RURAL POVERTY AND LAND DEGRADATION: A Determinant Study for Natural Resource Management in Marginal Lands of South Africa.

by

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Submitted in partial fulfillment of the requirements for the degree Philosophiae Doctor (Ph.D.) in Sustainable Ecological Management

in the

Faculty of Natural and Agricultural Sciences
University of Pretoria
South Africa

June 2001

<u>*DEDICATED*</u>

"To Kaka and all my forefathers,

grandfathers and grandmothers in the generation
of Gubhela ka Khabazela ka Mavovo, particularly
Agnes Sithombe, Salesia, Elijah Gingitshe, Dli, and Raphael
and all those I do not know but who brought me into this world".

NKOSI YAMI, NKULUNKULU WAMI, OYIKO KONKE KIMI

(St Francis of Assisi – patron saint of ecology)

ABSTRACT

RURAL POVERTY AND LAND DEGRADATION: A Determinant Study for Natural Resource Management in Marginal Lands of South Africa

The study started with the "four tenets of conventional wisdom", namely: (i) marginal lands are defined in biophysical terms which establish them as having low inherent productivity for agriculture, being susceptible to degradation, and involving high risks for agricultural production; (ii) they support a high proportion of the rural poor, particularly the poorest of the poor; (iii) the combination of fragility and high density of poor people who place a premium on current consumption (resulting in over-exploitation of natural resources) leads to accelerated erosion or vegetation destruction. The consequence is a downward spiral of poverty and resource degradation with significant negative externalities; and (iv) the impact of agricultural research on agricultural productivity increase, environmental protection and above all poverty eradication has been limited in these areas. The thesis presented direct empirical verification of the relationship between poverty and land degradation; explored poverty information, land degradation, and investigated correlations and models of degradation. This provided the basis for data collection and analysis, enabled the description of rural populations, rural poor living on marginal areas, post-harvest activities employed and the institutional constraints, all of which could potentially contribute to poverty eradication on "marginal lands", defined using biophysical characteristics. The thesis concluded with the rejection of the first tenet and confirmed the subsequent three. It introduced the concept of "marginal areas" (MA) as areas where there are concentrations of marginal rural people and where its geographic location can be derived from a set of relatively homogeneous poverty related variables together with biophysical variables. No specific inferences could be drawn regarding potential poverty eradication gains from research investment on MAs, be that in the form of new technologies, farm and off-farm linkages in family survival strategies, or changes in policy and institutional frameworks likely to hinder poverty eradication. The study raises four key issues and recommendations, which will guide future research and resource allocation decisions for reducing poverty in these marginal lands.

Keywords:

Rural poverty, land degradation, marginal areas, favoured areas, poverty eradication, biophysical, soil degradation index, veld degradation index, combined degradation index and sustainability.

ACKNOWLEDGEMENTS

Many colleagues, friends and people have journeyed with me on the path that led to the production and completion of this study, and are therefore an inevitable part of it, perhaps some unknowingly. I am therefore grateful for their assistance. I would, however, particularly like to thank the following: Prof. Albert S. van Jaarsveld, my promoter who supervised my work and I thank him for his patience and valuable input in this work. My colleagues at Cedara, KwaZulu Natal, who gave me more information through Cedara Reports. Ms Iris Mahlaule of the Technology Resource Directorate of the Northern Province Department of Agriculture, who helped me in gathering GIS information and survey data for the Northern Province. Colleagues from the National Department of Agriculture (NDA), were involved in extensive discussions and sharing of land degradation information, they also deserve to be thanked. Many thanks to my dear friends who are Dr Mekuria Mulughetta, Dr Mishack Molope, ARC- GEO: Corporate Programmes, and Ms Nonjabulo Zwane-Nduli, Chief Director: Sustainable Resource and Management, who were always my pillars of support and encouragement during the long task of this study. The National Research Foundation (NRF), through the Agrarian Rural Development Programme (ARDP), gave financial support to this project, and the NDA) gave both financial and material support to me in order to able to carry on with this project, I am therefore grateful to both these institutions for their support. I cannot forget support given by my young colleagues, Ronnie Lebese and Clinton Schoeman and not to forget Ms Henda Du Buisson and many others from the NDA who technically assisted me during the preparation of this thesis. Last but never least, I would like to thank my wife, Sibongile, and daughters, Sine and Lindo, for their love, motivation, and support they generously provided, suffering my long absence from home on this work.

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LIST OF ACRONYMS AND ABBREVIATIONS

ARC	Agricultural Research Council
BMR	Bureau of Market Research
CBNP	Community Based Nutrition Programme
CCWR	Computing Centre for Water Research
CDI	Combined Degradation Index
CGIAR	Consultative Group on International Agricultural Research
CPR	Common Property Resource
DBSA	Development Bank of Southern Africa
DEAT	Department of Environmental Affairs and Tourism
DME	Department of Mineral and Energy
DTI	Department of Trade and Industry
DWAF	Department of Water Affairs and Forestry
ENPAT	Environmental Potential Atlas
FL	Favoured Agricultural Lands
FAO	Food and Agriculture Organisation of the United Nations
GDP	Gross Domestic Product
GGP	Gross Geographic Product
GIS	Geographical Information System
HDI	Human Development Index
IARCs	International Agricultural Research Centers
ICARDA	International Centre for Agricultural Research in the Dry Areas
ICRAF	International Centre for Research in Agroforestry
IDT	Independent Development Trust
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
ILO	International Labour Organization
IPM	Integrated Pest Management
IRDS	Integrated Rural Development Strategy
LQI	Land Quality Indicators

LUT	Land Use Types
LUZ	Land Use Zone
MA	Marginal Area
MAP	Mean Annual Precipitation
MAT	Mean Annual Temperature
ML	Marginal Land
NARS	National Agricultural Research System
NDA	National Department of Agriculture
NGO	Non Governmental Organization
NGS	Natal Group Sandstone
NRM	Natural Resource Management
OHS	October Household Survey
PCA	Principal Component Analysis
PDA	Provincial Department of Agriculture
PPIs	Priority Poverty Indicators
PSLD	Project Living Standard and Development
R & D	Research and Development
RDP	Reconstruction and Development Programme
REI	Rainfall Erosivity Index
SADC	Southern African Development Community
SDI	Soil Degradation Index
SMMEs	Small, Micro, and Medium Enterprises
TVBC	Transkei, Venda, Bophuthatswana and Ciskei
UNDP	United Nations Development Programme
UNEP	United Nations Environmental programme
UNNCD	United Nations Convention to Combat Desertification
USLE	Universal Soil Loss Equation
VDI	Veld Degradation Index
WTO	World Trade Organisation

Chapter 1

BACKGROUND TO THE STUDY

1.1 Introduction

Environmental and land degradation varies in form and magnitude; global warming, air, water and soil pollution, loss of biodiversity and the declining productivity of land, to name but a few. All represent changes that threaten the well being of present and future generations. These changes threaten the livelihood of millions of people and future food security, with implications for water resources and the conservation of biodiversity. While these changes occur globally, they are particularly felt in rural parts of sub-tropical regions where people's livelihoods directly depend on the use of natural resources. Here, land degradation has serious and visible consequences. Soil erosion, progressive nutrient depletion, loss of vegetation cover, fuelwood shortages all affect rural livelihoods. Food security is at stake, while poor water quality and shortage of fuel jeopardize people's health.

Agricultural production stagnates at the moment that rural areas are confronted with increasing demands to feed a rapidly growing population. Until recently, it was possible to cope with this population growth by bringing new land under cultivation. Today this option is no longer available. In addition, experience shows that attempts to increase the productivity of natural resources are hampered by the absence of inputs and an agricultural support infrastructure. Indigenous systems to manage natural resources, generally developed under much lower levels of population pressure cannot adequately respond to these rapidly changing situations. At the same time, existing policies are often in conflict with traditional approaches to organize natural resource use and land tenure. There is therefore an urgent need to develop ways of combating or reversing the worldwide trend of accelerated soil degradation, by using an ecosystem approach, taking into account the needs of populations living in these ecosystems and recognizing the multiple functions of agriculture that govern their way of survival.

1.2 Background

This study is concerned with the determinants, impact, and management of land degradation and rural poverty, and it also looks at the research needs for future survival within the South African context.

In South Africa the previous apartheid dispensation had portioned marginal areas into homelands which were reserved for the Black communities. These areas are mainly found in the provinces of the Eastern Cape, Free State, KwaZulu Natal, Mpumalanga, Northern Cape, Northern Province, and North West. People who lived in these areas were disadvantaged, neglected, and often called the "forgotten people". It has therefore become the burden of the new government to start the process of assessing possible avenues for changing this reality by assessing various research options for marginal lands available to them. The point of departure is that marginal lands and the rural poor are likely to be concentrated in these areas, and further, that the incidence of extreme poverty will be higher than on favoured lands. These areas are seen to be fragile and extend across the bulk of presently settled lands. Accordingly, there is concern about the prospects for large-scale resource degradation, further intensification of poverty regimes and the lack of meaningful interaction from agricultural research on the poor in these areas.

All land types – marginal or favoured – require research related to environmental protection and sustainable production which can, to a greater or lesser extent, help in the quest for poverty eradication and expanded food security for the poor. On favoured lands, expanded production can result in lower prices for urban consumers, as well as increased jobs and food security for the rural poor. To the extent that the poor live on marginal lands, research that leads to productivity increases on those lands can also help to eradicate poverty and increase food security. It is because of these concerns that land degradation which is generally defined as the reduction in the soil's ability to contribute to crop production, and rural poverty, form the foci of this study. In marginal areas of South Africa, our understanding of the intricate processes of poverty and land degradation are still extremely limited. Definition, in each process, is driven largely by the perceptions of those analyzing the phenomena with each group bringing their own strong perceptions to bear. The lack of clear conceptualization, the observed heterogeneity and diverse perceptions of those attempting to circumscribe the phenomenon complicate attempts at measurements. Attempts at quantification suffer due to - among other things – a lack of representativeness and reduce the confidence that can be attached to such extrapolations. Evaluating cause and effect with confidence implies, ideally that we have been able to observe the processes at different points in time for a large number of well-defined and relatively homogeneous situations. In most cases, the lack of adequate data and the complexity of the relationships that need to be modeled, seriously limit rigorous empirical verification. Since a fuller understanding of the complex interactions between land degradation and rural poverty naturally leads on from a more comprehensive understanding of the individual processes, it too suffers from all the problems impeding a deeper understanding of each.

The aggregate information available is not very useful for making judgements about poverty and land degradation. Evidence available for a few micro-level studies are mixed and often contradictory. Most of the literature relates to the controversy regarding the reasons for the adoption (or non-adoption) of conservation practices. This literature does not specifically address the behaviour of the poor except through the cost implications of different conservation technologies and the incentive structures that it influences. Theoretical considerations are often cited as to why the poor can be expected to behave in ways that are land degrading. However, these considerations can generally apply just as well to the non-poor and can be explained by overall low levels of development. The pressures arising out of the processes of economic development that might induce people to degrade the land, have been classified in the literature as those related to: increase in population; declines in common property resources; interest rate changes; and technology transfers. However, the literature also includes considerable theoretical and empirical evidence that indicates that the response to population pressures and market forces, in the long run, is an endogenous process of adaptation towards sustainable behaviour.

Data are available, but does not focus mainly on problem areas and generally on marginal lands. Integration of these data and extrapolation with geographical information systems (GIS) to cover the entire marginal land zone is urgently needed. At the household level, much more research, in a variety of settings over a reasonable length of time, is needed for a fuller understanding of decision-making processes, especially in terms of the relationship with land. Such research should ideally be built on detailed household-level longitudinal socio-economic surveys with specific land use and quality assessment modules. Only then will it be possible to link behaviour to poverty status.

In moving ahead to articulate a strategy for achieving the overarching goal of sustainable poverty eradication and increased food security, the next step specifically with respect to rural poverty is to identify **where** these people live and their present numbers. From this information base, one may move to characterize the current status of the lands from which they derive part or the bulk of their livelihoods. From a technological perspective the goal may be to increase productivity of resources used in agriculture, this status may initially be expressed in terms of biophysical potential, i.e. biophysically favoured versus marginal lands. However, the determinants of poverty (marginal people) lie mainly with socio-economic and institutional aspects (markets, policies, physical infrastructure, human capital) which govern the choices of people in using natural resources to which they have access and in obtaining off-farm incomes. With an understanding of the biophysical, institutional, policy, and socio-economic characteristics that collectively explain **why** the various target groups are poor, one is in a position to explore research options, of which outputs and outcomes may be expected to impact on sustainable poverty alleviation. From that point one can proceed to examine what the government and the research community might do, i.e. the entry points where there is an expectation of significant impacts from research through output of public goods.

1.3 Aims and Objectives of the Study

The aim of this study is to trace the evolution of general thinking, starting from four tenets of conventional wisdom about: (i) the nature of marginal lands; (ii) the concentration of rural poverty on such lands; (iii) the linkage between poverty and accelerated resource degradation; and (iv) the role of agricultural research in poverty eradication on these lands. There are thus four major objectives that are to be achieved by this study, namely:

(i) to define land degradation and sustainability;
(ii) to investigate the impact of land degradation on the poor;
(iii) to investigate the impact of poverty on natural resource management; and
(iv) to determine and investigate the links between poverty and land degradation.

It is envisaged that demonstration and/or intervention projects would develop from this initiative. These projects could facilitate much greater interaction between the different "actors" to bring realism where narrow disciplinary perceptions prevail, especially in the area of land degradation. Such interactions would lend much greater realism to the understanding of issues that have important implications for the present and future of South Africans in these areas. These interactions should naturally build on existing understanding, so as not to reinvent the wheel. The broad research agenda on poverty and land degradation could only be better defined after a reasonable period over which such understanding is developed. Such research can only enhance the efforts within the agricultural research community toward integrating commodity research with natural resource management. This research agenda will form a key forum for addressing the South African dearth of knowledge about the link between land degradation and poverty.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

This study embarked from the "four tenets of conventional wisdom," namely: (i) Marginal lands are defined in biophysical terms which establish them as: having low inherent productivity for agriculture; being susceptible to degradation; and involving high risk for agricultural production; (ii) They support a high proportion of the rural poor, particularly the poorest of the poor; (iii) The combination of fragility and high density of poor people who place a premium on current consumption (resulting in over-exploitation of natural resources) is leading to accelerated erosion or vegetation destruction; the consequence is a downward spiral of poverty and resource degradation with significant negative externalities; and (iv) the impact of agricultural research on agricultural productivity increase , environmental protection and above all poverty alleviation has been limited in these areas. Within this framework focus on the need to understand more fully the causes and consequences of rural poverty with a view to identifying the options for meaningful intervention, and to improve our understanding of land degradation processes, are obvious.

2.2 Defining Land Degradation and Sustainability

There are several definitions of land degradation. Land degradation is generally defined as the reduction in the soil's ability to contribute to crop production (Blaike and Brookfield, 1987) and as a change to land that makes it less useful for human beings (Wasson, 1997). Examples of land degradation can be found in erosion, salinisation, waterlogging, vegetation depletion, fertility loss, soil structure change, and pollution of soil. In each case, the focus is on the physical or biological effects with land-use methods seen as the ultimate causes of degradation. Land degradation can take many forms and its effects are often cumulative. The off-site effects (sedimentation of reservoirs and depletion downstream fields through siltation), both positive and negative can also be considerable. A formidable problem exists because there is no simple relationship between these physical processes and the human perceptions of land resources. What is observed in the present, is the result of the interaction of several complex processes over long periods of time. For more comprehensive detection and measurements of land degradation, a system is needed for monitoring change in physical, biological and social phenomena. The heterogeneity of the situations, the complexity and changing interactions (over time) of the interacting processes have negative implications for precise and conclusive measurement.

Concern with land degradation has heightened due to the increasing focus in policy circles on sustainability. There are several definitions in use for sustainability in agriculture, which leads to some confusion. There is a need for a clear and widely agreed-upon perspective. Existing definitions can be broad and all encompassing. For example, sustainability is defined as "meeting the needs of the present generation without compromising the ability of the future generations to meet their own needs" (WCED, 1987). Sometimes sustainable development in agriculture means more efficient use of arable lands and water supplies. It requires avoiding over use of chemical fertilizers and pesticides so that they do not degrade rivers and lakes, threaten wildlife and contaminate human food and water supplies. It means careful use of irrigation to avoid salinisation or water logging of croplands. It means avoiding the expansion of agriculture to steep hillsides or marginal soils that would rapidly erode (World Resource Institute, 1992).

