NATURAL RESOURCES AND LOCAL MANAGEMENT IN THE HEWU DISTRICT OF THE EASTERN CAPE: LIMITATIONS TO ACHIEVING SUSTAINABILITY

by

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April 1998

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ABSTRACT

The Mceula Commonage Land in the Hewu district lies due northwest of Whittlesea and west of Queenstown in the Eastern Cape. This thesis has two main objectives. Firstly, to survey and analyse the condition of the natural resource base in the Hewu district with particular reference to water, soil, vegetation and land use. Secondly, to investigate the relationship between scientific approaches to assessing land use degradation and to compare these to the results obtained using a participatory approach of the rural environment of the Hewu district of the Eastern Cape .

Random quadrats ($4m^2$) were sampled and corresponding line transects were done with increasing distances from the villages. The Braun-Blanquet method was used to find the cover and abundance of the various species of plants. Data obtained from point sampling along 100 metre line transects was used to assess the condition of the veld using Trollope's technique.

Six communities were defined using TWINSPAN, and grazing capacities and veld condition scores of the respective sites were calculated. It was concluded that the six communities were distributed along a gradient of palatable to non palatable grass and grasslike species. Rangelands close to the villages had low veld condition scores and percentage plant cover as opposed to those farther away from the villages. The null hypothesis of no significant difference between the percentage plant cover and condition of the veld close to the villages and farther away from the villages was rejected.

Whilst it is urgent to resolve political disputes around land through land distribution, a key issue for the future is sustainability of the natural resource base of South Africa. To attain this, the old traditional methods of research must be supplemented with the participatory method, where the local community becomes fully involved.

The central theme of the participatory approach was to investigate the possibility of promoting local management of the natural resources. Workshops were conducted to involve the local community in the project. The community formed six discussion groups that met regularly to discuss environmental issues. The six groups that were formed were: Firewood or woodlot collectors, shepherds / livestock raisers, crop farmers / agriculturists, water collectors, building material / soil collectors and medicinal plant users.

The results obtained from the meeting of the discussion groups were used to compare the scientific results obtained from Braun-Blanquet method. Perceptions about their environment, which came out of the results of the discussion groups showed that the local knowledge of the rural community of Mceula was sufficient to train them to manage their environment sustainably.

ACKNOWLEDGEMENTS

The assistance and motivation provided by the following persons during the course of the study is greatly appreciated:

Dr. A. M. Avis for his supervision of the project and constructive comments;

The Mceula community for willingly taking part in the project;

C.S.D. for providing the funds for the project;

Mrs E. Brink, Messrs D. Booi and Tony Dold who assisted with most of the plant identifications;

Mr L. James, the late X. Yanta and Miss N. Morgan for acting as interpreters;

Messrs S. Asem and R.K. Klu for allowing me to use their computers to type the manuscript;

Messrs R.T. Asafo-Adjei, N. K. Ofosu-Kwakye, E.K. Sonkor and Dr. E. Afari for their encouragement;

Mr. O.K. Owusu-Aduomi for his assistance and encouragement;

Mrs S. Abraham of the Department of Geography, Rhodes University, for willingly drawing the maps for the project;

The entire Ghanaian community in the Eastern Cape Province for their support;

The entire staff of Rhodes University Library and to my wife Juliana, and children Joe and Kate who provided the inspiration to complete the manuscript.

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CHAPTER ONE: INTRODUCTION

1. GENERAL INTRODUCTION

This thesis has two main objectives. Firstly, to survey and analyse the condition of the natural resource base in the Hewu district with particular reference to water, soil, vegetation and land use. Secondly, to investigate the relationship between scientific approaches to assessing land use degradation and to compare these to the results obtained using a participatory approach. The need for a participatory approach to sustainable management of natural resources and a review of relevant concepts in participatory research will be presented in this chapter.

1.1. THE NEED FOR A PARTICIPATORY APPROACH TO NATURAL RESOURCES MANAGEMENT

South Africa is a water-scarce country and the management of water resources is in the national interest, and is a key policy issue for underwriting future economic and social development (IDRC 1994). South Africa has an average annual rainfall of about 500mm per year, and except for the eastern and southern coastal areas, most of the interior and western parts of the country are arid or semi-arid.

In the rangelands of communal lands, a drastic reduction in the palatable grass species and a shift towards single dominance by unpalatable species has occurred (Palmer & Avis 1994). Natural resource data, if assessed and evaluated carefully, can be used as a guideline for planning the future resource utilization of an area (Hensley 1978). A number of research projects have been done in the field of natural resource management, but most of these have never directly involved the community of local inhabitants.

In the Katherine-Darwin area of Northern Australia, a regional survey of natural resources indicated that the Tipperary Land System, a dry monsoonal area with one wet and one dry season, had potential for dryland crop production (Christian & Stewart 1952). In a similar study in the arid and semi-arid areas in Northern and Central Australia, Christian and Stewart (1960) recommended the area for grazing beef cattle.

In another study Reshkin (1990) used the data on natural resources to formulate a management programme of natural resources in the Indiana Dunes. In a fairly remote area of western Sudan, a natural resource study led to the application of irrigation water to the agricultural land on the alluvial terraces on the volcanic mountains of the Jebel Marra (Robertson 1963). A'Bear *et al.* (1977), an evaluation of the natural resources of the St. Lucia Eastern Shores led to the most appropriate land use of the area, as well as the effect which any land use would have on the environment. The Institute of Social and Economic Research (ISER) has been conducting research relating to rural development and social issues in the former Ciskei Region for forty years, and has become a base for multi-disciplinary research in this area. The goal of the Development Studies Unit is to "use the outcome of its research to help people formulate strategies to overcome the impoverished effects of history and their environment" (ISER 1993).

Many examples of work on natural resources evaluation or assessment within the former Ciskei Region and Hewu district exist. A study on the natural resource and agricultural potential of the Ciskei was undertaken by the Faculty of Agriculture of the University of Fort Hare (Laker 1975). This project reviewed current knowledge regarding the agricultural potential and resources of the Ciskei, and discussed the production systems and management practices. Loxton Venn (1988) gathered and assessed the natural resources of the Hewu district to ascertain the land use potential of the area. The area was found to be unsuited to dryland cropping due to a shortage of major surface water. The area was recommended for livestock production and the limited irrigable soils used for subsistence food production.

The Shiloh Irrigation Project Scheme (Loxton Venn 1978) came about as a result of a similar study. The inception of the Tsolwana Game Park (Palmer 1978) was as a result of a natural resource survey of the area. O'Connel Manthé *et al.* (1985) made a survey of natural resources, socio-economic and agro-economic conditions of the Hewu region, to determine how the scarce resources would support the high population of the area. Hawkins and Osborne (1985) investigated the natural resource base to propose an irrigation scheme for the Black Kei River in the Ntabatemba area.

Of the few projects that have been done in the Hewu district, none dealt with the sustainability of the natural resources, the participation of the local community, or addressed the local management of these resources. Again, all the previous researchers used old traditional methods in conducting their research. For example, it is known that soil conservation and afforestation entail much labour and expense and are slow to bring returns. People are not easily persuaded that they will profit from their own efforts to protect the environment. Many of them have few resources and are more concerned with ensuring they have enough to eat today and tomorrow than with planning years ahead. But, unless the people of the rural areas are involved in the planning and implementation of projects, little progress is likely to be made (Grove 1994).

The International Development Research Centre (IDRC 1994), has recognised that "whilst it is urgent to resolve political disputes around land through land restitution and redistribution, the key issue for the future is sustainability of the land resource base of South Africa: that is, the prevention of the further degradation of land and soil quality. The land tenure systems and management of land under the apartheid regime, exacerbated by lack of access to extension services and markets, has resulted in impacts such as overgrazing, erosion and topsoil loss, with concommitent social impacts (IDRC 1994). Soil erosion may well be the greatest environmental problem facing South Africa (Verster *et al.* 1992).

In densely populated areas where people rely heavily on their local environment for fulfilling their basic needs, effective local control in the use of communal resources is needed if such use is to be sustainable. At the community level, this depends on many aspects of "capacity", such as technical skills and knowledge, effective organisational structures, social cohesion and sufficient motivation. It also depends on adequate support from higher levels in the form of appropriate policy, legislation and access to information. The apartheid era has left South Africa in a situation where the above conditions are largely absent (ISER 1993). This project aims to help develop appropriate strategies for filling that gap.

The Hewu district has for a long time been recognised as a degraded area with communities in need of rural development assistance. It has low rainfall and marginal agricultural potential. The shallow soils have low storage capacity and are severely eroded. This project focuses attention on these issues, and will redress them where possible. This is in line with Reconstruction and Development Programme (RDP) principles and follows the recommendations made by the IDRC that "research be undertaken to establish the extent, rate and causes of land degradation in South Africa in order to establish the most appropriate and cost effective remedial measures, including changes to present agricultural practices" (IDRC 1994). The Reconstruction and Development Programme is the cornerstone of development policy for the new government. It envisages "a process that will lead to growth in all parts of the economy, greater equity through redistribution and sustainability" (ANC 1994).

CHAPTER TWO

2. NATURAL RESOURCES

2.1. TYPES OF NATURAL RESOURCES

In classifying natural resources it has been traditional to distinguish between those that are renewable and those that are non-renewable. The former were once considered to be living resources, that is, forests, wildlife, etc. because of their ability to regenerate through reproduction. The latter were considered to be non-living mineral or fuel resources, which once used, did not replace themselves (Britannica 1989).

Because all natural resources form a continuum, from those that are non-renewable in the short term to those that are least renewable, they do not readily lend themselves to a single system of classification. It is useful, therefore, to examine the various types of natural resources in relation to their cycling time, that is the length of time required to replace a given quantity of resources that has been utilized with an equivalent quantity in a similar useful form. From this point of view, renewable resources can be considered as those with short cycling times and non-renewable resources as those with very long cycling times. Any resources can be non-renewable, however, if the demand and rate of utilization exceed its cycling capacity (Britannica 1989).

2.2. RENEWABLE RESOURCES

The most clearly recognizable renewable resources are those consisting of, or produced by, living things, usually plants and animals. These include agricultural crops, animal forage, forest crops, wild and domestic animals. All can continue to reproduce and regenerate their populations as long as environmental conditions remain favourable, and adequate seed source or breed stock is maintained. Moreover, all can be cropped or harvested without diminishing their supply, provided that the cropping does not exceed the reproduction growth rate (Britannica 1989).

Resources that contain a combination of interacting living and non-living components are called ecosystems. It is impossible to separate an ecosystem into its living and non-living components, because the whole constitutes a dynamic system in which there is a flow of energy from sunlight and the atmosphere, and from minerals and water from the soil. The soils of natural areas that yield water to streams and rivers are as important as are those in which agricultural crops are raised.

If soils are kept in place and in good condition, they support functional ecosystems and yield clear water for human use. If, however, these soils are damaged physically by being compacted or allowed to erode, they lose not only their capacity to support vegetation but also their capacity to hold and slowly yield useful water to streams or springs.

Furthermore, eroded soils cause siltation of waterways and accumulate in reservoirs. Plant biomass is a renewable resource that can be converted to alcohol fuels or burned directly to provide heat. In the 1980's, for example, wood fuel provided more energy used in the United States than did nuclear power. In developing countries, such as South Africa, wood is often the major supplier of energy. However, the mean estimates from Southern Africa are relatively low at 687 kg ± 48 kg / person / year (Gandar 1983; Liegme 1983; Von den Bussche 1988; Kennedy 1990). Water may be considered as an inexhaustible resource, because the total supply of water in the biosphere is not affected by human activities. Water is not destroyed by human uses, although it may be held for a time in combination with other chemicals. To be useful, however, water must be in a particular place and of a certain quality, and so must be regarded as a renewable and often scarce resource, with recycling times that depend on its location and use (Britannica 1989).

In certain locations, water has a much longer cycling time. After entering the ground from rainfall, it may percolate slowly through underground channels until it reaches underground reservoirs. In certain arid and semi-arid regions, such as the area under study, the total water supply may be underground water that accumulated during past ages when the climate was more humid. Since that time there may have been little or no addition to its supply because of the existing climatic conditions. Because its cycling time may be extremely long and dependent upon the frequency with which wet and dry climates alternate in a particular region, such ground water resources can be virtually non-renewable.

Past and present intervention into the utilization and manipulation of environmental resources are having anticipated consequences. Dregné (1990) reported that North Africa has experienced soil erosion since the time of the Roman Empire, but the real threat seems to have appeared in the seventh century after the Arab conquest. Forests cut because timber was needed for shipbuilding, construction and fuel, resulted in the exposure of the soil to natural and man-made degradative processes.

The often indiscriminate destruction of forests and woodlands, the overgrazing of vegetation by increasing numbers of livestock, the over exploitation of vegetation for domestic uses and the improper management of land, have all resulted in more or less severe soil degradation. Although soil degradation is recognized as a serious and widespread problem in Africa, its geographical distribution and total area affected are only approximately known (Sant'Anna 1993). Sant'Anna again reported that the economy of Africa depends upon its land resources, especially the productivity of its croplands, its pastures and its forests. "The very well-being of our people depends on the state of our lands. But our lands are at a risk because they are undergoing severe degradation"(Sant'Anna 1993).

Alexandratos (1988) concluded that the environmental problems of developing countries are largely due to overexploitation of land, extension of cropping and deforestation. Increased use of pesticides and artificial fertilizers are also causing environmental problems. Particularly, the degradation of soil fertility and the scarcity of fuelwood indicate the graveness of the situation (Reijntjes *et al.* 1992).

2.3. ECOLOGICAL PRINCIPLES OF LAND UTILIZATION

According to Reijntjes *et al.* (1992), the basic principles to better land utilization can be grouped as follows:

(1) Securing favourable soil conditions for plant growth, particularly by managing organic matter and enhancing soil life.

(2) Optimizing nutrient availability and balancing nutrient flow, particularly by nitrogen fixation, nutrient pumping, recycling and the complimentary use of external fertilizers.

(3) Minimizing losses due to flows of solar radiation, air and water by way of microclimate management, water management and erosion control.

(4) Minimizing losses due to plant and animal pests and diseases by means of prevention and safe treatment.

2.4. SUSTAINABLE AGRICULTURE

Sustainability implies a time dimension and the capacity of a farming system to evolve and endure indefinitely (Lockeretz 1988). There have been many definitions of sustainable agriculture; however, most of them are similar and involve the same components. For example, the United States Agricultural Research Service (USDA) defines sustainable agriculture as: "Agriculture that for the foreseeable future will be productive, competitive and profitable, conserve natural resources, protect the environment and enhance public health, food quality and safety" (USDA 1953). The United States Congress (1990) in drafting the 1990 Farm Bill defined sustainable agriculture as: "An integrated system of plant and animal production practices having site-specific application that will, over the longer term:

- Satisfy human food and fibre needs.
- Enhance efficient use of renewable resources.
- Utilize natural biological cycles and controls.
- Improve the economic viability of farming systems.
- Enhance the quality of life for farmers and society as a whole.

The ultimate goal of suitable agriculture is to develop farming systems that are productive and profitable, conserve the natural resource base, protect the environment and enhance health and safety, over the long term (National Research Council 1989).

CHAPTER THREE

3. THE STUDY AREA

3.1. MCEULA COMMONAGE LAND

3.1.1 THE HISTORY OF MCEULA

The geographic region defining the study area extends from 32° 05' S; 26° 40' E to 32° 08' S;26° 43' E being part of the Hewu District of the northern region of the former Ciskei, now part of the Eastern Cape Province (Figure 1a). This area is covered by the 1:50000 South Africa Topographical series sheet 3226 BA Poplar Grove. The Mceula Commonage Land lies due northwest of Whittlesea, and west of Queenstown. It is bounded by Kamastone to the north, the Hukuwa River to the south and Poplar Grove to the east (Figure 1b). It has the highest altitude within the Hewu District (of about 1367) metres, and is characterized by an abundance of steeply sloping hills.

The people of Mceula came from different areas of the former Transkei and Ciskei, KwaZulu, Herschel, Matatiele, Mzimkhulu and Tsitsikama. They fled these areas as a result of the wars of Tshaka. They arrived in the region during the seventeenth century and came together at Mceula in 1835. They were called Fingos because they had come from different places. The Mceula community initially comprised only eighty families. These families were given land titles during the time of the Colonial government. Currently, Mceula consists of about 5000 inhabitants. It is made up of four individual villages, namely; Xaleni, KwaManzikrakra, Maqulomba and White City. The distance from one village to the next ranges from two to four kilometres.

3.2. CURRENT LAND USE

Soil, slope, climatic factors, vegetation cover and conservation potential were used to classify the former Ciskei into suggested land use categories (Table 1) (Laker 1978). According to Laker (1978) the study area falls under pedosystem C.3, namely the Bulhoek pedosystem. The suggested land use is grazing, and irrigation along rivers and streams, and is described as being suitable for rainfed cropping. Currently, the Mceula Commonage Land is used mainly for grazing and subsistence farming.

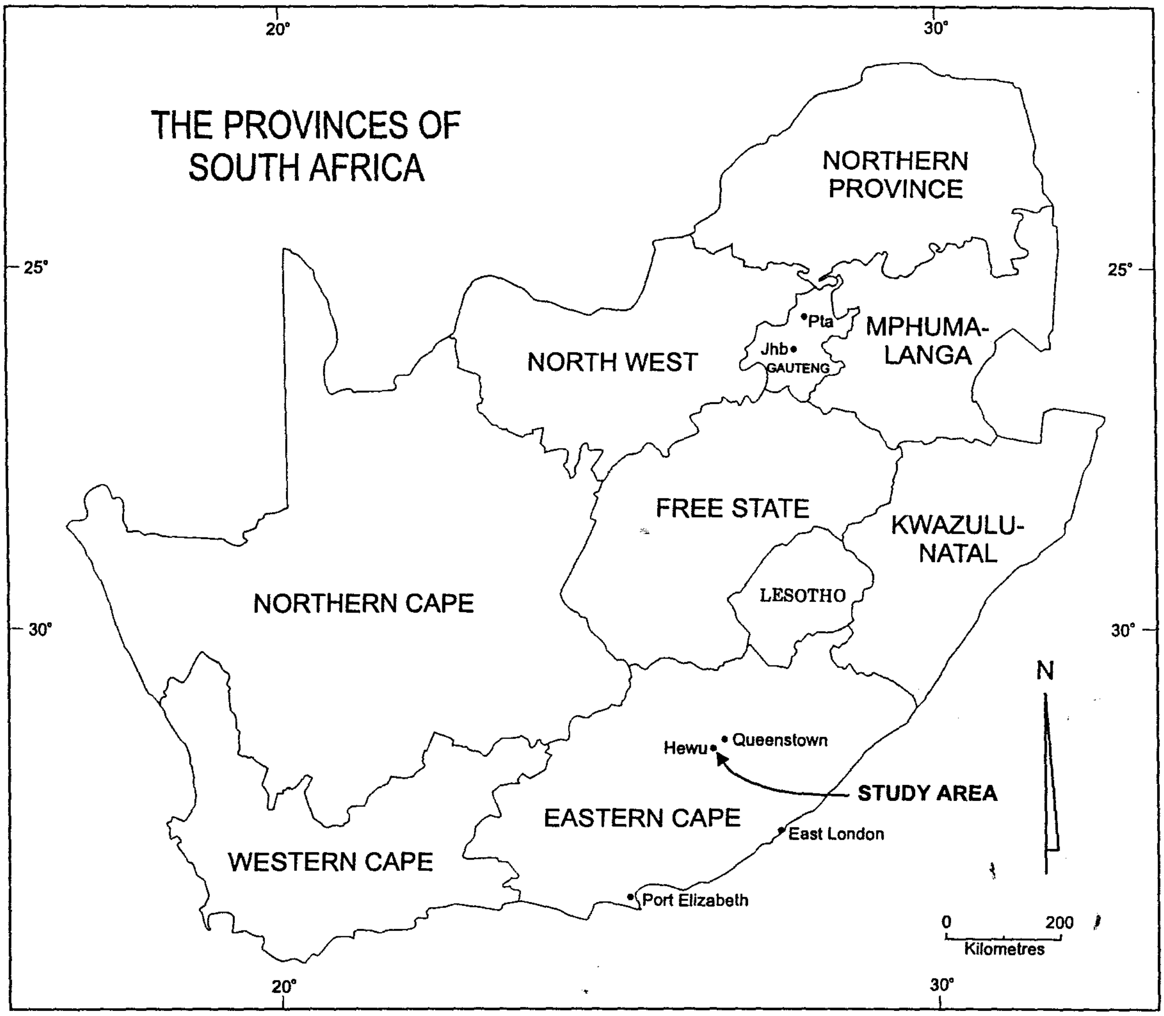


Figure 1a : Map of South Africa showing the position of the study area.

