code:	Code:
Trees 5 - 10m	W10 - Short Closed Woodland	W20 - Short Open Woodland	W30 - Short Sparse Woodland
Trees 2 - 5m	W11 - Low Closed Woodland	W21 - Low Open Woodland	W31 - Low Sparse Woodland
G - GRASSLAND - Total tree cover < 0.1%, shrub cover < 0.1%, grass cover dominant and > 0.1 %		Species: *Themeda triandra*, *Aristida junciformis*, *Themeda/Aristida* Mosaic, *Hyparrhenia* sp. *Cymbopogon* sp.	Other Coding to add: Habitat moisture regime (aquatic, aquatic-riparian, hygrophilous, hygrophilous-riparian, mesic and xeric). Simplified to aquatic, riparian and other for mapping purposes; Management Status (hay, old abandoned cultivation, restored, commercial Proteas, burnt, air strip, overgrazed, polo field).
	Coverage 100 - 10% Crown:gap ratio 0 - 1	Coverage 10 - 1% Crown:gap ratio 2 - 8.5	Coverage 1 - 0.1% Crown:gap ratio 8.5 - 30
DOMINANT HEIGHT CLASS	Code:	Code:	Code:
Grasses > 2m	G10 - High Dense Grassland	G20 - High Open Grassland	G30 - High Sparse Grassland
Grasses 1 - 2m	G11 - Tall Dense Grassland	G21 - Tall Open Grassland	G31 - Tall Sparse Grassland
Grasses 0.5 - 1m	G12 - Short Dense Grassland	G22 - Short Open Grassland	G32 - Short Sparse Grassland
Grasses 0.2 - 0.5m	G13 - Low Dense Grassland	G23 - Low Open Grassland	G33 - Low Sparse Grassland
Grasses < 0.2m	G14 - Dwarf Dense Grassland	G24 - Dwarf Open Grassland	G34 - Dwarf Sparse Grassland

Table 1. continued

H - HERBLAND - Total tree cover < 0.1%, shrub cover < 0.1%, herb cover dominant and > 0.1%			Other Coding to add: Under storey code - Code upper storey first then put Under storey code underneath as for grasslands etc.
	Coverage 100 - 10% Crown:gap ratio 0 -1	Coverage 10 - 1% Crown:gap ratio 2 - 8.5	Coverage 1 - 0.1% Crown:gap ratio 8.5 - 30
DOMINANT HEIGHT CLASS	Code:	Code:	Code:
Herbs > 2m	H10 - High Closed Herbland	H20 - High Open Herbland	H30 - High Sparse Herbland
Herbs 1 - 2m	H11 - Tall Closed Herbland	H21 - Tall Open Herbland	H31 - Tall Sparse Herbland
Herbs 0.5 - 1m	H12 - Short Closed Herbland	H22 - Short Open Herbland	H32 - Short Sparse Herbland
Herbs 0.2 - 0.5m	H13 - Low Closed Herbland	H23 - Low Open Herbland	H33 - Low Sparse Herbland
Herbs < 0.2m	H14 - Dwarf Closed Herbland	H24 - Dwarf Open Herbland	H34 Dwarf Sparse Herbland
Fo - FORBLAND - Total tree cover < 0.1%, shrub cover < 0.1%. Cover contributed by total graminoides and total herbs are within 20% of one another.			
	Coverage 100 - 10% Crown:gap ratio 0 - 1	Coverage 10 - 1% Crown:gap ratio 2 - 8.5	Coverage 1 - 0.1% Crown:gap ratio 8.5 - 30
DOMINANT HEIGHT CLASS	Code:	Code:	Code:
Forbs > 2m	Fo10 - High Closed Forbland	Fo20 - High Open Forbland	Fo30 - High Sparse Forbland
Forbs 1 - 2m	Fo11 - Tall Closed Forbland	Fo21 - Tall Open Forbland	Fo31 - Tall Sparse Forbland
Forbs 0.5 - 1m	Fo12 - Short Closed Forbland	Fo22 - Short Open Forbland	Fo32 - Short Sparse Forbland
Forbs 0.5 - 0.2m	Fo13 - Low Closed Forbland	Fo23 - Low Open Forbland	Fo33 - Low Sparse Forbland
Forbs < 0.2m	Fo14 - Dwarf Closed Forbland	Fo24 - Dwarf open Forbland	Fo34 - Dwarf Sparse Forbland

Table 1. continued

EM **'EXOTIC VEGETATION - MANAGED'**	Code: PL - Timber plantation	Species: *Acacia* spp. *Eucalyptus* spp. *Populus* spp. *Pinus patula* *Pinus* spp. *Quercus* spp. Unknown	Status: Abandoned Felled Newly planted
EW **'EXOTIC VEGETATION - WILD'**	Code: Follow with codes as per shrubland, forbland woodland etc. Not forest, forest is reserved for only indigenous trees.	Species: Wattle, Pine, Gum, American Bramble, mix.	Status: Cleared Habitat moisture regime (aquatic, aquatic-riparian, hygrophilous, hygrophilous-riparian, mesic and xeric). Simplified to riparian and other for mapping purposes
EHH **'EXOTICS VEGETATION - HUMAN HABITATION'**	Code: F - Farmstead associated R - Recreational areas I - Institutional areas		

Table 2. Primary Categories for Land Use not termed Indigenous Vegetation, adapted from Granger (undated)

CC - 'CULTIVATION COMMERCIAL'	Code: P - Perennials A - Annuals	Crop Type: Other (Pasture & crops) Fruit	Status: Abandoned
CS - 'CULTIVATION SUBSISTENCE'	Code: A - Annuals	Crop Type: Maize Vegetables	Status: Ab - Abandoned
R - ROCK OUTCROPS	Code: R1 - vertical < 30° R2 - horizontal 31° - 90°		
E - EROSION	Code: SE - Sheet erosion RE - Rill erosion GE - Gully erosion 1 - Slight 2 - Moderate 3 - Severe		
Q - QUARRY			
W - FARM DAM	D - Dam		
B - BUILDINGS	Code: African White Commercial Labour village		
R - MAIN ROADS			

Definitions of Physiognomic Categories

The definitions of the primary physiognomic categories shown in Table 1. (p.1), as adapted from Granger (undated) are as follows:

1. 'Forest' comprises generally evergreen communities, although many trees and shrubs may be deciduous or semi-deciduous. Trees and shrubs are the conspicuous life forms. Trees form an interlocking canopy. In profile the community is (unless severely disturbed) multi storied, the main strata being: sub-canopy tree and shrub layer; dwarf shrub layer; field layer; epiphytes; climbers and lianes and a ground layer;

2. 'Thicket' is an evergreen to semi-deciduous community. Shrubs are considerably more common than trees and most trees tend to be low branching. 'Thicket' is multi storied, however the strata are much less distinct than those which occur in 'Forest'. Straddling of shrubs and trees are common. This imparts to 'Thicket' its distinctive characteristic of impermeability;

3. 'Shrubland' differs from 'Thicket' primarily in the fact that straddling in the woody strata is far less pronounced. Shrubs are the dominant woody growth form with trees being rare or absent. There is no pronounced appearance of impermeability. The area between the shrubs is often occupied by grassland or sometimes herbland or forbland;

4. 'Woodland' has trees as the dominant growth form of the tallest stratum. There is marked stratification in which the woody component is clearly separated from the lower grass and herbaceous component. Grass cover but sometimes a herb or forbland is the characteristic under storey;

5. 'Grasslands' are dominated by grasses and grass-like plants i.e. graminoids, Poaceae & Cyperaceae;

6. 'Herbs' are defined as rooted, non-woody or partially woody or soft-woody non-graminoid plants (i.e. not members of the families Poaceae, Cyperaceae, Juncaceae or Restionaceae). Where woodiness occurs it is usually restricted to the permanent lower portion of the plant at or near ground level;

7. 'Forbland' are areas that are neither clearly grassland or herbland;

8. The eighth primary category, 'Exotic Vegetation' was omitted and three 'Exotic Vegetation' categories were added, namely: 'Exotic Vegetation - Managed'; 'Exotic Vegetation - Wild' and 'Exotic Vegetation - Human Habitation'.

'Exotic Vegetation - Managed' is defined as exotic vegetation that has been intentionally planted and is managed by man for commercial gain. Its planting shape is often geometric and regular. Timber plantations are included. Timber species include: *Acacia* spp., *Eucalyptus* spp., *Populus* spp., *Pinus patula*, *P.* spp., *Quercus* spp. and unknown (not able to be determined due to being felled or recently abandoned). 'Exotic Vegetation - Wild', refers to any 'Exotic Alien Vegetation' not intentionally planted, but which has spread into mostly indigenous vegetation areas. This may include 'Exotic Alien Vegetation' along defined habitat moisture regimes. 'Exotic Vegetation - Human Habitation', refers to exotic and sometimes indigenous vegetation that has been planted and is maintained by man for some functional or aesthetic value. This may include grassed sports field and road verges, gardens around farm-steads and wind breaks.

The definitions of the primary physiognomic categories of land use that can not be termed indigenous shown in Table 2. (p.5), as adapted from Granger (undated) are as follows:

1. 'Cultivation - Commercial', refers to areas where commercial crops are cultivated. This may include annual crops such as maize and vegetables, and perennial crops such as Kikuyu and Rye pastures as well as fruit orchards. The status of the crops, such as whether they are abandoned or not may be recorded;
2. 'Cultivation - Subsistence', refers to areas where crops are cultivated on a subsistence basis. Crops cultivated are mostly annual and include crops such as maize and vegetables. The status of the crops, such as whether they are abandoned or not may be recorded;
3. 'Rock outcrops' consist of two categories: 'Vertical Outcrops' or cliffs where the gradient is between 0 ° and 30 °, and 'Horizontal Outcrops' which vary in steepness between 31 ° and 90 ° ;
4. 'Soil erosion' is composed of 'Sheet Erosion', 'Rill Erosion' and 'Gully Erosion'. 'Sheet Erosion' refers to soil which is removed in a more or less uniform pattern from an area; 'Rills' are small but conspicuous channels; and 'Gullies' which may be often several metres deep and wide, are channels via which detached soil particles and large aggregates are removed. 'Soil Erosion' is deemed to be 'Slight' if it is noticeable but not obvious; 'Soil Erosion' is deemed to be 'Moderate' if removal of soil is obvious.

Even when most severe, moderately eroded areas will still have an obvious cover of vegetation although this will invariably be short and patchy. 'Soil Erosion' is deemed to be 'Severe' when the area of bare ground greatly exceeds areas covered by vegetation and when numerous 'Gullies' are present;

5. 'Quarries' are large open areas of bare earth > 250 m^2 from which soil and rock materials have been extracted for the construction of roads, buildings etc.;

6. 'Farm dams' are man-made structures, whereby water has been dammed by a dam wall. Dams are used for the supply of water for farming, living and recreational activities;

7. 'Buildings' include any structure which may be used as a residence or for commercial activities;

8. 'Main roads' include the main access roads to the area. Smaller farm roads have not been included.