Sustainability is often confused to imply zero depletion of the natural resource base or zero environmental costs. However, as Crosson and Anderson (1993) point out "agricultural production that imposes some resource depletion and environmental damage are consistent with rising per capita welfare". From an economic perspective, degradation only occurs beyond the socially defined optimal use level. Such degradation occurs where individuals cannot or do not optimize returns to their resources (e.g. due to inadequate information) and/or because there is a divergence between private and social interests (e.g. externalities or inappropriate public policies) [see for example Scherr and Yadav (1995) and Binswanger (1989)]. This lack of an agreed perspective on sustainability has implications for how land degradation is defined, measured, and analyzed.

There is general recognition that data on the physical processes of land degradation as well as on its economic and social consequences are sparse (Scherr and Yadav, 1995). Earlier reviews of the evidence for land degradation around the world have also found this evidence to be "extraordinarily skimpy". "No country has comprehensive estimates of the productivity consequences of land degradation or the rates of degradation from current practices" (Crosson and Anderson, 1992). Several authors, including Biot et al. (1995), recognizing this inadequacy, have called for a thorough review of experimental and field data and a sharper focus, particularly on robust and cheap methods of measurement in order to improve the understanding of the physical process(es) involved.

The problem associated with drawing representative samples for plot-level measurements has meant that most aggregate estimates are based on non-scientific methods of "raising" the information. Experts base most estimates of the impact of land degradation on "objective assessments". Available aggregate estimates of the cost of degradation have to be interpreted with even greater caution since they are based on standard formulas relating certain levels of degradation to estimates of yield losses. Attempts to extrapolate from the estimates of the effects of yield losses at the plot level to aggregate estimates about the socio-economic impact at national or regional level, have often been dubbed as "giant leaps of faith".

The inadequate basis for the available figures is, however, generally lost in the emotionalism that pronouncements about catastrophic extent of land degradation stir up. Statements such as "over the last thirty years alone, the world has lost nearly one fifth of the top soil from its crop land, one fifth of its tropical rainforests and tens of thousands of plant and animal species" (Brown, 1990), stir up visions of imminent and impending doom. The literature associated with the "Tragedy of the Commons" (Hardin, 1968) has brought focused deliberations on the negative consequences of the interaction between humans and natural resources. On the other hand, complacency - based upon the phenomenal increase in agricultural (especially food) production during the past fourty years or so - might well be misplaced, particularly when viewed against recent declining food production patterns in Africa.

There is thus a tremendous need to obtain a fuller understanding of the different aspects of land degradation based on data generated through consistent definitions and scientific rigor. As already noted, studies about the impacts of land degradation are based, in one crucial aspect or other, on the assessments of experts. In most countries the data used for such estimates generally comes from a few studies that were not originally designed to generate estimates for the whole country, this is also the case with South Africa. Moreover, the capacity to monitor changes over time is limited by the weak statistical foundations and the lack of comparability in the available data.

Attempts are being made to address some of these concerns through research on land quality indicators (World, 1997). The land quality indicators (LQI) programme[1] was set up under a coalition of international agencies in 1994. Its objective was to better understand the problems of land degradation. This program seeks to "develop a set of natural resource indicators: statistics or measures that help characterise the conditions of natural resources related to land. The programme seeks to develop a set of standardised indicators (mainly focused on local and districts levels) to provide concise, reliable information about the condition of land, including the combined resources of soil, water, vegetation and terrain that provide the basis for land use"(Pieri et al. 1995).

Land degradation can lead to declining potential yields on farms. However, fertilizer use or changing the land use can camouflage the effects of this degradation for long periods.

[1] This programme involves agencies such as the Food and Agriculture Organization, the United Nations Development Programme, the United Nations Environment Programme, the World Resources Institute, while IFPRI and other CGIAR institutions are also participating.

As such it is almost impossible to establish a one-to-one relationship between the amount of degradation and the effects on yield. Moreover, the level at which yields are affected by changes in land quality can differ according to the type and variety of crop grown the soil type and its depth etc. While measurements of land degradation generally cover only limited periods of time, measurable effect on crop yields could, take longer to materialise because of the accumulative nature of land degradation.

For developing countries the literature on land degradation is even more qualitative and less rigorous than that available for developed countries. The difficulty of modeling complex farming systems and the lack of necessary data both contribute to this paucity[2]. Most glaring is the lack of knowledge about the effects of degradation on social welfare. "Most of the technical literature on the socio-economic aspects of land degradation can be classified into three broad categories: soil conservation as an input in agricultural production: top soil as natural resource, somewhere between nonrenewable and renewable; and the effects of land degradation on common property resources and externalities"(Anderson and Thampapillai, 1990). Studies at the household level that attempt to rigorously verify difference in behaviour between the poor and the non-poor with respect to land are generally difficult to find.

Most of the available literature looks at the impact of land degradation in terms of crop production. Scherr (1998), based on her detailed review of this literature, concludes that "many studies examine the gross impact of degradation on crop production [but] very few examine the net effect, taking into account price effect, substitution of supply by other producing areas, or other secondary impacts. [And moreover] very few studies incorporate into their analysis any active farmer response to degradation". Scherr could find only three studies that provided data relevant to the assessment of human welfare impacts.

[2] The lack of technical information such as rates of soil loss and physical parameters such as those required for the definition of the universal soil loss equation (USLE) led some studies to use site parameters from specific developed country locations [for example Veloz et al, (1985)].

These welfare assessments use different indicators to assess the impact at national or international levels. A detailed review of the results and methodological aspects of these studies is available in Scherr (1998) and is therefore not attempted here.

2.3 Defining Poverty

Poverty is increasingly viewed as a multidimensional concept. It has social and psychological effects that prevent people from realizing their potential (IFAD, 1992). Measurement of poverty can include material deprivation, isolation, alienation, dependence, and lack of participation or freedom of choice of assets, vulnerability, and insecurity. Introducing several such dimensions can seriously complicate the measurement problems. This is why most measurements are based on material deprivation generally linked to the inability of incomes to meet basic nutritional demands.

Poverty is, thus, operationally defined as the inability to attain a minimal standard of living. Generally, a consumption-based poverty line is used and estimates are made of the head count index, the poverty gap ratio, and a severity of poverty index[3]. The World Bank supplements the consumption-based poverty measures with others such as nutritional status, life expectancy, under five mortality and school enrollment rates in what it terms the Priority Poverty Indicators (PPIs). The World Bank is currently considered to be the largest repository of information on poverty in the world. The research work at the Bank has confirmed that, in order to answer the question of how the poor have participated in the general improvements, it is necessary to move from aggregate data to more disaggregated survey-based household-level data. Without such disaggregated data, it is impossible to conduct a rigorous analysis of the decision-making processes of poor households.

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[3] The Foster-Greer-Thorbecke (1984) class of decomposable indices that are generally used as measures of poverty are presented in Annex 2.

Poverty measurement is difficult at national level and even more so at the sub-national and household levels. The quality and reliability of the data, where available, are generally questionable. Census taking is generally in its infancy in developing countries - at least South Africa is doing better in this regard, with the last census dating to 1996. Increasing attention is only now being paid to the systematic collection of socio-economic information through household representative income and expenditure surveys. The heavy costs involved generally imply that the data that such surveys yield, are only representatives at the national or at most sub-national level. Given the nature and distribution of poverty, such aggregate estimates can often be misleading. The ability to match the quantitative information with more qualitative data is generally severely limited by the even greater scarcity of the latter. Even where such information is available, meaningful integration is limited because these are derived from studies with entirely different purposes. The problems of the reliability and non-availability of basic information are compounded by problems associated with measurement. The use of one cut-off point or poverty line for the country as a whole aggregates across tremendous heterogeneity and does not necessarily reflect the particular situation in a sub-region or segment. The use of a standard calorie requirement cut-off so fashionable in previous studies, for example, masked tremendous differences in minimum calorie requirements across regions due to differences in body structures, climate, and levels of physical activity.

While considerable headway has been made at improving the quality of the aggregate poverty information, there is still considerable variability in quality. Poverty profiles answer the questions such as, where are the poor? Who are the poor? Why are they poor and is it transitory or chronic poverty? A poverty profile is a simple instrument for making poverty comparisons. These can show how poverty varies across sub-groups of society, such as region of residence or sector of employment. A poverty profile can be extremely useful in accessing how the sectoral or regional patterns of economic change are likely to affect aggregate poverty measures. If the poverty profile shows that, for example, there is significantly more poverty in the rural farm sector than the non farm sector then a policy intervention which improves farmers terms of trade is very likely to reduce aggregate poverty

(Kanbur, 1987, 1990). This variability was confirmed by a report of the Operations Evaluation Department of the World Bank (1996)[4]. While considerable headway has been made in counting the poor, considerably less has been done to explain why they are poor and in particular to explain which strategies for poverty alleviation work and why? While the need to move towards more disaggregated data and analysis is keenly felt, there is no hard evidence available that shows that the poor, as opposed to the non-poor, behave differently in key aspects and especially in terms of natural resource management. The data available are generally at levels of aggregation that limit their usefulness for analysis of specific land degradation problems that generally have a locational dimension. The PPIs are available at national level for the countries for which these have been collected. This limits the usefulness for the understanding specific processes related to poverty and the relationship to other processes such as land degradation.

IFAD (1992) identifies five types of rural poverty. Material deprivation and alienation cause interstitial poverty or pockets of poverty surrounded by power, affluence, and ownership of assets. Material deprivation can combine with isolation and alienation to lead to peripheral poverty, which is, according to different studies, found in the marginal areas. Material deprivation arising from population pressure and limited resources will breed alienation and overcrowding poverty. Vulnerability to natural calamities, (e.g. drought, floods) labour displacement, and insecurity, produces traumatic or sporadic poverty, which can be transitory but often ends up being endemic. Isolation, alienation, technological deprivation, dependence, and lack of assets are also signs of endemic poverty.

This classification is important for linking the types of poverty processes to the types of poverty produced and the segments of the population affected. According to the IFAD (1992) study, environmental degradation leads to both transitory and chronic

[4] Only 54% of the 46 poverty assessments evaluated in this study met with the requirements. Most were five years old and some were based on data that were more than ten years old. The report used the following benchmarks for evaluation: (1) inclusion of a Priority Poverty Indicators (PPIs), (2) diagnosis of poverty, (3) set of prescriptions for poverty reduction and (4) operation content of the prescription.

poverty (IFAD terms these as peripheral and endemic poverty) and affects smallholders, landless, nomadic pastoralists, ethnic groups, refugees and households headed by women. The IFAD study contains an extensive classification of different types of poverty processes, the type of poverty that is produced, and the segments of the rural population affected by these, for at least 42 of the least developed countries. While this classification is helpful, given the nature of the data on which it is based, it is only indicative of the types of aggregate patterns. Given the heterogeneity of poverty types that it indicates and the extremely aggregate available data that it marshals, the study does not help in rigorously answering specific questions or in furthering our understanding of the interaction between poverty and land degradation process.

Rural poverty also implies that the "wrong crops" may be grown. In sub-tropical conditions, most export crops (except cotton and groundnuts) tend to be less damaging to soil than cereal and roots crops. Most export crops grown on trees and bushes have a continuous root structure and provide canopy cover. Reppetto (1988) shows that, with grasses planted underneath such export crops, the rate of soil erosion is substantially less than with food crops. However, the fact that women control food while men control cash crops, can generally translate into reduced incomes for women with increasing commercialization, resulting in the deterioration of the nutritional status of families (see for example Von Braun and Kennedy, 1986). Moreover, poor people are constrained in their access to credit, insurance, and capital markets. These conditions get translated into larger herd sizes especially in times and places that have a high risk of drought and the possibility of greater mortality amongst the herds. These extra animals can lead to overgrazing and land degradation.

Rigorous analyses of the differential behaviours of poor versus non-poor households in terms of land degradation are sadly deficient. Such analyses require data specifically collected and detailed modeling of the household decision making processes. Collecting such data is a resource-intensive process and often requires skills that are not generally available in developing countries. Cost constraints generally imply small and often "non representative" samples. This leads to obvious questions about the generality of the results. There is a strong need to replicate such studies in as many situations as possible in order to be able to build up a body of information from which conclusions can be generalized.

2.4 Poverty and Land Degradation

In Africa, with still relatively sparse population levels, the productivity of the drylands steadily declined during the 1980s while forests were being cut 17 times faster than they were being replanted (Norgaard, 1994). Norgaard continues to state that due to ineffective or exploitive social organization, poor terms of trade, inappropriate technologies and bad weather, food production did not keep pace with population growth. Furthermore that fertility rates, nearly twice that of the rest of the world, will result in a population by the year 2025 roughly equal to the combined populations of Europe and North and South America. Lipton (1997a) states forcefully that it is irrational to expect people to knowingly behave in ways that destroy resources necessary for their survival or that of their future generations unless very strong pressures to do so are present. He lists four such pressures generally discussed in the literature. These include: (1) an increase in population as morality falls but fertility declines, and (2) declines in common property resources (CPRs). In addition there are international pressures, including (3) interest rate changes and (4) technology transfers (Lipton, 1997a).

Poverty generates significant incentives to have large families. Traditionally the impact of population growth on natural resources is discussed in terms of "carrying capacity". Conceptually, if nothing else changes, it is assumed that the increasing population will put demands on the resources that can no longer be met without damaging the ability of these resources to support human life. Social and economic factors such as trade, technology, consumption preferences, and levels of inequality can alter the carrying capacity. Poor people will often use migration as a coping strategy. However, migration may not always benefit rural environments since the absolute numbers of rural people may continue to increase.

Lipton (1997b) notes that technology generation in agriculture remains exogenous to most of the developing countries and is not driven significantly by their resource saving or other requirements. This is the classic choice of techniques problem highlighted in the literature on industrial development during the 1970s that first made popular terms such as technological determinism. This argument holds that the technically efficient techniques are generally developed in the capital-abundant labour scale developed countries and generally reflect the factor endowments of these countries.

2.5 Impact of Degradation

The poor generally have access only to areas that have high a risk for health and income generation. They generally lack the resources to reduce their exposure to risk or to invest in alleviating the causes of such risk. Environmental degradation therefore can affect the health and nutrition status of the poor and lower their productivity. This can happen both directly through, for example, lower yields per unit of labour or land because of reduced soil quality, and indirectly through the reduced physical capacity of labour to produce because of malnutrition and poor health. Even in cases where the poor are healthy, labour productivity can be low due to increased time being allocated to less productive activities such as fuel wood collection and other pursuits away from agriculture and other income generating activities (Kumar and Hotchkiss, 1998). In terms of the productivity of the resources that the poor manage, the decline is intricately related to the poverty-population-environment interaction (Mink, 1993). Where the poor depend on biomass fuel and confront increasing fuel wood scarcity they often shift to using animal dung, fodder and crop residues for fuel. The quantities of these materials that are returned to the soil, are thus reduced and its fertility declines. Non-replishment of soil nutrients leads to soil exhaustion as fuel wood supplies diminish and animal manure is increasingly used as a fuel substitute. Poverty forces a trade-off between the immediate demands for fuel for cooking and heating and manure for the land. The time-preference argument suggests that the immediate and urgent needs be satisfied. Mortimore (1989) shows how soil exhaustion occurs when certain nutrients are taken from the soil, but are not replenished naturally of artificially with fertilizers. A homogenous crop, usually a cash crop, grown repeatedly on the same piece of land can lead to soil exhaustion. Increasing population pressures on land can also lead to shortened fallow periods and this coupled with the farmer's inability to apply variable inputs more intensively because of poverty, can lead to decreased soil productivity. Productivity, especially, in open-access natural resources or of resources under deteriorating common property management may often decline due to over-use.

2.6 Poverty Impact on Natural Resource Management

Poverty is generally assumed to impose short time horizons. Theoretically this results from the poor having high rates of pure time preference which lowers the ability to forego consumption today. This leads to using up savings previously set aside for later consumption and to borrowing if access to credit is available. The implications of a high subjective discount rate are rapid resource extraction to meet present income or consumption needs and low investment in natural resources to improve future returns. Overgrazing of pastures and shortening of fallow periods can result from the high subjective discount rate. Similarly, farmers are less likely to make natural resource investments where returns are expected after a number of years. These factors combine and lead to a wide divergence between private and social discount rates. The empirical evidence on whether the poor really do have high rates of time preference is limited and sketchy.

2.7 The links between Poverty and Land Degradation - mixed empirical evidence

The study by Grepperud (1997) concludes that in the relationship between poverty, land degradation and climatic uncertainty it is unclear whether poverty in general induces farmers to manage their resources poorly in the long run. The study by Scherr *et al.*, (1995) also found no consistent relationship between population density and the frequency in which land is used for productive purposes and land degradation. Population growth and poverty, they noted, create both incentives and disincentives for land degradation. There is an extreme dearth of studies that seek to rigorously test these relationships. The lack of appropriate data underlies this paucity. To do this effectively, information is required not only on the physical aspects of the land, but also on its availability. Reliance, therefore, has to be placed on studies from which these relationships can be inferred.