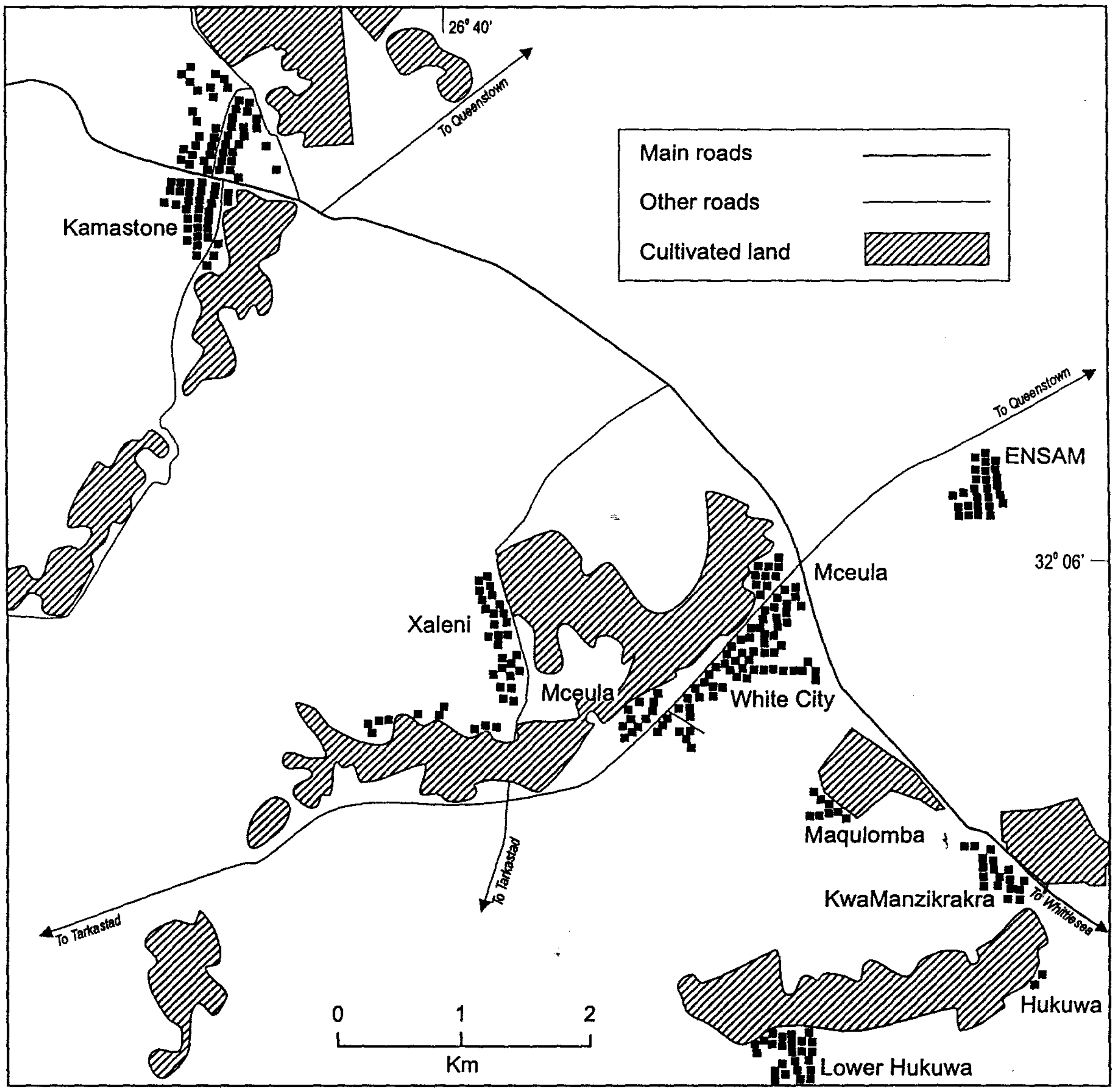


Figure 1b : Map of the Mceula Commonage Land.

Table 1: Pedosystems of the Ciskei (Laker, 1978)

Pedosystem	Important soil forms	Visible erosion	Suggested land use
C1. Amatola	Hutton; Clovelly; Mispah (Rock)	–	Forestry; grazing; cropping on deep soils on suitable slopes
C2. Bekruipkop	Glenrosa; Mayo	Little	Grazing; limited cropping
C3. Bulhoek	Swartland; Valsrivier; Mispah; Shortlands; Hutton	Moderate	Grazing; irrigation along rivers and streams
C4. Kat	Mispah; Valsrivier; Oakleaf	Little	Grazing; irrigation along rivers and streams
C5. Keiskamma	Hutton; Oakleaf; Mispah	Little	Forestry; grazing; limited cropping; irrigation along rivers
C6. King William's Town	Glenrosa; Mayo	Little	Grazing; irrigation; limited cropping
C7. Mavuso	Glenrosa; Mayo; Valsrivier; Hutton; Shortlands; Arcadia; Oakleaf	Generally moderate; severe in patches	Grazing; irrigation along rivers and streams; limited cropping
C8. Middledrift	Glenrosa	Generally moderate; severe in patches	Grazing; irrigation; very limited cropping

The structure of the soil classification system (Pedosystem).

The system employs two main categories or levels of classes; an upper or general level containing SOIL FORMS, and a lower, more specific one containing SOIL FAMILIES. Each soil form is defined by a unique vertical sequence of diagnostic horizons and materials. All forms are subdivided into two or more families which have in common the properties of the form (that is, the prescribed horizon sequence) but are differentiated within the form on the basis of other defined properties (DAP, 1991).

Pedon- The smallest three-dimensional portion of the soil mantle needed to describe and sample soil in order to represent the nature and arrangement of its horizons.

3.3. THE PHYSICAL ENVIRONMENT

3.3.1. TERRAIN MORPHOLOGY

The Hewu District is the northern most part of the former Ciskei. The highest part is occupied by the Winterberg pedosystems. To the north, the descent from the Winterberg pedosystem is relatively gradual to form the very rough and stony Baviaansberg pedosystem with its slopes and very shallow soils (Hensley & Laker 1975).

The Baviaansberg pedosystem generally ends quite sharply against the planed, fairly level Bulhoek pedosystem which occurs mainly at an altitude of about 1150 metres. The Tarka pedosystem is transitional in nature between Baviaansberg and Bulhoek. It is characterized by an abundance of steeply sloping hills formed by dolerite dykes.

3.3.2. SOILS

The Tarka and Bulhoek pedosystems are occupied by soils with unfavourable clayey subsoils (Val Rivier and Swartland forms). These soils have mainly developed from shales. The topsoils of these soils form the main part of the total effective rooting depth, but these topsoils are shallow, which means that these soils have limited effective depths and low plant available water storage capacity (Hensley & Laker 1975).

In later reports on the Hewu region (O'Connell Manthé & Partners 1985) the soils were grouped into four major physiographic sub-regions and all four are represented in the study area. These divisions are:-

- Alluvial soils
- Soils of the pediments (footslopes)
- Soils of the higher rocky areas
- Upland soils

Generally the soils in the area are shallow, litholic and unsuitable for tillage. Since the area falls into the rain shadow, soil development tends to be limited and soils are often immature, little leached and poorly structured. High salinity is found in many soils. The shallowness of the soils, coupled with low and erratic rainfall, results in an almost universally low agricultural potential (Loxton Venn 1988).

3.3.3. CLIMATE

Whitmore (1957) includes the study area in Region 5 (Subhumid Transitional Zone between the humid Eastern Highveld and the Karoo). Most of the Hewu area, which comprises land types Bulhoek, Tarka and even Baviaansberg is situated in the rain shadow of the Amatolas, and therefore receives less than 500 mm of rain annually. Whitmore further states that a marked dry season occurs during winter, with most of the rain occurring in summer (October to March) and more particularly late summer (February and March). This late peak, combined with the long frost period results in a short effective growing season, before the onset of the first autumn frost.

Schulze (1965) and Els (1971) describe the climate of the major part of the former Ciskei, as follows: " The climate of this area is temperate to warm and humid with a definite summer rainy season which is at a maximum in March and at a minimum in June." Generally speaking, the climate of the northern part of Ciskei viz. the Hewu area, north of the Winterberg mountains is distinctly different from the rest of the Ciskei (Hensley & Laker 1975).

The rainfall in this semi-arid region mainly results from thunderstorms during the summer months (Schulze 1984). Laker (1978) also adds that the nature of the thunderstorms are quite frequent, about 20 to 30% per annum and are occasionally accompanied by hail. Specifically in the study area, the annual rainfall is 491,5mm and the total for September to March is 403,7mm (Table 2) (Laker 1978).

Table 2: Rainfall of stations representing different land types in the Ciskei (Laker, 1978)

Station	Average annual rainfall (for three years)	Average September to March (for three years)	Land type
Poplar Grove	491.5	404.7	Bulhoek
Rocklands	439.1	358.0	Bulhoek
Whittlesea	485.9	464.9	Bulhoek
Seymour	564.5	416.9	Kat
Keiskammahoek	628.6	475.8	Keiskammahoek
Lenye	724.1	558.8	Keiskammahoek
Fort Murray	594.3	443.4	King William's Town
K.W.T. (Club)	618.0	459.3	K.W.T.
K.W.T. (TNK)	535.7	412.7	K.W.T.
Orange Grove	508.2	469.2	K.W.T.
Lovedale	575.4	427.9	Mavuso
Woburn	476.5	369.3	Mavuso
Middledrift	498.5	379.3	Middledrift
Ntsikizini	504.1	381.6	Middledrift-Debe
Cross Roads	497.4	402.5	Ngwekazi
Great Fish Point	589.8	382.1	Salem
Kessendrum	663.6	444.0	Salem
Blackwoods	694.3	569.2	Winterberg
Cintsa	818.9	636.0	Winterberg

Absolute minimum temperatures fall as low as -6 °C and extreme summer temperatures reach 40°C. The average daily maximum is around 29,6°C during January and 18° C during July, whilst average minimum temperatures are 14,5° C and 2,6° C respectively (Els 1971). Winds are usually north-westerly, attaining their maximum speed in the afternoon. During thunder storms, strong and gusty south-westerly winds of short duration are a common feature, and occasionally cold snaps are accompanied by unpleasant southerly winds. Mountains are snow-clad (Schulze 1965).

3.4. BIOLOGICAL ENVIRONMENT

3.4.1. VEGETATION

In classifying the vegetation of southern Africa, the Hewu district was described as "The invasion of grassveld by *Acacia karroo" (*Acocks 1953; 1988). It was also described by Hensley and Laker (1978) as "The invasion of grassveld by thornbush." Low and Rebelo (1996) described this vegetation type as "Sub-arid Thorn Bushveld." Hoare (1997) criticises Acocks' (1988) description of Veld Types of South Africa as being based on agro-ecological units and are, therefore, fairly broad. In his new classification of the vegetation of the Eastern Cape, Hoare places Hewu District under "*Acacia karroo - Tragus koelerioides* dry savanna grassland." This is mainly wooded grassland, and the physiognomy is open savannah with trees and shrubs forming a prominent feature of the vegetation. The dominant woody species is *Acacia karroo*, and the herbaceous shrubs are co-dominant by *Felicia muricata* and *Hermania coccocarpa*.

The main grass species are *Sporobolus fimbriatus*, co-dominant with *Heteropogon contortus* and interspersed with *Eragrostis* and *Tragus* species. The forbs and sedges are dominated by *Kyllinga pulchella*. From the footslopes of the mountains there is a change in vegetation. It is much denser and *Acacia karroo, Aloe vera*, *Euryops oligoglossum*, and *Berkhaya pinatifida* are present (Plate1). The vegetation is more fully described in Chapter Five.

Plate 1: Vegetation of the study area. Note the invasion of *Acacia karroo* and the change of vegetation on the mountain slopes showing *Aloe* species, *Euryops oligoglossum* and *Acacia karroo* in the foreground.

CHAPTER FOUR

4. PARTICIPATORY METHODS AND RESULTS

4.1. INTRODUCTION

This chapter deals with the participatory methods used in this project and the analysis of the results. It gives an overview of what participatory research entails. The objectives of the particpatory methods used are:

(1) to find out the local knowledge pupil have about their environment, and

(2) to use this to enhance capacity building.

4.1.1 PARTICIPATORY RESEARCH APPROACH

4.1.1.1. GENERAL INTRODUCTION

This section seeks to provide an overview to the issues of participatory research. It begins with the definition, background and aims of participatory research. It also explains the principles and techniques of participatory research.

Participatory research refers to the efforts in several spheres to develop research approaches which involve those persons who are the expected "beneficiaries" of the research. The term deliberately focuses on involvement of those who are traditionally the objects of research in the entire research process itself (Hull 1992).

People cannot be developed; they can only develop themselves (Nyerere 1973). For while it is possible for an outsider to build a man's house, an outsider cannot give the man pride and self-confidence in himself as a human being. Those things a man has to create in himself by his own actions. He develops himself by what he does; he develops himself by making his own decisions, by increasing his understanding of what he is doing and why; by increasing his own knowledge and ability and by his own full participation as equal in the life of the community he lives in (Nyerere 1973). Research is always and by logical necessity based on moral and political valuations, and the researcher should be obliged to account for them explicitly (Myrdal 1979).

Participatory research has emerged mainly out of the context of developing countries where an incompatibility has developed between traditional social research methods and the development needs and problems of the Third World societies (Walters 1983).

4.1.1.2. DEFINITION

Participatory research can be defined as a three pronged process involving: social investigation with the full and active participation of the community in the entire process; it involves an educational process of mobilization for development; and a means of taking action for development (Kassam 1980; Van Vlaenderen & Nkwinti 1993). It therefore includes aspects of research, social investigation (finding out from people), education i.e. capacity building and action.

4.1.1.3. BACKGROUND

The methods of participatory approach began in the 1970's as a result of various influences: The first was the anti-poverty bias. Urban based professionalism due to spatial bias (visit only certain spots such as village centre or road side); person bias (speaking only to elite, men), seasonal bias (only going in dry cool season) and diplomatic bias (researcher avoids to ask "ugly" questions) resulted in the worst poverty and the biggest problems remaining unrecognised.

The second was the increasing complexity of the interaction between ecological and socio-economic processes, which required a multi-disciplinary approach. The third was the disillusion with conventional methods in rural development which involved research which was too time consuming and expensive, too formal and fixed, lacking integration, top-down in direction and had a low level participation from local people.

The fourth was the growing recognition that rural people were themselves knowledgeable on many subjects that touched their lives (what became known as indigenous technical or local knowledge). It became clear that it would be cost effective to use that knowledge more (McCracken; Pretty and Conway 1988). For participatory research to be truly participatory the researcher must establish a rapport with the local participants in the project, a skill which is not easily acquired by traditional researchers because it requires a considerable shift in the researcher's perception of rural people (Van Vlaenderen 1995).

4.1.1.4. AIMS OF PARTICIPATORY RESEARCH

Participatory research the following basic aims: firstly, it aims to develop consciousness of the people involved in the development. Secondly, it aims at improving their living conditions and thirdly, participatory research aims to transform the social structures. Finally, it aims to create a two-way learning process between the researcher and the community in which there is active involvement in all aspects of the process including problem identification, data gathering, analysis and application of results (Social Research Africa 1995).

4.1.1.5. PRINCIPLES OF PARTICIPATORY RESEARCH

The principles of participatory research can be summarized as follows:

(a) Investigation with full and active participation of all involved.

(b) It is problem-centred in that it moves towards a common goal to create a sense of community.

(c) It makes use of the importance of indigenous knowledge and resources.

(d) It is a combination of social investigation, education and action.

(e) Appropriate methods are used by both the researcher and the participants.

(f) It uses and builds on existing community organisational infrastructure.

4.1.1.6. METHODS AND TECHNIQUES OF PARTICIPATORY RESEARCH

In participatory research both traditional and innovative research methods are used. What makes the techniques participatory is that the participants together with the researcher decide on an appropriate method or technique for each particular situation at each stage in the process.

The methods used within a participatory framework aim at equipping the communities with the necessary tools for identifying, analysing and solving their own issues. Another point is that in the participatory research approach, the researcher is a catalyst and facilitator within a community process rather than a data collector and analyser in charge of a research process.

Lastly, participatory research assumes that communities possess local knowledge and traditional as well as established systems and methods of problem solving that are used for survival in harsh conditions (Social Research Africa 1995).

4.2. RAPID RURAL APPRAISAL (RRA)

Rapid rural appraisal (RRA) can be defined as a collective of techniques for conducting action-oriented research in developing countries (MaCracken *et al.* 1988). It was developed as a quick, relatively cheap, insightful and multidisciplinary method of data gathering and analysis in response to rural development and agricultural challenges in the Third World countries.

RRA can be used to:

- Assess development needs of a community.
- Identify priorities for further research / development.
- Assess the feasibility of planned interventions.
- Implement development action.
- Monitor development action.

4.2.1. PRINCIPLES OF RRA

- It optimises trade-offs, it aims at finding out only what needs to be known (optimal ignorance) and measuring it more accurately than is needed (appropriate impression).
- RRA attempts to off-set biases of the professional urban outsiders vis-a-vis the local rural reality.
- It involves a learning as-you-go, which means that process and goals of the study are modified as is deemed necessary during the research process.
- RRA attempts to learn from and with the rural people, gaining from indigenous physical, technical and social knowledge.

4.2.2. RRA TECHNIQUES

These include the use secondary data reviews. Data that has been acquired by other people is quickly reviewed and summarised. It is used to set the RRA task and for avoiding time wasted in repeating studies. Direct observation techniques, where indicators such as events, processes or relationships are easily observed or measured, for example, indicators for wealth, semi structured interviews, which may consist of household interviews and group interviews analytical games, stories and portraits may also be used.

Diagrams are simple, schematic devices which present information in visual, accessible form. The construction of such diagrams with groups is useful because it is an analytical process which helps the group to think through issues clearly. Secondly, diagrams also become a means of creating communication and discussion between the group and the researcher as an aid to analysing his collected data (Chambers 1992). There are several forms and includes transects, seasonal calendars, maps and historical profiles. Workshops can also be organized, and most of the techniques mentioned above can take place in a workshop situation.

A workshop is a bringing together of people (usually local people and researcher, but sometimes also other outsiders) in order to discuss issues, priortise needs, plan actions, solve problems, evaluate programmes, etc. A workshop implies active participation of all involved, and is run according to certain guidelines (e.g. small group discussion, brainstorms, plenary report backs etc.) (McCracken *et al.* 1988).

Workshops were conducted with the Mceula Residents' Association which constituted the various discussion groups over several Sundays in 1996. Three assistants acted as interpreters in the course of the workshops.

4.3. RESULTS OF THE PARTICIPATORY STUDY

4.3.1. INITIAL CONTACTS AND THE FOCUS ON MCEULA COMMUNITY

In April 1995, a meeting was held with the SANCO executives of Thornhill. It became evident that there was conflict between them and the chiefs of the area. Several trips were made to Thornhill, as there was a promise that the conflict would be resolved. After it was supposedly resolved, a promised meeting with the Residents' Association to discuss the objectives of the project, and to form discussion groups did not take place. After many trips to Thornhill to meet the SANCO executives in connection with the said proposal, the researcher was told he would be informed when the groups were ready.

In March 1996, a similar meeting was held with the SANCO executives of the Mceula residents, and at the same meeting a date was fixed for a meeting with the Residents' Association. On the 21st of March 1996, the first meeting was held with the Residents' Association to explain the objectives of the project. At the same meeting, the various discussion groups were formed. Due to the enthusiasm that was shown by the Mceula residents at the first meeting, and the difficulties experienced in setting up meetings, it was decided to limit the study to Mceula only.

Not much problem was encountered by the researcher gaining access to the Mceula community, since the researcher teaches just a few kilometres away from the study area and had been known to the community for the past eight years. In view of this, building a relationship with the local residents and winning their confidence became easier .

4.3.2. DISCUSSION GROUPS

On the same day that the meeting with the Residents' Association was held, (which was a large group) six discussion groups were formed, namely:

(1) Firewood or woodlot collectors
(2) Shepherds or livestock raisers
(3) Crop farmers or Agriculturists
(4) Building material gatherers
(5) Medicinal plant users
(6) Water collectors.