The physiognomic categories: 'shrubland', 'woodland', 'grassland' and 'Exotic Vegetation - Wild' have been further distinguished on the basis of their general moisture regime of their habitat. These include:

1. 'Aquatic' habitats, are characterized by the soil in which the plants are rooted being covered during at least eight months of the year by a continuous body of water. Examples include wetlands or vleis, open natural water bodies and rivers. 'Aquatic habitats' may be riparian, being a habitat with moving water;

2. 'Hygrophilous' sites, are where permanent continuous surface water is normally present only during the very wettest weeks in the rainy season. Examples may include drainage lines or depressions. 'Hygrophilous' habitats may be riparian, these being a habitat with moving water;

3. 'Xeric' sites, are moist for only very short periods (a few days at a time at most, often after heavy rainfall) even in the rainy season either as a result of very rapid drainage of water away from these sites or because they are shielded from precipitation. Sites include rock outcrops, the sides of valleys, hilltops and ridges;

4. 'Mesic' sites, have habitat conditions that exist between 'Hygrophilous' and 'Xeric'.

For the purpose of mapping, these habitat moisture regimes have been simplified into, 'Aquatic', 'Riparian' and 'Other' categories. 'Aquatic' refers to areas that do not have moving water. 'Riparian' may include aquatic-riparian and hygrophilous-riparian areas. 'Other' includes 'Mesic' and 'Xeric' habitats.

APPENDIX 6.

LIST OF GIS DIGITAL DATA SETS UTILIZED IN THE STUDY

GIS Digital Data sets Acquired

Database Name	Description	Method and scale of capture	Date of capture	Source of data / acknowledgment	Use in dissertation
Topographic map images	2930 AA Weston, 2930 AB Mount Alida, 2930 AC Howick, 2930 AD Albert Falls.	Scanned 1:50 000 topographic maps	Topographic maps compiled in 1989	Maps published by Chief Directorate: Surveys and Land Information, Mowbray, Cape Town. Maps scanned by Data World, Durban, for Indlovu Regional Council, Pietermaritzburg.	Figure 2.2.
Contours	Contours for topographic maps; 2930 AA Weston, 2930 AB Mount Alida, 2930 AC Howick, 2930 AD Albert Falls.			Chief Directorate: Surveys and Land Information, Mowbray, Cape Town.	Figure 2.3.
Rivers	Karkloof catchment clipped from Indlovu Regional Council dataset.	On-screen digitizing over 1:50 000 scanned topographic maps	1995	Umgeni Water, Pietermaritzburg.	Figure 2.4.
Crop potential, showing Bioresource Units.	Karkloof catchment clipped from Indlovu Regional Council dataset.	Digitized from overlays over 1:50 000 topographic maps.		KwaZulu-Natal Dept. of Agriculture, Natural Resource Section, Cedara, Pietermaritzburg.	Figure 2.5.
Agricultural potential, showing rainfall and temperature.	Karkloof catchment clipped from Indlovu Regional Council dataset.	Digitized from overlays over 1:50 000 topographic maps.		KwaZulu-Natal Dept. of Agriculture, natural Resource Section, Cedara, Pietermaritzburg.	Figure 2.6. Figure 2.7.

GIS Digital Data sets Acquired

Database Name	Description	Method and scale of capture	Date of capture	Source of data / acknowledgment	Use in dissertation
Vegetation (Low & Rebelo 1996)	Karkloof catchment clipped form South African dataset.	Forest Biome - 1:250 000 and 1:50 000. Grassland Biome - 1:1000 000	1996	Department of Environmental affairs and Tourism.	Figure 2.8.
Cadastral Boundaries - 1999	Property ownership and extents.		Original capture 1998, updated in 1999 by iNdlovu Regional Council. Only details on properties and property ownership added.	Indlovu Regional Council, amended from 1998 cadastral boundary dataset, attained from Surveyor-General, Pietermaritzburg.	Figure 4.22. and used as a base on which to create Figure 4.21.

APPENDIX 7.

LIST OF INTERVIEWEES CONSULTED AND WORKSHOPS ATTENDED

Interviewees

Name	Farm Name and Contact Details	Current Land Use and Ownership Dates	Date Interviewed
Dr Pat Coleby, Mrs P. Coleby and Mr Arthur Coleby	Sherwood and Clipstone P.O.Box 182, Nottingham Road, 3280 Tel: (033) 263 6922 H/W - Sherwood Tel: (0333) 306 998 H - Weltevreden	Beef farming on grasslands. Some timber plantations. Property acquired by family in 1850.	8/10/1998 10/6/1999
Mr Tony Matchett (Farm manager for Mr Mike Benson)	Shannon, Connemara, Tullamore, Mbetchaleni and The Wedge P.O.Box 1055, Howick, 3290 Tel: (0333) 302 525 H/W Fax: (0333) 302 391 W	Dairy pastures, cultivation, timber plantations and pig farming. First property acquired in 1967.	6/11/1998
Mr Brian, Walter and Bruce MacKenzie	Hawkstone, Glenord and Cockpen P.O.Box 174, Howick, 3290 Tel: (0333) 306 011 H (Walter) Tel: (0333) 302 733 H (Bruce) Tel: (0333) 302 063 W Fax: (0333) 302 063 W e-mail: mackfarm@pmb.lia.net	Cultivation, dairy pastures and timber plantations. Property owned by the family for the past 120 years.	11/11/1998
Mr Rene Stubbs	Denleigh P.O.Box 658, Howick, 3290 Tel: (0333) 304 602 H Tel: (0333) 302 822 W Fax: (0333) 304 602 W e-mail: denleigh@pmb.lia.net	Cultivation, dairy pastures and timber plantations. Acquired property in 1986.	11/11/1998
Mr Peter Burdon	The Forest P.O.Box 389, Howick, 3290 Tel: (0333) 302 740 H / W	Timber plantations, some cattle and conservation of indigenous forest. Property owned by the family since 1902.	12/11/1998

Name	Farm Name and Contact Details	Current Land Use and Ownership Dates	Date Interviewed
Mr Miles Hunt	Leopard's Bush P.O.Box 185, Howick, 3290 Tel: (0333) 302 643 H / W Fax: (0333) 302 643 H e-mail: hunt@intekom.co.za	Tourist accommodation and conservation of indigenous forest. Property acquired in 1990.	18/11/1998
Mr Charlie MacGillivray	Gartmore P.O. Box 178, Howick, 3290 Tel: (0333) 302 651 H Tel: (0333) 302 623 W Fax: (0333) 302 623 W Cel: 082 809 2590 e-mail: gartmore@pmb.lia.net	Cultivation and Dairy pastures. First property acquired in 1963.	18/11/1998
Mrs Penny Shaw	Former owner of Colbourne and Tullamore P.O.Box 705, Howick, 3290 Tel: (0333) 303 782 H / W Cel: 082 785 9275	Timber plantations, some pastures. Cut hay for live stock. Properties owned by the Shaw family since 1900. Penny came to live at Colbourne in 1970. Sold properties in 1984 & 1990.	18/11/1998
Mr Peter Train	Gala P.O.Box 180, Howick, 3290 Tel: (0333) 302 332 H / W Fax (0333) 303 332 W Cel: 082 822 5746 e-mail: gala@pixie.co.za	Mainly dairy pastures. Some timber plantations and limited cultivation. First property acquired in 1961.	19/11/1998
Mr Austin Symons	P.O.Box 954, Howick, 3290 Tel: (0333) 305 380 H Tel: (0333) 302 711 (son-Billy)	Wattle plantations. Father, Rodin purchased Shafton in 1914, sold to Sappi in 1958.	9/12/1998
KwaZulu-Natal Nature Conservation Services Mr Gavin Shaw Mr Paul Harrison	Karkloof Nature Reserve Mr Gavin Shaw P.O. Box 481, Merrivale, 3291 Tel: (0333) 307 097 H / W Fax: (0333) 307 097	Conservation of indigenous forest and grasslands. Properties acquired in 1984 and 1986.	19/11/1998

Name	Farm Name and Contact Details	Current Land Use and Ownership Dates	Date Interviewed
Dr Ian Player	PhuzaMoya P.O.Box 192, Howick, 3290 Tel: (0333) 302 727 H Tel: (031) 462 2808 W Fax: (031) 462 4656 W	Cattle on grasslands and residential. Acquired property in 1969.	21/11/1998
Mr and Mrs Peter Goble	Triandra P.O.Box 1287, Howick, 3290 Tel: (0333) 304 590 H Tel: (0333) 304 971 W Fax: (0333) 304 590 H	Dairy pastures, cultivation and timber plantations. Acquired property in 1995.	26/11/1998
Mr and Mrs Glen Boyd	BenEden P.O.Box 231, Howick, 3290 Tel: (0333) 302 628 H Tel: (031) 701 7274 W Fax: (031) 709 2044 W	Cattle, residential and conservation of indigenous forest. Acquired first property in 1988.	28/11/98
Mr Nic Hancock	Aldora P.O.Box 943, Durban, 4000 Tel: (031) 466 4001 H Tel: (031) 304 2811 W Fax: (031) 304 0804 W e-mail: nhancock@iafrica.com	Dairy pastures, cultivation, Nguni cattle and timber plantations.	2/12/1998
Mrs Joan Hancock	Spitzkop Farm / The Cottage / Rockwood P.O.Box 309, Howick, 3290 Tel: (0333) 302 603 H	Dairy pastures, cultivation, Cattle, timber plantations, conservation of indigenous forests. Came to live on 'Spitzkop' farm in 1952.	2/12/1998
Mr Kevin Lang	Fairfield Farm / Wintersun Farm P.O.Box 802, Howick, 3290 Tel: (0333) 303 754 H Tel: (0333) 304 757 W Fax: (0333) 304 757 W	Dairy pastures. First property acquired in 1987.	4/12/1998

Name	Farm Name and Contact Details	Current Land Use and Ownership Dates	Date Interviewed
Sappi Forests (Pty) Ltd Leander Jarvel (Environmental Manager KwaZulu-Natal) Colin Boake (Long time employee)	P.O.Box 13124, Cascades, 3202 Tel: (0333) 47 3666 W Tel: (0333) 306 225 H Fax: (0333) 47 3541W Cel: 083 631 4350 e-mail: leanderj@za.sappi.com Tel: (0333) 47 3666 W Fax: (0333) 47 3541W	Timber plantations. Libanon and De Magtenburg acquired in 1993. Shafton acquired in 1958.	28/5/1999
Mondi Don Alborough (Been with Mondi since the early 1970's) Ricky Pott (Environmental Manager)	P.O.Box 39, Pietermaritzburg, 3200 Tel: (033) 897 4066 W Fax: (033) 94 6313 W	Timber plantations. Gilboa properties acquired between 1975 and 1980. Tetworth properties acquired in 1980 and 1989.	27/5/1999

Workshops Attended

Workshop Name	Place	Date
Karkloof Conservancy launch	Karkloof Recreational Club	28/11/1997
Karkloof Catchment Management Forum launch	Umgeni Valley	12/5/1998
Karkloof Catchment Management Forum meeting	Karkloof Recreational Club	1/7/1998
Albert Falls Management Unit of the Mgeni Catchment - Core Steering Group meeting	Umgeni Water	4/2/1998
Albert Falls Management Unit of the Mgeni Catchment - Core Steering Group meeting	Umgeni Water	1/4/1998
Albert Falls Management Unit of the Mgeni Catchment - Core Steering Group meeting	Umgeni Water	18/6/1999

APPENDIX 8.

QUESTIONNAIRE SUBMITTED TO INTERVIEWEES

Background to the Study and purpose of the questionnaire

A research study, which forms part of the academic requirement of a Masters' degree, is currently being undertaken by Vanessa Weyer, a Master's student in the School of Environment and Development, University of Natal, Pietermaritzburg.