Most of the available studies look at the problem in terms of the behaviour of small-scale farmers and land degradation. Southgate (1988) maintains that small-scale farmers have been the main agents responsible for land degradation activities. He states that market and institutional failure were the primary causes for farmers adopting non-sustainable practices. Pagiola (1995) shows how government price controls on agricultural goods in Kenya failed to provide incentives for the small-scale and poor farmers to conserve their land. In some cases, this led to the mining of resources for maximum output. Mortimore (1989), on the other hand, finds evidence of small-scale farmers' willingness to forgo short-term income gains, even under price and famine pressure, to pursue long term sustainable management strategies. The existence or non-existence of secure land tenure systems might explain the contradiction regarding smallscale farmer behaviour. Several studies cite the lack of secure land tenure as the primary reason for poor farmers cultivating their land excessively to the point of exhaustion for the simple reason that they have no vested interest in conserving an asset that they do not own (Southgate, 1988; Mink, 1993; Repetto et al., 1989).

2.8 Household Effect of Degradation

Changes in agricultural practices can have primary and secondary effects on the environment. Von Braun (1997) describes the relationship between agricultural change and the eventual effects at the household level through these environmental effects. Such changes have come about in large parts of the world through the adoption of green revolution type technologies. Agricultural change can also occur where green revolution technologies have not been (as yet) adopted. In the case of the latter, the primary effects on the environment are generally stated to be in the form of desertification, deforestation, watershed degradation, soil erosion and soil fertility declines. The secondary effects can be droughts and floods. These environmental effects can translate into specific effects at the household level. These effects can take the form of impoverishment/productivity decline, migration–related health stress, vector borne disease (if the migration occurs into disease prone areas), communicable disease (when sanitation breaks down), chronic food insecurity, seasonal malnutrition and famines. In the case of green revolution technologies, potential environmental degradation can result from each element in the technology package. It can result from the direct use of each of the technology elements in the technology package or their indirect effects. For example, irrigation can lead to reduced water quantity or quality, salinisation, increases in mosquitoes, aquatic snails and blackflies. Inappropriate pesticide use can have harmful household effects. Fertilizer use can result in nitrates leaching into drinking water. At the household level these aspects of potential environmental degradation can translate into diseases such as diarrhea, cholera, typhoid, malaria, schistosomiasis, onchocerciasis, poisoning and diseases of the circulatory system in infants. The secondary effects of the use of such technology can be crowding, deficient sanitation, diet changes and vector control (through inappropriate pesticide use). These can lead to communicable diseases, nutritional diseases and poisoning etc. These household effects imply a reduction in welfare, which under the conventional consumption based methods of measuring poverty, might not emerge. That is why it is important to include the non-income measures of poverty, such as anthropometric measures in assessments of poverty status.

2.9 Conceptualizing Between Poverty and Land Degradation

Vosti and Reardon (1997) present an interesting conceptual model of the linkages between poverty and the environment that helps to highlight the complexity of such relationships. Poverty is seen to be the product of "asset" components comprising, natural resources (private and commonly held), human resources, off-farm resources, community-owned resources, social and political capital. The links between the components determine household and village behaviour in terms of income generation, consumption, investment in assets, migration and human fertility, which in turn has implications for use and management of the natural resource component that determines the asset components of poverty. How natural resources are used and managed, feeds back as a determinant of the asset components of poverty. A set of conditioning factors governs the relationship between the asset components of poverty and household and village behaviour and between the household and the natural resource components. These conditioning factors are markets (prices), village and regional infrastructure, technologies (production and conservation), village level asset poverty and population pressures.

This conceptualization leads to innovative policy implications. In comparing traditional productivity investments such as irrigation, fertilizers, and modern seeds with conservation investments (such as bunds, terraces, windbreaks, and practices such as organic matter application), the study concludes that the latter have different requirements and characteristics. Conservation investments need innovative policies beyond just "getting prices right". The three non-price policies suggested by the study are complementary public infrastructure investments (such as culverts to divert water flow from farm bunds) that: (1) make household investments more profitable to institutional innovations; (2) that improve security and transferability of resource tenure; and, (3) that modify community level arrangements to improve the management of the commons or watershed (Vosti and Reardon, 1997). In the same source, Von Braun (1997) also points out that poor communities lack resources for community level investments such as physical infrastructure, health and education. Policies that strengthen traditional institutions and make them more flexible (particularly in the face of increasing population pressure), can reduce poverty and the dependence of rural communities on resource mining especially in response to droughts and floods.

Defining poverty in the Vosti and Reardon (1997) manner sets a much higher cut-off than conventional definitions. Implicit in this conceptualization is the assumption that sizeable resources, over and above meeting bare subsistence consumption and production, are required by the poor to address issues of resource degradation. While this model provides an interesting tool for conceptualizing some complexities, it also highlights the trade-off between the depth and detail of understanding, concomitant data requirements, and the inadequacy of available methodology and resources for measuring poverty. Duraiappah (1996) presents an interesting conceptual framework for analyzing the many complex inter-relationships between poverty and environmental degradation. For simplicity, he postulates four possible, though not mutually, exclusive relationships. These are:

RI: Poverty leads to Environmental Degradation

R2: Power Wealth and Greed leads to Environmental Degradation

R3A: Institutional Failure leads to Environmental Degradation

R3B: Market Failure leads to Environmental Degradation

R4: Environmental Degradation leads to Poverty

If only R1 is observed, then the poverty-induced environmental degradation argument can be accepted. However, based on the initial conditions, only exogenous poverty can cause this environmental degradation. On the other hand, if only R2 is observed, then policies adopted under R1 assumptions can be misleading and may in fact exacerbate the degradation process, as demonstrated by Binswanger (1989). In case of either R3A or R3B being responsible for environmental degradation, the solution is theoretically relatively simple – remove or correct the market or institutional failure. If R4 is present, two interesting observations arise. First, R4 can only be present if R1, R2, R3A, or R3B or various combinations of all four cause it. Secondly, the presence of R4 can set into motion an R1 type of link but in this case, it is indigenous poverty that causes the environmental degradation. This is the R1 feedback or R1FB link.

In the R1 - R4 link two outcomes are possible. The first scenario would be that R1 causes R4 and the causality link ends. On the other hand we can get a situation whereby the indigenous poverty caused by R4, can set into motion more environmental degradation by an R1FB relationship. The downward spiral of poverty leading to degradation, leading to more poverty (Durning, 1989), is typically a R1FB type of relationship. The various permutations and combinations of these four scenarios highlight the complexity of the problem. The model has four

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contributing forces, namely: the power greed and wealth factor; exogenous poverty; institutional failure; and market failure. It addresses two externalities, namely environment degradation and indigenous poverty. The fear of losing land by the poor is a direct implication of R2. R3A is also a primary contributor to land degradation in this manner. R1FB can be a contributory factor for soil exhaustion because of two reasons: first from within the sector due to decreases in agricultural productivity, and secondly from the fuelwood-manure relationship. In the first case, there is evidence of declining agricultural productivity in degraded lands causing indigenous poverty, which in turn forces many people to continue to degrade their land further to extract subsistence outputs. The R2 link in the forest sector can cause an R1FB effect in the land degradation category. R2, R3A, R3B, and R1FB linkages can cause salinisation. In the case of desertification, the primary links identified by Duraiappah (1996) are R2, R3A, and R3B. Duraiappah (1996) concludes that most environmental protection programs fail because they address only the symptoms while ignoring the underlying causes.

2.10 Sustainable Use Management

Much of the literature that simplistically assumes that poverty leads to degradation cannot explain instances of (materially) poor communities living sustainably with their environment for centuries. Induced innovation theory suggests that degradation at least in the long run may be self-correcting as resource scarcity and rising private and/or social costs from degradation induce the development and use of new agricultural and resource management practices (Hayami and Ruttan, 1985; Boserup, 1965). The Induced Innovation Model in Natural Resource Management assumes that, with increasing population density of market demand, four distinct phases/time periods of management response can be identified. The first phase is characterised by dependence on naturally occurring resources. The second stage marks the period of resource degradation. The third phase marking the onset of resource rehabilitation occurs with transition to intensive management because the benefits from the investment in resource rehabilitation outweigh the costs. The fourth phase is characterised by dependence on human managed resources (for example agroforestry, forest plantations and managed reserves). Most of the observed degradation can be explained by assuming that the innovative responses of phases three or four have not occurred. In many cases it can be shown that these have been delayed due to a number of conditions.

However, there is considerable controversy over the adoption of conservation strategies. One school of thought maintains that the adoption of land conservation technologies is low across all agricultural environments despite major support and investment in research and development in this area. Instances where land degradation management have been successful are known, but analyses of these instances have not yet provided clear guidance to policy makers, researchers or developers to enable a more general adoption of these technologies (World Bank, 1991a). An alternative school maintains that the lack of adoption of conservation technologies results from a lack of incentives. "The success of conservation measures is highly dependent on farmers receiving crop yield and economic benefits in the first or second season after implementation" (FAO, 1989). This debate highlights the need to understand more fully why resource users do what they do, and how they reach decisions on resource use and environmental management. This debate does not differentiate between the behaviour of the poor versus the non-poor.

Chapter 3

METHODOLOGY

3.1 Introduction

The study focused on three provinces, namely the Eastern Cape, KwaZulu Natal and Northern Province. Land degradation data and results, used, however, were taken from all 367 magisterial districts across the nine provinces in South Africa. The three provincial studies included former homelands and independent Bantustans of Ciskei and Transkei, KwaZulu, Gazankulu, Lebowa, and Venda respectively. Different areas, magisterial districts, and towns in these provinces were used to test different scenarios. These are tabulated in the study procedures and methods section below.

3.2 The Terms of Reference

The terms of reference that provided a basis for the design of the data collection and analyses, were:

(a) to examine concepts and definitions.

(b) to quantify marginal biophysical characteristics, rural population and rural poor living on these areas, and the government commitment devoted to research on productivity increase (agriculture, environment, forestry and water), post-harvest activities and options for the removal of institutional constraints, all of which are expected to contribute to poverty eradication on "marginal lands" as defined by their biophysical characteristics.

(c) to make suggestions about future agricultural priorities and strategies for research work on marginal lands, including whether the current level of effort is adequate in relation to that devoted to other land types.

3.3 Study Procedures and Methods

The study created a database for identifying marginal and non-marginal (favoured) lands and their characteristics, including: biophysical environment and climate, land use and land tenure systems, demography, labour and employment and economic production indicators. The purpose or scope of the database was to indicate orders of magnitude of different land types in these provinces, i.e. the extent of favourable and less favourable lands available for agricultural purposes, the extent of forest and woodlands and dry areas, and the number of rural people and rural poor living on them.

3.3.1 Primary Data

Information about the severity of water, soil and vegetation degradation in South Africa was obtained from four main sources. These were:

- a series of workshops (12 in total), which were held in the three Provinces (Eastern Cape, KwaZulu Natal and Northern Province) between March and September 1999, involving 82 participants, most of whom were either agricultural extension officers, development workers and or resource conservation officers. During these workshops informal and unstructured interviews were conducted with participants (see *ANNEX 5 and 6*);
- extensive South African literature on natural resource degradation was reviewed and information about the nation's soil and vegetation degradation was synthesized and prepared for this study;
- several case studies were carried out in 1999 in districts from the three provinces, to verify and add to workshop findings. Selected information derived from these case studies was also used in the study;
- extensive statistical records, that exist for each magisterial district in these Provinces and that cover a wide range of subjects, from agriculture to demography, and from labour to economics, have also been used throughout the study;

- 31 variables (see *Annex 2*) which defined each of the 367 magisterial districts in South Africa in terms of their biophysical environment and climate, land use and land tenure systems, demography, labour and employment and economic production indicators, were used;
- three correlation matrices (soil degradation, veld degradation and a combined, soil plus veld degradation index) which were developed during the workshops, were used;
- the degradation indices and land use variables derived from the workshops were used, and all biophysical and climatic variables, except runoff and erodibility, were calculated from data sets available in the GIS directorates of the Computing Centre for Water Research (CCWR), which are explained in detail in Schulze *et al.*, (1997).
- runoff and erodibility were calculated from the Environmental Potential Atlas (ENPAT, 1996) database (van Riet *et al.*, 1997); and
- the mean values for each of the 367 magisterial districts were calculated using ArcView GIS™.

3.3.2 Socio-Cultural and Economic Data

The data used throughout the study for the purpose of analysing and reporting the socio-cultural and economic analysis were extracted from one of the following tools;

- the population data for the three provinces was collected per magisterial district, based on the 1996 census, as well as from previous studies conducted by the Development Bank of Southern Africa (DBSA). Data from the 1991 census is sometimes used in this study to illustrate the former homeland scenarios.
- the Human Sciences Research Council (HRSC) [Development indicators for Eastern Cape, KwaZulu Natal and the Northern Province, 1997], was used;
- country values on percentage rural population were taken from Development indicator and/or UNDP Human Development Report 1994.
- demography, labour and employment and economic production variables were taken from the nine statistical macro-economic reviews (one from each province) published by the Development Bank (DBSA) in 1995.

- stocking values were taken from the 1995/96 Census of the National Department of Agriculture.

3.4 Workshop protocol

A series of participatory workshops were organised in these provinces during 1999. The main aim of the workshops was to formulate a programme of collaboration between the Republic of South Africa and the Food and Agriculture Organisation of the United Nations (FAO) – Special Programme for Food Security and Development of Rural Information Systems (SPFS). It also had a mandate to develop a consensus map of status of land degradation in these poorest Provinces. Information concerning land use practices and changes in land use area intensity over the last 10 years was also collected. In total, 12 workshops were held each lasting 4 – 6 hours. The location of the workshops were Umtata, Kokstad, Queenstown and East London (Eastern Cape); Cedara, Pieters, Port Shepstone, and Eshowe (KwaZulu Natal); and Giyani, Potgietersrus, Pietersburg and Thohoyandou (Northern Province).

Table 3.1: Itinerary for the 12 Workshops held in Eastern Cape, KwaZulu Natal and Northern Province between March and September 1999. The province, agricultural region and town where each workshop was held, as are the date of the meeting and number of people who attended.

Province	Agricultural region (s) assessed	Workshop location	Date	Number of people attending
Eastern Cape	Eastern	Umtata	9/6/99	9
	Griqualand	Kokstad	10/6/99	6
	Northern	Queenstown	11/6/99	6
	Central	East London	23/6/99	8
KwaZulu Natal	Northwest	Pieters	16/3/99	9
	Northeast	Eshowe	18/3/99	10
	Southeast	Port Shepstone	23/3/99	9
	Southwest	Cedara	25/3/99	10
Northern Province	Western	Potgietersrus	7/9/99	5
	Central	Pietersburg	9/9/99	9
	Northern	Thohoyandou	14/9/99	6
	Lowveld	Giyani	15/9/99	6

A total of 82 people attended the workshops. The majority of the participants were agricultural officers and or resource conservation technicians. The officials were chosen for a number of reasons, but especially for their expertise. These officials are a significant workforce of the Provincial Departments of Agriculture and National

Department of Agriculture. They have a presence in both marginal and favoured areas and are, for the most part, very knowledgeable about the state of natural, and especially the agricultural resources, of an area. Many have served for many years, if not decades in a single magisterial district or agricultural region and their understanding of the changes that have occurred in an area are unparalleled. It is appreciated, however, that their perspective is strongly influenced by their background and training. This is especially true in terms of their bias towards commercial agricultural production as opposed to their appreciation for the merits of marginal land tenure and land use practices.

However, because agricultural personnel, with a wide experience in both favoured as well as marginal areas, were used, it is believed that the study achieved a realistic and balanced perspective on the problems of land degradation in South Africa. In very subjective assessment of these differences, it is suggested that the officials with a commercial agricultural background tended to over-estimate the problems in favoured districts while those with a history of working in the marginal areas often underestimated the degree and extent of degradation in an area. Overall, however, I support the findings from a survey, which suggest that agricultural extension officers possess reasonably balanced perception of the state of resources of a region. This perception lies between the underestimation generally experienced amongst farmers and the over-estimation of many range scientists

Table 3.2: Differences in the perceptions of veld condition by farmers, agricultural extension officers and range scientists:

	Veld condition %		
Scored	Poorly to very poor	Fair	Good to very good
Farmers	5	21	74
Extension Officers	13	46	41
Range Scientists	40	45	15

Source: Data from Roux (1990) who cites them as being from "a survey carried out by the Extension Research Institute, University of Pretoria (undated).