Two of these discussion groups met every Sunday afternoon to discuss and identify environmental problems and to suggest possible solutions to them. The rapid rural appraisal method was used to facilitate the discussion and to extract information.

4.3.3. FIREWOOD OR WOODLOT COLLECTORS

These groups of people fetch firewood for household cooking and heating during winter. Firewood is also fetched for cooking during occasions such as funerals and customary weddings. Although it is fetched regularly, fetching of firewood is not a major activity since it is not a means of livelihood. The type of wood fetched is mainly *Acacia karroo*.

The following problems encountered in the fetching of firewood were identified by the discussion group:

(1) Residents walk up to six kilometres away in order to fetch firewood.

(2) There are rules regulating the cutting of firewood. Live wood / trees close to the settlement area must not be felled.

(3) There are fewer trees remaining and the vegetation is generally no longer dense.

The group attributed the causes of some of these problems to the following:

(1) Permission is given to cut dry trees close to the settlement area during the winter period.

(2) An increase in population has brought about an increase in the number of trees cut.

(3) The cutting down of trees and an increase in farm animals has led to overgrazing, which has resulted in the formation of bare ground and subsequently soil erosion.

(4) Lack of rainfall has led to the wilting of thorn bushes, thus making them dry and dead.

4.3.4. SHEPHERDS / LIVESTOCK RAISERS

These are residents who take livestock to the fields for grazing. This is a major activity and a means of livelihood. From the discussion, quite a good number of livestock raisers knew about carrying capacity of the veld. They claimed they used to be given stock cards and their animals were counted regularly to see if they were overstocking. There were four camps and rotational grazing was practised, but with the cutting of the fences rotational grazing is no longer practised and animals graze anywhere. According to them, the stocking rate is very low presently, due to stock theft and loss of animals through thirst and hunger.

Problems identified by the livestock raisers are as follows:

(1) Stock theft

(2) Diseases affect livestock easily, thus reducing the number of livestock when they strike.

(3) Payment of taxes on animals owned by an individual. A tax of 50 cents per ox per year and 25 cents per sheep or goat per year is charged.

(4) Presence of ticks on animals and unavailability of dips.

(5) Shortage of water for animals.

(6) Damaged fences.

(7) Taking livestock farther away from settlement areas for grazing.

(8) Undesirable weeds have invaded the grassland.

Causes of some of the problems listed above are:

(1) Unemployment has caused a lot of the residents to resort to stock theft and the cutting and stealing of fence wires.

(2) The number of agricultural (veterinary) officers has been reduced.

(3) There are six windmills in working order and each grazing camp has a dam but these dry up during the dry season leading to the shortage of water.

(4) Eroded areas close to the settlement areas due to overgrazing.

4.3.5. CROP FARMERS / AGRICULTURISTS

These individuals till the land for agricultural purposes. Crop farming forms the basis of the local economy, since very few people go to the urban areas to seek employment. It is believed that only eighty (80) families own land at Mceula and the other farmers obtain land from the original land owners and the harvest is shared on a 50:50 basis as their reward for loaning them part of their land.

The Mceula residents have a community garden and household plots also exist. Farm produce includes maize, potatoes and vegetables such as spinach, pumpkin, beans, tomatoes, onions, cabbage and peas. All these are harvested and sold except maize. Barley and wheat are no longer cultivated due to severe drought conditions. Communal labour exists whereby all residents help an individual farmer and he in turn helps the others in cultivating their crops.

Problems encountered by crop farmers as identified by the discussion group:

(1) There are no fences on the ploughing fields. Crops are damaged by grazing animals as a result.

(2) There are no access roads for tractors to get to some of the ploughed fields.

(3) There is no means of irrigation of the fields when there are no rains. Water is not available for irrigation.

(4) Eroded soils exist on some ploughed fields.

(5) Most farmers do not have money to hire tractors.

The cause of some of the problems above:

There is often severe drought since the dams dry up and there are no irrigation facilities.

4.3.6. WATER COLLECTORS

These residents fetch water for household purposes i.e. cooking, washing and drinking. The Mceula community used to get water from the Mceula river. Windmills were built for the provision of stock water and taps were provided for the supply of drinking water. Potable water supply from the taps is from a borehole driven by a diesel engine. A total of eleven taps were provided, but only four are in working condition. It was revealed during the discussion that it is thought there is an immense source of underground water.

Problems encountered with the provision of water:

(1) There is no money for purchasing diesel oil for the running of the diesel engine to pump water.

(2) The engine attendant is no longer on the government pay roll after the re-incorporation of the homelands into the Republic of South Africa.

(3) Rivers and streams are sandy and choked and residents at times compete with animals for water from the dams and rivers.

Residents' solution to the problems of water supply:

(1) Dams must be built and they must be fenced.

(2) The government must provide diesel oil for the running of the diesel engine.

(3) More boreholes should be constructed since there is a large source of underground water.

4.3.7. ATTEMPTS MADE TO SOLVE THE WATER PROBLEM

Gibbs Africa, a commercial engineering company that often deals with rural water supply was approached in an attempt to find a solution to the water problem. It was later in the course of negotiation revealed that the Mceula community had been provided with a borehole driven by a diesel engine by this same company. The funding of the project came from the former Ciskei government. Thus it was suggested, that residents must make monthly contributions to buy diesel engine and to pay the engine attendant.

4.3.8. BUILDING MATERIAL / SOIL COLLECTORS

These individuals collect soil for making bricks for building houses. Soil was previously dug from anywhere for the moulding of bricks, resulting in soil erosion. However, during the Sebe regime (Ciskei government) there was legislation that soil must be dug from an approved common place for the moulding of bricks. This was revealed by SANCO and the Residents' Association in the cause of the discussion. Presently, there is only one place where soil is collected for this purpose. There is only one person who moulds bricks as a means of livelihood. However, there are those who collect soil for bricks and use them for constructing their own houses.

The main problem identified by the group as a result of the removal of soil for the moulding of bricks is that it leaves the ground bare and accelerates soil erosion, especially when the residents could dig soil from anywhere.

4.3.9. MEDICINAL PLANT USERS

There are only two individuals who specialize in collecting herbs for medicinal use. Attempts to get them to take part in the discussion failed. The reason given for their refusal to take part in the project was that 'they want to protect their profession and would not want to reveal any information to any outsider'.

4.4. MAPPING - COMPARISON OF THE PAST, PRESENT AND FUTURE MAPS OF MCEULA

Using RRA, the residents were asked to draw two maps of Mceula village. All the members of the various discussion groups were put together. They were supplied with pencils, coki pens and plain newsprint sheets. They were divided into two groups and each group was assigned a different map of Mceula to draw. Two Sunday afternoons were used to complete this assignment. The first group was assigned to draw a map of the 'old Mceula' i.e. from 1879 to 1965. The second group was asked to draw the map of the present Mceula.

4.4.1. DIFFERENCES BETWEEN THE PAST AND PRESENT MAPS OF MCEULA

The recent map of Mceula (Figure 3) shows a better planned community with grazing camps for rotational grazing. The old map (figure 2) indicates the presence of more trees than the recent map. More indigenous trees e.g. *Acacia karroo* have been chopped down, for use as fuelwood for cooking and providing a source of heat durnig the winter months. This process has gone on over the years, and as a result there are few trees remaining and the vegetation is no longer dense.

This has led to firewood collectors walking up to six kilometres away in order to fetch firewood. Another reason which has led to the presence of fewer trees on the recent map is the lack of rainfall. This has led to the wilting of the thorn bushes, thus making them dry and dead for firewood collectors to make use of.

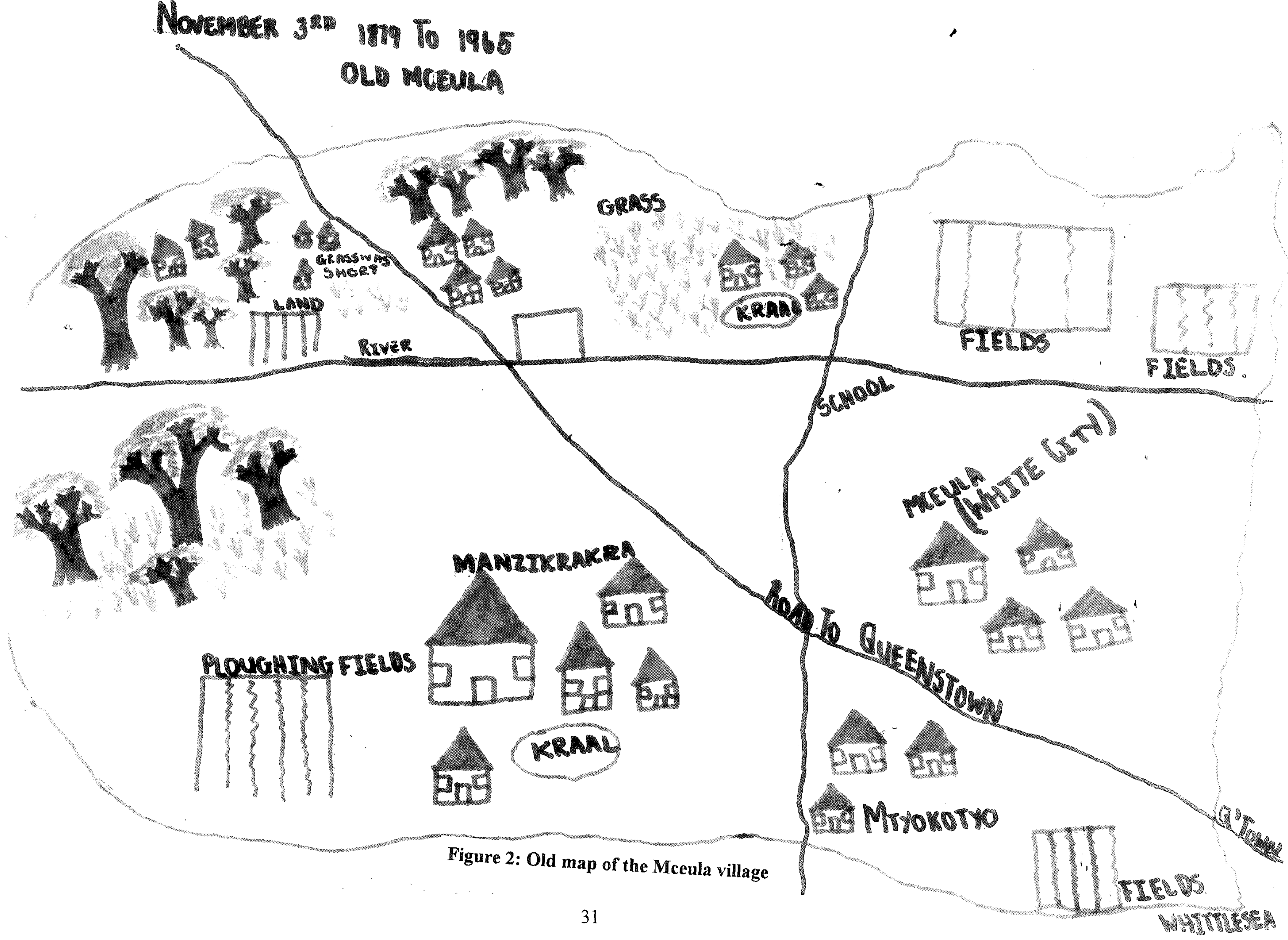


Figure 2: Old map of the Mceula village

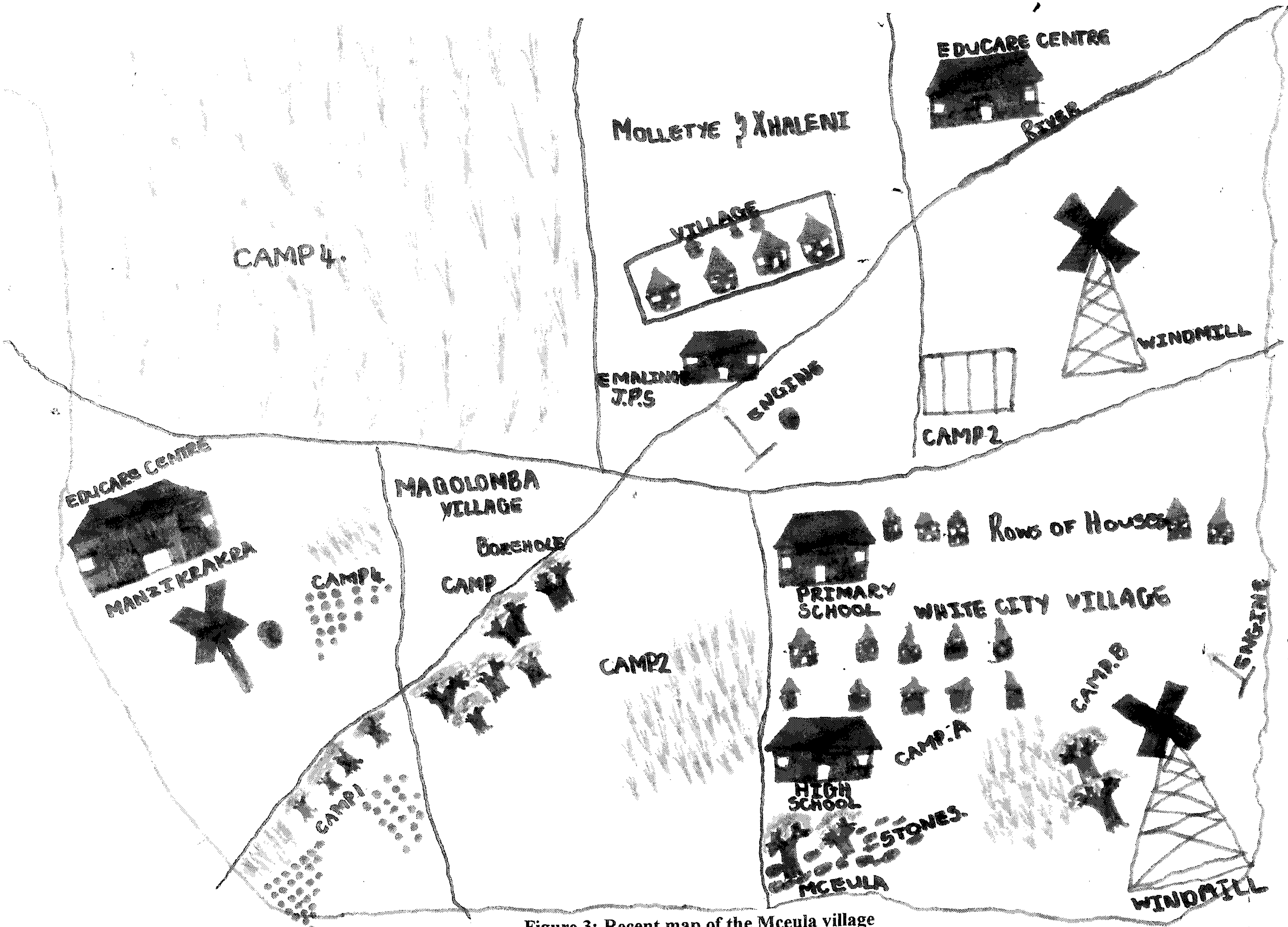


Figure 3: Recent map of the Mceula village

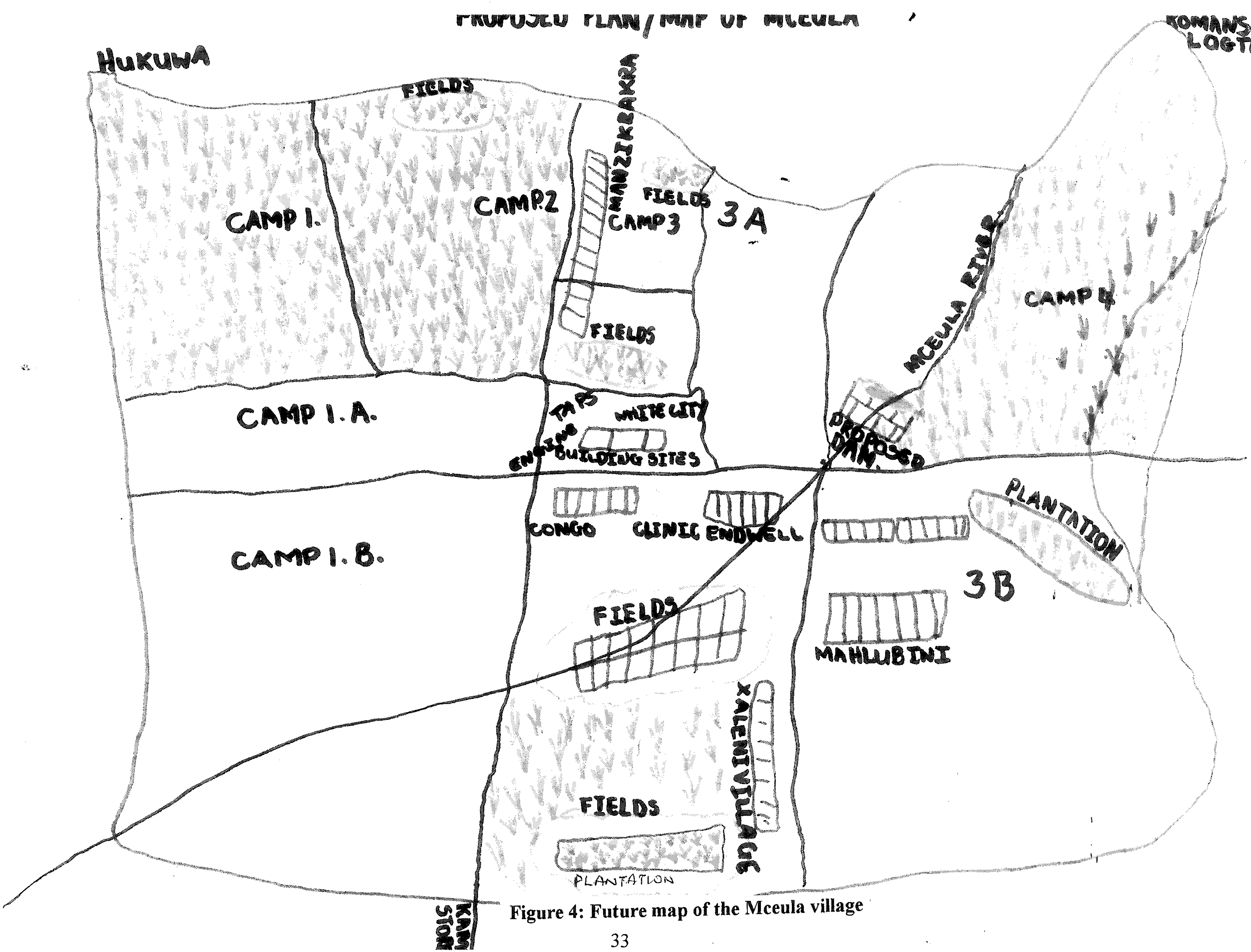


Figure 4: Future map of the Mceula village

The cutting down of trees and the increase in the number of farm animals have led to overgrazing which has also resulted in the formation of bare ground and subsequently to soil erosion. However, a few gum trees have been planted around houses to provide shade and to serve as wind breaks.

Residents used to get water from the rivers which were dirty, but on the present map, water is obtained from boreholes and windmills. The population estimate within the period the old map represents was 2500 - 3000 people (80 families). The present population is approximately 5000, since a lot of people moved in from Transkei. The soils are generally poorer now, but better near the rivers. There are no dams on the two maps, and water seems to be the most important problem. Only four taps are available for all the residents.

4.5. FUTURE PLANS

Based on the third comment made at the winding up session, the residents were again asked using RRA to draw a future or proposed map of Mceula (Figure 4). This map shows a remarkable improvement on the two previous maps (Figures 2 & 3). The village is better planned on this map.

The four grazing camps are each sub-divided into sub-camps to provide a much better rotational grazing. The greater number of camps enable the more effective implementation of rotational grazing and grazing programs. Generally, multi-camps are preferred to single systems because selective grazing can be more easily controlled, and they provide greater managerial flexibility (Trollope *et al.* 1987). Conversely, multi-camp systems are more expensive in terms of fencing and drinking points, and in practice the actual number of camps that are developed on a farming unit depends on economics rather than ecology (Trollope *et al.* 1987).

A proposed dam on the Mceula river is included to provide water for irrigation purposes. Provision is made on the map for establishing plantations at the various eroded areas (plate 2) as a means to check the erosion problem of the area. Site selection for tree planting obviously depends to a greater extent upon the object of planting. The tree must serve the purpose for which it is selected (Bands & Britton 1977).