The aim of the study is to examine changes in land-use and land management in the Karkloof River Catchment between 1944 and 1998.

It is hoped that from this research changes in land-use and management may be quantified and that a socio-economic understanding may be attained as to why these changes have occurred and how land may be used and managed in the future for the betterment of society.

Base data attained from this study shall be utilized by the newly formed; Karkloof River Catchment Management Forum and the Karkloof Conservancy. This data could assist in the formulation of future land-use plans or conservation projects which may be undertaken by the Forum or Conservancy.

Your assistance in answering questions contained in the questionnaire will be of valuable assistance to the study, particularly in 'painting a picture' of what the catchment was like in 1944, what it is today and what makes it 'tick'.

Date: _____

Name: _____

_____

Postal address: _____

_____

Telephone no.: _____ *(W)* _____ *(H)*

Fax no.: _____

e-mail address.: _____

1. Changes in land ownership and property size from 1944 - 1996

(To be answered by all respondents)

1.1 Name of farm / property: _____

1.2 Property description (eg. Rem. of Sub 1 of Libanon):

_____

_____

_____

1.3 Title deed (eg. 82/20129): _____

1.4 Grant no. (eg. 14388): _____

1.5 Size of farm / property in hectares: _____

_____

1.6 On what date was the property acquired ?: _____

1.7 From who was the property acquired ?: _____

_____

_____

2. *Changes in selected land management methods from 1944 - 1998*

(To be answered by respondents where applicable)

2.1 Timber Plantations

2.1.1 Are/were the timber plantations easily accessible for harvesting and maintenance ?:

_____

_____

_____

_____

2.1.2 Are/were the timber plantations located on any marginal sites (steep land, edges of cliffs, directly adjacent to indigenous vegetation, shallow soils, dry aspects, drainage lines, streams and wetlands) ?:

_____

_____

_____

_____

2.1.3 What timber plantation tree species are/were planted and do any of these species have a tendency to invade surrounding areas, if so which species ?:

_____

_____

_____

_____

2.1.4 How is/was encroachment of alien plant species, into surrounding areas prevented ?:

2.1.5 How is/was weed infestation of felled areas prevented ?:

2.1.6 What type of landuse did timber plantations replace?:

2.2 Fire Management / Control

2.2.1 Do fire breaks generally follow features such as ridges, cliffs, roads, rivers etc. ?:

2.2.2 How is/was the firebreak cleared (mowing, slashing, burning or chemical use) ?:

2.2.3 How frequently are/were fire breaks burnt ?:

2.3 Grassland management

2.3.1 What is/was the general condition of the grasslands in terms of grazing quality ?:

2.3.2 How often are/were grassland areas burnt ?:

2.3.3 What type(s) and numbers of animals graze/grazed the grassland areas ?:

2.3.4 Were there/are there any significant eroded areas ? If so, what in your opinion is the cause of the erosion, have some of these eroded areas improved over time ?:

2.4 General Cultivation

2.4.1 Are/were cultivated fields located on any marginal sites (steep land, directly adjacent to indigenous vegetation, shallow soils, dry aspects, streams and wetlands) ?:

2.4.2 How is/was weed infestation of fallow land areas prevented ?:

2.4.3 How is/was erosion of fallow land prevented ?:

2.5 Farm Labor

2.5.1 Where do/did farm labor live ?:

2.5.2 If farm labor is living/lived on the property what farming/subsistence activities are/were undertaken ?:

3. *Current extent and presence of invasive alien vegetation*

(To be answered by all respondents)

3.1 State current location and extent of invasive alien vegetation on the property:

_____

_____

_____

_____

_____

3.2 What management methods are used to clear alien vegetation ?:

_____

_____

_____

4. *Alien vegetation invasion and it's relationship to changes in land-use and management*

(To be answered by all respondents)

4.1 When did you first notice the encroachment of alien vegetation, were any species in particular noticeable, if so what were they ?:

_____

_____

_____

_____

4.2 Can the encroachment of alien vegetation be related to any changes in land-use or land management that may have taken place on the property ?:

_____

_____

_____

4.3 How quickly did the alien vegetation spread; rapidly, moderately or slowly ?:

5. *Future planning and management of the catchment*

(To be answered by all respondents)

5.1 How do you see your involvement in the future planning and management of the catchment ?:

6. *Other comments*

APPENDIX 9.

LAND OWNERSHIP IN 1944 AND 1999

Land Ownership and Property Size in the Karkloof Catchment in 1944

Note: Area shown in square meters. Perimeter shown in meters

Identity	Property Name	Grant No.	Owner Name	Date Acquired	Sub. No.	Registered Area	Owner Type	Area	Perimeter
1	Spitzkop	970	Bryan Symons	22/12/1943-1953	Rem (of Rem)		Private - individuals	9380747.776	14946.302
2	Stocklands & Oatlands	878	Frank Chapman	13/10/1919-1946	Sub 14	83 Acres	Private - individuals	347017.583	2911.303
3	Mooigepierd	910	H.J.M.Mackenzie	7/9/1891-1962	Sub 4 (of Rem)		Private - individuals	1019988.732	4728.440
4	Halliwell	924	Kate Parkinson	21/10/1910 & 5/12/1934	Sub 1		Private - individuals	2133688.636	6183.517
5	Halliwell	924	Robert Armstrong	12/6/1937-1956	Sub E		Private - individuals	643420.552	3327.318
6	Halliwell	924	Walter David	17/5/1944	Sub 13 (of 5)		Private - individuals	92753.300	1305.164
7	Weltevreden	946	Eric Greene	24/11/1926-1955	Sub 4	1555 Acres	Private - individuals	6256441.638	10791.829
8	Spitzkop	970	Arthur Taynton	19/11/1917-1950	Sub 3	681 Acres	Private - individuals	2726702.744	6945.651
9	Spitzkop	970	Frederick Taynton	12/8/1939-1964	Sub 5	421 Acres	Private - individuals	1698055.971	5693.575
10	De Magtenburg	985	Robert Logan	18/3/1943	Sub 11(of 3)		Private - individuals	699321.771	3391.534
11	Shafton	1014	William Morris Sutton	29/7/1954	Rem		Private - individuals	3807277.697	8090.134
12	Shafton	1014	Kate Parkinson	25/1/1910 & 5/12/1934-1974	Sub 2	200 Acres	Private - individuals	854498.636	4881.926
13	Shafton	1014	Church of England	5/11/1867	Sub 3 (of 1)	5 Acres	Religious	20238.926	569.071
14	Shafton	1014	Edwin Parkinson	13/1/1893-1981	Sub 13 (of 1)	14 Acres	Private - individuals	63428.129	1596.922
15	Shafton	1014	H.J.M.Mackenzie	27/2/1911	Sub A (of12of11)		Private - individuals	15455.619	726.207
16	Vlak Hoek	1371	Walter Thomas Shaw	1864-1946	Rem		Private - individuals	4726950.890	10039.164
17	Belvidere	1405	Alfred Gower Shaw	8/8/1910-1949	Rem		Private - individuals	3480309.682	10658.242
18	Belvidere	1405	Robert B. Fyfe	16/6/1933-1953	Sub 2/Sub Gala		Private - individuals	2557272.571	7192.102
19	Belvidere	1405	Peter Burdon	6/9/1901-1949	Sub Luggath of 1		Private - individuals	1283527.934	5432.843
20	Belvidere	1405	Alfred Gower Shaw	3/8/1910-1946	Rem (of 1)		Private - individuals	1230150.566	5939.945
21	Lot 67	1465	Union Government	6/7/1939-1971	Sub 2	141 Acres	State - Union Government	519888.691	2945.667
22	Thomasville	2120	Frank Curry	5/11/1920-1947	Sub 4		Private - individuals	338026.312	2400.025
23	Talavera	2157	J.Geekie	23/11/1925-1951	Benvie (of 1)	250 Acres	Private - individuals	576371.291	4351.994
24	Talavera	2157	Campbell Gower Shaw	6/8/1931-1948	Sturton (of 1)	582 Acres	Private - individuals	2093593.503	6977.774
25	Talavera	2157	J.Geekie	23/11/1925-1951	Rem (of 1)		Private - individuals	936981.485	4917.799
26	Mansfield	2373	Catherine Fanx	16/10/1941-1951	Sub 1		Private - individuals	1013689.979	5280.486
27	Middle Draai	4129	William A. Strapp	10/9/1915-1948	Sub 1	139 Acres	Private - individuals	553999.338	3672.790
28	Middle Draai	4129	Mary J. Shaw	2/10/1915-1963	Sub 2	814 Acres	Private - individuals	3336244.030	8705.657
29	Dartmoor	5093	Durand P. Menne	6/8/1931	Whole	2000 Acres	Private - individuals	8209486.473	12199.734
30	Friar Tuck	6046	Samual Bathalomew	31/10/1902-1951	Whole	331 Acres	Private - individuals	1345174.252	5477.547
31	Mountain View	6444	Est. Walter J.Marshall	22/5/1908	Whole	40 Acres	Private - individuals	177213.574	4015.267
32	Lot R7	7148	John and Thomas Anderson	30/8/1907-1945	Whole		Private - individuals	447969.058	3343.327
33	Avondale	7631	Edith E. Michel-Smith	12/6/1944-1972	Sub 1		Private - individuals	29368.592	1124.668
34	Melmoth	7673	Charles Barlow	22/7/1944	Whole		Private - individuals	7894807.023	11487.438
35	The Peak	2181	Sydney Marshall Smith	13/31913-1971	Whole	1478 Acres	Private - individuals	6834227.882	11173.322
36	Middle Draai	4129	Johannes Boshoff	20/5/1925-1972	Sub 3	228 Acres	Private - individuals	956623.947	5088.798
37	Spitzkop	970	Alfred Taynton	12/8/1939-1964	Sub 4	539 Acres	Private - individuals	2112888.336	6022.801
38	Mount West	3152	Ellen Smith	24/4/1926-1971	Sub 1		Private - individuals	2401176.362	7193.825
39	Talavera	2157	Hubert William Shaw	9/8/1905-1951	Rem	424 Acres	Private - individuals	1435536.098	5967.282