The same approach in all workshops was adopted. This approach is similar to that used in the Global Map of Human - Induced Soil Degradation (GLASOD) (Oldeman *et al.*, 1991) but the method was modified considerably to suit my own needs and circumstances. Generally, the procedure is laid out in Liniger and Van Lynden (1998) for the assessment of land use practices and soil degradation only. This methodology has emerged from several iterations of WOCAT Task Force (World Overview of Conservation Approaches and Technologies), and has been shown to be robust enough to be used under a wide range of circumstances. An example of the data sheets used in the workshops is shown in *Annex 5*. The workshop itself was divided into three main components. The first, concerned land use practices in the magisterial district. Although there are many land use classification that have already been applied to South Africa (e.g. Schoeman and Scotney, 1987; Thompson, 1995), the study recognises six, main Land Use Types (LUT). These are croplands, grazing land or veld, commercial plantations, conservation areas and state land, settlement areas and "other".

Workshop participants, with particular knowledge of their magisterial district, were asked to determine:

- the proportion of the magisterial district used for favoured or marginal purposes, expressed as a percentage;
- the area of each LUT within a district, expressed as a percentage of entire district;
- whether the area for each LUT has increased or increased over the last 10 years and reasons for the change (0=stable over the last 10 years, + 1=slightly increasing, +2=moderately increasing, -1=slightly decreasing, -2=moderately decreasing);
- whether the intensity of land use had increased or decreased over the last 10 years and reasons for the change (0= no change, +1 = moderate increase, +2 =major increase, -1 = moderate decrease, -2 +major decrease);

The second component of the exercise concerned soil degradation in the magisterial district. Soil degradation was divided into erosive forms such as acidification or salinisation. Participants were asked to determine for their magisterial district:

- the two or (rarely) three main types of soil degradation in each LUT.

- the degree of soil degradation in each LUT (1= light, 2+ moderate, 3= strong, 4 = extreme);
- the relative extent of soil degradation in each LUT, expressed as a percentage class;
- the severity class (read from severity class in *Annex* 6);
- the rate of soil degradation that has occurred over the last 10 years (0= no change, +1 = slightly increasing, +2 = moderately increasing, -1 = slightly decreasing, -2 = moderately decreasing).

The main reasons for soil degradation in each of the magisterial districts were discussed and a soil degradation index was then calculated for each district as:

Σ (LUT Degradation Severity Class + LUT Degradation Rate) * % Area of LUT

The final component of the exercise concerned veld degradation in the magisterial district. The study recognised six main types of veld degradation. These were loss of cover and change in species composition, bush encroachment, alien plant invasions, deforestation and a general category of "other". Participants were asked to determine for their magisterial district:

- the two or (rarely) three important types of veld degradation in the grazing lands only;
- the degree of veld degradation in the grazing lands (1 = light, 2 + moderate, 3 = strong, 4 + extreme);
- the relative extent of veld degradation in the grazing lands, expressed as a percentage class;
- the severity class (read severity class table in *Annex* 6);
- the rate of veld degradation that has occurred over the last 10 years (0= no change, +1 = slightly increasing, +2 = moderately increasing, -1 = slightly decreasing, -2 = moderately decreasing).

The main reasons for veld degradation in each of the magisterial districts were discussed and a veld degradation index was then calculated for each district as:

(Veld Degradation Severity Class + Veld Degradation Rate)* % Area of veld

The soil degradation indices were added together to form a single combined index of land degradation, which incorporated, both soil and vegetation parameters.

Following the formal section of the workshop and completion of the data sheet (*Annex 5 and 6*) a more general discussion followed. Degradation indices were totalled and districts ranked according to their degradation status. The data for each magisterial district was assembled in a Microsoft Excel™ spreadsheet and imported into ArcView GIS™ GIS Version 3.1 for analysis and presentation.

The study has not undertaken a comprehensive analysis of the reliability of the results or potential inaccuracy of the workshop results. However, in some cases there is a significant correlation with other studies (e.g. Versveld *et al.*, (1998) map of the distribution of alien plants; Loxton *et al.*, (1985) assessment of soil erosion in 28 former Transkei districts. This suggests that data in this study might reflect some level of reality that can be corroborated by detailed scientific measurement.

3.5 Case Studies

The 12 degradation workshops, held in the three provinces provided a useful general perspective on land degradation. The workshops pointed to problem areas, and in a very limited time available during meetings, also enabled the study to gain some insight into the probable causes of land degradation in specific districts. Despite the value of this approach it also has a number of weaknesses.

First, local users were generally not represented at the meetings. The opinions of crop and livestock farmers and other land users were not known. For marginal areas this includes those people who use the natural resources of an area for a multitude of purposes such as firewood, construction timber, medicinal plants etc. It was felt that it would be important to consult more widely with the land users of a district to assess whether their perceptions were similar to those of agricultural personnel who attended workshops. Secondly, there was a need for more detailed accounts of land degradation problems and solutions and the best way was to embark on a series of case studies in key magisterial districts.

Six districts, Herschel and Peddie (Eastern Cape); Nongoma and Weenen (KwaZulu Natal); and Schnoord and Mhala (Northern Province) that comprise both favoured and marginal land tenure systems were used for case studies. Some, such as Herschel and Weenen are perceived to be amongst the worst in the country in terms of their land degradation status:

Three broad areas of investigation were emphasized in each case study.

1. An attempt was made to describe the biophysical resources of the district in more detail and to assess the accuracy of the information obtained in the workshop.
2. An investigation into the environmental history of a district was undertaken largely through asking people about their perceptions of how land degradation status has changed in their lifetime.
3. Local user perceptions and impacts of land degradation in the district were also assessed with the following four theme questions:
   - What are the perceptions, level of awareness and priorities of local land user in terms of their soil and veld resources?
   - What are the perceived reasons for the levels of land degradation in the district or village?
   - How does the extent of land degradation affect local user livelihoods?
   - What approaches have been or should be initiated to reverse or maintain the agricultural status of the district?

With each of these four general themes several additional questions were posed to the land users depending on the composition of the group or on the level of the group or individual. Individual case study investigations lasted from a few days to a week at a time. The information gathered from these case studies is sprinkled throughout the study.

3.6 Magisterial district statistics

Each magisterial district in South Africa has a unique history, which is partly recorded in an extensive set of statistical records. These records define a district and are able to provide insight into the important correlates and predictors of land degradation. Information from several sources was used to assemble a statistical portrait for each magisterial district.

Chapter 4

BIOPHYSICAL ENVIRONMENT

4.1 Introduction

The purpose of this chapter is to outline the underlying information relevant to natural resource management (NRM) across the study area, and to indicate its utility and possible weaknesses. It is basically a description of what information is available and what it can deliver. As a background to the rest of the study, this chapter provides descriptive natural resources information on three provinces.

4.2 Physical and Biological Environment in South Africa

4.2.1 THE EASTERN CAPE

The Eastern Cape is one of the poorest provinces in South Africa. It is situated in the south east of the country and encompasses what is traditionally known as the Eastern Province, Border and north Eastern Cape areas, as well as the former "homelands " of Transkei and Ciskei. On the northern side, it borders the Kingdom of Lesotho and Free State, while the districts of Middelburg, Graaff-Reinet, Aberdeen, and Willowmore form its western borders. The Eastern Cape is spatially the second largest province, covering 170 616 km^2, or 13.9 per cent of the total surface area of South Africa.

4.2.1.1 Climate

According to the South African Weather Bureau classification, the Eastern Cape comprises five climatological regions, based on temperature and rainfall variations.

The climatological regions are as follows:

- **Arid to semi-arid (Southern Cape interior/Karoo)**

This area receives on average less than 250 mm rain per year although this figure rises to 400 mm in the east. It is only in the mountain ranges, such as the Sneeuberge, that the average rainfall exceeds 600 mm. Rain falls throughout the year. Thunderstorm frequency is between 10 - 20 per year, while hail occurs on one - three days per year. Snow falls about five times per year. Temperatures demonstrate a large diurnal and seasonal range. Contrasts of 28^{0}C from night to day are common. Frost occurs from about 1 June to 31 August, but sometimes extends several weeks either way. Prevailing winds are light to moderate, varying from southeast and east in January to northwest in July. On occasion, high velocity winds have been recorded in this region.

- **Semi-arid (North-Eastern Cape interior)**

This area, also known as the Southern steppe, receives 250 – 600 mm rain per year, the wettest areas being in the east where rainfall can rise to 800 mm in the mountainous regions. Most rain is in the form of showers or thunderstorms in the summer months, with a peak in February/March, during which it may rain up to 10 days per month. In winter precipitation can be in the form of snow on the mountain ranges accompanied by intensely cold temperatures. Hail falls from two - six days per year, increasing in prevalence towards the northeast. This is largely a summer phenomenon. Air temperatures fluctuate widely on both diurnal and seasonal time scales. The average daily maximum temperature varies from 33^{0}C in January to 17^{o}C in July. In contrast, some average daily minimums are 15^{0}C in January and 0^{0}C in July. Frost occurs on about 150 days per year between May and September in the south of this region, which decreases to about 100 days per year towards the north. Prevailing winds in summer tend to be light southeasterly, becoming moderate northwesterly in winter. Stronger southwesterly winds are common in association with thunderstorms, but are generally of short duration.

- **Drakensberg region (North-Eastern highlands)**

Primarily its altitude shapes this highland region. Rainfall is high, ranging from 600 - 1500 mm. Most rain falls in summer, from November to March, with 12-13 days of rain per month. In winter, this decreases to two or three days' per month. Most of the rain falls as intense thundershowers, occurring between 60 and 90 times per year. Mist and drizzle are common and hail occurs from three to seven times per year. Snow is fairly common, with falls about eight times a year – some of which do not melt for several days. Temperatures fluctuate widely on both a diurnal and seasonal basis. Average daily maximums are 27⁰C in January and 19⁰C in July, while average daily are 15⁰C in January and 3⁰C in July. Frost varies widely with the topography, but occurs on average from 90 to 150 days per year between April and September. Prevailing winds are moderate southerly in January, and change to slightly stronger northerly and northwesterly winds in autumn and winter.

- **Coast with evenly distributed rainfall (Eastern Cape)**

The entire region receives rain in more or less equal amounts throughout the year, but with slight increases in the autumn and spring months. Amounts vary between 400 mm on the inland plains to over 1 000 mm on some of the mountain ranges, where rain can be recorded for up to 12 days per month. Hail and snow are rare, both occurring on average twice a year. Temperatures are modified by proximity to the ocean and generally only exceed 38⁰C during 'berg winds conditions'. Average daily maximums are 26⁰C in January and 19⁰C in July. The average daily minimum values are 15⁰C in summer and 7⁰C in winter. Frost is uncommon, especially near the coast. Prevailing wind are generally strong, and range from southwest to northwest in winter and from southwest to southeast in summer.

- **Humid, summer rainfall coastal region (Ciskei to Transkei)**

This coastal region is warm and humid, with a summer rainy season peaking in March. The summer rainfall period produces about 12 rainy days per month, whereas winter will account for four days of rain per month. Rainfall increases steadily from 500 mm along the Great Fish River to over 1 200 mm at Port St Johns. Generally, the rainfall is showery, with about 20 to 30 thunderstorms per year, which are occasionally accompanied by hail. Average daily maximum temperatures are 28⁰C in January and 21⁰C in July. Average daily minimums are 17⁰c in January and 8⁰C in July. Frost usually only occurs on 30 to 40 days during July and August in the interior valleys. Prevailing winds are northeasterly and southwesterly for much of the year along the coastline and can occasionally reach gale force. 'Berg winds' sometimes blow from the northwest in winter and bring hot, dry weather to the region.

In summary, the climate is characterised by extreme variability as regards both temperature and precipitation. This variability permits an unusually wide choice of production options in selected areas, but the area in which production can be intensified under suitable rainfall conditions is limited. The large desert and semi desert areas confine crop production mainly to the coastal strip and immediate hinterland, as well as the northern sector of the province.

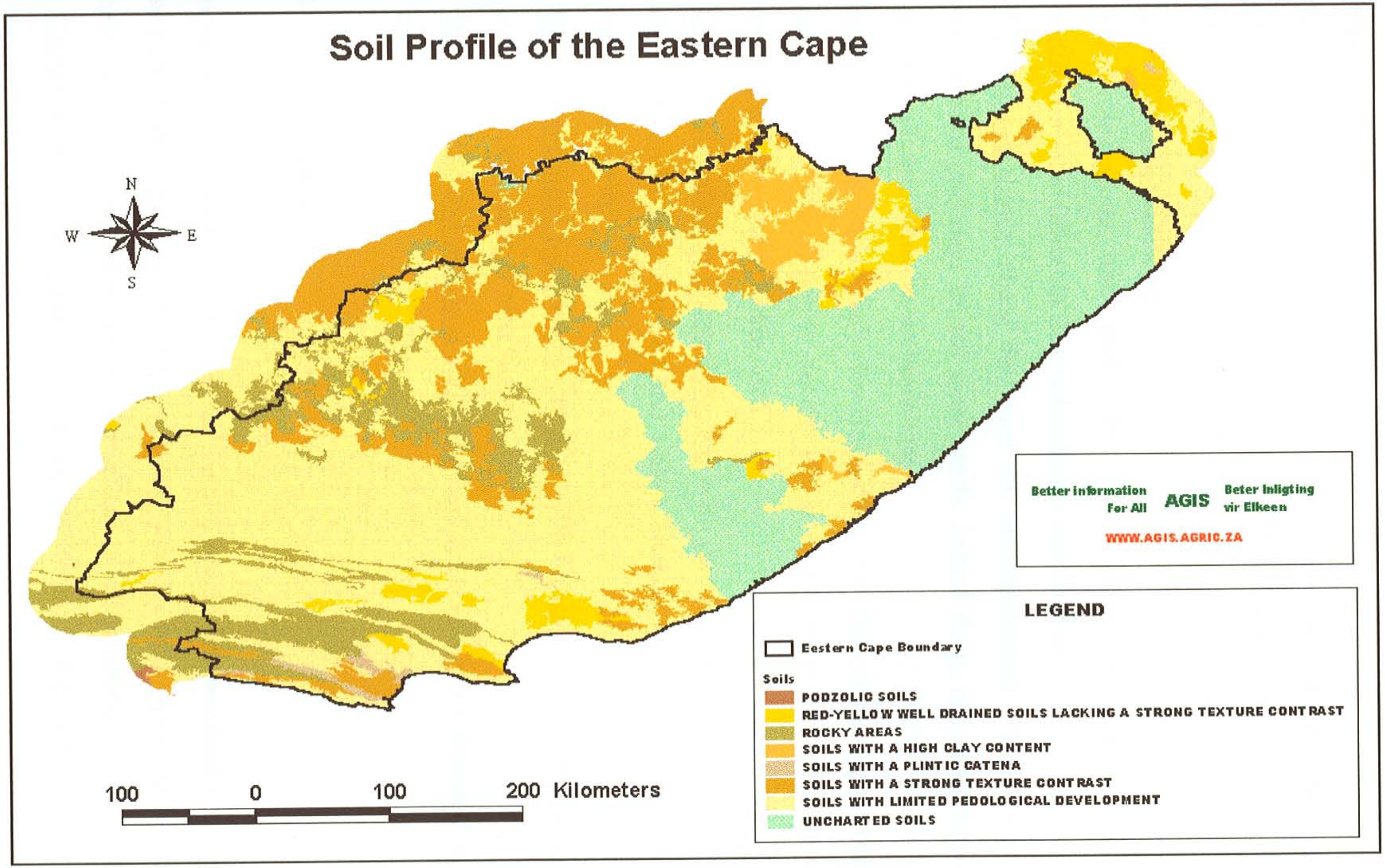
4.2.1.2 Topography

The topography is as variable as the climate, including flat plains, highland areas and stretches of beautiful coastline. This variability in itself does not serve as an impediment to appropriate agricultural production. It also provides an invaluable resource for nature-based tourism, enhanced by the climate and freedom from dangerous diseases such as bilharzia and malaria.

4.2.1.3 Soils

Apart from the river valleys where deeper alluvial soils are found, soils are shallow and of agricultural potential. There are, however, two major exceptions, namely the substantial area of North Pondoland (the area around Lusikisiki and Flagstaff) and the 100km strip between Paterson and Port Alfred. North Pondoland, which is by far the larger area of the two, has deep, fertile soils and high rainfall. The agricultural potential of this area is considered to be amongst the highest in the country. Soil degradation in the region is mainly associated with agriculture on unsuitable soils. Vegetation changes due to heavy grazing pressures have occurred.