Plate 2: An eroded site selected for plantation

SEASONAL CALENDAR OF MCEULA

NATURAL RESOURCES

SOILS			DRY AND HARD							Soft and easier to plough and till		
CROPS	NO Crops			DAMAGED CROPS FROM FROST						PLANTING		
FIRE WOOD	WOOD FOR COOKING ONLY			BEST TIME			DIFFICULT TIME FOR WOOD					
Grazing Land	GOOD			HAVE TO BUY LUCERNE; AUCTION; VERY DRY						NOT VERY BAD ; AUCTION		
WATER										Depends on the amount of rain		
	Poverty	Growth Season		UKUVUNA		Cold, Strong wind		Spring	Ploughing and planting			Hot
	January	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec

MONTHS AND SEASONS

Table 3 . Seasonal calendar of the Mceula community

In view of this, the local Department of Agriculture and Forestry at Whittlesea was approached by the researcher and the executive members of SANCO, and a proposal was submitted with regard to the tree plantation scheme. The local department delegated two officers who had a meeting with the Residents' Association. Two meetings were held in October 1996, but the project is yet to take off.

4.6. SEASONAL CALENDAR

A seasonal calendar involves drawing, together with the local people, all the major changes occurring during the year. This can include climate, diseases, labour demands, cropping, problems and opportunities (Van Vlaenderen 1995). Using RRA, the residents were asked to draw up a seasonal calendar of the community (Table 3).

4.6.1. COMMENTS ON THE SEASONAL CALENDAR

4.6.1.1. WATER

The availability of water in January depends on the rains in November and December and the soil cannot store much water. In February and March the river is full of silt and there are no facilities to store water. If more boreholes could be sunk, water from underground source could be made available for use. Very few people have tanks for storage of water since they are very expensive to purchase.

4.6.1.2. GRAZING

January, February and March are good grazing months. The fields start getting dry from April and May. Between June and August the fields are very dry and the residents start buying lucerne from white farmers who grow lucerne using irrigation practices. This makes it very expensive to purchase (R 148 per bag). Lucerne is used for feeding cattle, sheep and goats during the dry winter period. The rains start from October but residents still need to buy lucerne to feed animals. During the dry season, especially between June and August, young sheep and goats often die of thirst and hunger.

4.6.1.3. SOIL

The soil is soft and easier to till and plough at the beginning of October when the summer rains begin. Planting of crops is done during this period. The soil becomes dry and hard between March and September. However, Winter crops can be produced if the farmers can get a means of irrigating the land.

4.7. DISCUSSION

Elements of participatory research processes that can be identified in this study are considered in this section, in order to draw together some ideas and principles relating to human capacity building. They are the development of skills; the importance of interaction between local and formal knowledge, and procedures for collective action.

4.7.1. SKILLS

A component of human capacity building involves the generation of skills for development.The participatory research process at Mceula has provided opportunities for the acquisition of a number of skills amongst which were: organization, negotiation, drafting letters of requests from governments and organizations, and identification and solving of environmental problems. These skills were disseminated through a process of combined action and education.

The problem solving skills were connected to knowledge that the residents already had about the ecological profile of their community. Problem solving techniques were acquired through discussion exercises. The researcher assumed a facilitating / catalyst role, in that, useful contributions from individuals were encouraged in building a common problem solving strategy. The acquired strategy included existing knowledge and knowledge added on by the project.

4.7.2. LOCAL AND FORMAL KNOWLEDGE

Building human capacity involves acknowledging the existence of local knowledge, recognizing its value and using it as a building block in creating bridges to new knowledge (Korten 1980). The participatory approach, in giving space to people to articulate their ideas, provides an opportunity for this knowledge to emerge and be used. The identification and solution of environmental problems used in this study is a good example of this. It became clear from the discussions that people knew what had led to the degradation of the environment, and had ideas about what they could do to solve this. This problem identification played an important role in formalising this knowledge. Compiling the information gave them an objective picture of their circumstances, and they used their report to negotiate with the Department of Agriculture and Forestry for the tree planting programme.

In general, the residents of Mceula are not only aware of their environmental problems but the causes as well; which goes to say that the existing knowledge and capacity of the local residents should be enough to train them to manage their environmental resources sustainably.

4.7.3. COLLECTIVE ACTION

The generation of skills and knowledge at an individual level should be complemented with the creation of collective action for development. Such action occurs when people see that it is in their interests to join together and create organizational structures and procedures to meet their needs (Korten 1980).

It is often assumed that because people live in close proximity to each other, or share similar life styles or problems, that they constitute a community, in that they share a sense of belonging and mutual trust and are prepared to work collaboratively on issues (Social Research Africa 1995). This statement supports the results of the participatory process. This was clearly revealed in the response to the call for the tree planting programme. Various committees were formed and organized in this regard. They made the best use of existing leadership potentials. Secondly, individuals with skills for fencing were also identified by the residents. Other residents also volunteered for the training for the tree planting programme. They were indeed prepared to work together as a community.

4.7.4. PROBLEMS AND PROSPECTS

The process as presented in this study may appear to have been a smooth one. In reality participatory research is fragile and at times a rudimentary process. A discussion of some of the limitations and constraints that were experienced follow.

The transfer of power to the local participants, which forms part of participatory research, means that the process can go through directions not originally intended by the project (Korten 1980). One way of checking this was to be very attentive always during the course of the workshops and discussions to streamline issues. This was, however, not encountered during the course of this study.

Secondly, linked to the issue of different agendas is the question of time. Participatory research has to operate at a pace of local progress and emerging capacity to cope with change. It is not possible to implement blueprints generated independently of local processes (Van Vlaenderen 1995), and it is difficult to work with funder's or project time schedules. As at the time of compilation of this thesis the Department of Agriculture and Forestry had not provided the fencing materials promised for the commencement of the tree planting project. The researcher would have liked to see the implementation of the project within the period during which the compilation of the thesis was done. Due to financial constraint, the plantation project has been delayed to date.

4.7.5. COMMENTS MADE AT THE WINDING UP SESSION

(1) The residents learned about their village and that things that seemed to be unimportant proved to be very important. For example, the drawing of a seasonal calendar gave them an objective view of their environment. It actually gave them a time table of events that they knew about but did not really mean much to them. They have a clearer picture of what happens in their environment and can plan with it. Secondly, the drawing of the three maps enabled them to formulate a better planned community for the future.

(2) It helped the residents to understand their environment better.

(3) They learned things about their village but asked what they will benefit from the project. It was then explained to them that the project will help them identify their environmental problems as well as help them plan their environment better since they were physically involved in the project.

4.7.6. CONCLUSION

Although the process is ongoing and fragile, participatory research at Mceula had an impact on capacity building in that some skills were generated and organizational capacity was enhanced. For example the Executive members of SANCO were trained to draft a letter which was used to negotiate for the tree planting project. What was also astonishing was the emergence of self confidence of the people in this process of change. Despite the project's attempts to disseminate skills, several training skills were not fulfilled, especially the analysis of the data obtained.

CHAPTER FIVE

5. ECOLOGICAL METHODS AND RESULTS

5.1. INTRODUCTION

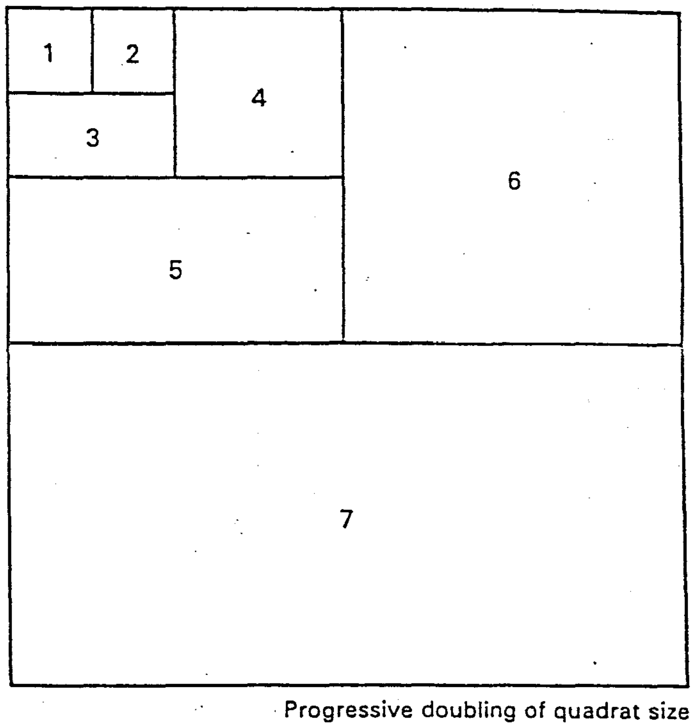
This section of the report gives an overview of the scientific methods and materials used in the project. Field surveys were made to quantify perceived changes to the environment and to compare local perceptions to scientific results. From a preliminary study of the vegetation of the study area point sampling along a line transect was used to determine the aerial and basal cover of the vegetation. Data obtained from this method was used to calculate the veld condition (Trollope 1993). The objectives of the ecological analysis are threefold:
(1) to describe the vegetation of the area,
(2) to determine the condition of the veld, and
(3) to calculate the grazing capacities of the respective sites of the study area.

Quadrats were used to sample the plants in the study area. The data obtained was used to describe the plant community using the Braun-Blanquet cover / abundance scale (Whittaker 1962; McIntosh 1967; Langford & Buell 1969) and classified using TWINSPAN and DECORANA (Hill 1979a; b). Plant specimens in the study area were collected and pressed for identification at the Albany Museum to help in the description of the vegetation.

5.1.1 SAMPLING PROCEDURE

The usual sampling unit for describing the floristic composition of vegetation is the quadrat and the choice of quadrat size in designing a survey is very important and will vary from one vegetation type to another (Gilbertson *et al.* 1990). The optimal plot size to be used in sampling vegetation for phytosociological studies will be one giving the most favourable balance between information obtained and effort expended (Werger 1972). The regression equations of Gleason (1925) and Fisher et al (1943) based on logarithmic series are generally regarded as best fitting the observed data (Goodall 1952; Hopkins 1955; Dahl 1957; Von Broembsen 1962).

(a)



(b)

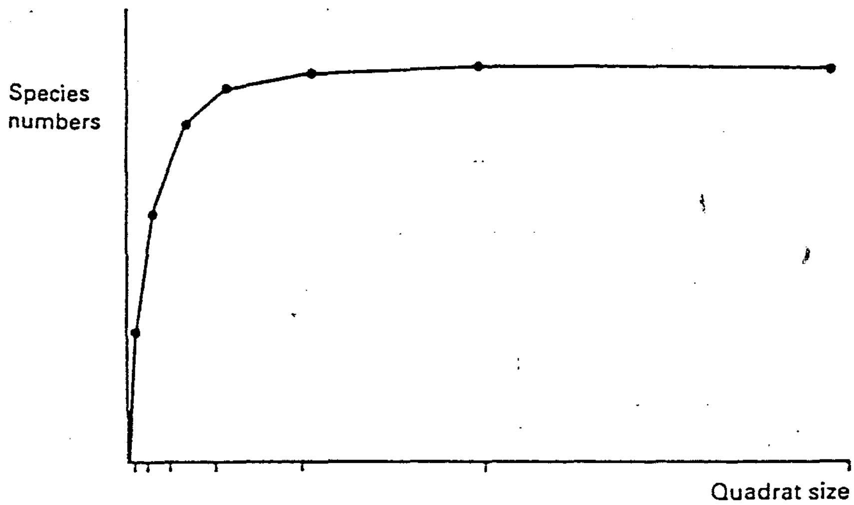


Figure 5: (a) Nested quadrat: progressive doubling of quadrat size for minimal area;
(b) The resulting species-area curve.

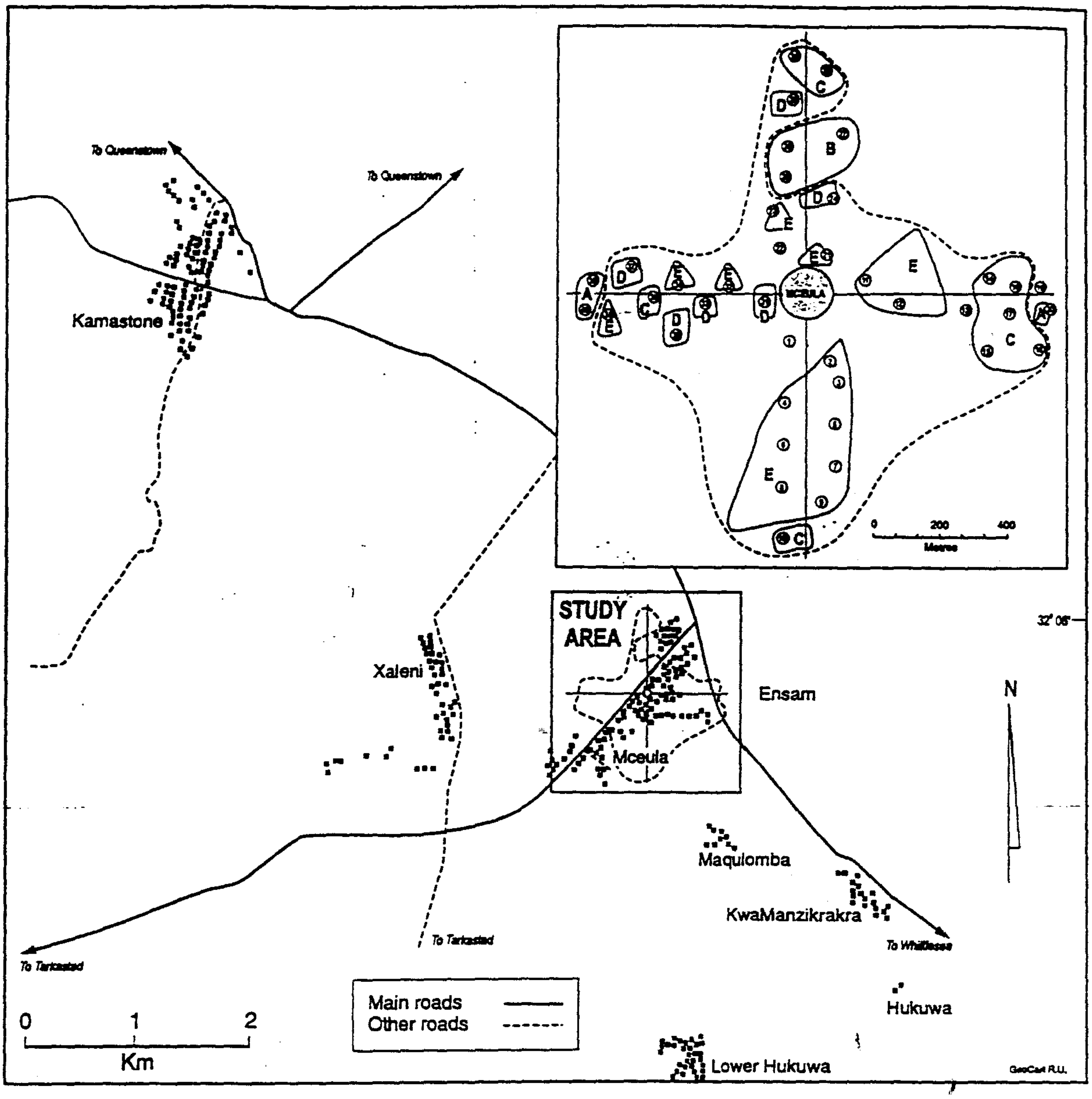


Figure 6: Map of Mceula Commonage Land showing the sampled area

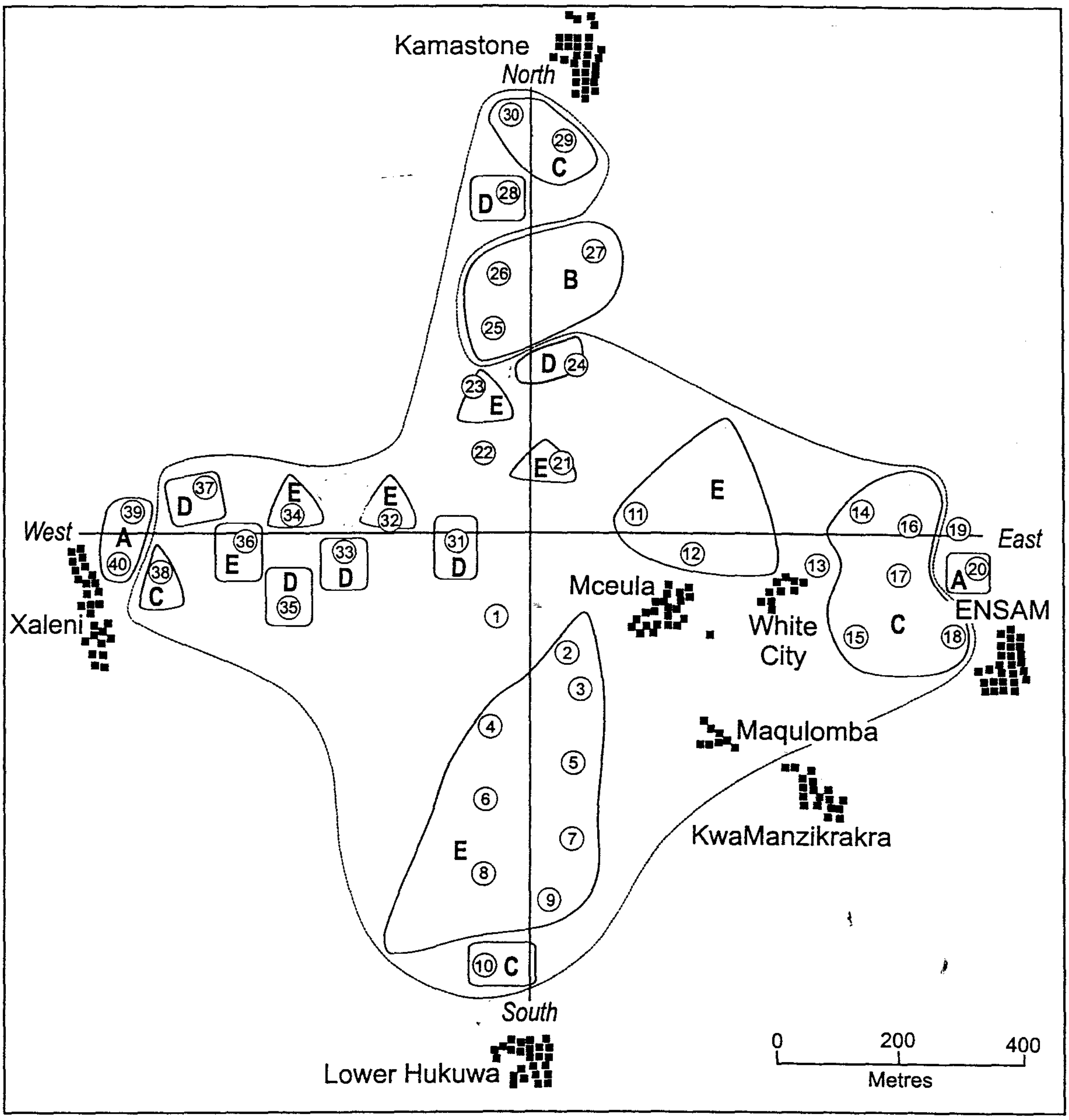


Figure 7: Map of the Mceula Commonage Land showing where the quadrats were laid. Note: Numbers 1 - 40 show where quadrats were laid. A, B and C are rangelands close to the villages, and D, E and F(not shown, is a broad vegetation zone consisting of (C, D & E) are rangelands farther away from the villages. Blocks [•] indicate location of settlements.