Land Ownership and Property Size in the Karkloof Catchment in 1944 continued

Note: Area shown in square meters. Perimeter shown in meters

Identity	Property Name	Grant No.	Owner Name	Date Acquired	Sub. No.	Registered Area	Owner Type	Area	Perimeter
40	Talavera	2157	Hubert William Shaw	9/8/1905-1951	Sub 2	352 Acres	Private - individuals	1216929.843	5333.982
41	Weltevreden	946	Frank Curry	8/11/1895-1948	Sub 3	730 Acres	Private - individuals	6446839.828	11670.445
42	Weltevreden	946	Mary Ethel Morton	5/6/1931-1964	Sub 1	1705 Acres	Private - individuals	6691912.260	11423.301
43	Weltevreden	946	Mary Ethel Morton	5/6/1931-1964	Sub 5	65 Acres	Private - individuals	811694.869	4426.634
44	Weltevreden	946	W.F.Morton and Mary Morton	10/12/1896 and 5/6/1931-64	Sub 1 and Rem	1229 Acres	Private - individuals	4349067.369	9697.579
45	Vlak Hoek	1371	Campbell Gower Shaw	8/8/1910-1948	Sub Braco/Sub 1		Private - individuals	15457989.013	15599.771
46	Middle Draai	4129	Susanna & Johanna Lotter	19/10/1927-1956	Sub 4	972 Acres	Private - individuals	4152857.375	9950.599
47	Welgevonden	969	Walter Joseph Gower Shaw	8/8/1910-1957	Rem	3007 Acres	Private - individuals	12235579.270	15141.882
48	Welgevonden	969	Joseph Edward Gower Shaw	8/8/1910-1948	Sub 1	3026 Acres	Private - individuals	12238264.578	17414.084
49	Spitzkop	970	Susanna & Johanna Lotter	19/10/1927	Sub A/1 (of1)	59 Acres	Private - individuals	260621.421	3274.077
50	Spitzkop	970	William A. Strapp	9/3/1907-1948	Rem (of 1)	1008 Acres	Private - individuals	4068369.749	8534.697
51	Spitzkop	970	Alfred Taynton	28/8/1919-1964	Sub 2	482 Acres	Private - individuals	2011566.521	6147.900
52	Kar Kloof	1866	Kenneth McAlister McKellar	30/5/1944	Sub 1	800 Acres	Private - individuals	3232171.251	7581.747
53	Kar Kloof	1866	Will of Niel McKellar Snr.	7/7/1934-1971	Rem	1403 Acres	Private - individuals	5816173.957	10810.812
54	De Magtenburg	985	Hannah Anderson	18/3/1943	Rem (of 3)		Private - individuals	1949432.056	5953.043
55	De Magtenburg	985	Ethel Smith	28/7/1941-1951	Sub A (of 3)		Private - individuals	2671431.477	7033.917
56	De Magtenburg	985	Hannah Anderson	18/3/1943-1958	Sub 4		Private - individuals	4425605.186	10457.046
57	De Magtenburg	985	Frances E. Brewitt	8/3/1941-1962	Sub 6		Private - individuals	1358815.145	5168.389
58	De Magtenburg	985	Frances E. Brewitt	8/3/1941-1962	Sub 9(of 7 of 1)		Private - individuals	392225.625	3129.328
59	De Magtenburg	985	Mary Ethel Morton	5/6/1931-1964	Sub 5		Private - individuals	2936050.078	8057.264
60	De Magtenburg	985	Mary Ethel Morton	6/6/1931-1964	Rem (of 7 of 1)		Private - individuals	4103139.103	8582.272
61	De Magtenburg	985	Frank Curry	7/7/1904-1948	Rem (of 1)		Private - individuals	1200442.437	6161.573
62	De Magtenburg	985	Frank Curry	7/7/1904-1948	Sub 8(of 7 of 1)		Private - individuals	396482.417	5488.943
63	Twee Fontein	3293	Eva Woods	26/11/1942	Rem		Private - individuals	1265864.302	5549.652
64	Twee Fontein	3293	Anna Boshoff	17/3/1923-1973	Sub 3		Private - individuals	2967781.716	8406.551
65	Scawby	4211	Est. Walter Marshall	22/5/1908-1951	Rem (of 1)		Private - individuals	3746449.573	7756.140
66	Scawby	4211	Est. Walter Marshall	22/5/1908-1951	Rem (of Rem)		Private - individuals	1616763.829	7637.676
67	Shafton	1014	Eric Greene	24/1/1926-1955	Rem (of12of11)		Private - individuals	1234910.944	6729.434
68	Mooigepierd	910	Eric Greene	24/11/1926-1955	Rem (of Rem)		Private - individuals	6147352.933	10415.452
69	Mooigepierd	910	H.J.M.Mackenzie	7/9/1891-1962	Rem (of 2)		Private - individuals	4094661.420	10603.940
70	Mooigepierd	910	William G. Mackenzie	16/6/1936-1945	Sub A (of 2)		Private - individuals	4180292.703	9334.251
71	Mooigepierd	910	Eric Greene	24/11/1921-1955	Sub 1		Private - individuals	7948308.577	12924.802
72	Enfin	2980	Cecil Moore	26/9/1939-1947	Whole		Private - individuals	6093315.669	10402.227
73	Mount West	3152	Howard Gazzard	25/10/1935-1951	Rem		Private - individuals	8686457.057	13233.689
74	Shooters Hill	908	Cyril Otto	5/1/1926-1957	Sub 1		Private - individuals	10518116.454	15729.709
75	Roodespruit	960	Robert B. Fyfe	14/12/1920-1953	Sub 5		Private - individuals	697512.499	3738.088
76	Roodespruit	960	Peter Burdon	6/9/1901-1949	Rem (of Rem)		Private - individuals	3037696.648	8833.071
77	Nooitgedacht	1149	J.Geekie	23/1/1925-1951	Sub 3		Private - individuals	13588890.953	18292.486
78	Nooitgedacht	1149	Helen Train	16/2/1943	Sub 11 (of 4)		Private - individuals	2565541.798	9016.164

Land Ownership and Property Size in the Karkloof Catchment in 1944 continued

Note: Area shown in square meters. Perimeter shown in meters

Identity	Property Name	Grant No.	Owner Name	Date Acquired	Sub. No.	Registered Area	Owner Type	Area	Perimeter
79	Nooitgedacht	1149	Helen Train	16/2/1943	The Exchange		Private - individuals	89197.455	1852.681
80	Nooitgedacht	1149	Hubert William Shaw	9/8/1905-1951	Rem		Private - individuals	5269172.150	9072.175
81	Everdon	981	William H.Sutton	5/6/1891	Sub 3	2000 Acres	Private - individuals	7808230.020	14592.078
82	Everdon	981	William H.Sutton	28/3/1914	Sub 4	1000 Acres	Private - individuals	4120633.616	14316.615
83	Everdon	981	Morris A. Sutton	5/6/1891-1954	Sub 2	1000 Acres	Private - individuals	4175922.805	9223.949
84	Everdon	981	Chervington Sutton	1/2/1937-1952	Rem		Private - individuals	5082378.524	10332.813
85	Balmoral	1375	William Deane	28/8/1939-1952	Sub 10		Private - individuals	2382896.434	10402.009
86	Balmoral	1375	William Deane	5/10/1900	Sub 4 (of Rem)		Private - individuals	3008254.121	8895.688
87	Balmoral	1375	Donald Cockburn	28/9/1940-1948	Rem (of 5)		Private - individuals	3763755.893	8832.611
88	Balmoral	1375	Grey Norton	19/5/1939	Sub 1		Private - individuals	6502808.446	14375.389
89	Epworth	2204	Union Government	19/11/1923-1951	Sub 1		State - Union Government	3636083.503	10133.891
90	Sherwood Forest	2077	Mary Ethel Morton	5/6/1931-1964	Sub1	693 Acres	Private - individuals	2811173.651	7507.701
91	Sherwood	2173	Mary Ethel Morton	5/6/1931-1964	Rem	2371 Acres	Private - individuals	9628099.957	12374.880
92	Sherwood	2173	Frances E. Brewitt	8/3/1941-1962	Sub 1	693 Acres	Private - individuals	2779806.628	8063.568
93	Sherwood Forest	2077	Frances E. Brewitt	8/3/1941-1962	Rem	2303 Acres	Private - individuals	9131245.011	14597.518
94	Freestone Ridge	2979	Trust S.M.Smith, E.N.Tennant	31/10/1908-1948	Whole	3040 Acres	Private - Trusts/trustees	11650634.826	14377.805
95	Mansfield	2373	Victor W. Greene	16/10/1941	Rem		Private - individuals	12606980.702	16306.061
96	Lot 53	1817	Robert B. Fyfe	16/6/1933-1959	Whole		Private - individuals	10508501.392	13050.004
97	Glenaruel	13096	Ruth Iris Forsyth	17/6/1942-1966	Rem		Private - individuals	1629522.069	5996.666
98	Thomasville	2120	Frank Curry	5/11/1920-1947	Sub X (of 1)		Private - individuals	185420.876	2103.556
99	Thomasville	2120	Frank Curry	18/11/1912-1947	Rem (of 1)		Private - individuals	282314.799	2288.093
100	Thomasville	2120	Frank Curry	18/11/1912-1947	Sub 2		Private - individuals	676368.911	3438.460
101	Thomasville	2120	Frank Curry	18/11/1912-1947	Sub 6		Private - individuals	1046470.466	5199.588
102	Thomasville	2120	Willoghby Methley	8/11/1917-1955	Sub 5		Private - individuals	269715.799	2257.599
103	Halliwell	924	Arthur Taynton	19/11/1917-1950	Sub 2		Private - individuals	2079605.113	5900.263
104	Halliwell	924	Union Government	21/10/1930-1951	Sub 11 (of 4)		State - Union Government	4413065.443	9570.678
105	Halliwell	924	Robert Armstrong	17/8/1938-1949	Sub 12 (of 4)		Private - individuals	5027707.511	9841.808
106	Halliwell	924	Charles Mullins	17/5/1944	Sub 14 (of 5)		Private - individuals	774580.620	3651.529
107	Halliwell	924	Morris Adlard Sutton	18/11/1903-1954	Sub 6		Private - individuals	179391.107	3472.508
108	Halliwell	924	James Buchanan	5/11/1912-1953	Sub 7		Private - individuals	1441036.736	5000.224
109	Halliwell	924	James Buchanan	8/8/1912-1953	Rem (of 5)		Private - individuals	1594666.138	7709.256
110	Halliwell	924	James Buchanan	6/5/1934-1953	Sub 8		Private - individuals	2615714.503	6906.830
111	Halliwell	924	Robert Armstrong	12/6/1937-1957	Sub 9		Private - individuals	4468955.080	10192.276
112	Halliwell	924	Harry Collins	25/8/1928-1947	Rem		Private - individuals	6204360.541	12303.351
113	Lot 67	1465	Union Government	6/7/1939-1971	Sub 1	306 Acres	State - Union Government	1272999.986	4625.948
114	Lot 67	1465	H & C Taylor	5/11/1940-1946	Sub 5	188 Acres	Private - individuals	883533.996	4313.438
115	Lot 67	1465	H & C Taylor	5/11/1940-1946	Sub 3	235 Acres	Private - individuals	1080112.314	4709.317
116	Lot 67	1465	H & C Taylor	5/11/1940-1946	Sub 4	258 Acres	Private - individuals	1517767.307	5370.842
117	Lot 67	1465	H & C Taylor	5/11/1940-1946	Sub 6	70 Acres	Private - individuals	200405.703	2266.855

Land Ownership and Property Size in the Karkloof Catchment in 1944 continued
Note: Area shown in square meters. Perimeter shown in meters