Figure 4.1


Soil Profile of the Eastern Cape
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RED-YELLOW WELL DRAINED SOILS LACKING A STRONG TEXTURE CONTRAST
ROCKY AREAS
SOILS WITH A HIGH CLAY CONTENT
SOILS WITH A PLINTIC CATENA
SOILS WITH A STRONG TEXTURE CONTRAST
SOILS WITH LIMITED PEDOLOGICAL DEVELOPMENT
UNCHARTED SOILS
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Soil composition is such that the potential for erosion for most of the region is fairly high and it is also subject to heavy erosive rainstorms. The soil types found in this region include:

- Poorly developed soils on rock with lime in the bottomlands. Soils are generally well drained. Further inland are undifferentiated rock and lithosols. Along the cost, windblown sand dunes provide littoral grey sands.
- Undifferentiated lithosols are primarily shallow and weakly developed with surface limestone and rocks. In the mountainous regions soils are undifferentiated lithosols. The red soils are well drained.
- Wind–blows dunes: along the coast are unconsolidated wind-blown dunes with littoral and near littoral grey sands. Inland deep, red, undifferentiated porous soils and lithosols on limestone.
- Solonetzic soils: with a high clay content occur in the central region but these become shallow and poorly developed on rock with some surface limestone tending to lithocutanic to the north.
- Deep, acidic sands or loams (latosols): with poor drainage. Solonetzic soils in the south and non-humic red and yellow latosols together with black clayey soils in the north.
- Deep, non-humic red/yellow latosols: with smaller areas comprising black clay with rocky land or acid latosols.
- Shallow black and red clays and solonetzic soils: with poor drainage in the B-horizon.

4.2.1.4 Vegetation

The topographic diversity and history of the sub-region has resulted in an equally diverse pattern of vegetation. Most major South African veld types can be found in this region, and four major different veld types can be distinguished:

- Coastal tropical forest: that occurs from Alexandria to the southwestern border of the Eastern Cape near Knysna.
- False bushveld: is found between the Kei and Keiskamma River valleys.

- Karoo and Karroid vegetation: covers most of the interior of the region and is subject to erosion, especially on the western side.
- Grasslands: are found north of the Great Fish River basin only, and are sensitive to overgrazing.

Veld conditions are under pressure throughout the region, owing to heavy stocking and poor land-management practices. Invasive plant species are on the increase, and altered species compositions of the rangelands have reduced their potential productivity. Of particular importance to conservation is the Tsitsikama Forest, the smaller forest along the former Transkei coast, and the Baviaanskloof mountain catchment area as well as the primary grasslands of the region. In the Eastern Cape, the interaction of climate, vegetation and geology has resulted in an infinitely varied landscape and environment. The diverse geology, climate and soils of the region provide for vegetation and flora, which has been noted for its fill-geographical complexity.

Because of its low rainfall and the nature of its topography and soils, most of the region is suitable only for grazing. Since about 90% of the total farming area is utilized for livestock production, the spread of undesirable veldtypes will require firm management. The introduction of exotic plant species, free of their natural controls, has brought about a slow but steadily accelerating deterioration of the indigenous vegetation. The region seems to have a large compliment of naturalized plants from Australia, such as the many *Acacia sp.* or Cactaceae from the Americans. These invasive plants may also affect water supplies and add to the danger of fires, reduce farming productivity and promote the loss of the biodiversity. Biological control of plant invaders has been successful for some species in the region and, ideally, land management procedures should be modified in conjunction with the use of selected natural enemies to best achieve control.

4.2.1.5 Water Resources

The province is deficient in water over most of its area. The data show that water demand in the East London-Berlin-King Williams Town area already exceeds the supply capacity, and it is apparent that the demand for water for urban and industrial use imposes a limitation on the development of large-scale irrigation schemes. The Port Elizabeth-Uitenhage area has been water deficient since 1988 and has relied on inter-catchment transfer from the Gariep River system (formerly the Orange River). Further expansion, particularly of irrigation, depends on the outcome of the current re-planning of the Gariep River system. The Queenstown-Ezibeleni-Sada area seems assured of water into the next century, and potential for further impoundment will permit growth for twenty years or longer. The limited potential and skewed distribution of water calls for careful spatial and strategic planning of future developments, particularly in the large-scale irrigation sector. The dispersed nature of the resource does, however, favour small-scale, low-cost irrigation schemes.

4.2.1.6 Agricultural potential

4.2.1.6.1 Land use patterns

Potential arable land in the province comprises about 1 172 901 ha or 7%, of which 155 000 ha is irrigated. The potential arable land is almost evenly distributed between large scale farming and subsistence agriculture, with 643 501 ha and 529 400 ha respectively. Grazing land comprises 81%, while forestry and nature conservation respectively comprise 1% and 4% of the total surface area. Little land is available for lateral expansion of the large scale farming areas of the province, while land available for expansion is of medium to low cropping potential. Agricultural production activity in the province is highly diversified, correlating strongly with the diverse natural resource base and especially the variance in climate. According to Kassier (1988), the province has extremely erratic and limited water resources. Average annual rainfall increases from west to east and varies from 300 – 400 mm in the lower rainfall of the west to 700 - 800 mm towards to the east. A few isolated areas on the upper slopes of the Winterberg enjoy rainfall of over 900mm per annum. In the commercial farming areas irrigation is mostly undertaken by private farmers and in many cases they fall under the jurisdiction of Irrigation Boards or Associations. The most important rivers in the area from an irrigation point of view are the Gamtoos, Sundays and Fish Rivers. The most important source of water in this portion of the province is the Orange River Project, which is used to supplement water supplies in these river systems. The area under irrigation which could be linked to Irrigation Boards comprises about 43 820 ha and some 95 000 ha irrigated by farmers utilizing private water sources.

The river catchment of areas in former Ciskei include the Keiskamma, Kat/Fish, Swart Kei/Oxkraal/Klipplaat, Buffalo and Chalumna covering a total surface area of almost 8 170 km^2. According to Hill *et al.*, (1987) the area of potentially irrigable land in the former Ciskei is estimated at 9 930 ha which is highly recommended, 3 795 ha which is recommended and 102 060 ha which could be regarded as marginal. At that time about 4 294 ha was irrigated, which was expected to increase to 12 532 ha by year 2000. The existing storage facilities in the southwestern Transkei have the capability of providing water for some 17 877 ha of irrigation of which 6 295 ha were irrigated in 1987. Land under irrigation was expected to increase to 9 236 ha by the year 2000. The ratio of grazing land (82%) relative to potential cropland is much higher than the average for South Africa, indicating that livestock production is the most important and significant farming enterprise in the province. Forestry land occupies an estimated 133 520 ha or 0,8% of the land area of which more than 65% occurs in the high rainfall zone of the former Transkei.

4.2.1.6.2 Large scale agriculture

There are 6 429 large scale farming units in the province covering a surface of 10,0 million ha – which is equal to 12,3% of the total surface area of South Africa. In the period from about the mid 1980s drought, high interest rates and declining terms of trade resulted in lower net returns from farming and rising debts. According to the 1988 census, farms in the Central and Northern Cape subregion of the province average about 1 400 ha in extent while those in the Coastal subregion of the province are significantly smaller, namely 586 ha. Although having the same or smaller areas under rainfed crops, coastal farms produce mainly higher–valued crops such as pineapples, chicory and wheat, while irrigated crops of importance include citrus and vegetables. The number of farming units and the farm income from animal products highlight the dominance of the livestock-production sector. Except for field crops and forestry, paid employment decreased significantly in other enterprises. The animal-production sector of the Eastern Cape and the gross income of this enterprise are almost three times that of horticulture, which lies second. The Eastern Cape has a comparative advantage in the production of mohair because of the abundance of high quality natural grazing compared to other provinces, which tend to rely on cultivated pastures.

4.2.1.6.3 Crop production

Field-crop production shows a declining trend, which correlates with the national trend. Trend analysis performed on maize and wheat production shows a significant decrease in the area cultivated. The area under maize in the large scale farming sector decreased from 38 000 ha in 1980-1 to only 29 000 ha in 1991-2, while production followed the same trend. The main cause for this phenomenon is the lower profitability of maize production, the deteriorating financial position of farmers and the withdrawal of marginal cropping land. The area under wheat decreased significantly from 80 000 ha to only 7 000 ha over the same period. This trend could be ascribed to the combined effects of low product prices, rising input costs and erratic rainfall patterns. There are strong indications that field crop production in the Eastern Cape is decreasing at an increasing rate as the establishment of pastures progresses. The production of maize, wheat, and fodder crops is the most important field-crop farming activity from a farm income perspective. The production of citrus and vegetables forms the backbone of the horticultural crop industry. The citrus industry is export-oriented, but the South African market is growing in importance. Production in the high rainfall coastal region seems to be expanding at a faster rate than in the Eastern Cape Midlands. The availability of water could in the long run limit the expansion of this industry.

4.2.1.6.4 Livestock production

Livestock is important throughout the region. The distribution of beef cattle, sheep and goats generally coincides with the suitability of the vegetation, while dairy cattle, pigs and poultry are found in the Coastal region nearer the larger population concentrations. An analysis of livestock numbers in both commercial farming areas and subsistence farming regions shows that cattle numbers in the former homelands almost equal those of large scale agriculture, namely 882 000 commercial versus 970 000 subsistence. On average, cattle numbers comprise nearly 22% of total South African stock numbers. Sheep numbers total nearly 8 million, or 28% of South Africa's in total. Declining profitability in the grain industry has resulted in a steady increase in stock numbers. The existing stocking densities exceed recommended stocking densities. Overstocking has led to severe deterioration of the veld's condition in most parts of the former homelands.

4.2.1.6.5 Forestry and forestry production

The commercial plantations in the Eastern Cape comprise about 121 923 ha of which more than 87% is owned by the State. The surface under commercial forestry in the former Transkei currently comprises 55,6% of the total forestry area of the province. Lateral expansion of plantation areas is expected to serve an estimated doubling of the demand for timber over the next 30 years. Commercial plantations mainly consist of pines and other softwood for the production of pulpwood for sawlogs and veneer. The production of veneer totaled 91 288m³ in 1992-3.

4.2.1.6.6 Mineral

The Eastern Cape is the poorest of all provinces in terms of mineral resources in South Africa. Clay, limestone, sand, salt, heavy mineral sands and low-grade kaolin are the main products. Several stone-quarrying sites exist, as well as a granite mine in the former Transkei. Even when taking all these into account, the province produces only 0% of South Africa's total mineral sales.

4.2.1.6.7 Ecotourism

The principal tourist potential is found in one of the world's most renowned coastal stretches, its primary attractions being its relatively unspoiled landscape and rich cultural heritage. There are two distinct areas of tourism attraction in the Eastern Cape, namely the coastal zone and the mountains. It is one of the world's regions of highest biodiversity, and supports many endemic plants and animals. The Eastern Cape has three national parks (Mountain Zebra, Addo Elephant, and Tsitsikamma Coastal), several provincial parks, and several private game reserves.

4.2.2 KWAZULU NATAL

KwaZulu Natal is situated on the eastern seaboard between latitudes 27^0S and 31^0S and longitudes 29^0E and 33^0E. The Indian Ocean to the east, the Drakensberg range to the west, Mpumalanga Province, Swaziland and Mozambique border the province to the north and – west, and the Eastern Cape Province to the south. A portion of the Eastern Cape, 269 900 ha in extent, is enclosed within the Province in the south. KwaZulu Natal is approximately 300 km long and 300 km wide, has a surface area of 92 100km^2 of which 13,1% is potential arable and 61,7% suitable for grazing.

Forestland currently occupies 5,1% of the total surface area. These high potential indicators have to be related to the population of 9,1 million which gives a density of 100,1 people per km^2, that is well above the average for the country. Of the total, 47,1% live in the rural areas and depend heavily on natural resources for their survival. The HDI value is 0,602 which is higher than for the other two provinces, but is still below the South African national average.

4.2.2.1 Climate

The climate of KwaZulu Natal is geographically highly variable as a consequence of the influence of the coast, the Drakensberg range, and its broken topography. It has consequently been categorized into 11 bio-climatic zones, based mainly on precipitation. Some degree of uniformity is found within each of these.

Group 1 – Coastal lowlands

Rainfall is well distributed and varies between 850 and 1 500 mm per annum, with an average of 970 mm. Mean annual temperatures are mostly between 22^{0}C and 23^{0}C. There are no ecologically dry months (less than 25 mm of rain), but dry spells of several weeks' duration are common, and can reduce growth. Rare to occasional heavy flooding is also experienced. Frost is non-existent to very rare, but may occasionally be locally severe. Lightning and hail are rare. Windy conditions considerably enhance evapotranspiration and, together with high temperatures, reduce the effective rainfall along the coast. Humid heat from October to March is also not conducive to working comfort.

Group 2 – Coastal hinterland

There is considerable variation among the subregion. Annual rainfall varies between 850 mm and 1 300 mm, with an average for the area of approximately 954 mm and that encompasses not more than two ecologically dry months. Mean annual temperature ranges from 17,5^{0}C to 20^{0}C, the average for all stations in the group being 18,3^{0}C. Climatic hazards include occasional drought and light frosts.

Group 3 – Midlands mist belt

The climate is mostly humid to sub-humid, but may vary considerably among subregions. Annual rainfall ranges from 800 mm to 1 600 mm, with an average of over 1 000 mm. Mist is a common phenomenon. Mean annual temperature range between 16^{0}C, and 18^{0}C with an average of 17,1^{0}C. Climatic hazards include occasional dry spells of short duration in summer, excessive cloudiness in early summer, slight to sometimes severe frosts, occasional hail and hot "berg" winds in early spring, sometimes followed by sudden cold snaps.

Group 4 – Highland sourveld

The annual rainfall is between 800 and 1 500 mm, with an average of 920 mm. There are usually two to three ecologically dry months. Mean temperatures are between 13^{0}C and 15^{0}C. Cool summer conditions are followed by regular to very severe frosts, with snow being experienced locally. The major climatic hazards include a relatively short growing season, severe frosts, sporadic hail, and hot "berg" winds.

Group 5 – Montane

In this area, annual rainfall exceeds 1 500 mm, mean annual temperature is less than 13^{0}C, and severe frosts and snowfalls occur regularly. It comprises magnificent mountain scenery, and its importance resides in the fact that it is the source of a number of the most important rivers, which flow through the Province.

Group 6 – Moist tall grassveld

Mean annual rainfall is between 800 and 1 000 mm, with an average of 848 mm. There are three to four ecologically dry months. Mean annual temperature is between 16^{0}C and 18^{0}C. Climatic hazards include occasional periods of drought during the rainy season, moderate to severe frosts for several months in winter, and occasional hailstorms.

Group 7 – Valley thornveld (Tugela)

Annual rainfall is between 600 and 800 mm, with an average of 716 mm. There are four to five ecologically dry months, and generally, the rainfall is not as reliable as that of group 6. Mean annual temperatures are between 17^{0}C and 18^{0}C. The low and rather erratic rainfall pattern is the primary limitation.

Group 8 – Dry tall grassveld

Annual rainfall is between 600 and 800 mm, with an average of 716 mm. There are four to five ecologically dry months, and generally, the rainfall is not as reliable as that of group 6. Mean annual temperatures are between 16°C and 18°C. The main climatic hazards are erratic rainfall, frequent periods of moisture stress and moderate to severe frosts in winter.

Group 9 – Zululand bush thornveld

Annual rainfall is between 700 and 850 mm, with four ecologically dry months. Mean annual temperature range from 21°C to 22°C. Frosts are very rare. Uncertain dry spells during the rainy season constitute the main climatic hazard.

Group 10 – Interior and valley thornveld

Annual rainfall varies between 600 and 700 mm, with four to five ecologically dry months (three nearer the coast). Rain shadow effects are particularly marked in this area. Mean annual temperatures are between 16°C and 18°C locally. Significant climatic hazards include frequent periods of drought, moderate to locally and seasonally severe frosts, especially in the riverine faciation (excluding the north eastern and coastal sectors), considerable heat during summer in the north-eastern sectors, lightning and hail. Hail may cause heavy losses to horticultural crops under irrigation.

Group 11 – Arid lowveld

This is the most arid area, receiving an annual rainfall of only 320 to 600 mm and experiencing six or more ecologically dry months. Mean annual temperatures are between 21°C and 23°C, but may be considerably higher locally. Evaporation (Symmons Tank) exceeds 1 524 mm per annum. The major climatic hazards include low and erratic rainfall, high temperatures, and excessive evaporation.

4.2.2.2 Topography

KwaZulu Natal is noted for its variation in scenery resulting from altering topography, ranging from impressive mountains to plateaux, upland areas, basin plainlands, deeply incised river valleys, and picturesque coastal hinterland and lowlands. In 1967, Turner identified 43 physiographic regions, which Phillips (1973) grouped into seven broad categories, namely:

- **Mountain ranges**

Found along the Great Escarpment of the High and Low Drakensberg they form the boundary between KwaZulu Natal, Lesotho and Free State to the west, Mpumalanga to the north, and the Eastern Cape Province to the south.