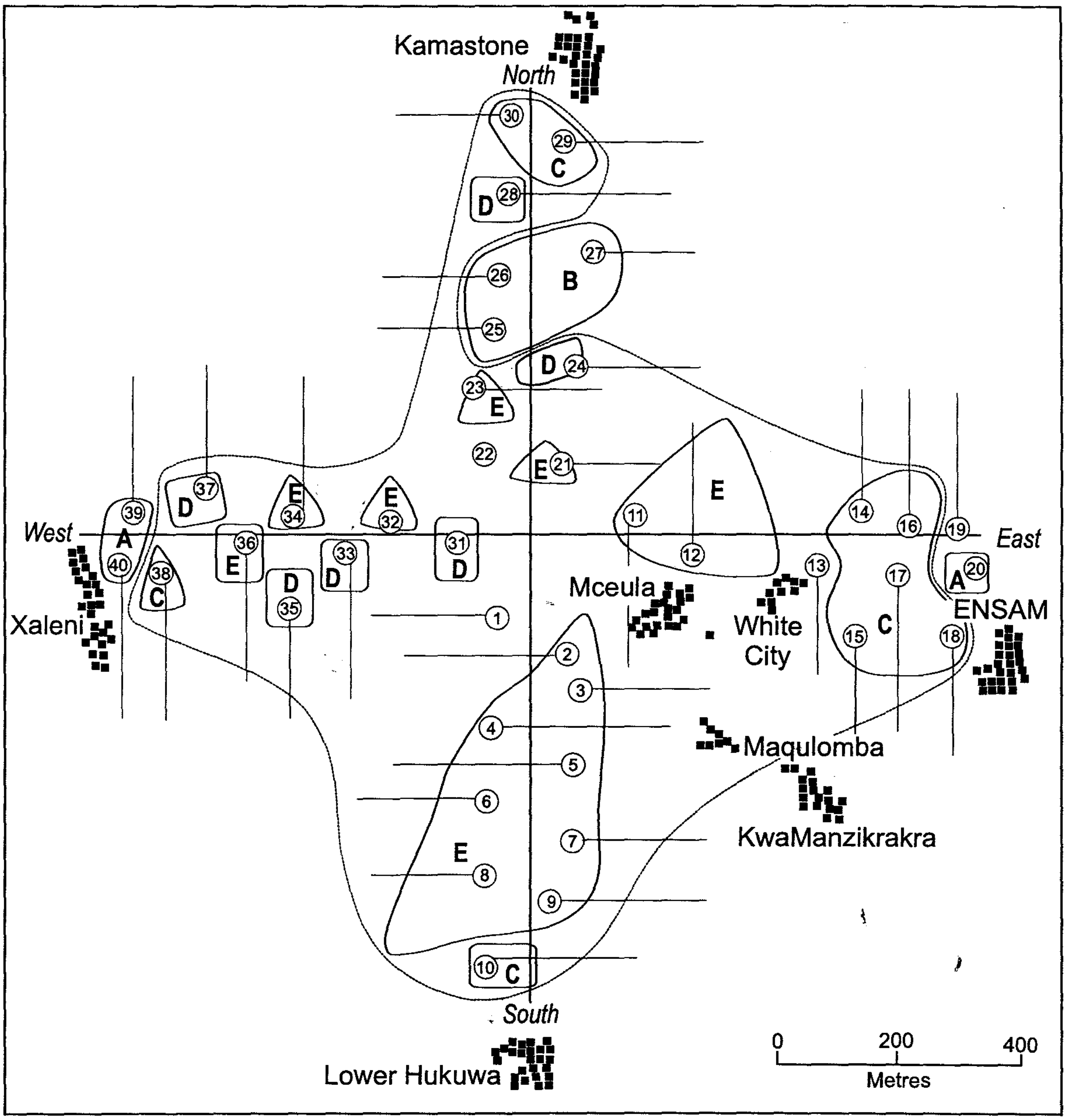


Figure 8 : Map of the Mceula Commonage Land showing where the transects were done. Note : Lines with numbers at ends show where transects were taken. A, B and C are rangelands close to the villages, and D, E and F are further from the villages.

The ratio of increase of information (here the increase of species per area) to increase of time needed to survey that area, was used by Scheepers (1968) to determine the most efficient plot size in a survey of the Highveld.

The amount of time necessary to sample a plot is not an intrinsic character of vegetation due to factors such as wind, rain, temperature and topography (Werger 1972). Time measurement is, therefore, rejected as a means for determining plot size. William (1943) plotted the number of species against the size of the area in which they occurred, both on a logarithmic scale. He found up to an area of circa one hectare the curve follows the expected increase in species due to increase in size of sample within a uniform population.

A pilot study was conducted in November 1995 to decide on the size of the sample and exact sample technique. With the use of nested quadrats (figure 5a) and line intercept, a species- area curve (figure 5b) was plotted to determine the minimal area of the quadrats. Quadrats were used to determine species presence and abundance using Braun-Blanquet's subjective method of assessment. From the pilot study a 4 square metre quadrat and a 100 metre line intercept were used in this study.

The four cardinal points of the study area were located by using a Magellan GPS Satellite Navigator instrument. Ten quadrats were thrown randomly at intervals of 200 to 300 metres along each cardinal point (figure 7 and figure 8). Each quadrat laid had a corresponding 100 metre line transect at 1 metre intervals. Altogether, forty quadrats were sampled and forty point samplings along a hundred metre line transect (figure 8) were also done. Sampling was done with increasing distance from the village.

Raw data was collected as presence of species and their relative abundance for all the forty sites. All unknown plant species were taken to the Schonland Herbarium in the Albany Museum, Grahamstown for identification.

The data from the point sampling along the 100 metre line transect was used to calculate the veld condition scores. Cover / abundance of the various species of plants in the study was calculated using Braun-Blanquet cover / abundance method. TWINSPAN computer programme was used to classify the vegetation of the study area and DECORANA computer programme was used to describe the vegetation. These are shown in chapter six.

5.1.2. NULL HYPOTHESIS

The null hypothesis for this study states that: there is no significant difference between the percentage cover and the condition of the veld closer to the villages and the veld farther away from the villages.

The Mann-Whitney U test was used as a non parametric test to accept or reject the null hypothesis and with the use of the STATGRAPHICS and Microsoft Excel computer programmes, histograms will be drawn to show the differences in the percentage plant cover of the samples closer to the villages and the samples farther away from the villages. Another histogram will be drawn to compare the condition of the veld closer to the villages and farther away from the villages.

5.2. RESULTS OF THE ECOLOGICAL STUDIES

5.2.1. VEGETATION DATA ANALYSIS

5.2.2. VEGETATION DESCRIPTION (TWINSPAN)

Two Way INdicator SPecies ANalysis (TWINSPAN) is a polythetic classification technique that uses reciprocal averaging (RA) to recognise major variations in the data set. It begins with all samples in a single clusters and then successively divides samples into a hierarchy of smaller clusters (Hill 1979a). The recognition of the final level of subdivision depends on the investigator (Gauch 1982). The result is a dendrogram showing a hierarchy which is then used in the description of the different plant communities.

TWINSPAN uses both the species and samples to produce an arranged data matrix grouping the most similar species together. The raw data from the quadrats was classified using TWINSPAN analysis (Gauch 1982), and this classified the communities according to hierarchical groupings. The classified samples and species data were shown in the form of dendrograms (Figures 10 and 11).

5.2.3. ORDINATION

CANOCO (Ter Braak & Prentice 1988) computer programme is an extension of DECORANA (Hill & Gauch 1980). CANOCO stands for canonical correspondence analysis (Ter Braak 1986) and included weighted averaging and reciprocal averaging / (multiple) correspondence analysis. It also includes detrended correspondence analysis (DCA) which is a form of ordination (Kershaw & Looney 1985).

Though the programme DECORANA (Hill 1979a) has been the standard ordination package used in recent years, it has been demonstrated to have serious flaws (Minchin 1987; Oksanen 1988; Knox 1989; Van Groenewoud 1992; Tausch *et al.* 1995; Oksanen & Minchin 1997; Podani 1997).

Ordination has been well described by Goodall (1954), Morris (1969), Whittaker (1967, 1973, 1978), Austin (1976) and Gauch (1982). It can be defined, however, as uni- or multivariate analysis which arranges sample sites along axes on the basis of data on species composition. The sites are represented by points in two dimensional space. Entities which are similar are grouped together while dissimilar ones are far apart. Another fact is that sites which are close show a similarity in species composition. Numerous ordination methods have been tested using simulated and field data, with the objective of establishing which method summarizes ecological data most effectively in low dimensional space (Gauch 1982). Detrended correspondence analysis (DCA) (Hill 1979) stands out as the most suitable ordination method for community analysis for very heterogeneous communities (Hill & Gauch 1980; Gauch 1982). An application of DCA includesstudies in island vegetation off the coast of southern California (Westman 1983), in Tasmanian vegetation (Brown *et al.* 1984), in hazel scrub in northeast Ireland (Cooper 1984) and in Savanna, forests, woodlands and grasslands in South Africa (Lubke *et al.* 1983; Theron *et al.* 1984; Whittaker *et al.* 1984; Deall 1985).

Many researchers have attempted to correlate environmental factors with the distribution of plant communities. A few recent examples are Dargie *et al.* (1991); and Palmer (1989). Examples of other phytosociological publications which include a description of the environment and a phytosociological classification in South Africa are Palmer (1991b); Breytenbach *et al.* (1993a; 1993b); Eckhardt *et al.* (1996a; 1996b); Taylor (1996).

Ordination was done using the CANOCO - DCA programme (Ter Braak 1987). It showed the similarity in species, which are classified in a hierarchy along a gradient. The Microsoft Excel computer programme was used to produce scatter diagrams (figures 12 and 13) drawn for samples and species respectively, taking axis 1 as the x-axis and axes 2 or 3 as the y-axis. The scatter diagrams provided a means of evaluating the floristic information according to the prevailing factors (gradient).

5.2.4. RESULTS

5.2.4.1. TWINSPAN

TWINSPAN generated a two way table (figure 9) which classified the data into a number of hierarchical groups. The plant communities are homogeneous and predominantly *Sporobolus fimbriatus* grassland. However, there are five sub-communities associated with the predominant grass species. At the first level, the plant community is represented by *Eragrostis racemosa* as the key species, with traces of *S. fimbriatus, Tragus koelerioides* and a variety of herbs (Figure 10).

```
                      2221113 113112233233 122333 11    234
                      567789010564698174354911324857233628090

14  ERAG  RAC    ----------------2--1-----1-1--------445  1
11  CONV  THU    -----------------------------------1-1-  1
 7  CHEN  MUC    -------------------------------------1-  1
47  TRAG  KOE    -----1--222311-----------------------1-  01
40  SONC  OLE    ---11--1-111-----111--1-------------1--  01
 6  BERK  SPP    -------1---1------1----1---------1---1-  01
41  SPOR  FIM    3-34442533342244325354455455554345552-2  001
33  OXIL  ALG    -------1----11----11----1-1111-11-11--1  001
27  KYLL  PUL    5551--11----121--------------------1---  00011
23  HETE  CON    41--1------12--42121----1-11-----------  00011
 2  ALBU  ALT    -11----1-----12-21------11-111--11-----  00011
 3  ANTH  PAN    ----2-11-11-11111-------1-11-----------  000101
48  WAHL  RIV    ----------------1----------------------  000100
34  POLL  CAM    -----1---------------------------------  000100
30  LYCI  CIN    --------------1-1----------------------  000100
26  INDI  SPP    -------1-11----------------------------  000100
25  INDI  SES    -----------1---------------------------  000100
21  HERM  COC    -----1211-------------------------1----  000100
 8  COMM  AFR    ----1-1--------------------------------  000100
 1  ACAC  KAR    -----1---------------------------------  000100
45  TEPH  SPP    ------------------11------1------------  000011
31  MONS  EMA    -------------------------1-------------  000011
20  HELI  ZEY    ------1-1--------------------1---------  000011
13  ERAG  OBT    ------------------11-----1--------2----  000011
18  FICI  STO    --------------1-------------------11---  000010
39  SONC  DRE    ----------------------1----------------  000001
37  SCHI  ASC    ---------------------11-11----1--------  000001
29  LIGH  SPP    -----------------------1---------------  000001
19  GAZA  SPP    --------------1--------1---1-----1-----  000001
16  FELI  MUR    --------------------51----11-----------  000001
12  CYNO  SPP    -------1------------1-1---------11-----  000001
 9  CONV  SAG    --------------------------1------------  000001
46  THEM  TRI    -----------------------------1---------  000000
44  TENI  EXC    -------------------------------1-1-----  000000
43  SUTE  PIN    ------------------------------1--------  000000
42  SUTE  ASP    -----------------------------1---------  000000
38  SOLA  SPP    -----1-----------------------1-1-------  000000
36  SCAB  COL    ------------------------------11-------  000000
35  POLY  AMA    ----------------------------1-1-11-----  000000
32  OXAL  ALG    ---------------------------------1-----  000000
28  LASS  DEP    ----------------------------1----------  000000
24  HYPO  ARG    -------------------------------1-------  000000
22  HERM  SPP    ---------------------------------1-----  000000
17  FICI  ALG    ----------------------------------1----  000000
15  ERAG  SPP    --------------------------------1------  000000
10  CONV  SPP    ---------------------------------1-----  000000
 4  ANTH  SPP    ----------------------------------31---  000000

                 000000000000000000000000000000000000111
                 0001111111111111111111111111111111111
                    0000000000000000111111111111111
                    0000000000111111000000000000000011
                    000011111110001110000000111111
                        0000111        00011111000011
```

Figure 9 : Two-way table generated by TWINSPAN.

The second level of division shows *Kyllinga pulchella* as the indicator species with traces of *Sporobolus fimbriatus* , *Heteropogon contortus* and other herbs. The three other communities are the *Tragus koelerioides / S. fimbriatus* dominated grassland, *S. fimbriatus / H. contortus* dominated grassland and *S. fimbriatus / Felicia muricata* and other herbs of the grassland (Figure 10).

The main grass species are *Sporobolus fimbriatus, Digitaria eriantha, Eragrostis obtusa, E.chloromelas, E. curvula, Heteropogon contortus, Aristida congesta* and *Cymbopogon plurinodis*.

Low and Rebelo (1996) place this grassveld under "Sub-Arid Thorn Bushveld." *Acacia karroo* bushclamps characterise this vegetation. The most prominent grass species include *Themeda triandra, Cymbopogon plurinodis, Eragrostis curvula, S. fimbriatus, H. contortus, D.eriantha* and *Eustachys paspaloides*. Hoare (1997) classifies the study area as "*Acacia karroo-Tragus koelerioides* dry savanna." Other commonly occurring species in the area are *E. capensis, A. cogesta, E. obtusa, H. contortus* . The dominant plant species are *E. curvula, S fimbriatus, C. plurinodis* and *Tragus koelerioides, D. eriantha, Gazania krebsiana* and *Felicia muricata*. Almost all the common plant species described earlier occur in the study area except *E. curvula, A. congesta, C. plurinodis and D. eriantha.*

The species dendrogram (Figure 11) shows the association of plant species in the study area. Nine different associations are indicated. **A, B C, D** and **G** form a cluster which indicates the association between *Themeda triandra, Heteropogon contortus, Sporobolus fimbriatus, Ficinia stolonifera* and *Heilichrysum argyrophyllum*. **E** indicates *Acacia karroo - Hermania coccocarpa* association. **H** indicates the *Tragus koelerioides - Berkhaya pinatifida* association while **I** indicates the *Eragrostis racemosa - Convolvulus thumbergii* association.

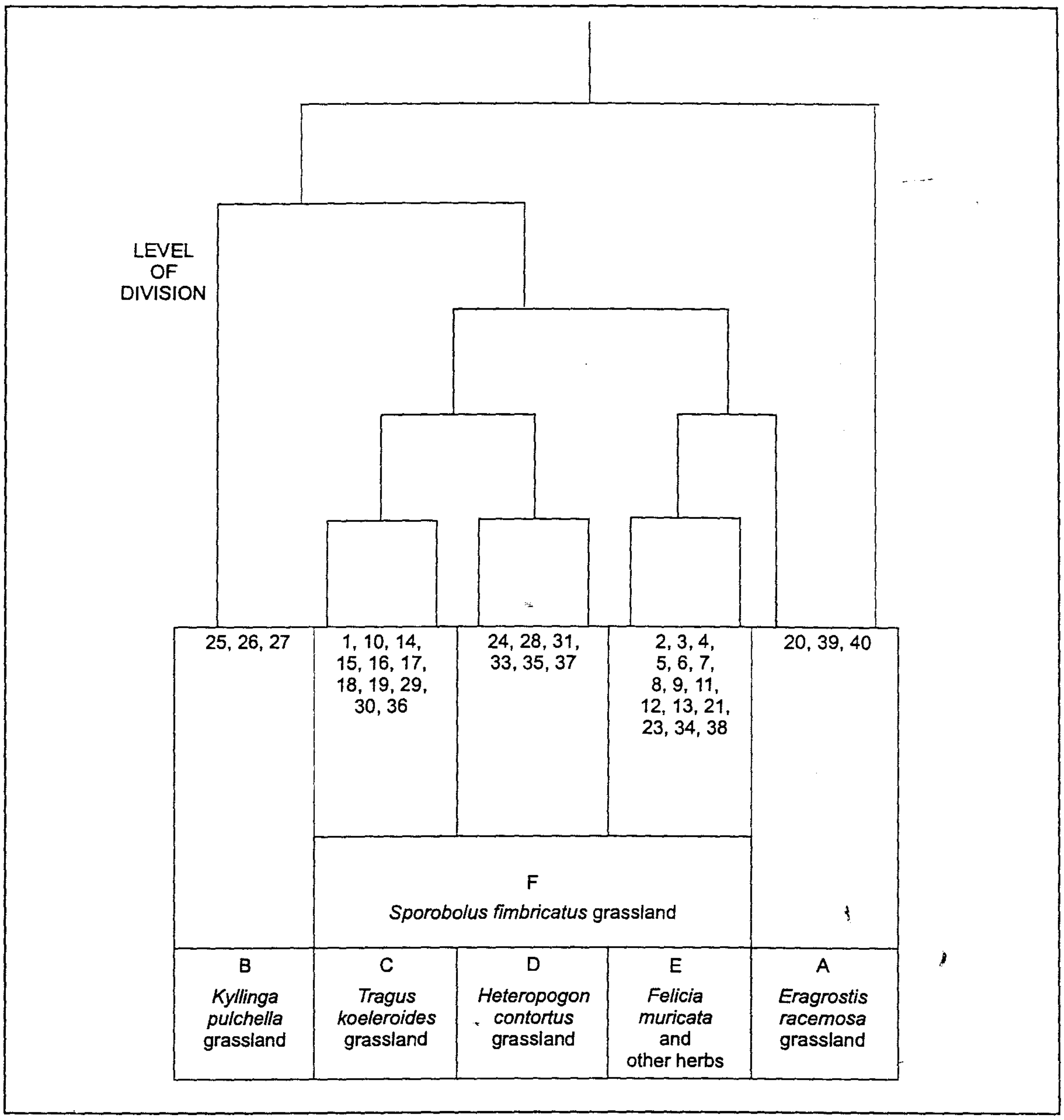


Figure 10 : Samples dedrogram. Groups A - F are the various vegetation groups present as a result of clustering of most similar samples.