Identity	Property Name	Grant No.	Owner Name	Date Acquired	Sub. No.	Registered Area	Owner Type	Area	Perimeter
118	Lot 67	1465	H & C Taylor	5/11/1940-1946	Sub 7	94 Acres	Private - individuals	148984.077	1565.727
119	Lot 67	1465	H & C Taylor	5/11/1940-1946	Sub 8	141 Acres	Private - individuals	279253.516	2147.188
120	Lot 67	1465	H & C Taylor	5/11/1940-1946	Sub 9	47 Acres	Private - individuals	91989.047	1314.395
121	Lot 67	1465	H & C Taylor	5/11/1940-1946	Sub 10	47 Acres	Private - individuals	132744.814	1479.302
122	Lot 67	1465	H & C Taylor	5/11/1940-1946	Sub 32	28 Acres	Private - individuals	145333.484	1565.511
123	Lot 67	1465	David Buntting	31/1/1927-1959	Sub 31	22 Acres	Private - individuals	69012.792	1213.941
124	Lot 67	1465	David Buntting	31/1/1927-1959	Sub 11	47 Acres	Private - individuals	168923.118	1751.199
125	Lot 67	1465	David Buntting	31/1/1927-1959	Sub 14	423 Acres	Private - individuals	1634896.693	5045.935
126	Lot 67	1465	David Buntting	31/1/1927-1959	Sub 15	94 Acres	Private - individuals	413087.356	2855.362
127	Lot 67	1465	David Buntting	31/1/1927-1959	Sub 12	94 Acres	Private - individuals	289309.285	2423.342
128	Lot 67	1465	David Buntting	31/1/1927-1959	Sub 13	94 Acres	Private - individuals	431726.745	3140.878
129	Lot 67	1465	Samual Stead	24/8/1883	Sub 16	141 Acreas	Private - individuals	515927.070	6404.411
130	Lot 67	1465	Samual Stead	28/11/1910	Sub 21	61 Acres	Private - individuals	252978.586	4169.832
131	Lot 67	1465	Samual Stead	28/11/1910	Sub 17	165 Acres	Private - individuals	734600.283	6550.228
132	Lot 67	1465	Samual Stead	28/11/1910	Sub 20	165 Acres	Private - individuals	501592.864	4606.205
133	Lot 67	1465	Samual Stead	15/4/1879	Sub 19	306 Acres	Private - individuals	1223491.399	5883.843
134	Lot 67	1465	Samual Stead	21/7/1880 & 26/7/1911	Sub 18	141 Acres	Private - individuals	778592.364	6104.121
135	Lot 67	1465	Unknown	Unknown	Rem	Unknown	Unknown	185259.189	3757.049
136	Lot 67	1465	Samual Stead	28/1/1910	Sub 22	47 Acres	Private - individuals	154524.991	3684.869
137	Lot 67	1465	Samual Stead	28/11/1910	Sub 23	47 Acres	Private - individuals	151969.329	3520.173
138	Lot 67	1465	Samual Stead	28/11/1910	Sub 24	352 Acres	Private - individuals	1144090.040	4829.110
139	Lot 67	1465	Samual Stead	26/7/1911	Sub 25	188 Acres	Private - individuals	1141271.056	4881.832
140	Lot 67	1465	G.Buntting	26/7/1911	Sub 26	47 Acres	Private - individuals	191850.647	3804.415
141	Lot 67	1465	S. Stead & D. Buntting	2/8/1882 & 13/1/1927-1959	Sub 27	94 Acres	Private - individuals	307330.049	3951.428
142	Lot 67	1465	G. Buntting	13/1/1927-1959	Sub 28	47 Acres	Private - individuals	303094.400	3963.864
143	Lot 67	1465	G. Buntting & D.Buntting	26/7/1911 & 31/1/1927-1959	Sub A&Rem (of29)	47 Acres	Private - individuals	304369.767	3984.250
144	Lot 67	1465	David Buntting	13/1/1927-1959	Sub A (of 30)	Sub 30 total 94 Acres	Private - individuals	99947.643	1536.065
145	Lot 67	1465	Samual Stead	28/11/1910	Rem (of 30)	Sub 30 total 94 Acres	Private - individuals	199508.608	2807.485
146	Shafton	1014	H.J.M.Mackenzie	12/1/1914-1962	Rem (of 5)	1643 Acres	Private - individuals	6710541.657	12318.028
147	Shafton	1014	Kate Parkinson	25/1/1910&5/12/1934-1963	Sub A/10 (of 5)	205 Acres	Private - individuals	811170.332	3726.946
148	Shafton	1014	P,R,B&J Symons,R.Clarke	7/5/1948-1953	Rem	503 Acres	Private - individuals	2059302.920	7281.378
149	Shafton	1014	Rodin Symons	10/4/1942-1955	Sub 8	11 Acres	Private - individuals	28769.605	689.510
150	Shafton	1014	Mary Anne Symons	31/3/1915-1949	Sub 4 (of 1)	200 Acres	Private - individuals	717953.134	3639.025
151	Shafton	1014	Mary Anne Symons	31/3/1915-1949	Sub 14 (of 1)	30 Acres	Private - individuals	143675.966	2939.543
152	Shafton	1014	P,R,B&J Symons,R.Clarke	7/5/1948	Sub 15 (of 1)	22 Acres	Private - individuals	69128.958	2175.413
153	Shafton	1014	Rodin Symons	10/4/1942	Sub 9	29 Acres	Private - individuals	132616.052	1785.839
154	Shafton	1014	P,R,B&J Symons,R.Clarke	7/5/1948-1952	Rem		Private - individuals	967115.511	6460.256
155	Shafton	1014	Rodin Symons	11/4/1942-1955	Sub 7	6 Acres	Private - individuals	51737.271	1632.473
156	Woodlands	876	Gweneth Mackenzie	20/12/1939	Rem (of 16)		Private - individuals	476590.662	3232.628

Land Ownership and Property Size in the Karkloof Catchment in 1944 continued
Note: Area shown in square meters. Perimeter shown in meters

Identity	Property Name	Grant No.	Owner Name	Date Acquired	Sub. No.	Registered Area	Owner Type	Area	Perimeter
157	Woodlands	876	James Tulley	5/12/1930-1967	Lot AA (of 16)	82 Acres	Private - individuals	284472.286	2488.655
158	Woodlands	876	James Tulley	5/12/1930-1967	Lot AA (of 17)	82 Acres	Private - individuals	224422.287	2354.696
159	Woodlands	876	Gweneth Mackenzie	20/12/1939	Rem (of 17)		Private - individuals	48020.482	1202.834
160	Woodlands	876	Frank Chapman	12/7/1941-1948	Sub 15/Outspan		Private - individuals	1368334.034	5395.408
161	Woodlands	876	Frank Chapman	3/10/1919-1946	Sub 11		Private - individuals	1667435.678	7250.486
162	Woodlands	876	James Tulley	5/12/1930-1967	Sub 6		Private - individuals	1423264.387	5579.624
163	Woodlands	876	Frederick Stedman	27/10/1927-1947	Sub 14		Private - individuals	2665991.390	8598.581
164	Stocklands & Oatlands	876	Gweneth Mackenzie	20/12/1939-1974	Sub 15	250 Acres	Private - individuals	1035755.176	4675.960
165	Stocklands & Oatlands	878	Charles Strapp	17/0/5/1904	Sub 17	816 Acresd	Private - individuals	3306670.036	7666.754
166	Stocklands & Oatlands	878	James Tulley	15/12/1930-1967	Sub 13	5 Acres	Private - individuals	24764.714	776.684
167	Stocklands & Oatlands	878	Gweneth Mackenzie	20/12/1939-1974	Sub 16	584 Acres	Private - individuals	2374795.740	6862.853
168	Stocklands & Oatlands	878	James Tulley	5/12/1930-1967	Sub 11	10 Acres	Private - individuals	16289.305	751.505
169	Stocklands & Oatlands	878	Mary Catchpole	25/6/1916-1956	Sub 18	487 Acres	Private - individuals	2025598.618	6811.643
170	Stocklands & Oatlands	878	James Tulley	5/12/1930-1967	Sub 12	19 Acres	Private - individuals	93382.641	1648.426
171	Stocklands & Oatlands	878	Mary Catchpole	15/10/1926-1956	Sub 22	484 Acres	Private - individuals	1957770.433	6564.168
172	Stocklands & Oatlands	878	Morris A. Sutton	18/11/1903	Sub 19	923 Acres	Private - individuals	3645661.108	8008.292
173	Stocklands & Oatlands	878	Charles & Henry Strapp	30/6/1892	Sub 20	535 Acres	Private - individuals	1835873.751	6244.637
174	Stocklands & Oatlands	878	H.Strapp, G&M.Sutton,N Hays	1892 , 1899&1903,1912	SubA&Rem(of21)	799 Acres	Private - individuals	2688437.979	9140.310
175	Stocklands & Oatlands	878	W.A.Strapp, Mervyn Galliers	1901-1948 & 1942-1947	SubA&Rem(of24)	628 Acres	Private - individuals	3604888.190	8355.242
176	Clarendon	923	Charles Barlow	31/8/1937-1946	Sub A	228 Acres	Private - individuals	1193408.739	5658.334
177	Clarendon	923	Alfred Gower Shaw	8/8/1910-1946	Rem	1254 Acres	Private - individuals	4809982.960	10548.175
178	Spitzkop	970	Alfred Taynton	12/8/1939-1964	Rem (of 6)	Total (of 6) 530 Acres	Private - individuals	1369830.871	5461.115
179	Spitzkop	970	Frederick Taynton	12/8/1939-1964	Sub 8 (of 6)	Total (of 6) 530 Acres	Private - individuals	749357.729	4577.334
180	Avondale	7631	Charles Mullins	12/6/1944-1952	Sub 2		Private - individuals	13954.830	490.238
181	Avondale	7631	William D. Buchanan	1/3/1940	Rem		Private - individuals	3341169.174	7500.012
182	Zeekoegat	883	Doreen M. Smythe	19/11/1940 & 1941-1968	Rem	2005 Acres	Private - individuals	7270697.640	18241.105
183	Zeekoegat	883	Eric Greene	24/2/1931-1972	Rem (of 1)	1232 Acres	Private - individuals	7016399.847	18713.371
184	Zeekoegat	883	Morris A. Sutton	29/10/1896-1954	Sub 2 (of 1)	445 Acres	Private - individuals	1200427.601	7715.349
185	Shafton	1014	P,R,B&JSymons & R. Acutt	8/12/1949	Rem		Private - individuals	2236008.477	11441.690
186	Shafton	1014	William Morris Sutton	29/7/1954	Rem		Private - individuals	2872166.469	11826.496
187	Shafton	1014	Fred W. Morton	27/2/1911-1962	Rem (of 11)		Private - individuals	2073889.172	9649.322
188	Yellow-wood	13732	Harrie and Robert Hall	19/10/1950	Whole		Private - individuals	9834845.471	15229.910
189	Thomasville	2120	Roderick Logan	6/12/1937-1947	Rem (of Rem)		Private - individuals	6759446.269	10384.639
190	De Magtenburg	985	Charles Taylor	5/11/1940-1946	Sub 2 (of 1)		Private - individuals	2188611.929	7462.956
191	Halliwell	924	John & Edward Parker	15/5/1882-1955/56/69	Rem (of Sub 4)		Private - individuals	5076752.974	9633.608