- **Elevated plateau**

These are found around Msinga and Qhudeni, and project the Drakensberg range.

- **Upland regions**

These lie to the west of the Intermediate Regions (see below), and typically range in altitude from 1 200m in the Natal Midlands to as much as 1 900m in East Griqualand.

- **Basin plainlands**

These dominate the upper reaches of uThukela catchment area, and the extreme west of southern KwaZulu Natal.

- **Intermediate regions**

These are located along a north-south axis through the centre of KwaZulu Natal between the interior uplands and the coastal lowlands, at the Kranskop Divide; the Melmoth-Nkandla Block; the middleveld of Zululand; the Ixopo-Highflats Benchland and the Harding Benchland. The Intermediate Regions generally are characterised by undulating terrain and steep slopes.

- **Low-lying regions**

These include the cleft made by the Lower Thukela River; the Pomeroy Bench; the Valley of Thousand Hills; the uMvoti River Valley; and the Lowveld of Zululand.

Coastal regions

This coastal area extends from the south of the province, widening considerably in the north across the Zululand Coastal Plain, and including the incised river valleys of the province. Lowveld areas form the interior of central Zululand as well as significant areas of Thukela Valley and the Valley of Thousand Hills to the northwest of Durban. In general, the topography of the province is extremely rugged in the south, but moderates north of Thukela Valley. The area to the northeast of the Lebombo range up to the uSuthu River on the northern border is flat and largely featureless. The uplands are flat or undulating, and relief is provided by deep valleys and gorges cut by rivers, e.g. Thukela Valley, which is 1 000 metres deep only 50km from its mouth. The rivers run from west to east. The High Drakensberg reaches an altitude of 3 300 metres only 120 km from the coast. The sharp drop in altitude enhances the hydroelectric potential of many rivers. Rainfall diminishes from the escarpment eastwards, and from south to north.

4.2.2.3 Soils

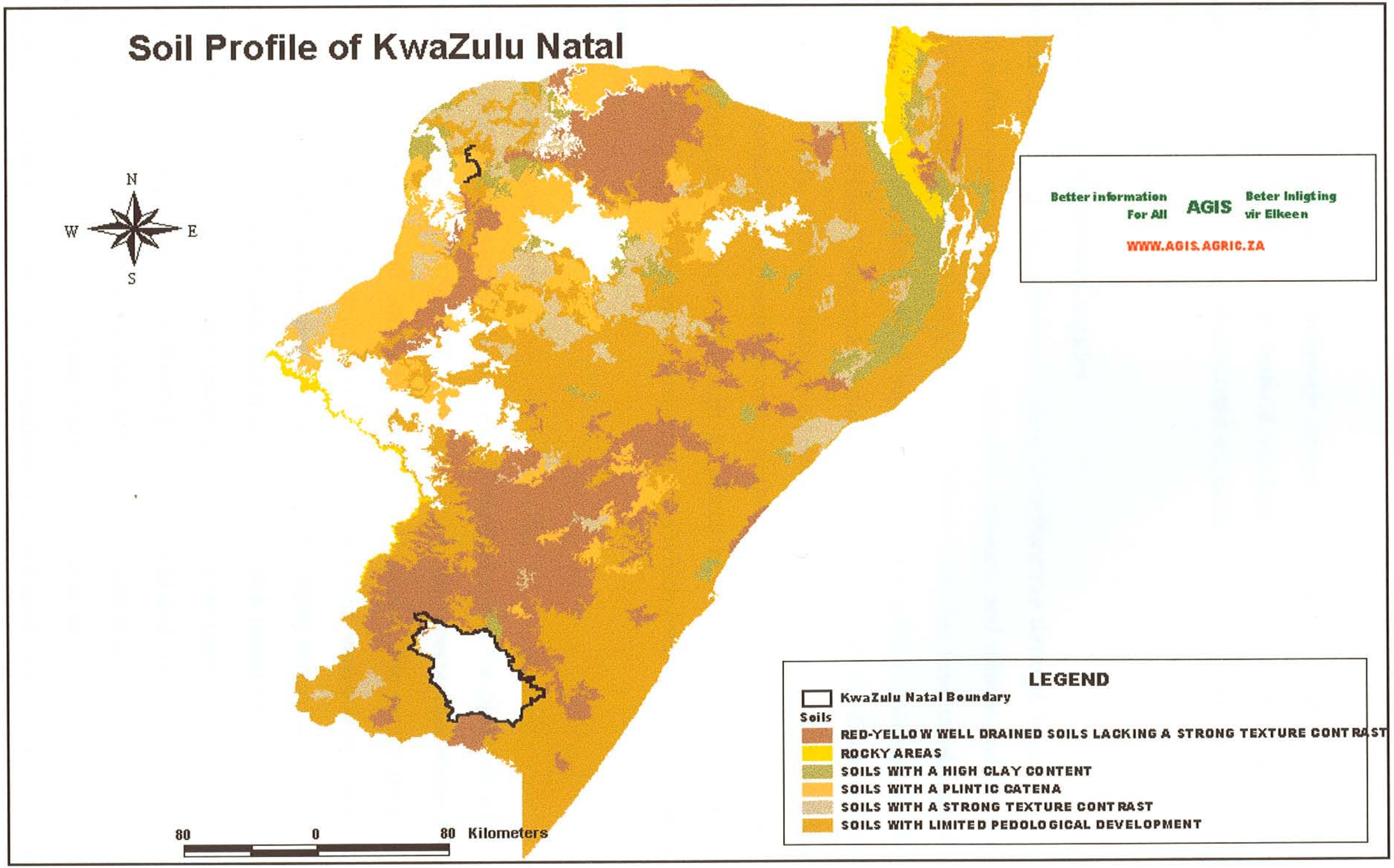
The environmental diversity in KwaZulu Natal results largely from the variety of parent rock [for example granite, sandstone, shales and tillite (diamicite)] and a range of interactions between geology and climate have resulted in a large number of different kinds of soils, which are best described in association with the geology of KwaZulu Natal (Anon., 1986a).

Recent sands cover most of the Maputaland plains in northeastern KwaZulu Natal and these occur, as a narrowing band, down the coast of the province. In the north the upland sites are mainly covered by grey Fernwood soils and, to a lesser extent, sandy Clovelly soils. Red sands are found on the prominent dune ridges. Along the south coast the sandy Shepstone form is encountered in places. In depressions, soil types consist of the Champagne form and, in places, the deep well-drained sands of the Fernwood form. On the Coastal Lowlands and in the southern hinterland of the province, granite has weathered into shallow medium-and coarse-textured Glenrosa soils. In the drier valleys of the northern interior, exposed granite has given rise to similar Glenrosa soils, with duplex soils found frequently in bottomland sites. The Natal Group Sandstone (NGS) is often exposed on moist upland plateau remnants, and here humic Inanda and Nomanci forms are common. On the slopes, common soils are shallow: Cartref and Glenrosa forms and occasional red sandy-clay Hutton forms.

Extensive areas of Dwyka tillite are exposed in the river valleys of the Lowland areas and in the basin of the Thukela River. In the dry interior valleys fine- and medium-grained sandy-loam soils of the Mispah and Glenrosa forms are widespread, while shallow plinthic soils such as Westleigh and Longlands forms are also found. In bottomland areas, severely –eroded calcareous duplex soils of the Swartland and Valsrivier forms are common. In the moderately moist Lowland areas, Swartland and Valsrivier forms are dominant on Dwyka tillite, while in the Moist Mistbelt areas of inland KwaZulu Natal, deep, highly weathered Griffin forms are common.

Sandstones and shales of the Ecca and Beaufort Groups comprise much of the bedrock over the interior of the province and these produce a variety of soil patterns. In relatively dry areas, the dominant soil on shale is Mispah, but it may occur in association with plinthic and duplex. Margalitic soils are also found. In cool, moist upland landscapes, however, the Clovelly form is widespread on shale. A wider spectrum of soils is found on sandstone. The Ecca Group is dominantly medium-grained, while the Beaufort Group commonly has finer sand fractions. In the interior valleys of the Province, the dominant soil types may be found together with the Longlands form in the moister upland sites of these valleys. Where dolerite has intruded into sandstone, heavier textured soils of the Shortlands, Bonheim, Arcadia and Rensburg forms are common and in the moist interior basins Avalon and Longlands forms predominate. In the cool, Moist Mistbelt and Highland areas above 900 m a.s.l., dystrophic clays and sandy clays of the Clovelly, Griffin, Hutton and Katspruit forms are common.

In general, dystrophic soils have developed where the rainfall exceeds 900 mm per annum, and leaching has resulted in fertility problems. With a decrease in rainfall less leaching of nutrients takes place, giving rise to mesotrophic and eutroc soil types that tend to have problems of a physical nature. Work done by Edwards and Scotney (1978), Fitzpatrick (1978) and Schulze (1982) resulted in a soil potential rating for the province. It is estimated that 26% of the region has very high potential soils, 12% high, 60% moderate and 2%, low potential soils. The highest potential soils occur along the Drakensberg escarpment, including the upper reaches of the Thukela catchment area and considerable portions of the Natal Midlands. High potential soils are also found in the western parts of Zululand. The coastal regions are generally characterised by moderate potential soils. However, regional representation of soil potential may vary significantly at a finer scale due to the influence of local geology, topography and climate and local conditions will determine the extent and quality of soils available.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SOILS WITH A STRONG TEXTURE CONTRAST
SOILS WITH LIMITED PEDOLOGICAL DEVELOPMENT
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4.2.2.4 Geology

The variety of different geological materials underlying KwaZulu Natal contributes with the variation of climate, to the marked ecological diversity encountered. The various geological formations and their distributions in the Province as described by Phillips (1973) are illustrated.

- **The Metamorphic Basement Complex**

The Basement Complex rocks, which according to radioactive datings, were formed about 1 100 million years ago, consist of granites, gneisses, and schists and contain minerals such as feldspar, hornblende and mica. Where there has been crustal uplift, these rocks are exposed at the surface, such as the domed granite outcrops in the Valley of a Thousand Hills. These rocks, which were formed within the Earth's crust, tend to weather rapidly, with the feldspar crystals breaking down to clays, and the quartz crystals to sand. These Basement rocks, in their many variations, are exposed mainly in the deep river valleys, although in places have they been uplifted to prominent positions, e.g. the east west crustal fractures which from the Ngoye Range near Empangeni.

- **The Natal Group Sandstone**

A sequence of rock strata lies above the basement Complex rocks, the oldest of which is the Natal Group Sandstone (NGS). This forms some of the spectacular scenery of vertical cliffs in the central and southern part of the Province. The sandy material which formed these strata, was laid down as sediments and varies from layer to layer, with the basal layers having been derived from the older formation on which they lie, that is, the weathered granite and quarzites. The thick upper part of the NGS consists of micaceous, sandy beds of various grain sizes. It is considered that some sediment may have originated in northern KwaZulu Natal and moved southwards (King, 1972). With transport, the particles became finer, resulting in maroon shales speckled with mica flakes. A second zone of orthoquartzite of the NGS, some 15-m to 18,5 m thick, had a source in the west. A washing back and forth, possibly by the sea, left a dominance of uniform, rounded quartz grains that, over a period of time, formed the orthoquartzite rock. The pebble beds found in the Dalton area may also have been come from the west (King, 1972). The NGS forms the impressive cliff faces of the Kloof Gorge and the Hillcrest plateau and extends northwards to Ndwedwe, Glendale and Maphumulo. In the Thukela River valley, the cliff faces are most impressive, especially to the east of the village of Kranskop, "the Kop" being a well-known view site. North of the Thukela River, the NGS forms the Melmoth and Eshowe plateau and part of the steep country in the vicinity of Nkandla. Beyond Eshowe, the NGS is absent. Orthoquartzite cliffs surround many plateaus and in southern KwaZulu Natal, Oribi Gorge and the Mthavuna Gorge are formed where the rivers have cut their way through the NGS. Above the NGS is a series of sedimentary strata, which covers the larger part of the province.

- **The Dwyka Group**

The Dwyka is exposed only in the eastern part of the province and its composition indicates its origin. Laid down during a glacial period, the original "mud' that was dragged along by the glaciers has a green-blue matrix and is studded with boulders and pebbles that vary considerably in size. These boulders and pebbles are of differing origins, representing samples of the rock rubble that was once beneath the ice. Rock types include granite, gneiss, quartzite, sandstone and orthoquartzite. This accumulation of rock rubble was then hardened and cemented together by the pressure of overlying material. Below this hardened rock, striated glacial pavements may be found, polished by the glacier as it moved over the rock surface. In the northern parts of the province, the striations indicate that the ice moved in from the north, whereas along the coast, indications are that the movement was from the northeast, i.e. from the direction where the Indian Ocean lies today.

- **The Ecca Group**

The Ecca Group has a total thickness of about 700 metres. Laid down in extensive bodies of fresh water during a cold temperature period, the Ecca shales and sandstone lie above the Dwyka. Sand stones of the Ecca Group crown the prominent escarpment that extends from the Thukela River to the west of the towns of Greytown, Pietermaritzburg and Ixopo as far as the Mzimkhulu River. These sandstones have a coarser grain size and crumble more easily than the NGS. In the northern part of the province, coal seams are found within the sandstones of this Group, which also form the many minor escarpments in that area. The shales of the Ecca Group tend to be dark and are exposed in the midlands and coastal areas Bricks of good quality are made from Ecca shales which, because of a high iron content, burn red.

- **The Beaufort Group**

The Beaufort Group was originally alluvial flats laid down during a warm temperature period and consists of grey-blue sandstones, which weather rapidly when exposed, and shales, which are even less resistant to weathering. Layers of these two materials can be seen as ledges on hillsides in the western part of the Province. Formations of the Beaufort Group extend from the foothills of the Drakensberg eastwards towards the towns of Donnybrook, Howick, Weenen and Ladysmith. North of Ladysmith, they are narrow to a strip along the western and northern border of the province. The shales of this Group are exposed in many dongas and are red, green or maroon in colour.

- **The Stomberg Series**

The Stormberg Series, which form the entire face of the Drakensberg, consists of the Molteno, Red Beds, Cave Sandstone and Basalt formations. Material and Molteno stage consists of shales and sandstones. Thickest in the south, where sandstone and shale bands are intermixed, it is widest in the Drakensberg Gardens area. It then becomes less apparent towards the north where, in the Loteni River valley, terraces are less prominent. The Red Beds and the Clarens sandstone (Cave Sandstone) are found along the whole length of the Drakensberg. The Clarens Sandstones, which are approximately 100 metres thick, are well known for their extent (Little Berg). A lack of bedding in the cliff faces and size grading of the particles, indicate that the sandstone was laid down as wind-blown sands under hot desert conditions. The Red Beds lie immediately below the Clarens Sandstone and are apparent as unstable slopes of red, crumbly shale and red micaceous sandstone, providing the name for this geological layer. After sedimentary accumulations of the Karroo system had been laid down, an outpouring of lava, which covered extensive areas with solidified lava hundreds of meters thick, disrupted them. At Mont-aux-Sources the basalt layer is 1 350 meters thick. The Ubombo Mountains in northeastern KwaZulu Natal were developed by ejecta of basalt and silica, forming rhyolite. North of Empangeni and west of the Ubombo Mountains, a large area of basalt extends northwards to Phongola. Lava that reached the surface solidified into basalt. However, much of the lava never reached the surface but intruded into fissures and passageways in the sediments of the Ecca and Beaufort Groups, the Natal Group Sandstone, and into the Basement rock. This lava, which cooled slowly compared with the surface lava, is known as dolerite and is harder and has finer crystals than the basalt. The material in the fissures formed dolerite dykes, and on exposure these dolerite ridges form a common feature in the landscape. The passageways, or sills, are sub-horizontal and are exposed to the surface following erosion, where they form hard caps to hills. Examples can be seen at Griffin's Hill near Estcourt and Mt. Gilboa, in the Karkloof.

- **Later geological formations**

After the period of geological build up, the African Surface was subjected to a series of uplifts and the splitting of Gondwanaland. This initiated a series of erosion cycles, which have led to the physiography and surface geology of KwaZulu Natal as it is today. New geological formations developed when alluvia were deposited on the coastal belt. This coastal belt underwent periods of submergence, when the sea land re-emerged, exposing sandy flats with marine shell deposits. Depressions remained forming lakes and lagoons such as Lake St. Lucia and Lake Sibaya. This coastal plain is widest in the north in Maputaland, where it is approximately 75 km wide, narrowing in the vicinity of Mthunzini, where it forms a narrow strip stretching down the north and south coasts of the Province. It consists of Quaternary, beach derived aeolian sands, which cover most of Maputaland and which are underlain by calcareous Cretaceous sediments.