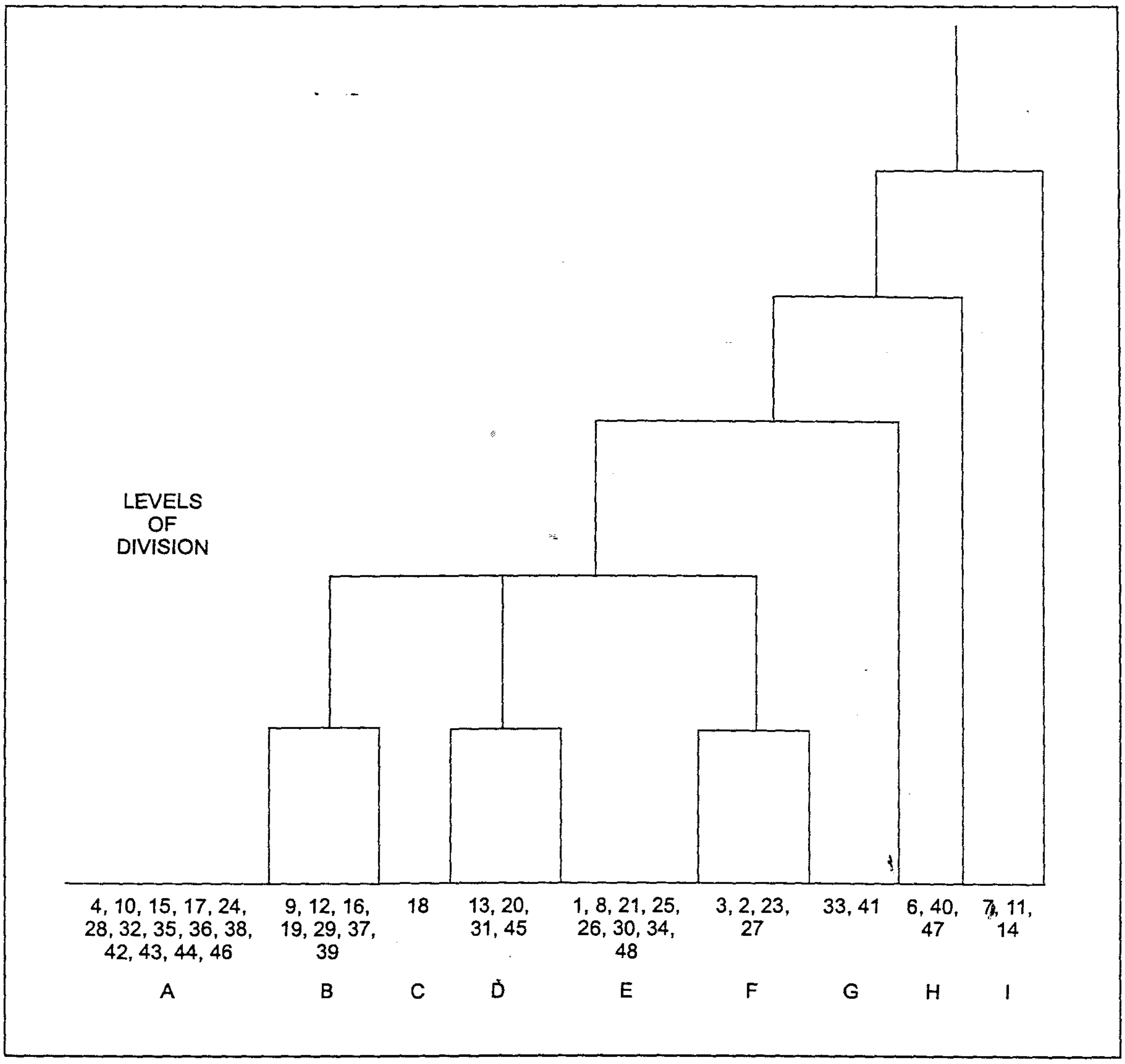


Figure 11 : Note : A - F form a cluster, while G, H and I are unrelated, separate clusters.

Cymbopogon plurinodis does not grow in the study area, perhaps, because it grows in dry shallowsoils on mudstone, and also in selectively grazed sites (Trollope *et al.* 1995). Though the soils of the study area are shallow, they are derived from shales and the area is not selectively grazed. *D. eriantha* does not grow in the study area because it occurs in dry fertile habitats with some bush (Trollope *et al.* 1995). *A. congesta* occurs in dry habitats with shallow soils or extreme soil erosion. The soils in the study area are shallow, but the soil erosion problem is not extreme (Table 1). This may be a good reason why it does not support the growth of *A. congesta*. *Kyllinga pulchella* grows at certain areas where there is overgrazing(Trollope *et al.* 1995) and this supports the TWINSPAN classification.

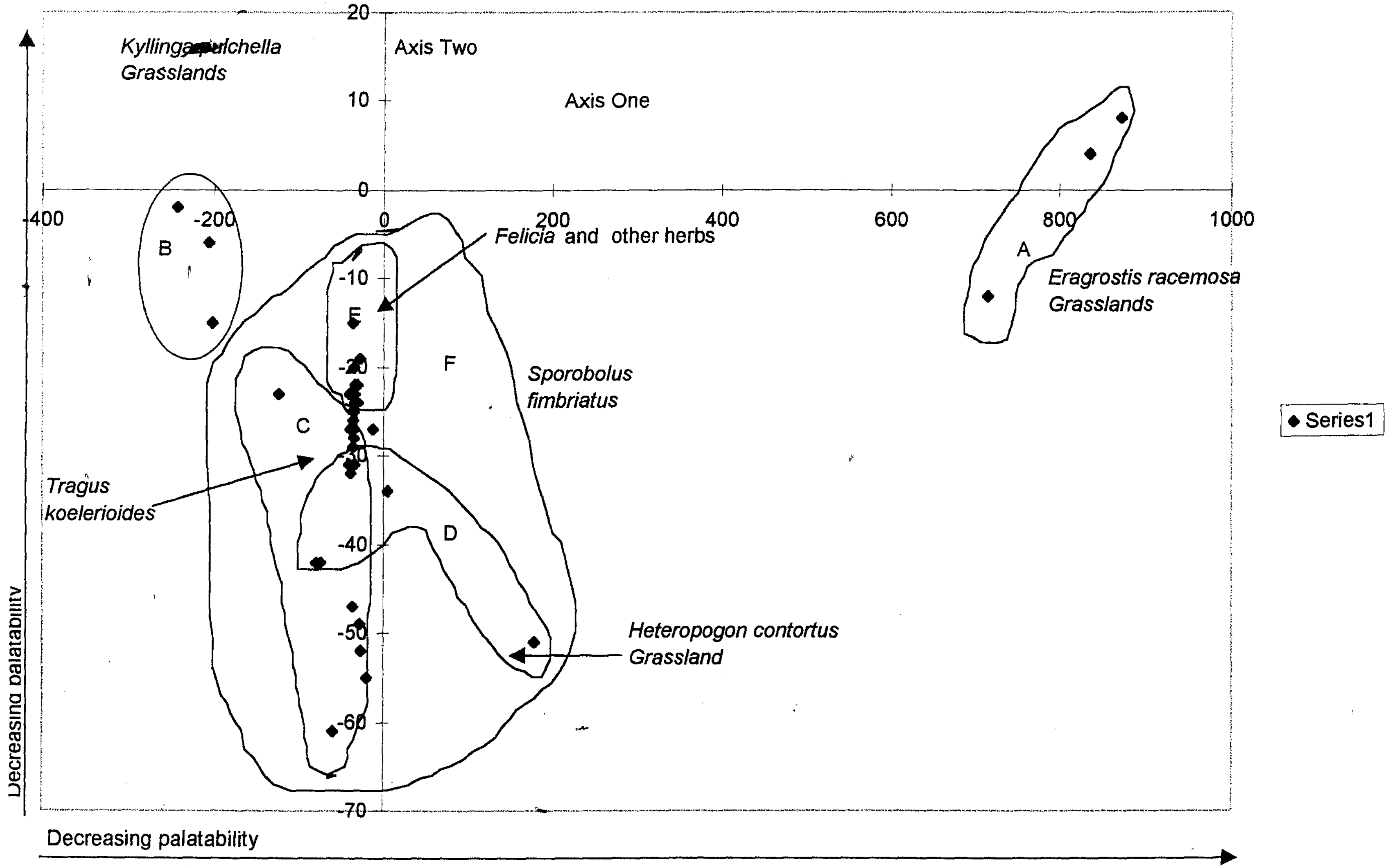
5.2.5. DECORANA

Scatter diagram (figure 12 and 13) were produced. Species and samples were grouped along axes 1 and 2 (samples) and axes 1 and 3 (species). The gradient described was palatable to unpalatable grasses along both axes. The gradient was more prominent from the lower end to the upper end of axis 2 in the sample ordination scatter diagram. Groups **A** ,**B** and **C** are closely related and belong to the rangeland closer to the village. Groups **A** and **B** consist of mainly unpalatable species, such as *E. racemosa, Kyllinga pulchella, T. koelerioides and E. obtusa.*

Groups **D**, **E** and **F** (Figure 12) are closely related and lie on the lower end of axis 2. They belong to the rangeland farther away from the village and are dominated by palatable grasses. The most palatable species are *S. fimbriatus, Themeda triandra* and *H. contortus*. The least palatable species are *T. koelerioides, F. muricata*, other herbs and sedges.

The scatter diagram for the species ordination was plotted along axes 1 and 3 (figure 13). It showed a close relationship between *H. contortus, T. triandra* and *S. fimbriatus* These are found in the cluster indicated by **A**, **B**,**C**, **D** and **G**. *Tragus koelerioides* falls midway along the gradient from palatable to unpalatable species. *Eragrostis racemosa*, the sedges and herbs also lie towards the end of the unpalatable grasses. The gradient from palatable to non-palatable species is more evident along axis one than axis three.

Figure 12: Samples ordination. Sites A, B and C are close to the villages, and D, E, F are farther from the villages.



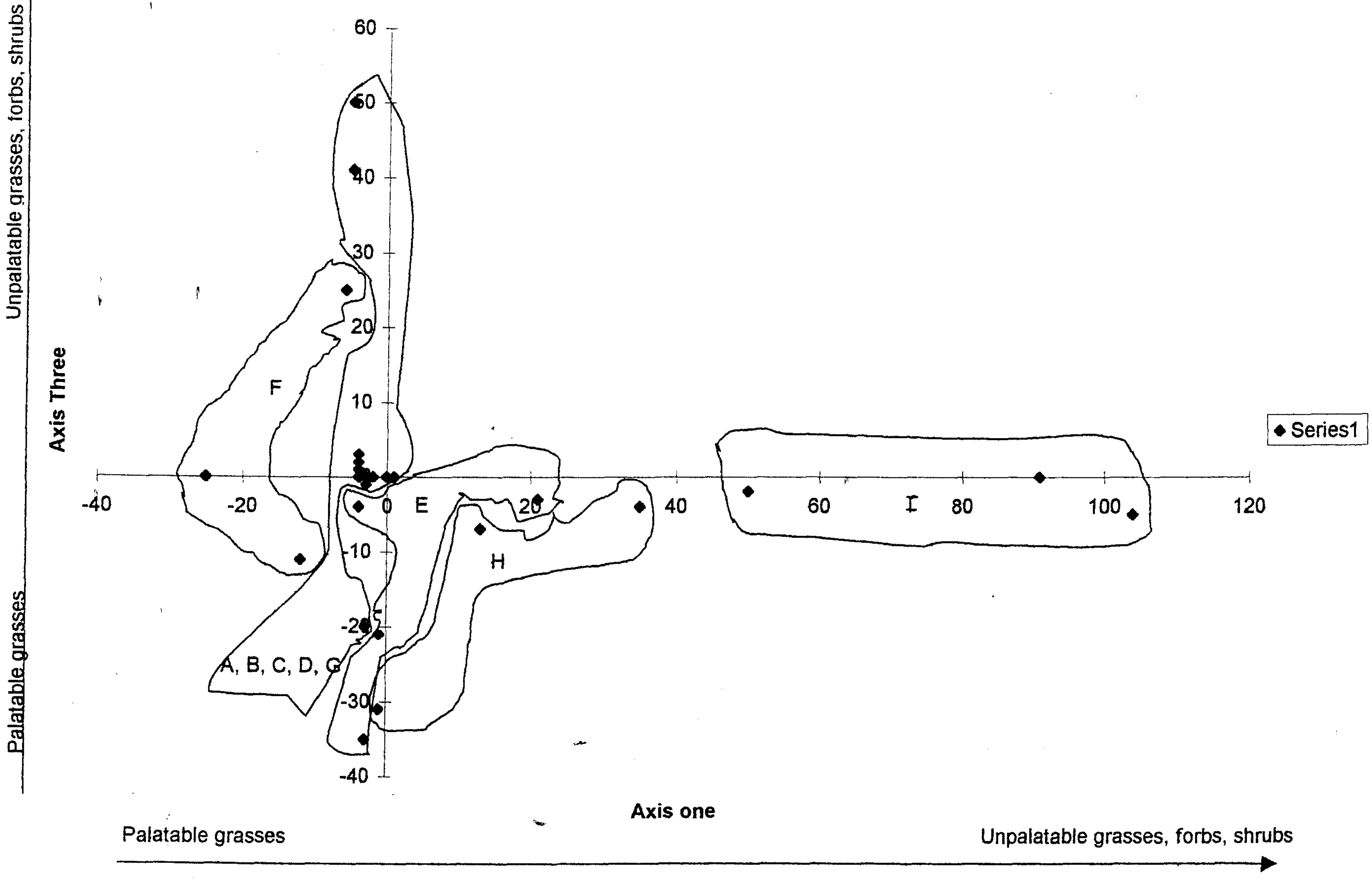


Figure 13: Species ordination. Note: A - F form a cluster, while G, H and I are unrelated, separate clusters.

5.3. VELD CONDITION ASSESSMENT

5.3.1. INTRODUCTION

Veld condition has been well described by Trollope (1987); Trollope *et al.* (1995); Danckwerts (1992), and Tainton (1981). Veld condition refers to the state of health of the veld in terms of its ecological stability and the potential for producing forage for livestock. A veld condition survey will indicate suitability of an area of land for livestock production but it does not play a role in determining its land use capability (Trollope 1987).

Trollope *et al.* (1991), defined veld condition as the condition of vegetation in relation to some functional characteristic, normally, forage production and resistance to soil erosion. The necessity for assessing the condition of an area of veld will depend upon what is known about the land use capability and suitability of the area under consideration. In situations where only the land use suitability is known, then veld condition surveys should be conducted in both arable and other classes of land. Conversely, if the land use suitability is known, then veld condition surveys should be restricted to the area classified as veld (Trollope 1987). This is an important procedural point, because much of the potential arable land in the study area is currently being used as veld for livestock production, and will continue to be used for this purpose because of social and cultural factors.

Trollope *et al.* (1995), re-affirmed that the purpose of assessing veld condition is to determine the current condition of the vegetation, and to use this information to formulate veld management practices such as stocking rates, grazing and browsing management, rotational resting and veld burning. Veld condition data can be used both for regional and farm planning. At regional level, the data are most useful in indicating the potential of an area for livestock production in terms of number and types of livestock. This information can also be used to indicate the conditions of the veld in relation to its potential condition. At the farm level, it is essential for the formulation of veld management practices like stocking rates, rotational resting, rotational grazing and veld burning (Trollope 1987).

5.3.2. MODE OF ASSESSMENT

The key forage species were selected using the method developed by Willis & Trollope (1987). This comprised subjectively assigning forage factors to each grass species occurring in the veld according to the procedure described by Trollope (1986) (Appendix 1). These represented the potential of the different grass species to produce forage for grazing livestock, particularly cattle and sheep. The forage factors were used to estimate the forage production potential of the six communities as mapped out by the DCA. The initial step in the identification of the key ecological grass species was the ordination of the sample sites of the grass species matrix using Detrended Correpondence Analysis (DCA) (Hill 1979b). Benchmark 4 (Trollope *et al.* 1995) was used in the study area to calculate the Veld Condition Scores (VCS) of the six communities.

Tainton (1981) and Trollope (1987) put the various species into these categories: Decreaser species, Increaser 1 species, Increaser 2 species and Invader species (Appendix 2).

1. Decreaser species: Species which dominate in good veld but decrease when veld is mismanaged (Tainton 1981).
2. Increaser 1 species: Species which dominate in poor veld and increase with understocking or selective grazing (Tainton 1981).
3. Increaser 2 species: Species which dominate in poor veld and increase with overstocking (Tainton 1981).
4. Invader species: Species which are not indigenous to a specific area (Tainton 1981).

DECREASER SPECIES DOMINATED VELD

This is veld that is in ideal condition for livestock production. The preferred grass species are grazed according to their physiological requirements and the livestock is allowed to select a superior diet (Trollope 1987). Examples of grass species in this category are: *Heteropogon contortus, Panicum maximum, Setaria sphacelata, Trachne dreggi, Themeda triandra, Bracharia serata* and *Eragrostis capensis*.

INREASER 1 SPECIES DOMINATED VELD

This is veld that has either been understocked or selectively grazed (Trollope 1987). Examples of grass species that fall into this category are: *Cymbopogon plurinodis, Merxmuellera distichia, Tristachya lencothrix, Elionurus muticus* and *Helichrysum spp*.

INCREASER 2 SPECIES DOMINATED VELD

This is veld that has been overstocked and ecologically constitutes a reversal in the grassland succession from the decreaser stage to the lower pioneer Increaser 2 stage (Trollope 1987). Examples of plants / grass species include *Aristidia congesta, Cynodon dactylon, Digitaria eriantha, Eragrostis chloromelas, E. lehmmaniana, E. obtusa, E. plana, E. racemosa, Karroochloa purpurrea, Sporobolus fimbriatus, Tragus koeleroides*, forbs and sedges e.g. *Kyllinga pulchella* and herbs such as *Felicia muricata*.

INCREASER 1 AND 2 SPECIES DOMINATED VELD

This type of veld develops in situations where there are a few large camps in the grazing system and either continuous grazing or very low form of rotational grazing is applied.

Heard *et al.* (1986) compared five methods of assessing veld condition and found that by using only a limited number of key species to calculate an index of veld condition, a considerable degree of precision would be achieved. These responsive key species provide an indication of the past grazing pressure (Hardy & Hurt 1989), but do not necessarily indicate the grazing potential of an area unless a direct linear relationship exits between veld condition and grazing capacity. Barnes *et al.* (1984) calculated grazing capacity by relating it to veld composition.

The key species approach, whereby species responsive to the grazing impact are used in the calculation of a Veld Condition Index (VCI) appears to have the greatest potential for indexing veld condition (Hurt & Bosch 1991). Westfall *et al.* (1983) made use of Braun-Blanquet data to assess the condition Sour Bushveld. These workers determined canopy cover-abundance and basal cover to facilitate veld condition assessment.

Stocking rate is probably the single most important element in determining sustainabilty of animal production from natural veld. The need for veld condition assessment and simultaneous determination of grazing capacity cannot be over-emphasized for the sustained use and management of the vegetation of South Africa. Much research has been devoted to the subject of veld condition assessment and grazing capacity (Foran *et al.* 1978; Vorster 1982; Mentis 1983; Willis & Trollope 1987; Danckwerts & Teague 1989).

5.3.3. DEFINITION OF TERMS

5.3.3.1. STOCKING RATE

Stocking rate is the area of land in a system of management that the operator has allotted to each animal unit in the system and is expressed per length of the grazable period of the year (Danckwerts 1982).

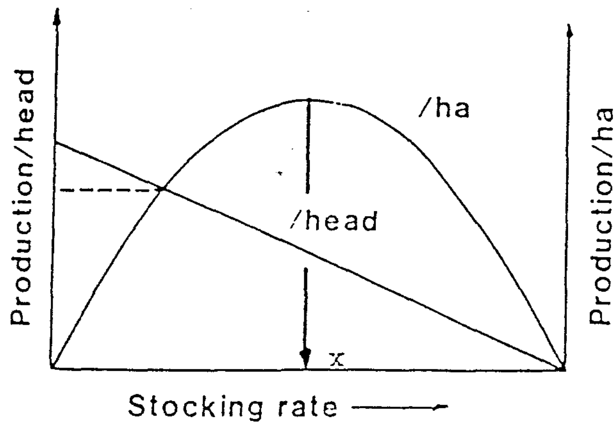


Figure 14: The generalised relationship between stocking rate and gain per Head and between stocking rate and gain per hectare (ha). (After Jones and Sandland 1974). The point x denotes the critical stocking rate.

Production per head (be it liveweight gain, milk production or wool production) remains constant at very light stocking rates after which it drops as stocking rate increases. In contrast, total animal production per hectare increases with increasing stocking rate up to a critical stocking rate after which it drops rapidly (figure 14).

5.3.3.2. CARRYING CAPACITY

Carrying capacity of veld is defined as the area of land required to maintain an animal unit over an extended period without deterioration to vegetation or soil (Danckwerts 1982). The difference between carrying capacity and stocking rate is that carrying capacity is a function of the veld while stocking rate is operator dependent and often the farmer's estimate of the carrying capacity.

5.3.3.3. GRAZING CAPACITY

The grazing capacity of veld is the area of land required to maintain a grazing animal unit over an extended period without deterioration to vegetation or soil (Danckwerts & Daines 1981). The single most important factor that determines grazing capacity is the veld condition. Danckwerts & Daines (1981) showed that the grazing capacity of the False Thornveld of the Eastern Cape is only 52% of its potential as a result of veld deterioration caused by overstocking. Thus, in order to halt veld deterioration, it is essential that stocking rates be reviewed and set to current grazing capacity of the veld.

5.4. CALCULATION OF VELD CONDITION SCORES

The key grass species must be put into their respective categories i.e Decreaser species, Increaser 1 species etc. (Appendix 2). The forage factor for each species must be assigned. The percentage of abundance of each species at each site obtained from the field data must be assigned. The score for each key grass species is calculated by multiplying the forage factor by the percentage abundance. The total score is found by adding up the scores of individual grass species at each site.