Land Ownership and Property Size in the Karkloof Catchment in 1999

Note: Area shown in square meters. Perimeter shown in meters

Identity	Property Name	Grant No.	Sub No.	Farm Name	Owner Type	Owner Name	Area	Perimeter
1	Spitz Kop	970	0		Private - individuals	Hancock	9380742.911	14946.300
2	Woodlands	876	16		Private - individuals	T.P.Chaplin	477470.100	3242.271
3	Woodlands	876	17		Private - individuals	G.C.Mackenzie	50122.398	1218.877
4	Woodlands	876	19		Sappi leased	Howick Plantations Pty Ltd	675490.019	4056.293
5	Woodlands	876	20		Private - individuals	D.W.Carpenter	128269.413	1570.482
6	Woodlands	876	31		Private - individuals	J.A.Snaith	223505.744	2440.701
7	Woodlands	876	58		Private - Inc.	Upnor International Inc	1535894.284	8862.565
8	Woodlands	876	60		Private - Trusts/trustees	Fairfield Trust	396333.701	3553.906
9	Woodlands	876	61		Private - individuals	J.F.Zuma	85127.877	1172.194
10	Stocklands & Oatlands	878	14		Sappi leased	Howick Plantations Pty Ltd	347017.949	2911.304
11	Stocklands & Oatlands	878	15		Private - individuals	T.P.Chaplin	721721.251	3858.558
12	Stocklands & Oatlands	878	16		Private - individuals	G.C.Mackenzie	2242580.675	6402.021
13	Stocklands & Oatlands	878	47		Private - individuals	R.M.Ainslie	66469.880	1042.231
14	Stocklands & Oatlands	878	48		Sappi	Sappi Manufacturing Pty Ltd	949425.039	4427.793
15	Stocklands & Oatlands	878	49		Sappi	Sappi Manufacturing Pty Ltd	645188.312	3700.316
16	Stocklands & Oatlands	878	54		Sappi	Sappi Manufacturing Pty Ltd	4860739.757	10273.901
17	Stocklands & Oatlands	878	55		Sappi	Sappi Manufacturing Pty Ltd	822894.915	5451.148
18	Stocklands & Oatlands	878	64		Sappi	Sappi Manufacturing Pty Ltd	3523403.716	8099.268
19	Stocklands & Oatlands	878	65		Sappi	Sappi Manufacturing Pty Ltd	335517.968	3390.931
20	Stocklands & Oatlands	878	73		Private - individuals	G.E.J.S.Stuart	496748.500	3714.470
21	Stocklands & Oatlands	878	74		Sappi	Sappi Manufacturing Pty Ltd	1881474.750	7073.139
22	Stocklands & Oatlands	878	80		Sappi	Sappi Manufacturing Pty Ltd	380571.936	2703.366
23	Stocklands & Oatlands	878	81		Sappi	Sappi Manufacturing Pty Ltd	388515.193	2878.922
24	Stocklands & Oatlands	878	82		Sappi	Sappi Manufacturing Pty Ltd	656089.961	3968.218
25	Stocklands & Oatlands	878	102		Private - CC	Anne's Farm Prop Inv CC	433298.722	2740.530
26	Stocklands & Oatlands	878	124		Private - individuals	M.S.Kelly	234644.646	2524.078
27	Shooters Hill	908	24		Private - Trusts/trustees	Shooters Hill Family Trust	5197902.821	13840.686
28	Shooters Hill	908	25		Private - Trusts/trustees	Morton Hill Family Trust	6983123.746	11439.442
29	Mooigepierd	910	3	Glenord	Private - Trusts/trustees	Cockpen Family Trust	4186874.822	9334.772
30	Mooigepierd	910	4		Private - Trusts/trustees	Hawkstone Family Trust	1019987.764	4728.440
31	Mooigepierd	910	5		Private - Trusts/trustees	Hawkstone Family Trust	42217.474	1200.997
32	Clarendon	923	0		Private - Administrators	D.I.Shaw - Administrator	4836610.959	10549.266
33	Clarendon	923	3		Private - Pty Ltd	Ehlateni Nature Reserve Pty Ltd	1166782.901	5635.710
34	Halliwell	924	0		Private - individuals	L.L.Hancock	3300817.555	9542.729
35	Halliwell	924	1		Private - Trusts/trustees	Nicholas Hancock Family Trust	2133688.636	6183.517
36	Halliwell	924	2		Private - Trusts/trustees	Goble Family Trust	1993800.383	5889.534
37	Halliwell	924	4		Private - Trusts/trustees	Fairfield Trust	1038051.929	4642.266
38	Halliwell	924	9		Private - Pty Ltd	Buckstone Pty Ltd	2440653.614	7384.938
39	Halliwell	924	10		Private - Pty Ltd	Buckstone Pty Ltd	643420.552	3327.318

Land Ownership and Property Size in the Karkloof Catchment in 1999 continued

Note: Area shown in square meters. Perimeter shown in meters

Identity	Property Name	Grant No.	Sub No.	Farm Name	Owner Type	Owner Name	Area	Perimeter
40	Halliwell	924	13		Private - individuals	M.M.A.Coetzer	92753.579	1305.165
41	Halliwell	924	16		Private - individuals	L.P.Arathoon	110970.886	1484.010
42	Halliwell	924	17		Private - individuals	A.J.Campbell	255308.557	2463.912
43	Halliwell	924	18		Private - individuals	A.J.Arathoon	85804.719	1313.227
44	Halliwell	924	28		Sappi	Sappi Manufacturing Pty Ltd	736737.125	4123.924
45	Halliwell	924	31		Private - individuals	D.J.Sykes	21503.971	1046.306
46	Halliwell	924	34		Private - individuals	J.N.Campbell	228137.639	2019.365
47	Halliwell	924	35		Private - individuals	J.N.Campbell	201104.758	2087.263
48	Halliwell	924	37		Private - CC	Abingdon Inv CC	516158.811	3590.918
49	Halliwell	924	38		Private - individuals	P.D.Beardsall	201437.633	2094.361
50	Halliwell	924	39		Private - individuals	J.H.Rust	204047.774	2085.996
51	Halliwell	924	40		Private - individuals	J.H.Rust	86683.365	1788.357
52	Halliwell	924	41		Private - individuals	J.B.Combrinck	201654.719	2103.623
53	Halliwell	924	42		Private - individuals	S.L.Reid	203343.990	2131.791
54	Halliwell	924	43		Private - individuals	B.D.Shaw	201116.572	1979.303
55	Halliwell	924	44		Private - individuals	D.J.Sykes	201602.591	1893.940
56	Halliwell	924	46		Private - Inc.	Anglo Scottish Trust & Finance	203104.367	1967.335
57	Halliwell	924	47		Private - individuals	D.G.Turvey	204839.956	1942.733
58	Halliwell	924	48		Private - individuals	P.H.Symons	255606.241	2314.443
59	Halliwell	924	49		Private - CC	Glucksheim Farm CC	353679.815	2552.520
60	Halliwell	924	50		Private - individuals	W.Austen.Symons	239218.639	2184.874
61	Halliwell	924	54		Private - individuals	R.E.Goetsch	825434.487	4000.855
62	Halliwell	924	55		Private - individuals	J.B.Combrinck	980784.127	4869.469
63	Halliwell	924	57		Private - CC	Building and Allied Trade Exhibition	904576.726	5389.435
64	Halliwell	924	63		Private - Trusts/trustees	Unsworth Security Trust	416888.323	2987.423
65	Halliwell	924	65		Private - individuals	C.A.Watkins	835430.514	4281.449
66	Halliwell	924	71		Private - Trusts/trustees	Fairfield Trust	1172170.432	4999.306
67	Halliwell	924	74		Mondi	Mondi Ltd	4059973.902	9991.346
68	Halliwell	924	75		Mondi	Mondi Ltd	6554741.353	17674.024
69	Halliwell	924	76		Private - Trusts/trustees	Fairfield Trust	897061.569	4524.885
70	Halliwell	924	78		Private - individuals	M.E.Nellist	320470.499	3465.936
71	Weltevreden	946	4	Clipstone	Private - individuals	Dr A.W.P.Coleby/PAL Traders Pty Ltd	6256444.185	10791.832
72	Weltevreden	946	7		Sappi	Sappi Manufacturing Pty Ltd	5563052.595	11056.401
73	Weltevreden	946	8		Private - individuals	I.C.Cawood	883802.066	4405.332
74	Roode Spruit	960	0	The Forest	Private - individuals	P.D.A.Burdon	1929844.970	7801.487
75	Welgevonden	969	0	Leopards Bush	Private - individuals	R.W.M.Hunt	3488378.279	8276.960
76	Welgevonden	969	1	Ben Eden	Private - individuals	G.W.Boyd	2920878.291	8257.751
77	Welgevonden	969	3		Private - individuals	F.Crooks	1424187.215	7419.026
78	Welgevonden	969	4		Private - individuals	M.D. O'Sullivan	400258.760	4051.096

Land Ownership and Property Size in the Karkloof Catchment in 1999 continued

Note: Area shown in square meters. Perimeter shown in meters

Identity	Property Name	Grant No.	Sub No.	Farm Name	Owner Type	Owner Name	Area	Perimeter
79	Welgevonden	969	6	Gartmore	Private - Pty Ltd	Gartmore Farm Pty Ltd	232357.377	2614.394
80	Welgevonden	969	9	Gartmore	Private - Pty Ltd	Gartmore Farm Pty Ltd	846244.252	4137.403
81	Welgevonden	969	10		Private - individuals	J. Meineke	178346.843	1888.563
82	Welgevonden	969	11	Gartmore	Private - Pty Ltd	Gartmore Farms Pty Ltd	3299540.891	8038.983
83	Welgevonden	969	12		Private - individuals	B.E.Raw	736849.413	5691.435
84	Welgevonden	969	14		Private - individuals	L.Botma	196287.354	2362.368
85	Welgevonden	969	15	Phuzamoya	Private - individuals	I.C.A.Player	226486.400	2074.814
86	Welgevonden	969	16	Phuzamoya	Private - individuals	I.C.A.Player	214149.831	1985.946
87	Welgevonden	969	17	Ben Eden	Private - individuals	G.W.Boyd	212010.790	1922.022
88	Welgevonden	969	18		Private - individuals	W.Raw	178514.223	1900.201
89	Welgevonden	969	20		Private - individuals	T.W.Goodwin	37394.396	889.063
90	Welgevonden	969	21		Private - individuals	P.A.Prince	932175.842	4524.549
91	Welgevonden	969	22	Tullamore	Private - Pty Ltd	Tulleymore Pty Ltd	3448428.963	7721.955
92	Welgevonden	969	23		Unknown	Unknown	161186.785	1710.691
93	Welgevonden	969	24		Private - Trusts/trustees	New Venture Trust	1525311.123	6805.624
94	Welgevonden	969	26	Indigenous Nurs	Private - individuals	Penny Shaw	36597.591	1014.939
95	Welgevonden	969	27	Colbourne	Private - individuals	P.G.Morphew	89657.523	1247.473
96	Welgevonden	969	28	Colbourne	Private - individuals	P.G.Morphew	3647204.399	13038.708
97	Welgevonden	969	33		Private - Trusts/trustees	Tree Fern Haven Family Trust	41408.532	1294.945
98	Spitz Kop	970	1		Private - individuals	T.J.Hancock	4328996.120	8683.185
99	Spitz Kop	970	3	Triandra	Private - Trusts/trustees	Goble Family Trust	2726702.744	6945.651
100	Spitz Kop	970	5	Mbecheleni	Private - Pty Ltd	Mbecheleni Pty Ltd	1698055.971	5693.575
101	Spitz Kop	970	8	Mbecheleni	Private - Pty Ltd	Mbecheleni Pty Ltd	760992.801	4574.241
102	Everdon	981	6		Sappi	Sappi Manufacturing Pty Ltd	201614.159	1842.711
103	Everdon	981	7		Sappi	Sappi Manufacturing Pty Ltd	20256.998	672.003
104	Everdon	981	12		Private - individuals	G.A.Warren	533859.840	4105.805
105	Everdon	981	13		Private - Pty Ltd	Hans Merensky Holdings Pty Ltd	7967335.963	13977.624
106	Everdon	981	20		Private - Trusts/trustees	Tara Trust	351208.534	2694.806
107	Everdon	981	21		Private - Trusts/trustees	Tara Trust	51157.199	1354.294
108	Geelhout Boom	982	38		Private - Pty Ltd	Geelhout Boom farming Pty Ltd	205973.478	1850.648
109	De Magtenburg	985	1		Sappi	Sappi Manufacturing Pty Ltd	1189268.841	6154.135
110	De Magtenburg	985	3		Sappi	Sappi Manufacturing Pty Ltd	1764522.109	5819.787
111	De Magtenburg	985	4		Sappi	Sappi Manufacturing Pty Ltd	2813235.185	8510.118
112	De Magtenburg	985	8		Sappi	Sappi Manufacturing Pty Ltd	407659.701	5500.063
113	De Magtenburg	985	11		Sappi	Sappi Manufacturing Pty Ltd	699321.731	3391.534
114	De Magtenburg	985	12		Sappi	Sappi Manufacturing Pty Ltd	184910.029	1791.004
115	De Magtenburg	985	13		Sappi	Sappi Manufacturing Pty Ltd	1612369.129	5414.957
116	De Magtenburg	985	14		Mondi	Mondi Ltd	224053.592	2208.693
117	De Magtenburg	985	15		Mondi	Mondi Ltd	226453.366	2097.759