- **Faulting and Erosion**

The whole landscape described above underwent changes when faulting uplifted parts of the strata in relation to adjacent strata. Submergence also occurred. Then the river systems, flowing largely from west to east, cut through the geological layers, exposing fresh faces in the deeply incised valleys. This exposed material was then subjected to a wide range of climatic conditions, with the resultant wide diversity of soils in KwaZulu. Extensive coal deposits are found throughout the KwaZulu Natal Midlands, which apart from mining for coal also forms the basis for heavy industrialisation, such as iron smelting. Kaolin, lithium mineral fluxes, and dolomites also have economic potential. The province provides 3% of the country's total mineral sales.

4.2.2.5 Water Resources

KwaZulu Natal is situated in the highest rainfall zone, and has one of the highest runoff: rainfall ratios in South Africa. Although the province comprises only 14% of the land surface area of the country, mean annual runoff from rivers in KwaZulu Natal accounts for 39% of runoff from all rivers in South Africa (Department of Water Affairs, 1986). The Province forms part of two hydrological drainage areas, namely the Eastern Escarpment (including drainage regions U, V and W) and parts of the Eastern Cape (including drainage region T). Some of the major rivers include the uSuthu, Phongola, Mkhuze and Umfolozi in drainage region W, Thukela in V, uMkhomazi and uMngeni in U, uMzimkhulu and uMthavuna in drainage region T.

Effluents as well as minerals from rocks and soils adversely affect the quality of surface water in the province. In northern KwaZulu Natal, the development of coalfields has contributed to pollution of the ecologically sensitive Black Umfolozi and Mkhuze Rivers, while groundwater near the coast is affected by salinity. The water balance is such that the region not only has the potential to meet future demands, but also the capacity to export water. However, export of water is only possible in a few catchment areas such as Thukela, highlighting the fact that it is not the lack of water, which might limit development in KwaZulu Natal, but rather its distribution within the province. Further, the sub-region is affected by periodic prolonged droughts, which are often terminated by severe floods (Department of

Water Affairs, 1986). Basically, sufficient water is either impounded or can be developed to suffice well into the next century. Availability of water does not constitute an impediment to development; KwaZulu Natal is more fortunate than the other provinces in this regard.

4.2.2.6 Vegetation

Several invaluable studies on the vegetation of KwaZulu Natal have been undertaken, providing a sound understanding of its nature and distribution. Climate, altitude, topography and distance from the sea largely determine the distribution of vegetation. Approximately 80% of the province is still under natural vegetation and this plays a vital role in both the agricultural economy and in the conservation of soil and water resources. Acocks (1975) classified the vegetation of KwaZulu Natal into eight major types, with several sub-types, namely:

- coastal tropical forests;
- inland tropical bushland savanna;
- tropical bushland savanna;
- karroo and karroid;
- temperate and transitional forest;
- pure grassveld; and
- false grassveld.

The coastal regions were initially covered by a form of forest of which little has survived. This was largely replaced by thornveld, which stretches inland up the river valleys. The current distribution of vegetation types in the province is markedly affected by altitude: the hotter, lower-lying areas being predominantly bush or dry woodland and the higher areas mainly grassland. The highland sourveld is found in the high rainfall areas of the Drakensberg foothills. The numerous valleys are clothed with tall grassveld, while pure grassveld is found in the level upland areas. This veld is palatable and permits intensification of production in a number of ways. A considerable proportion of the natural vegetation will give way to cropping, afforestation and urbanisation in the future. Phillips (1973) maintained that before humans had a major influence on the vegetation, climate, soil and natural fire would have had an influence on the development of vegetation in its progress towards one of several climaxes in the province. More recently, however, humans and their livestock have had a considerable influence on indicating the various cycles of succession. For the purposes of this study we are going to focus on the agro ecological zones defined by Pentz (1945). These are as follows:

- **Coast and Coastal Hinterland**

Most of the natural vegetation along the Coast and Coastal Hinterland has been destroyed and replaced by crops, for example sugarcane. The remaining vegetation consists of relict forest communities, which indicate the past and potential distribution of this vegetation type and patches of scrub and palm clumps. The remaining grasslands are generally in a degraded condition (Anon, 1972).

- **Mistbelt**

Crops and commercial timber plantations have largely replaced the vegetation of the Mistbelt zone. Isolated patches of relict forest are found mainly on south-facing aspects in areas where they are protected from fire. The grassland, as a result of excessive burning and selective overgrazing, has deteriorated to a sward dominated by unpalatable Ngongoni grass *(Aristida junciforms)*.

- **Highland and Montane**

In the Highland and Montane zone, the vegetation remains relatively undisturbed and the veld is in a relatively good condition. Isolated relict forests occur mainly on steep, rocky, south-facing aspects, where fires are usually of low intensity because of the rocky nature and moist conditions, which prevail on these slopes. The Montane area of the Drakensberg is mainly under the protection of conservation bodies and forests are thus fairly extensive.

- **Tall Grassveld**

The Tall Grassveld zone covers most of the interior basin of the Thukela River. Erosion is a serious problem in this area and the veld varies in condition from good to poor quality, the latter being found mainly on erodible, duplex soil forms. The invasion of thorn scrub *(Acacia sp.)* poses a threat to stock farmers.

- **Thornveld**

The Thornveld zone is found around the upper perimeter of most of the river valleys. This is a secondary veld dominated by *Acacia sp.*, which invades the grasslands from the river valley vegetation. The condition of the veld ranges from a highly productive condition to very poor quality with low productivity and basal cover dominated by pioneer species.

- **Bushveld**

Bushveld is found in northeastern KwaZulu Natal and in the valleys of most of the rivers. The vegetation is dominated by a wide variety of trees and the grassland is highly palatable, carrying stock effectively throughout the winter without a requirement for supplementary feed.

4.2.2.7 Agricultural Land Use

Details such as area, altitude range, soil, mean annual precipitation (MAP), and mean annual temperature (MAT) of each land zone are provided in *Table 4.1*. Soil data were adapted from Phillips (1973) and climate data from the Cedara Research Station.

Table 4.1: Details of area, altitude, soil, MAP and MAT of the land use zones (LUZ) in KwaZulu Natal

LUZ	Area (ha)	Altitude m. s. l	Arable %	High Potential Soil %	MAP mm	MAT ^0C
Coast and Hinterland	1924 026	<900	35	12	740 -1423	17.6-22.0
Mistbelt	1418 612	901-1400	45	37	738 -1280	16.7-17.0
Highlands & Montane	1539 405	1401-1800	22	7	620 -1400	11.5-14.3
Tall Grassveld	1664 562	451-1400	33	14	645 -1000	16.0-19.5
Thornveld	785 901	320-1200	16	7	644 -846	17.1-21.1
Bushveld	1528 744	<450	51	17	587 -800	19.0-22.0

- **Coast and Coastal Hinterland**

Sugarcane is the most important crop of this zone and covers approximately 35% of the cultivated land in KwaZulu Natal. Its contribution to the province's agricultural production is about 40% and the zone produces almost 90% of the national cane crop. Timber, mainly from *Eucalyptus*, has become increasingly important, particularly in the northern areas. Subtropical fruits produced include bananas, litchis and papaws, and vegetable production is also important.

- **Mistbelt**

The Mistbelt, with favourable climate and good soils, is an area of high agricultural potential. Most of it is afforested and commercial timber production, including *Eucalyptus*, Pine, Wattle and Poplar, is the most important form of land use. Sugarcane is grown at lower altitudes in the central and southern areas on frost-free slopes. The potential for maize production is high, particularly in the Greytown area. It is an important milk producing area.

- **Highlands and Montane**

Found mainly in the western areas of the province, this zone has cold winters with frequent severe frost. Snowfalls are experienced in the high-lying areas. It carries close to one third of the province's cattle and sheep and it has considerable potential for increased livestock farming. Maize and potatoes are the most important crops grown, and a considerable area of land is devoted to fodder production to carry livestock through the cold winters. The Drakensberg has spectacular scenery and has been set aside for water yield, nature conservation and tourism.

- **Tall Grassveld**

The largest portion of this zone lies in the interior of the Thukela River basin. Livestock farming, mainly cattle, is the most important source of income. Soil has to be carefully selected for cultivation, particularly because deep soils are required in an area where rainfall during the growing season is unreliable. Crops are irrigated on suitable soils adjacent to the main rivers.

• **Thornveld**

This zone lies on the upper perimeter of the major river valleys and on the western boundary of the bushveld. It is an extensive farming zone suited mainly to cattle, goat and game farming, with the density of bush dictating the balance of animal types, or species, in the case of game animals.

• **Bushveld**

The Bushveld is situated mainly on Lowland areas in northeastern KwaZulu Natal and in the valleys of the major river systems. Summers are hot and winters warm, although in the upper river valleys in the south, severe frosts do occur. The relatively high percentage of arable land in this zone has limited cropping potential unless it is situated adjacent to a reliable source of water for irrigation, because the rainfall is too low for crop production. On selected sites along rivers such as the Thukela and Phongola, there is good potential for cropping under irrigation. In the north, crops such sugar cane, cotton and vegetables can be grown, but in the south, frost-sensitive crops such as sugarcane cannot be grown due to low winter temperatures. Because of climatic factors the major portion of this area is suitable only for stock and game farming. Production is relatively cheap because of the high quality of the winter grazing, so that winter supplementation is not required. Tourism is a very important industry and game reserves such as Mkhuze, Hluhluwe – Umfolozi Park, Phinda and Ndumu, are situated in this zone.

4.2.2.8 Ecotourism

The division of KwaZulu Natal into five areas by Nicholson (1995) can be used to broadly define the tourism attractions of the Province. The five areas are: (a) The Drakensberg and battlefields; (b) Game reserves and Zulu culture; (c) South coast beach resorts; (d) Durban and North Coast; (e) and the Midlands. The natural resources of KwaZulu Natal provide many opportunities for resource-based or resource-linked recreation. These are focused along the coast, on the major towns, the major Zululand nature reserves, and the Drakensberg. In many instances, the use of natural resources is linked to recreational activities such as game viewing, swimming, hiking, or fishing. The protected areas of KwaZulu Natal cover 6 752 km², which represent 8,36% of the terrestrial area, and 28% of the coastline (Nicholson, 1995).

4.2.3 NORTHERN PROVINCE

The Northern Province straddles the Tropic of Capricorn and forms a narrow small landmass in the north widening gradually southwards. Broadly speaking, there are two climatic zones, namely sub-tropical and temperate, with significant variations within these zones. Spatially, the Northern Province covers 116 824 km² or 9,6% of the total surface area of South Africa. The province is poor compared to the eight other provinces. This is reflected in the low human development index value discussed later in this study. It has a larger population with substantial growth momentum. However, the population is poorly educated, impoverished and has limited access to health services.

4.2.3.1 Climate

According to De Villiers (1985), four climatological regions are found in the Northern Province, which are determined primarily by precipitation. The far north is an arid region, followed by an arid to semi-arid region in the north, a semi-arid region on the highveld and a sub-humid region in the lowveld. The demarcation of these regions has been based on total annual rainfall and average annual statistics for day and night temperatures.

- **The arid region**

This area is generally frost free and has an average rainfall of 300 – 360 mm north of the Soutpansberg, which is lower than the minimum of 800 mm required for dryland crop production. The mean annual evaporation of 2 500 mm indicates how desiccated the area is. The mean monthly minimum in the coldest month of the year is 2,5^{0}C, with a mean monthly maximum of 37,5^{0}C in the hottest month. Hail occurs on average less than 1 day per year. Prevailing winds are light to moderate, blowing in a predominantly northeasterly direction, changing to southwesterly during thunderstorms. The region is very hot and dry, and cropping is only possible with irrigation.

- **The arid to semi-arid region**

Temperatures range from –2,5^{0}C to 40^{0}C, the river valleys being particularly hot. The climate is cooler and more humid towards the Waterberg plateau and the Soutpansberg. The area east of the Drakensberg is mostly frost-free, but frost does occur west of the range. The average annual rainfall (mainly thunderstorms) ranges from 360 – 600 mm in the Lowveld to 360 – 540 mm in the northwest, north of the Soutpansberg. Parts of the Waterberg receive up to 700 mm of rain. Wind directions are predominantly northeasterly, becoming southwesterly during thunderstorms.

- **The semi-arid region**

The average rainfall of the region varies from 520-650 mm and in the Lowveld portion from 600-720 mm, with annual evaporation of 1 750 – 2 500 mm. This region has the coolest climate of all the regions, with the lowest minimum temperatures being recorded. East of the Drakensberg escarpment it is mainly frost-free, but frost does occur to the west. In general, light winds prevail, except during thunderstorms, and frequent tornadoes may occur. Hail occurs on average between one and three days per year.

- **The semi-humid region**

Annual rainfall in the low-lying areas varies from 500-700 mm from north to south, increasing considerably at higher altitudes to a maximum of 200 mm in certain parts. The balance of the climatic variables is similar to the other regions. A large section of the Northern Province is part of a global drought belt receiving less than 500 mm rain annually, which is usually regarded as the minimum for successful dryland farming. Furthermore, the average annual rainfall, which affects surface runoff from rainfall significantly and causes high evaporative losses of water stored in dams. The low rainfall and adapted vegetation of a large portion of the province are, therefore, only suited to extensive livestock farming.

4.2.3.2 Topography

In the west of the province, the landform is flat to undulating, broken by river valleys and occasional mountain ranges such as the Waterberg. The further east, the more broken the topography, until the northern outliers of the Drakensberg range are reached. Because of the latitude, this area is typically subtropical and moister than the more westerly portions of the province. The eastern region contains extensive and spectacular mountain and gorge scenery, constituting highly attractive tourist resources.

4.2.3.3 Soils

- **Dystrophic, red and yellow, well-drained clay soils**

These highly leached, clay-like, acidic soils are found in the high rainfall areas of the Drakensberg and Soutpansberg ranges. The arable use of these soils is limited because of low fertility, steep slopes, and rockiness. However, the soils support excellent sites for afforestation.

- **Red, yellow and grey soils in catenary association**

Eutrophic (unleached, slightly acidic to neutral) mostly sandy and loam soils are found in the 300 – 600 mm summer rainfall belt to the west and north-western parts of former Transvaal. Eutrophic soils are dominantly red, yellow, or grey, with varying amounts of rock and lithosols. These soils are the most arable in the Northern Province, but only occur in the low rainfall area, west to north of Thabazimbi, Vaalwater, Ellisras and Pietersburg.

- **Black and red clay soils**

These soils are characterised by black or red clay, with varying amounts of rock and lithosols, and in the Northern Province occur along a narrow strip of land parallel to the eastern border, the Springbok Flats (Warmbaths, Settlers and Roedtan) and the south-western border area near Dwaalpoort. Although highly erodible and being drought prone, these soils are utilized extensively for dryland cropping like cotton and winter cereals.