Species Category	Species	Factor	Banchmark		Site A		Site B		Site C		Site D		Site E		Site F	
			%	Score	%	Score	%	Score	%	Score	%	Score	%	Score	%	Score
Decreaser	*Heteropogon contorus*	7	0	0	4,3	30	5,5	39	10,3	72	17,0	119	3,5	25	10,3	71
	Panicum maximum	10	0	0	0	0	0	0	0	0	o	0	0	0	0	0
	Themeda triandra	10	4	40	0	0	0	0	0	0	0	0	0	0	0	0
	Eragrostis capensis	4	0	0	0	0	5,8	23	0	0	0	0	0	0	0	0
	Brachiaria serrata	2	0	0	0	0	0,7	1	0	0	0	0	0,3	1	0	0
Total Decreaser			4	40	4,3	30	12,0	63	10,3	72	17	119	3,8	26	10,3	71
Increaer 1	*Cymbopogon plurinodis*	7	5	35	0	0	0	0	0	0	0	0	0	0	0	0
	Merxmuellera distichia															
	Tristachya leucothrix															
	Elionuris muticus															
Total Increaser 1			5	35	0	0	0	0	0	0	0	0	0	0	0	0
Increaser 2	*Aristida congesta*	0	0	0	0	0	0	0	2,2	4	0	0	0	0	0	0
	Cynodon dactylon	2	4	8	0	0	0	0	0	0	0	0	2,0	4	1,4	3
	Digitaria eriantha	7	19	133	0	0	0	0	0	0	0	0	0	0	0	0
	Eragrostis lehmanniana	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Eragrostis obtusa	0	0	0	0,8	0	0	0	0	0	0	0	0	0	0	0
	Eragrostis plana	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Eragrotis racemosa	2	0	0	26,3	53	1,2	2	0	0	2,1	4	2,0	4	1,4	3
	Forbs and sedges	0	7	0	0	0	35,9	0	15,5	0	8,6	0	0,7	0	8,3	0
	Tragus koelerioides	1	0	0	5	5	0,4	1	4,6	5	2,1	2	1,0	1	2,6	3
	Sporobolus fimbriatus	7	35	245	28,9	202	20,6	144	20,6	144	49,8	349	67,6	473	46,0	322
Total Increaser 2			65	386	61,0	260	58,1	147	42,9	153	62,6	355	73,7	482	59,7	331
Total score				555		290		210		225		474		508		402
Percentage score				100		52,2		37,8		40,5		85,4		91,5		72

Table 4: Calculation of Veld Condition Scores at Six Sites in the Mceula Commonage Land

VCS = (Sample site) FS / Benchmark FS x 100

Where, VCS = Veld condition score.

Sample site FS = Forage score of sample site.

Benchmark FS = Forage score of benchmark (4).

Table 3 shows the calculations of the veld condition scores of all the six communities.

5.4.1. DISCUSSION: VELD CONDITION SCORES

Table 4 gives a full picture of the condition of the veld at the study area. It points to any deleterious effects of past management. Sites **D**, **E** and **F** (farther from the villages) represent veld in excellent condition. Site **D**, while in excellent condition, has a large number of Increaser 2 species, suggesting previous overgrazing and a larger number of Increaser 2 species than site **F**. This suggests that the degree of overgrazing on site **D** has been greater than site **F**.

Site **D** has a VCS score of greater than 80% and the proportion of Decreaser species is greater than that of the benchmark (Table 4). This indicates that site **D** has been well managed in the past and not been over- or understocked (Danckwerts 1982).

Site **E** has a VCS of greater than 80%. This indicates that it has been well managed. However, the proportion of Decreaser species is less than that of the benchmark. It also has a greater proportion of Increaser 2 species relative to that of the benchmark. This indicates previous overgrazing at site **E**.

Sites **B** and **C** (close to the villages) have a VCS of just about 40% and the condition of these two sites are the poorest. However, they have a greater proportion of Decreaser species than the benchmark and the proportion of Increaser 2 species is lower relative to that of the benchmark. This suggests that these sites had previously been overgrazed and are on their way to recovery, indicated by a lower proportion of Increaser 2 species relative to that of the benchmark. Site **A** (close to the villages) has a VCS of 52% and a lower proportion of both Decreaser and Increaser 2 species. Site **A** has not been well managed due to the lower veld condition score.

Overall, the veld in the study area has not been well managed. The relative usefulness of each site for livestock production is reflected by the percentage score at each site.

5.4.2. CALCULATION OF GRAZING CAPACITY

The grazing capacity of veld is low. Thus to avoid expressing grazing capacity in fractions of animal units, in veld situations the parameter is normally expressed in hectares per mature livestock unit (ha/A). However, these units diminish in magnitude as grazing capacity increases and are not linearly related to the number of animals on a specific area of land (figure 15) (Danckwerts 1982).

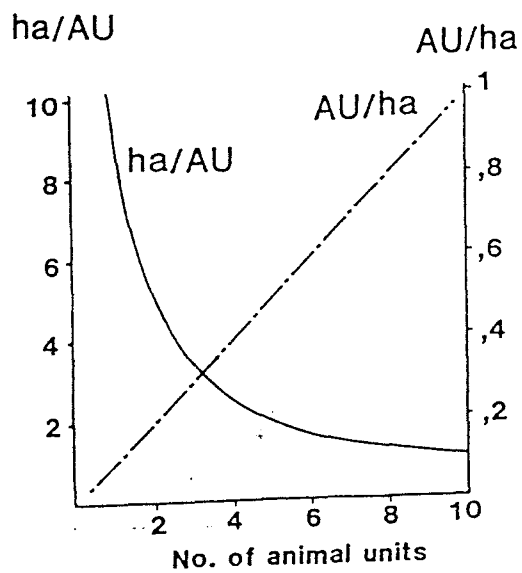


Figure 15: The relation of the units ha/AU and AU/ha with increasing Animal Units (0 - 10) on a 10 hectare area of land (Danckwerts 1982)

Accurate calculation of grazing capacity from veld condition can be achieved only after establishment of the relationship between veld condition score (VCS) and grazing capacity as determined by a research programme (Danckwerts 1982). In absence of research results, grazing capacity can only be estimated by using veld condition scores. In order to do this the grazing capacity of the benchmark must, however, be known. This is taken as the stocking rate actually applied at that site (Appendix 3) (Trollope *et al.* 1995). The grazing capacity of a sample site can then be calculated in proportion to the percentage veld condition score of that site, viz.

$$\text{Grazing capacity of sample site} = \frac{\text{\% score at sample site x grazing capacity of benchmark}}{100}$$

$$\text{From figure 15, ha/AU} = \frac{1}{\text{AU/ha}}$$

The stocking rate applied at benchmark 4 (appendix 3) (Trollope *et al.* 1995) is 6 ha / AU = 0,166 AU/ha.

$$\text{Grazing capacity, Site } \mathbf{A} = \frac{52{,}3 \text{ x } 0{,}166}{100} = 0{,}\ 087 \text{ AU/ha.}$$

$$\text{ha/AU} = \frac{1}{\text{AU/ha}}$$

$$= \frac{1}{0{,}087}\text{ha/AU}$$

$$= 11{,}5 \text{ ha/AU.}$$

The grazing capacities of the respective sites are found in table 5.

SITES	GRAZING CAPACITY ha/AU
A	11.5
B	15.9
C	14.9
D	7.1
E	6.7
F	8.3

Table 5: Calculated values of the grazing capacities of six sites at Mceula

Plate 3a

Plate 3b

Plates 3a & 3b: Good rangeland farther away from the villages

Plate 4a

Plate 4b

**Plates 4a & 4b: Overgrazed veld close to the villages.
Note the exposed surface of the soil.**

5.4.3. DISCUSSION: GRAZING CAPACITY

Appendix 3, benchmark 4, was used to compare the stocking rates with the estimated grazing capacities of the respective sites. The stocking rate (benchmark 4) used was 6 ha/AU. The calculated grazing capacity values at the six sites of the study area are expressed in table 5. At site **A**, the VCS was 52,3% and the stocking rate (benchmark) is 12 ha/AU. The estimated grazing capacity was 11,5 ha/AU. At site **B**, the veld condition score (VCS) is 37,9% and the estimated grazing capacity was 15,9 ha/AU. The VCS at site **C** was 40,5% and the estimated grazing capacity was 14,9 ha/AU. Sites **A**, **B** and **C** (Plates 4a and 4b) are closer to the villages and have poorer veld condition scores. Their estimated grazing capacities are much lower compared to that of the benchmark which is 6 ha/AU. This is an indication of poor grass cover at the sites closer to the villages.

The veld condition scores at sites **D**, **E** and **F** (Plates 3a and 3b) are 85,2%, 91,4% and 72,4% respectively. The estimated grazing capacities were 7,14 ha/AU for site **D**, 6,7 ha/AU for site **E** and 8,3 ha/AU for site **F**. Sites **D**, **E** and **F** are farther away from the villages. The estimated grazing capacities compared to that of the benchmark which is 6 ha/AU indicate a much better grass cover at the sites farther away from the villages. These values show an indication of overgrazing of the veld closer to the villages.

5.5. INFERENTIAL STATISTICS

In plant ecology, it is often very necessary to test whether samples of a phenomenon are derived from the same parent population. Where samples are independent of each other, the t-test may be applied as a parametric test, and the Mann-Whitney U test as a non-parametric test, to accept or reject the null hypothesis. If the test statistic is less than the critical value for a given rejection level, then the probability that the null hypothesis is correct is high and it is accepted. It is, however, rejected when the test statistics is greater than the critical value for a given confidence level (Fowler & Cohen 1997).

5.5.1. THE MANN-WHITNEY U TEST FOR TWO INDEPENDENT GROUPS

Two U values are now calculated for each set of values from Table 6:

$$U_1 = n_1n_2 + \frac{n_1(n_1 + 1)}{2} - R_1$$

$$= (6 \times 6) + \frac{(6 \times 7)}{2} - 358,0$$

$$= -301,0$$

$$U_2 = n_1n_2 + \frac{n_2(n_2 + 1)}{2} - R_2$$

$$= (6 \times 6) + \frac{(6 \times 7)}{2} - 379,4$$

$$= -322,4$$

The smallest of these two U values is - 322,4. The critical values for a (6:6) distribution are 5 (5% level) and 2 (1% level). Since the smallest U value is less than both of these values, the null hypothesis may be rejected. Thus, there is a significant difference between the percentage plant cover and the condition of the veld close to the villages and that farther away from the villages.

SAMPLE SITES	% PLANT COVER (R_1)	VELD CONDITION SCORES (R_2)
A	61,0	52,2
B	58,1	37,8
C	42,9	40,5
D	62,6	85,4
E	73,7	91,5
F	59,7	72,0
N = 6	(R_1) = 358,0	(R_2) = 379,4

Table 6: The Mann-Whitney U Test for two independent groups

Statistical two sample analysis tests were done on the six sites. With the use of the STATGRAPHIC and Microsoft computer programmes, the percentage plant cover and veld condition scores of the six sample sites were used in the drawing of histograms (figures 16 and 17). Sites **D**, **E** and **F** are rangelands farther away from the villages while sites **A**, **B** and **C** are rangelands close to the villages. The histogram of percentage cover and sample sites (Figure 16) compares the percentage plant cover of the sites **A**, **B** and **C** (close to the villages) with that of sites **D**, **E** and **F** (farther from the villages). Figure 16 shows that the rangelands close to the villages (Sites **A**, **B** and **C**) have a low percentage plant cover due to overgrazing. The rangelands farther from the villages (Sites **D**, **E** and **F**), on the other hand, have a higher percentage of plant cover.

The histogram of veld condition scores and sample sites (Figure 17) shows a comparison of the veld condition scores of sites **A**, **B** and **C** (close to the villages) and that of sites **D**, **E** and **F** (farther from the villages). Sites **D**, **E** and **F** have much higher veld condition scores than sites **A**, **B** and **C**. The low veld condition scores of sites **A**, **B** and **C** may be due to overgrazing and mismanagement of the veld at those sites.

Figure 16 : Histogram of % plant cover and sample sites

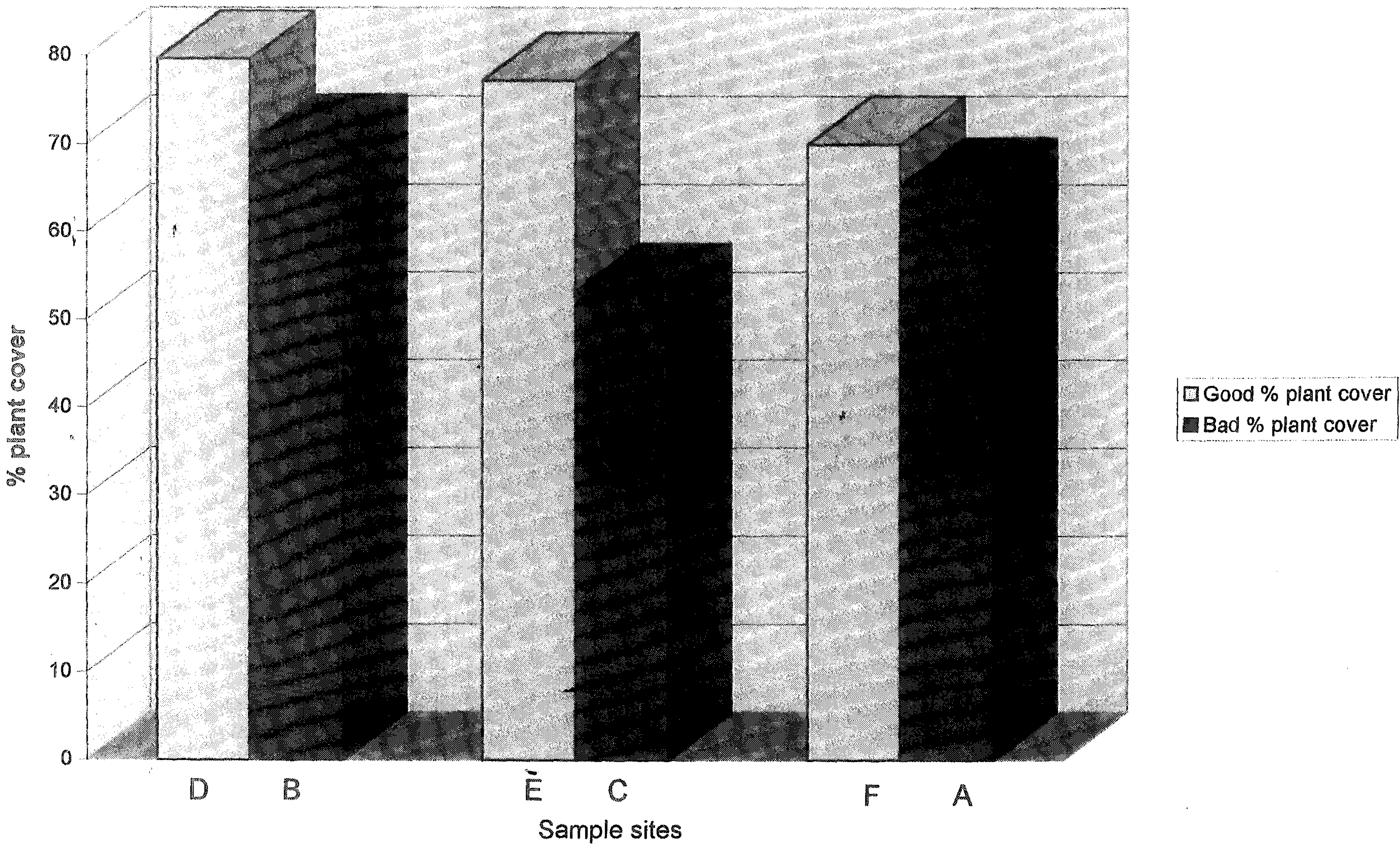
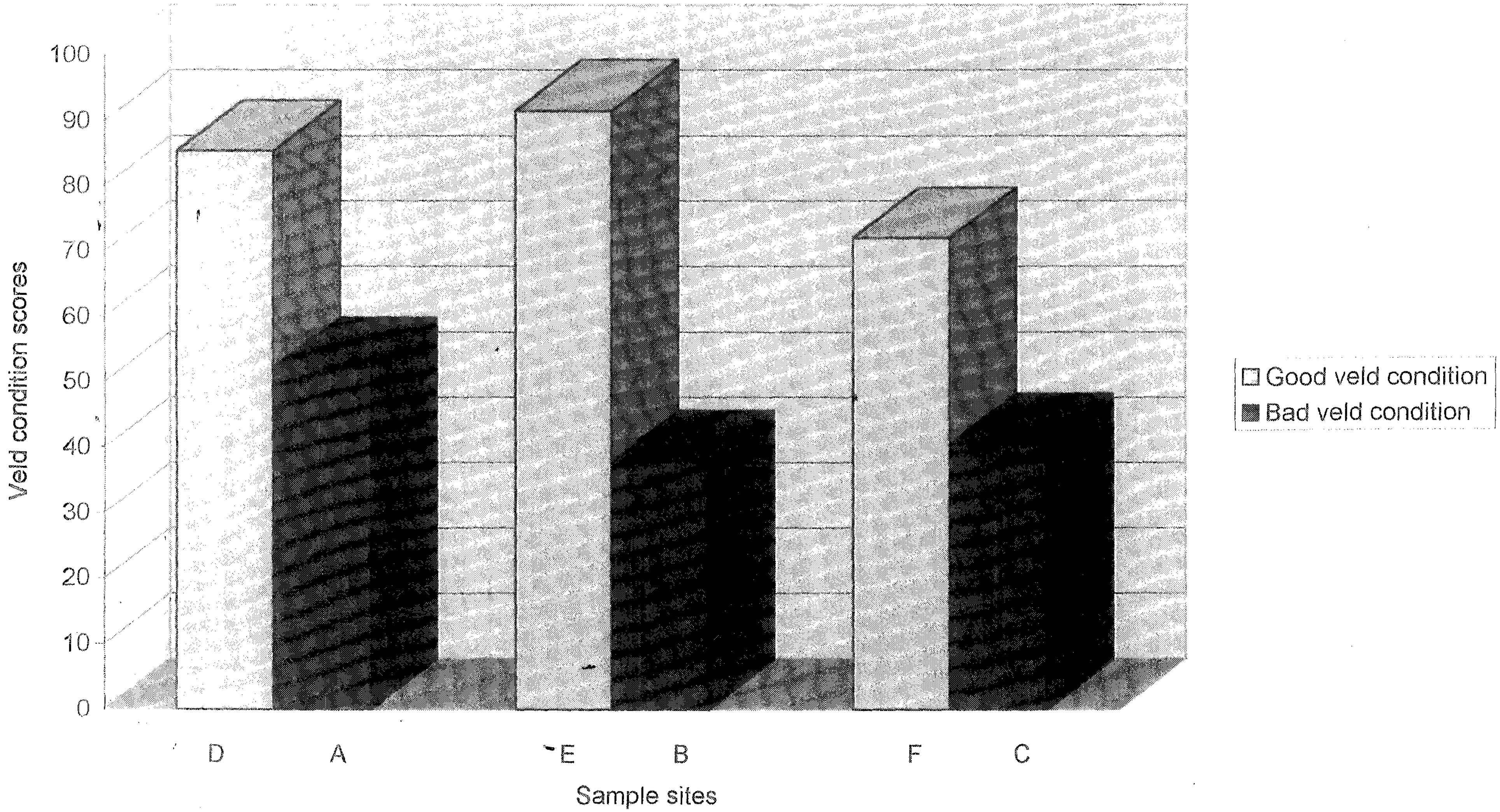


Figure 17 : Histogram of veld condition scores and sample sites



CHAPTER SIX

6. COMPARISON OF THE PARTICIPATORY AND SCIENTIFIC RESULTS

6.1. INTRODUCTION

A good number of livestock farmers know about carrying capacity of the veld, rotational grazing and stocking rate. It was revealed that livestock farmers were given stock cards and their animals were counted regularly and entered on the stock card. When asked about their perceptions on the issuing of the stock cards by the government, and the issue of rotational grazing, they stated that they were happy about them. This is because it helped them to know how many animals they owned at any particular time, and they recognised that it helped prevent overgrazing and soil erosion. Rotational grazing is determined by the community. Since there are no fences to keep the animals within a specific grazing camp, the only way to practise rotational grazing is to restrict the livestock raisers to specific areas of the rangeland for grazing at certain times of the year (for example during summer) and reserve the other areas of the rangeland for the other seasons.

It was also revealed during the group discussions that there is overgrazing of the veld close to the villages. The greater part of these areas are bare and without plant cover. this supports the scientific results. The three sites **A**, **B** and **C** generated by the DCA are the sites closer to the villages. The veld condition scores of 52,2%, 37,8% and 40,5% respectively make them the poorest of the six sites. Sites **D**, **E** and **F** which are farther away from the villages had veld condition scores of 85,4%, 91,5% and 72% respectively.