Land Ownership and Property Size in the Karkloof Catchment in 1999 continued
Note: Area shown in square meters. Perimeter shown in meters

Identity	Property Name	Grant No.	Sub No.	Farm Name	Owner Type	Owner Name	Area	Perimeter
118	De Magtenburg	985	16		Mondi	Mondi Ltd	212542.928	2125.213
119	De Magtenburg	985	17		Mondi	Mondi Ltd	195039.669	2054.207
120	De Magtenburg	985	18		Mondi	Mondi Ltd	212400.718	2036.073
121	De Magtenburg	985	19		Mondi	Mondi Ltd	204349.071	1990.425
122	De Magtenburg	985	20		Mondi	Mondi Ltd	213447.527	2042.660
123	De Magtenburg	985	21		Mondi	Mondi Ltd	204578.129	2166.855
124	De Magtenburg	985	22		Mondi	Mondi Ltd	223615.897	2103.478
125	De Magtenburg	985	23		Mondi	Mondi Ltd	264647.328	2189.067
126	De Magtenburg	985	24		Mondi	Mondi Ltd	244533.171	2183.273
127	De Magtenburg	985	24		Mondi	Mondi Ltd	245768.983	2185.312
128	Shafton	1014	1		Sappi	Sappi Manufacturing Pty Ltd	3807281.679	8090.135
129	Shafton	1014	2		Private - Trusts/trustees	Nicholas Hancock Family Trust	854498.635	4881.927
130	Shafton	1014	3		Religious	Church of Province of SA	20239.077	569.073
131	Shafton	1014	5		Private - individuals	C.S.Mackenzie	6303532.810	12763.091
132	Shafton	1014	10		Private - CC	Electprops 1031 CC	494535.538	3154.569
133	Shafton	1014	11		Private - Trusts/trustees	Hawkstone Family Trust	2073891.530	9649.313
134	Shafton	1014	13		Private - individuals	M. Benson	63428.129	1596.922
135	Shafton	1014	17		Private - Trusts/trustees	Hawkstone Family Trust	15455.590	726.206
136	Shafton	1014	20		Private - Clubs	Karkloof Recreation Club	12562.090	460.053
137	Shafton	1014	21		Private - Clubs	Karkloof Recreation Club	20476.445	638.189
138	Shafton	1014	22		Sappi	Sappi Manufacturing Pty Ltd	268451.006	2321.025
139	Shafton	1014	24		Sappi	Sappi Manufacturing Pty Ltd	1226667.343	5207.797
140	Shafton	1014	26		Private - individuals	M.Benson	1149272.276	5810.140
141	Nooitgedacht	1149	3		Private - Pty Ltd	Benvie Pty Ltd	5087920.327	11092.228
142	Nooitgedacht	1149	15		Mondi	Mondi Ltd	1754450.735	6472.705
143	Vlak Hoek	1371	0		Private - Administrators	D.I.Shaw - Administrator	4726948.818	10039.163
144	Balmoral	1375	12		Mondi	Mondi Ltd	4559373.989	9926.443
145	Balmoral	1375	13		Mondi	Mondi Ltd	831807.026	4526.391
146	Balmoral	1375	16		Mondi	Mondi Ltd	1681237.638	5682.891
147	Belvidere	1405	0	The Forest	Private - individuals	P.D.A.Burdon	3480309.682	10658.242
148	Belvidere	1405	2	Gala	Private - Trusts/trustees	Gala Property Trust	2557272.551	7192.103
149	Belvidere	1405	3	The Forest	Private - individuals	P.D.A.Burdon	1283527.934	5432.843
150	Belvidere	1405	5	The Forest	Private - individuals	P.D.A.Burdon	1230150.566	5939.945
151	Lot 67	1465	34		Private - individuals	F.N.Scott	519888.708	2945.669
152	Lot 67	1465	42		Private - CC	Sherbourne farming CC	845495.426	4908.244
153	Lot 67	1465	43		Private - individuals	J.A.J.Vermoesen	194684.308	2007.571
154	Lot 67	1465	44		Private - Trusts/trustees	Whinstone Farm Trust	1307042.306	5550.044
155	Lot 67	1465	51		Private - individuals	F.N.Scott	1353122.194	5408.922
156	Lot 53	1817	0		Sappi	Sappi Manufacturing Pty Ltd	884693.483	5781.296

Land Ownership and Property Size in the Karkloof Catchment in 1999 continued
Note: Area shown in square meters. Perimeter shown in meters

Identity	Property Name	Grant No.	Sub No.	Farm Name	Owner Type	Owner Name	Area	Perimeter
157	Lot 53	1817	1		Private - individuals	W.R.Waller	16674.592	582.002
158	Lot 53	1817	2		Private - individuals	C.H.Neethling	2647.481	270.649
159	Lot 53	1817	3		Private - Pty Ltd	W.G.Maxwell Inv Pty Ltd	3198635.091	12188.573
160	Lot 53	1817	4		Private - Pty Ltd	W.G. Maxwell Inv Pty Ltd	204552.048	1902.104
161	Lot 53	1817	5		Private - individuals	R.S.S.Carter	198418.400	1888.909
162	Lot 53	1817	6		Private - individuals	D.M.Symons	219430.212	2214.774
163	Lot 53	1817	7		Private - individuals	E.E.Schemel	248909.287	2549.354
164	Lot 53	1817	8		Private - individuals	R.W.J.Parker	225867.790	2213.558
165	Lot 53	1817	9		Private - individuals	R.P.Milbank	209141.685	2039.588
166	Lot 53	1817	10		Private - individuals	R.P.Milbank	212398.659	2293.363
167	Lot 53	1817	11		Private - individuals	D.W.Hoidge	201862.995	2214.320
168	Lot 53	1817	12		Private - CC	Little Yarrow Farm CC	211022.965	1946.318
169	Lot 53	1817	13		Private - individuals	P.J.McCort	230818.654	2184.920
170	Lot 53	1817	14		Private - individuals	A.A.Croxford	212516.699	2020.905
171	Lot 53	1817	15		Private - individuals	L.Houston	198012.844	1937.364
172	Lot 53	1817	17		Private - individuals	W.B.T.Lang	177287.199	2193.448
173	Lot 53	1817	18		Private - individuals	V.S.Wilson	205801.717	2234.917
174	Lot 53	1817	19		Private - individuals	T.A.Moffett	204328.717	2363.185
175	Lot 53	1817	21		Private - individuals	C.M.Croxford	285888.216	2157.405
176	Lot 53	1817	23	Gala	Private - Trusts/trustees	Gala Property Trustees	1855538.813	5933.871
177	Kar Kloof	1866	0		Private - individuals	V.A.Plumley	4249416.136	9463.864
178	Kar Kloof	1866	4		Private - individuals	E.A.Cannell	253128.893	2758.075
179	Kar Kloof	1866	5		Private - individuals	A.B.Swarbreck	239033.020	2662.826
180	Kar Kloof	1866	7		Private - CC	Nut Cottage CC	283930.978	2625.938
181	Kar Kloof	1866	8		Private - individuals	M.G.Price	226205.261	2141.966
182	Kar Kloof	1866	11		Private - Pty Ltd	Cosmak Properties Natal Pty Ltd	248763.056	2050.513
183	Kar Kloof	1866	12		Private - individuals	R.J.Aberdein	201243.499	1864.711
184	Kar Kloof	1866	17		Private - individuals	B.C.Tountas	809577.621	4536.430
185	Kar Kloof	1866	21		Private - individuals	Sub 21 Farm Kar Kloof no 1866	210942.923	2199.646
186	Kar Kloof	1866	22		Unknown	Unknown	27904.259	731.855
187	Kar Kloof	1866	23		Unknown	Unknown	461765.643	3973.771
188	Kar Kloof	1866	26		Private - individuals	B.J.Kruger	619820.953	3857.589
189	Thomasville	2120	3		Private - individuals	O.M.Dakers	43255.661	853.000
190	Thomasville	2120	4		Private - individuals	M.E.Cale	338026.572	2400.025
191	Thomasville	2120	10		Private - Trusts/trustees	Liz Attwell-Brown Family Trust	5451.842	312.110
192	Thomasville	2120	18		Private - individuals	G.J.Chaplin	24722.680	674.111
193	Thomasville	2120	19		Private - individuals	R.Jagaran	108578.601	1361.800
194	Thomasville	2120	20		Private - individuals	C.J.Davison	195886.346	1982.538
195	Thomasville	2120	21		Private - individuals	G.M.Rex	204807.990	1931.457

Land Ownership and Property Size in the Karkloof Catchment in 1999 continued
Note: Area shown in square meters. Perimeter shown in meters

Identity	Property Name	Grant No.	Sub No.	Farm Name	Owner Type	Owner Name	Area	Perimeter
196	Thomasville	2120	29		Private - Pty Ltd	First Paper House Ltd	206258.934	2042.584
197	Thomasville	2120	34		Private - Pty Ltd	Hillmorton Estates Pty Ltd	1910886.041	8667.740
198	Thomasville	2120	35	Blairmore	Unknown	Unknown	6358740.463	10069.544
199	Thomasville	2120	37		Private - Trusts/trustees	Curry's Post Educational Trust	161137.100	2073.659
200	Talevera	2157	0		Mondi	Mondi Ltd	576371.041	4351.994
201	Talevera	2157	3		Mondi	Mondi Ltd	2093593.850	6977.773
202	Talevera	2157	4		Mondi	Mondi Ltd	936981.485	4917.799
203	Epworth	2204	1		Private - Pty Ltd	St Brides Estates Pty Ltd	2646724.139	7877.806
204	Mansfield	2373	1		Private - individuals	A.M. Greene	1013690.089	5280.488
205	Enfin	2980	1		Private - Pty Ltd	Kayfour Inv Pty Ltd	848075.646	4524.829
206	Twee Fontein	3293	3		Private - CC	Flamite Charcoal CC	2442186.306	7045.453
207	Twee Fontein	3293	5		Private - CC	Flamite Charcoal CC	205003.070	2631.955
208	Middle Drai	4129	1		Private - individuals	T.J.Hancock	553999.309	3672.791
209	Middle Drai	4129	2		Private - individuals	A.R.Mackenzie	3336243.957	8705.657
210	Scawby	4211	0		Mondi	Mondi Ltd	1581366.676	7617.811
211	Dartmore	5093	0		Private - Pty Ltd	Craigieburn Estates Pty Ltd	8209486.473	12199.734
212	Friar Tuck	6046	0		Private - Pty Ltd	St Brides Estates Pty Ltd	1345173.223	5477.545
213	Mountain View	6444	0		Mondi	Mondi Ltd	177213.574	4015.267
214	Lot R7	7148	0		Private - Trusts/trustees	Batu Trust	447969.423	3343.328
215	Avondale	7631	1		Mondi	Mondi Ltd	29368.484	1124.668
216	Melmoth	7673	0		State - KZNNCS	RSA / KZNNCS	7894806.471	11487.438
217	Glenaruel	13096	0		Mondi	Mondi Ltd	1629522.069	5996.666
218	Braco	13499	0		Private - individuals	W.V.C.Shaw	5879366.046	11389.917
219	Braco	13499	3		Private - Administrators	B. Henfrey - Administrator	47977.316	1266.311
220	Braco	13499	4		Private - individuals	R.N.Dales	581500.784	3565.222
221	Braco	13499	9		Private - individuals	E.C.Shaw	4437813.595	8895.911
222	Essenhyrst	13589	0		Private - individuals	R.E.A.Folker	1498149.982	5109.569
223	Essenhyrst	13589	1		Private - Trusts/trustees	Cranford Trust	393671.792	3072.007
224	Essenhyrst	13589	2		Private - individuals	R.G.Williams	352717.273	2513.532
225	Essenhyrst	13589	3		Private - individuals	B.M.Williams	298883.214	2200.474
226	Essenhyrst	13589	0		Private - individuals	W.A.Hagerman	411924.219	2704.304
227	Essenhyrst	13589	6		Private - Pty Ltd	Hubers Pty Ltd	399778.863	3126.716
228	Yellow-Wood	13732	0		Sappi	Sappi Manufacturing Pty Ltd	4885785.930	12439.441
229	Yellow-Wood	13732	1		Sappi	Sappi Manufacturing Pty Ltd	3826696.158	8720.882
230	Yellow-Wood	13732	2		Sappi	Sappi Manufacturing Pty Ltd	11290.176	517.446
231	Yellow-Wood	13732	3		Sappi	Sappi Manufacturing Pty Ltd	1111124.955	4706.184
232	Mbona	13856	5		Private - individuals	N.B.Wood	205710.859	2131.433
233	Mbona	13856	6		Private - Pty Ltd	Mbona Enterprises Pty Ltd	3509228.273	7954.465
234	Mbona	13856	18		Private - individuals	W.R.Waller	195850.431	2156.398

Land Ownership and Property Size in the Karkloof Catchment in 1999 continued
Note: Area shown in square meters. Perimeter shown in meters

Identity	Property Name	Grant No.	Sub No.	Farm Name	Owner Type	Owner Name	Area	Perimeter
235	Mbona	13856	19		Private - individuals	W.R.Waller	203620.664	1982.197
236	Mbona	13856	20		Private - individuals	P.A.Hall	195420.773	2189.624
237	Mbona	13856	21		Private - individuals	P.A.Hall	205994.415	2267.692
238	Mbona	13856	22		Private - individuals	P.A.Hall	204233.167	1880.713
239	Mbona	13856	23		Private - individuals	R.Gardner	194307.507	1912.183
240	Mbona	13856	24		Private - individuals	P.A.Hall	205320.433	1966.889
241	Veeplaas	14209	0		Private - CC	Shelf Prop CC	2775882.151	7478.668
242	Veeplaas	14209	1		Private - individuals	D.J.Vermaak	1376977.084	6193.249
243	Libanon	14388	0		Sappi	Sappi Manufacturing Pty Ltd	5215461.167	8997.919
244	Libanon	14388	1		Sappi	Sappi Manufacturing Pty Ltd	4584249.991	8974.981
245	Libanon	14388	2		Sappi	Sappi Manufacturing Pty Ltd	1663147.022	5945.503
246	Libanon	14388	3		Sappi	Sappi Manufacturing Pty Ltd	2199186.734	6113.960
247	Siteka	14400	2		Sappi	Sappi Manufacturing Pty Ltd	1276524.967	4810.562
248	Siteka	14400	3		Sappi	Sappi Manufacturing Pty Ltd	681750.937	4263.019
249	Siteka	14400	4		Sappi	Sappi Manufacturing Pty Ltd	651763.154	3267.876
250	Siteka	14400	5		Sappi	Sappi Manufacturing Pty Ltd	521819.771	3065.825
251	Siteka	14400	6		Private - individuals	B.K.Holt	247436.724	2064.013
252	Siteka	14400	7		Private - individuals	F.A.Taylor	281497.857	2222.715
253	Acutt	14802	0		Private - Pty Ltd	Hubers Pty Ltd	236496.668	2394.818
254	Umgetu	14830	0		Private - individuals	A.E.Saville	1469217.760	7210.993
255	Umgetu	14830	1		Private - individuals	Z.A.Duncan	199100.707	2072.322
256	Umgetu	14830	2		Private - Trusts/trustees	Zetu Trust	244630.892	2184.595
257	Umgetu	14830	3		Private - individuals	F.Crooks	214522.493	2023.222
258	Umgetu	14830	4		Private - individuals	J.A.R.Warren	583836.029	3903.739
259	Pines	14833	0		Sappi	Sappi Manufacturing Pty Ltd	6706183.892	12435.946
260	Elderslie	14886	2		Private - individuals	B.T.Dalling	213838.413	2010.294
261	Elderslie	14886	3		Private - individuals	S.Edwards	222147.946	2036.656
262	Elderslie	14886	4		Private - Trusts/trustees	Faraway Trust	226916.908	1959.200
263	Elderslie	14886	5		Private - individuals	P.H.D.Hay	251959.172	2041.250
264	Elderslie	14886	6		Private - individuals	C.E.Holmes	221494.752	1925.227
265	Elderslie	14886	7		Private - individuals	C.A.Houston-Mcmillan	238045.166	2142.270
266	Elderslie	14886	8		Unknown	Unknown	211342.885	2079.729
267	Elderslie	14886	16		Private - individuals	F.S.Vries	247044.018	2239.731
268	Hawkstone	15344	0	Hawkstone	Private - Trusts/trustees	Hawkstone Family Trust	5192131.037	13966.226
269	Ezulwini	15380	0		Private - individuals	J.H.P.Meyer	9401527.237	18180.939
270	Eweni	15381	0		Private - individuals	K.Leo-Smith	4527725.351	12983.181
271	The Start	15458	0		Private - individuals	J.A.A.M.T.Riele	3435881.131	9139.780
272	The Start	15458	1		Private - Pty Ltd	Denleigh Farm Pty Ltd	4455219.978	10522.360
273	The Start	15458	2		Sappi	Sappi Manufacturing Pty Ltd	3545129.196	9451.983

Land Ownership and Property Size in the Karkloof Catchment in 1999 continued
Note: Area shown in square meters. Perimeter shown in meters

Identity	Property Name	Grant No.	Sub No.	Farm Name	Owner Type	Owner Name	Area	Perimeter
274	The Start	15458	3		Private - individuals	D.G.Kok	1275577.184	4807.779
275	The Start	15458	4		Private - Pty Ltd	Hans Merensky Holdings Pty Ltd	5675757.326	11477.901
276	Barkston Ash	15533	4		Private - individuals	I.S.Lindsay	3078.654	310.337
277	Arlington	15561	0		Private - Pty Ltd	Arlington Farms Pty Ltd	2515306.019	9081.098
278	Arlington	15561	2		Private - Pty Ltd	Arlington Farms Pty Ltd	1797899.575	6199.760
279	Arlington	15561	6		Private - Pty Ltd	Arlington Farms Pty Ltd	1727694.103	8133.954
280	Mansfield	15609	0		Private - individuals	A.M.Greene	8888310.137	14600.289
281	Mansfield	15609	1		Private - individuals	A.M.Greene	3208923.858	7633.233
282	Mansfield	15609	2		Private - individuals	A.M.Greene	509764.958	3657.515
283	Mbona	15756	0		Unknown	Unknown	3188839.987	8933.900
284	Instead	15857	0		Private - Pty Ltd	Arlington Farms Pty Ltd	2874881.028	10322.867
285	The Peak	16097	0	The Peak	Private - Pty Ltd	Pinewood Products Pty Ltd	6834229.175	11173.324
286	Unknown	16412	0		Sappi	Sappi manufacturing Pty Ltd	7108000.527	23532.171
287	Unknown	16412	1		Sappi	Sappi Manufacturing Pty Ltd	285002.268	2751.658
288	Narina	16532	0		Private - CC	Goevy Farming CC	1123530.089	5470.124
289	Sherwood	16636	0	Sherwood	Private - individuals	Dr. A.W.P. Coleby	31331136.550	35355.743
290	Berlynn	16642	2		Private - Trusts/trustees	Berlyn Timber Trust	3756603.053	9882.340
291	Rialto	13788	1		Mondi	Mondi Ltd	3606683.960	10168.699
292	Scawby	4211	1		Mondi	Mondi Ltd	3723023.566	7720.342
293	Middle Drai	4129	3		Private - CC	Robwillie Grazing CC	956623.947	5088.798
294	Twee Fontein	3293	6		Private - CC	Robwillie Grazing CC	517269.547	4798.181
295	Nooitgedacht	1149	16		Mondi	Mondi Ltd	8488384.521	12033.257
296	Braco	13499	8		Private - Pty Ltd	Mholweni Eiendomme Pty Ltd	4512735.728	8903.703
297	Spitz Kop	970	6		Sappi	Sappi Manufacturing Pty Ltd	1817814.252	7362.511
298	Spitz Kop	970	2		Sappi	Sappi Manufacturing Pty Ltd	1551903.222	5038.309
299	Spitz Kop	970	4	Shannon	Private - individuals	M. Benson/Shannon	2112888.062	6022.801
300	Berlynn	16642	1		Private - Trusts/trustees	Berlynn Timber Trust	1904464.459	6650.041
301	Mount West	3152	0		Private - individuals	R.J.Brewitt	8703031.631	13187.160
302	Mount West	3152	1		Private - Trusts/trustees	Berlynn Timber Trust	2401176.362	7193.825
303	Enfin	2980	3		Private - Pty Ltd	Kayfour Inv Pty Ltd	1999375.168	5389.228
304	Glen Afton	15851	0		Private - individuals	J.B.S.Osborne	803029.340	4833.612
305	Kar Kloof	1866	19		Private - individuals	T.H.Stent	28883.035	724.719
306	Siteka	14400	0		Private - Pty Ltd	Siteka Pty Ltd	2550124.347	9388.923
307	Siteka	14400	8		Unknown	Unknown	313481.282	2463.484
308	Halliwell	924	15		Private - individuals	L.L.Hancock	959367.069	4421.862