The scientific results of the condition of the veld show that three out of the six sites generated by the DCA are in excellent condition. However, the presence of a large proportion of Increaser 2 species suggests previous overgrazing (Trollope 1987). Only two sites had veld condition score (VCS) greater than 80% (sites **D** and **E**), and the proportion of Decreaser species of site **D** was greater than that of the benchmark. This indicates that only one sample site out of the six had been well managed in the past, and had not been over or understocked. Overall, the scientific results of the condition of the veld at Mceula generally indicates the veld is not in good condition, and has not been well managed.

6.2. CARRYING CAPACITY AND GRAZING CAPACITY

Even though a good number of livestock raisers know about carrying capacity of the veld, rotational grazing and stocking rate, some still believe that grazing is determined by good rains and that rainfall rather than stocking rate is the key determinant of pasture quality. This came out from the discussion of their perceptions about carrying capacity and stocking rate.

Eighty (80) families have a right to own land. If a livestock farmer obtains grazing land from a landlord, the requirements are as follows: one ox is equivalent to six sheep or goats. One must have a maximum of 20 cattle or 120 sheep or goats. The landlord obtains 4 out of the 20 cattle or 24 out of the 120 sheep or goats (20%) as rental for use of his land. Thus, if one does not own land the number of livestock one can own is determined by the landlord. This situation can lead to overstocking, since, the landlords , in an attempt to get more stock for themselves, would encourage prospective land seekers to own more stock.

From discussions , it was confirmed that there is no overstocking at present, due to loss of animals through stock theft and drought. The capacity of the Mceula commonage land is 3776 hectares. Expressed in terms of carrying capacity, it is capable of stocking up to a maximum of 1200 sheep / goats and 600 cattle. However, currently, there are 600 sheep / goats and 500 cattle. Thus, at the moment, the stocking rate is much lower than the carrying / grazing capacity of the veld. The grazing capacity calculated for the six sites at Mceula is much higher than what the veld is actually carrying at the moment. This is because livestock owners have fewer animals. It pre-supposes that there is understocking, which also has adverse effects on the condition of the veld.

Understocking of livestock will lead to selective grazing of the more acceptable grass species. This causes a decrease in these species, and a corresponding increase in the less acceptable grass species. Grazing animals discriminate against the less acceptable grass species. This same problem results from the implementation of rotational grazing and resting systems (Laker 1975).

It was pointed by the community that certain unpalatable grass species and undesirable plants are found in the grass veld, thus causing an encroachment of the undesirable plants into the veld to the detriment of the grazing potential of the veld. Identification and examples of some of the undesirable plants was revealed by discussion with the residents. The scientific results confirmed the presence of these species:

(1) *Euryops oligoglossus* (common name: Ulapesi). It is estimated that approximately 8500 ha in the Hewu district are encroached by *E. oligoglossus* (Laker 1975). The encroachment is apparently primarily caused by the destruction of the cover and vigour of the grass sward through overgrazing (Trollope 1970).

(2) *Acacia karroo* (common name: Umga). Acocks (1953) described the encroachment of *Acacia karroo* as a national disaster. The situation has deteriorated since that time. *A. karroo* (Umga) encroachment is very prominent in this grassveld. Du Toit (1968) estimated that encroachment of *A. karroo* into Sweetveld reduced the production of grass by 52 per cent per annum.

(3) Herbaceous species

The most important encroaching herbaceous species in the study area are *Helichrysum argrophyllum* (Ichlolachola) and *Senecio retrosus* (Idwarha). *Helichrysum argrophyllum* has encroached this veld and these species are unacceptable to livestock. They appear to encroach whenever the grass competition and cover is reduced by overgrazing (Laker 1975). *Senecio retrosus* is a natural component of the vegetation and encroaches when the veld is overgrazed. It is extremely poisonous to livestock and is responsible for serious losses annually (Marais 1978).

6.3. DISCUSSION

The main aim of comparing the scientific and participatory results is to relate the scientific results to the knowledge of the community about their environment. From the discussions held with the groups, they were able to identify some of the grass species as being palatable. Examples are *Heteropogon contortus* (common name: Umkhonto), and *Cynodon dactylon* (common name: Uqaqaqa).

They also identified some undesirable plant species which have encroached the grassveld. An example of these includes *Acacia karroo* (common name: Umga). However, they said this woody plant, even though they realise is encroaching the grassveld, is also beneficial since the use it as a source of fuelwood. The other examples identified were, *Helichrysum argrophyllum* (common name: Ichloachloa), *Euryops oligoglossus* (common name: Idwarha). *E. ologolgossus*, according to them, has some peculiar characteristics, and that, wherever they start growing no grass species grows close to them. This means the grass species cannot compete favourably with them.

From the discussions, it was also evident that the community has a good knowledge about their environment. They were able to establish the overgrazing of the rangeland close to the villages. They attributed the bare areas around the villages to overgrazing. This was realised, because it was confirmed that animals are taken to grazing land far from the villages at present. This is a result of overgrazing of the veld close to the villages. Thus, the knowledge of the community confirms that of the scientific results. In the same manner, their knowledge about the palatable and unpalatable grass species and undesirable plant species which are encroaching the grassveld also confirms the scientific results.

One thing that needs looking into is their perception of stocking rate and grazing capacity. From the group discussions, it was revealed that the landlords determined the number of animals one can own, in an attempt to own more stock themselves as a result of the rentals they collect from prospective livestock raisers who want land to hire. This is a matter of great concern since this practice may lead to overstocking of the veld. In general, the community has sufficient local knowledge for training to manage their environment.

CHAPTER SEVEN

7. GENERAL DISCUSSION AND CONCLUDING REMARKS

7.1. GENERAL DISCUSSION

Standard Braun-Blanquet procedures were used as a means of describing the vegetation of the study area. Trollope's (1992) method was used to calculate the condition of the veld at the study area. Grazing capacities of the six sites in the veld were calculated using Danckwerts' (1982) method.

Grazing negatively affects veld vigour, with a greater effect on palatable grass than unpalatable grass. This results in an increase in the vigour in non-palatable grasses (Palmer & Avis 1994). Results from this study show that due to stock theft and loss of animals due to drought, there is understocking of livestock in some of the villages. As a result, grazing is done selectively in such a way that there is a decrease in palatable grasses and an increase in non-palatable grasses.

The TWINSPAN classification showed that the vegetation of the study area is homogenous. It is predominantly *Sporobolus fimbriatus* grassland co-dominated by *Eragrostis racemosa, Tragus koelerioides* and *Kyllinga pulchella* that is all Increaser 2 species, with traces of *Heteropogon contortus* (Decreaser species).

The DECORANA showed a pattern of palatable to unpalatable grass species in the six sites. Sites **A**, **B** and **C** that are closer to the villages have scanty grass cover with a high presence of inferior and unpalatable species (*Eragrostis racemosa, Tragus koeleriodes,* shrubs, forbs and sedges). This reveals a high level of degradation around the villages. This is representative of poor rangeland, and the condition may be attributed to high grazing intensity at the sites closer to the villages.

All six sites have a fair percentage of *S. fimbriatus*. Five out of the six sites have a low percentage of *E. racemosa,* while all six sites have a low percentage of *T. koeleriodes.* The veld dominated by mainly Increaser 2 species (species that dominate in poor veld and increase with overstocking) (Trollope 1995). The veld consists of no Increaser 1 species i.e. species that dominate in poor veld and increase with understocking (Trollope 1995). This is contrary to the community's perceptions, that due to stock theft and loss of animals the veld is understocked at present. However, the classification and species composition of the vegetation of the veld do not confirm this situation. If it were so, there would be a high percentage of Increaser 1 species present at all the sites. Perhaps, the effect of understocking has not shown up yet, and a follow-up of this investigation may be necessary in due course.

In South Africa, cattle, sheep and goat numbers during the last decade have been at their lowest in sixty years (Hoffman 1997). This is in agreement with the claim made by the community with regard to loss of animals. However, overgrazing by domestic animals is seen as the main cause for vegetation degradation (Hoffman 1997). For other southern African countries that lack accurate stock census figures, overgrazing is also cited as one of the most important causes of landscape degradation (Cook 1983; Ringrose *et al.* 1990; Wolters 1994).

Of all modern agricultural practices, crop cultivation probably has the greatest impact on the terrestrial biota of a region (Hoffman 1997). This is because the relatively diverse cover and composition of natural vegetation are replaced by one or few alien species. Soil destruction, water, and nutrient additions further transformed the environment. Majority of the residents of the study area are crop farmers, and much of the commonage land is used for agricultural purposes. The discussion group of the crop farmers revealed that a good yield of barley and wheat was harvested in the past. However, due to bad soil and drought, low yields are experienced. Because of this, the community no longer cultivates these crops.

Thus, any agricultural expansion of crop lands in the future will encroach increasingly on economically marginal environment, where yields are lower and environmental impacts, such as wind and water erosion, probably greater (Hoffman 1997). Increase in population of the study area has also affected cultivation, as more grassland has been used to produce crops, such as maize and vegetables. Hoffman (1997) affirmed that nearly half of the area cultivated in South Africa has been planted to maize, and the Savannah and grassland biomes have been most affected.

Heavy grazing pressure may have a strong negative effect on seed production by grasses, both through consumption of inflorescences and by suppressing the production of flowering culms (Owen-Smith & Danckwerts 1997). The rangelands close to the villages confirm this effect, due to the negative effect on seed production as a result of overgrazing.

The species composition of the various sites of the study area, and the overgrazed nature of the sites closer to the villages show overstocking rather than understocking. Thus, the high dominance of *S. fimbriatus,* shrubs, forbs and sedges, *E. racemosa* and *T. koeleriodes* suggest overgrazing, especially around the villages. This has led to the bare nature of the veld in these areas, which in some cases have developed into erosion sites. Three sites **D**, **E** and **F** (farther away from the villages) have been very well managed. Thus, there is a grazing gradient from the veld closer to the villages towards the veld farther away from the villages.

Water is by far the most scarce natural resource of the study area. Lack of water for domestic and agricultural purposes was expressed as a major problem. The distance from water sources varied across the villages, and residents walked up to four kilometres to fetch water in some cases. In all instances, the water source from the river is invariably shared with livestock.

Many community-based organisations in contemporary South Africa developed in an era of repression, and formed part of the broad resistance movement to state policy and action. This milieu continues to exist (Social Research Africa 1995). Characteristic of these organisations is their capacity to mobilise for protest at putting demands on the Government. This concern for confrontation and resistance is not necessarily sufficient for implementing strategies for development and reconstruction. In the process of capacity building, therefore, there is the need to create an orientation to development.

When the study started at Mceula, the points of access to the community were the SANCO and the Residents' Association. These two groups had developed initially to resist the 'headmen' structures implemented by President Sebe under the Ciskei Government. Through them, discussion groups were formed in the participatory process, and members of the respective groups were able to come up with some of the environmental problems related to the natural resources of the study area.

For communities to better anticipate the possible social consequences of a project, timeous communication is very essential (Heath & Ntsaba 1993). In this study, constant communication with the local residents took place throughout the period of the project. This was to ensure that research on the community involved maximum participation from the people concerned. In South Africa, there is a practical problem in obtaining the participation of "disadvantaged" communities because of lack of communication. They are not easily reached through the media, and therefore formal techniques for making contact and soliciting their option must be developed (Ridl 1994). The Modimola Dam Project in the former Bophuthatswana (Heath & Ntsaba 1993) failed to inform the people about the proposed project. As a result of that, the people felt disempowered to participate in any form of decision making.

Participatory methods evolved as a result of shortcomings of traditional extractive research, where the researcher analyses the situation and reports on the findings, but may or may not have the capacity to act on the findings (David 1992). The participatory research approach (PRA) and Rapid Rural Appraisals (RRA) were used to conduct the research to ensure the involvement of the community.

Comparison of both the participatory and scientific results showed that Mceula community had a good knowledge of their environment. They were able to identify some palatable and unpalatable grass species as well as some undesirable plant species that have encroached the veld of the study area.

Most of the local residents at first did not see the need for drawing the three maps and the seasonal calendar (Figures 2, 3, 4 & Table 3). However, it was when the exercise had been completed that they realised their importance. This was evident from the comments made at the winding up session. It was revealed that the residents learned more about their village and that things that seemed to be unimportant proved to be important. For example, the drawing of the seasonal calendar gave them an objective view of their environment. It also gave them a time-table of events that they knew about, but did not mean much to them. This has now given them a clearer picture of what happens in their environment and can now plan with it.

Before the old and the new maps (Figures 2 & 3) were drawn, the residents could not immediately realise the changes that had taken place in their community over the years. However, after the two maps had been produced, the changes were revealed to them. With the drawing of the future map of Mceula (Figure 4), they were able to plan their community better. One of the best ways to prepare for the future is to understand the trends and patterns of the past. Although extrapolation of these historical trends into the future could be problematic. The community should take note of cultural devastation created by past environmental degradation (Hoffman 1997).

7.2. CONCLUDING REMARKS

- Standard Braun-Blanquet procedures were successfully used to produce a classification of the grassland and grass-related vegetation of the study area. This method was found to be useful in describing the vegetation pattern of the study area. The data obtained is also compatible with similar studies of vegetation types in the Eastern Cape.

- Six sites were identified. Three of the sites (**D**, **E** and **F**), farther from the villages had been better managed, while sites **A**, **B** and **C**, close to the villages had been heavily overgrazed. Thus, there is a grazing gradient from the rangelands close to the villages to those farther from the villages.

- Using the various techniques of PRA and RRA the local community fully participated in the research process. This enabled them to learn more about their environment. It also helped them to plan their environment better. The local knowledge of the community was found to be enough to train them to manage their natural resources sustainably.

- We need to understand the long-term implications of the areas rapid population growth on the environment, since the health of the primary resource base affects the people's livelihoods directly. Indeed the future of the people of Mceula community rests ultimately on its renewable natural resources.

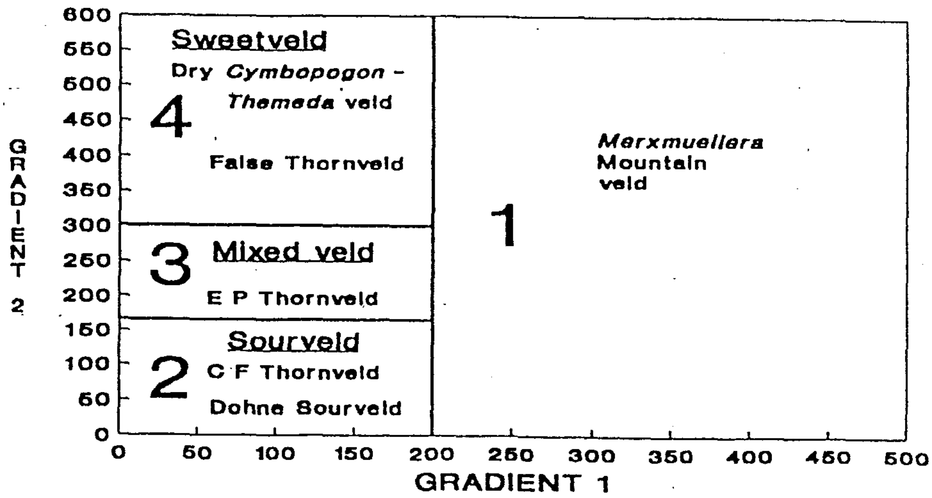
Appendix 1: A herbaceous species list with the forage factors assigned to each species. (Trollope *et al.* 1995)

Name	Forage factor
Alloteropis semialata	2
Andropogon appendiculatus	7
Aristida bipartita	0
Aristida congesta	0
Aristida diffusa	0
Aristida galpinii	0
Aristida junciformis	0
Brachiaria serrata	2
Chloris virgata	1
Chrysocoma tenuifolia	0
Cymbopogon excavatus	2
Cymbopogon plurinodis	4
Cynodon dactylon	2
Cynodon hirsutus	2
Dactylotenium australe	7
Digitaria eriantha	4
Digitaria eriantha (Smuts)	7
Digitaria setifolia	2
Diheteropogon amplectans	4
Diheteropogon filifolius	0
Ehrarta calycina	2
Elionuris muticus	0
Eragrotis capensis	4
Eragrostis chloromelas	4
Eragrostis curvula	4
Eragrostis lehmanniana	4

Eragrostis obtusa	0
Eragrostis plana	2
Eragrostis racemosa	2
Eragrostis superba	2
Eulalia villosa	4
Eutachys mitica	2
Felicia filifolia	0
Festuca caprina	2
Festuca costa	2
Festuca scabra	2
Fingeruthia sesleriaformis	7
Forbs	0
Harpochloa falx	4
Helichrysum argrophyllum	0
Helichrysum odoratissimum	0
Helitotrichon hirtulum	2
Heteropogon contortus	7
Hyparrhenia hirta	4
Karrochloa purpureum	2
Karoo species	0
Koeleria cristata	2
Melica decumbens	0
Merxmuellera distichia	0
Microchloa caffra	0
Miscanthus capensis	2
Moncymbium ceresiforme	2
Panicum maximum	10
Panicum stapfianum	7
Paspalum dilatatum	4

Pennesitum spp.	2
Pennesitum sphacelatum	4
Pentaschitis spp.	0
Rhynchelytrum repens	2
Rhynchelytrum setifolium	2
Ricardia humistrata	0
Sedges	0
Selago corybosa	0
Senecio pterphorus	0
Senecio retrosus	0
Setaria flabellata	7
Setaria neglecta	10
Setaria nigrirostris	4
Setaria perinnis	2
Setaria sphacelata	7
Sporobolus africanus	7
Sporobolus capensis	2
Sporobolus cetrifugus	1
Sporobolus fimbriatus	7
Sporobolus pyramidalis	2
Stenotaphrum secundatum	10
Trachne dregei	10
Themeda triandra	10
Trachypogon spicatus	2
Tragus berteronianus	0
Tragus koelerioides	1
Tristachya leucothrix	7

Appendix 2: Species categories. (Trollope *et al.* 1995)



	BM 1	BM 2	BM 3	BM 4
DECREASER				
Heteropogon contortus	*0*	*13*	*0*	*0*
Panicum maximum	*0*	*0*	*0*	*0*
Setaria flabellata	*0*	*0*	*5*	*0*
Themeda triandra	*30*	*37*	*62*	*3*
TOTAL DECREASERS	30	50	67	3
INCREASER I				
Cymbopogon plurinodis	*0*	*0*	*0*	*5*
Merxmuellera disticha	*23*	*0*	*0*	*0*
Tristachya leucothrix	*0*	*12*	*0*	*0*
Elionuris muticus	*0*	*8*	*0*	*0*
TOTAL INCREASER I	23	20	0	5
INCREASER II				
Aristida congesta	*0*	*0*	*0*	*0*
Cynodon dactylon	*0*	*8*	*1*	*3*
Digitaria eriantha	*1*	*0*	*24*	*19*
Eragrostis chloromelas	*19*	*2*	*0*	*0*
Eragrostis lehmanniana	*0*	*0*	*0*	*0*
Eragrostis obtusa	*0*	*0*	*0*	*0*
Eragrostis plana	*0*	*0*	*1*	*0*
Forbs and sedges	*2*	*3*	*1*	*7*
Karroochloa purpurea	*12*	*0*	*0*	*0*
Sporobolus fimbriatus	*0*	*0*	*0*	*35*
TOTAL INCREASER II	34	13	27	65
OTHER	13	17	6	27
TOTAL	**100**	**100**	**100**	**100**
FORAGE SCORE	**533**	**638**	**768**	**555**
GRAZING CAPACITY (HA/AU)	**5**	**2**	**3**	**6**

Appendix 3: The recommended mean stocking rates of grazing animals for veld in different condition for each benchmark in Ciskei expressed in hectares per animal unit. (Trollope *et al.* 1995)

VCS	Benchmark 1	Benchmark 2	Benchmark 3	Benchmark 4
%	HA/AU	HA/AU	HA/AU	HA/AU
100	5.0	2.0	3.0	6.0
90	5.6	2.2	3.3	6.7
80	6.3	2.5	3.8	7.5
70	7.1	2.9	4.3	8.6
60	8.3	3.3	5.0	10.0
50	10.0	4.0	6.0	12.0
40	12.5	5.0	7.5	15.0
30	16.7	6.7	10.0	20.0
20	25.0	10.0	15.0	30.0
10	50.0	20.0	30.0	60.0

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