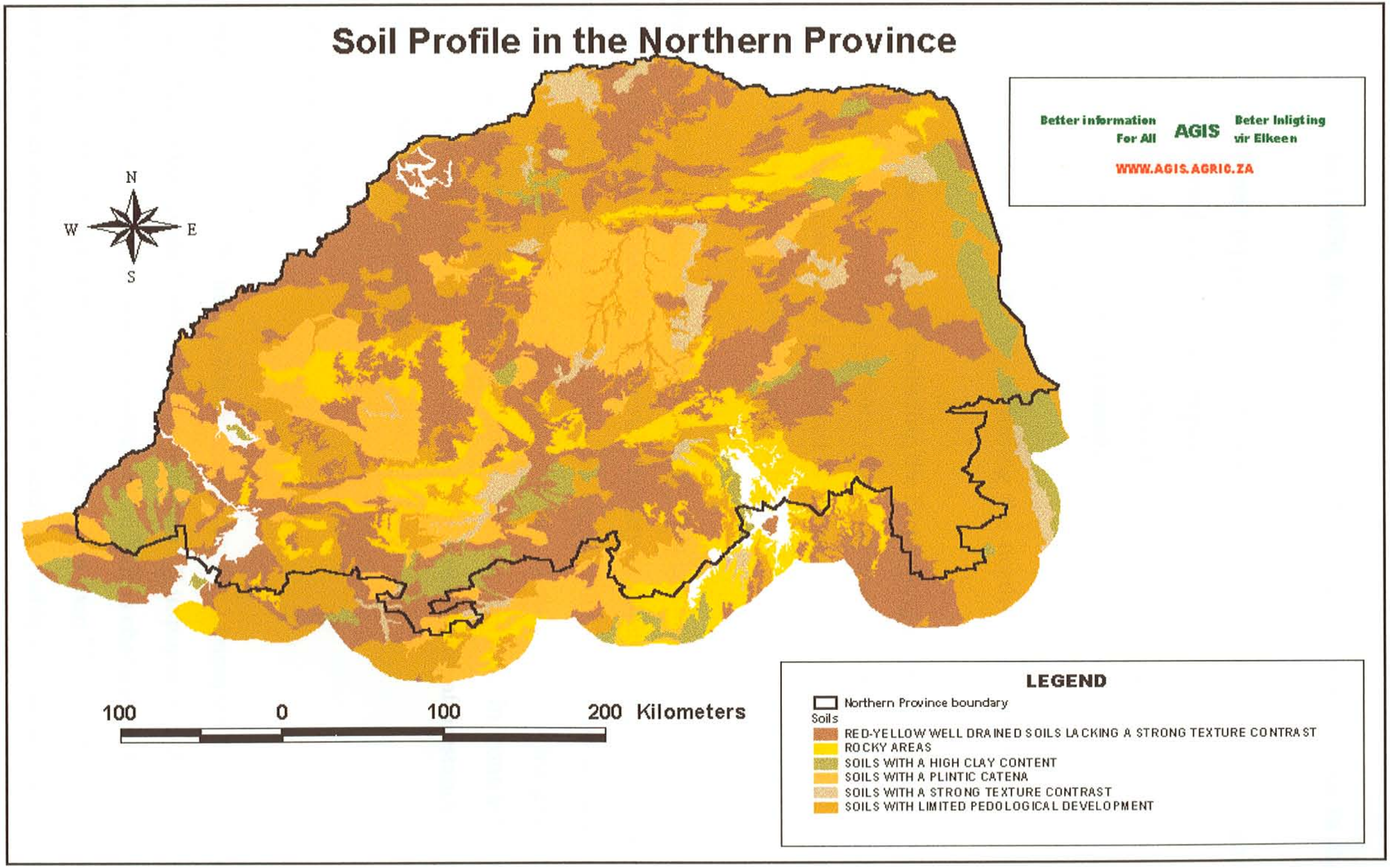
- **Duplex and paraduplex soils**

Duplex soils are characterised by a duplex morphology; that is, a topsoil that differs distinctly from subsoil with regard to texture, structure and consistency. Major occurrences of these soils are found in the Sekhukhuni district of the former Lebowa and in an area south to south-west of Ellisras in the Waterberg district, as well as in an area between Louis Trichardt and Tshipise, passing through a large section of the former Venda near the eastern border. These soils are not generally utilised as arable because of their erodibility.

- **Weakly developed soils on rock**

Soils within this category consist of topsoil overlying rock or weathered rock, which could be ascribed to low rainfall, steep topography, resistant rocks or youthful landscapes. A fairly large portion of the province to the east of the Drakensberg, including a large section of the former Gazankulu, could be described as sand and loam, with lime being common in bottomland sites, but absent in upland sites. The area to the west and east of Messina could be described as having sandy and loam soils, with lime in upland and bottomland sites together with the general occurrence of rocky outcrops. Arable utilisation is generally not advised, owing to the shallowness of these soils and their occurrence mainly in dry areas.

Figure 4.3


Soil Profile in the Northern Province
N
W
E
S
Better information For All
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Beter Inligting vir Elkeen
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100
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200 Kilometers
LEGEND
Northern Province boundary
Soils
RED-YELLOW WELL DRAINED SOILS LACKING A STRONG TEXTURE CONTRAST
ROCKY AREAS
SOILS WITH A HIGH CLAY CONTENT
SOILS WITH A PLINTIC CATENA
SOILS WITH A STRONG TEXTURE CONTRAST
SOILS WITH LIMITED PEDOLOGICAL DEVELOPMENT

4.2.3.4 Vegetation

According to Acocks (1975), the following four different veld types occur in the Northern Province:

- inland tropical forest types (Acocks II), including the north-eastern mountain sourveld and Lowveld sour bushveld types;
- tropical bush and savannah types (Acocks III), including the Lowveld, arid Lowveld, Springbok Flats turf thornveld, other turf thornveld, arid sweet bushveld, mopani veld types;
- pure grassveld types (Acocks IV), including the north-eastern sandy highveld type; and
- false grassveld types (Acocks VI, including the Pietersburg plateau false grassveld type. The central and southern portions of the portions of the province consist mainly of sour and mixed veld types, that is the pure and false grassveld types, with a carrying capacity of between 7 and 12 ha/LSU.

The general condition of the veld is deteriorating. This can be attributed to an over-estimation of its carrying capacity and the vulnerability of different veld types, due to environmental factors such as soils, climate and topography, which are not always acknowledged. Some 78% of the Northern Province is suitable only for grazing. Cattle farming, therefore, constitute the main farming activity. In contrast, the mountain sourveld and lowveld sour bushveld are suitable for afforestation, and constitute important water catchment regions.

4.2.3.5 Water Resources

The Northern Province falls into what is known as the Limpopo-Olifants River system, which can be divided into drainage regions A (Limpopo) and B (Olifants); and small section of the Komati River system, region X. It is characterised by a large number of rivers, tributaries of those above, and no less than 72 named dams. The latter are a form of assurance against the low and unreliable rainfall of the region. Many rivers have peak flows during January and February and low flows during

August and September. Only the Limpopo, east of the confluence with the Shashi River, and the Nzhelele, Levuvhu, Nwanedzi, Mutale, Letaba, Olifants, and Sabie Rivers are perennial. The region has substantial underground water supplies. Three important dolomitic aquifers are:

- an area southeast of Pietersburg;
- areas to the southwest of Pietersburg on the boundary of drainage regions A and B; and
- areas to the north and southwest of Thabazimbi.

It is estimated that 500 Mm^3 and 440 Mm^3 groundwater could be extracted annually from the main drainage regions respectively. Large areas, which consist of sand and alluvial deposits (e.g. the Springbok Flats and the Crocodile, Sand and Limpopo Rivers), could be utilised for irrigation purposes. Large quantities of groundwater are available in the Nyl River valley, approximately three kilometers east of Naboomspruit. Known sources also occur on the farms Haakdoring, De Hoop and Soetdoring near Potgietersrus. A pump scheme near Naboomspruit extracts some 526 Mm^3 water per annum. The quality of groundwater in the main drainage regions ranges from 200 to 1 500 mg/l total dissolved solids, thus falling within international standards for domestic consumption. An area of concern in the province is pollution of its water resources. The Limpopo River system is polluted by effluent discharged into its tributary, the Crocodile, by Gauteng (a province to the south of Northern Province) industrial area. The high concentration of dissolved solids in the Hartebeespoort Dam on the Crocodile (situated in the NorthWest Province) has created heavy metal and salinity problems which, in turn, have had negative economic impacts on irrigation. The Olifants River water system is affected by high acidity, largely the result of pollution by mining activities in the Witbank catchment area. High acidity in water has a detrimental effect on the fauna and flora, especially in ecologically sensitive areas like the Kruger National Park.

The relative scarcity and unreliable water resources seriously hamper the development potential of the province. An important issue to be dealt with in planning water usage in the province is equitable allocation of available water amongst competing users. Demand arises from rural communities, agriculture, industry, mining and urban development in the province, as well as from various users in the neighbouring states of Botswana, Zimbabwe and Mozambique.

4.2.3.6 Agriculture

More than 73% of the total surface area of the Northern Province can be regarded as grazing land, while only 14% is arable land. Of this, dryland and irrigated land comprise 11,5% and 24,5% respectively. More than 2,7% of the total arable land can be classified as being marginal, with a low soil and production potential. Warmbaths and Potgietersrus have a relatively large proportion of the high potential arable dryland. According to cropping patterns for cereals, fibre crops and oilseeds, the most important irrigation areas are found in the Northern and Lowveld Regions and the cultivation of horticultural crops including citrus fruits, subtropical fruit, nuts and vegetables predominate. Arable land is almost entirely utilised, with lateral expansion of cropping land being possible only in the southern and, to a lesser extent, in the central regions. An expansion of planted pastures could be expected in the low potential or marginal cropping regions, which comprise almost 2,4% of the total surface area.

4.2.3.7 Mining

The Northern Province is the best endowed of the three provinces included in the study (Eastern Cape and KwaZulu Natal), but nonetheless it supplies only 10,2% of the country's total mineral sales compared to Gauteng, North West and Mpumalanga, each of which produce over 20%. The major minerals found are platinum and chromite, while there is potential for developing titaniferous magnetite and vanadium.

4.2.3.8 Ecotourism

The Northern Province is known for the diversity of its countryside, which ranges from mountains to extensive grasslands, bushveld, wetlands and the Lowveld. It is claimed that the tourism potential of the province is based on experiencing the 'real Africa' by exploring its historic/cultural heritage and engaging in nature related leisure activities. Resource based tourism consists mainly of mountaineering and hunting. Several famous nature parks, notably the northern section of the Kruger National Park, are situated in this Province. Further opportunities exist for the sustainable use of natural resources for tourism development.

Chapter 5

POVERTY INFORMATION

5.1 Introduction

The aim of this chapter is to provide an overview of human settlement; poverty and poverty related information in South Africa. It first focuses on South Africa, and then focuses on the study area, the Eastern Cape, KwaZulu Natal and the Northern Province. Although the data are available at district level the study did not utilise it at that level in this chapter. Descriptions cover the demographics of a province; income poverty and human development; access to social and economic services, and labour force and employment conditions. A composite indicator of needs is included to facilitate identification of the poorest districts. Any review of poverty in South Africa has to take cognisance of the multifaceted nature of poverty, the socio-economic conditions that support it and the processes that perpetuate it. At a national level, data to support such an analysis are available from several sources. However, an understanding of local level poverty across different provinces is constrained by a lack of disaggregated and comparable information at the district level. Given the lack of appropriate data, descriptions in this chapter are essentially static.

Table 5.1: Population of South Africa by Province

South Africa	Eastern Cape	Free State	Gauteng	KZN/ Natal	Mpuma langa	Northern Cape	Northern Province	North West	Western Cape
40583573	6302525	2633504	7348423	8417 021	2800711	840321	4929368	3354 825	3956 875

Source: Census '96, 1998

5.2 Poverty in South Africa

The World Bank and the United Nations Development Programme (UNDP) classify South Africa as a middle income developing country. However, the quality of life of its population compares unfavourably with conditions in other middle income countries in terms of general social indicators like life expectancy, literacy and infant mortality. In addition, these indicators conceal wide disparities between different socio economic groups, due to a particularly skewed distribution of income and the legacy of apartheid policies. As a result of these policies, the poor in South Africa are predominantly Black South Africans. Many poor households are female-headed, and about 45% of the poor people are children. Poor communities are concentrated in rural areas, and approximately two-thirds of the poor live in the Eastern Cape, KwaZulu Natal and Northern Province. Not surprisingly, all these provinces contain large former homelands, where about 70% of the poor are located.

In addition to living primarily in the former homelands, the poor also have other characteristics in common. Poverty in South Africa is associated with feelings of alienation, family fragmentation due to employment-related migration, food insecurity, overcrowding, inadequate access to energy, and inadequate access to adequately paid and secure employment opportunities. Access to land is also limited among the poor – only one third of rural households engage in agricultural production, whether to be sold or consumed, and earn on average only R90 a month from this activity. Analysis of the PSLD[5] data indicates that the poorest 20% of households spend less than R120 a month per adult equivalent *[see Table 5.2]*. Of this amount, nearly 60% is spent on food. More than half the labour force is unemployed, and nearly half the households depend on remittances and pensions as a primary source of income. The poorest 20% of households are mainly rural and Black and nearly half of these are headed by women. Over four-fifths have no modern facilities, and about the same fraction of household heads have less than a primary level education (i.e. seven years). Almost 40% children are stunted. Nearly three-quarters of these households expressed dissatisfaction with their living situation, and over half named the provision of jobs as the preferred way in which the Government could improve their lives. Poverty also has a seasonal pattern, and vulnerable households are often at greater risk in the winter months and early spring. During this period they have little home-produced food, the demand for casual labour is lower, and subsistence farmers who have to invest in crops, require a considerable

[5] 1993 Project for Statistics on Living Standards and Development survey. Most of the poverty statistics in South Africa are based on this survey.

investment of time (May, 1996). Households combine several income producing activities to generate an adequate livelihood and attempt to deal with external shocks such as the death of a household member, illness, drought or sudden unemployment. Based on the PSLD data, May *et al.*, (1995) classified rural households according to the different livelihood strategies they employed to survive. About 4% of rural households are classified as marginalised, having no access to regular wages, remittances or social pensions and transfers. They earn on average only R70 a month. A second group is classified as welfare dependent, and only has access to welfare transfers. This group comprises about 11% of the rural population and earns about R500 per month. Among those who have access to remittances from a migrant(s), some 16% are dependent on irregular remittances of about R370 per month. About 10% receive regular remittances and may receive other transfers as well, adding up to an average income of R530 per month.

About 20% are dependent on wages from unskilled labour and earn about R650 per month, while 14% have access to wages from skilled and semi-skilled labour. At R1 400 their income is considerably higher. Of the groups that combine different income strategies, 16 per cent receive wages from unskilled labour, and earn approximately R720 per month. About 8% receive wages from skilled labour yielding an average of R1 925 per month. Only 1% derives a considerable share of their income from entrepreneurial activity, and their average monthly income is R2 800. Household strategies and the income derived from them are clearly influenced by factors like household structure. In general, female-headed households and households where the male head is absent, receive lower average monthly incomes than households in which the male head is present. For example, among households dependent on wages, a male-headed household earns an average of R1 675 per month while female-headed households earn only R1 377 on average. This pattern holds true for most income strategies. The bulks of landless households are either female-headed or are characterised by an absent male head.

5.2.1 EASTERN CAPE

5.2.1.1 Population

According to the latest statistics from Census 1996, the population of the Eastern Cape is 6 302 525 (6.3 million) [*see Table 5.1*]. This makes it the largest province in terms of population, after KwaZulu Natal and Gauteng. Between 1985 and 1994, the population of the Eastern Cape increased at an average annual rate of 2,96%. This was marginally higher that the average annual growth rate for the country. The province has over 43% of the population rated as under the age of 15. This is the highest proportion of children in the country and implies that the Eastern Cape has considerable demographic momentum, which is likely to affect population growth rates for a considerable period. These children are usually left with their mothers whereas the fathers are absent as migratory workers. In addition, during the recent past, parents in urban areas often sent children to relatives in rural areas where schooling was relatively uninterrupted.

More than 53,9% of the adult population of the Eastern Cape is female. Most of these women are poor, live in isolated rural areas in the former homelands and have little, if any access to family planning. In many cases, prevailing social values and conditions (e.g. poverty) favour large families. The homeland migrant-labour system is the main historical reason for this state of affairs. In addition, men are generally more mobile than women and are likely to migrate (often on a temporary basis) to neighbouring areas in search of employment. Thus, men outnumber women in provinces, which offered employment in mining, agriculture or industry, such as Gauteng and Free State, while women outnumber men in predominantly rural areas with poor economic prospects.

Compared with the rest of South Africa, the population density in the Eastern Cape is just above average at 41,4 people per km^2. The level of functional urbanisation is below average at 43,3%. This includes people living in the vicinity of an urban area who are dependent on that area for an income (semi and peri urban). Most of the urban concentration occurs in and around the Port Elizabeth/Uitenhage area, the greater East London/King Williams Town area, and the Queenstown/Ezibeleni area and, to a lesser extent, the Umtata area. During the 1996 census, the level of functional urbanisation increased by 4,4% per year, compared with the South African average of 3,3%. The only province to record a higher growth in its urban population was the Northern Province, albeit from a small base.

5.2.1.2 Poverty and human development

The level of human development in a country is measured by people's freedom to choose and act upon their choices. To make informed choices, people must first have some basic human capacities, secondly, a reasonable range of opportunities. The HDI proposed by the UNDP uses life expectancy and adult literacy as an indication of people's capacities, while income is used to suggest the opportunities available to them. The HDI of the Eastern Cape is 0,507, (very low which is very poor) which places it in the company of countries, like Cameroon. The only province with a lower ranking is the Northern Province. The level of income poverty mirrors low human development in the Eastern Cape. The Bureau of Market Research estimates the annual personal per capita income for 1994 to be R3 985, which is far lower than the average of R8 148 for the whole country. The Project Living Standard and Development (PSLD) data base estimates the average per capita income for the country at R7 062, while that for the Eastern Cape is only R2 852, the second lowest income. According to the latter survey, there are over 710 000 poor households, or 4,1 million poor people in the Eastern Cape. This implies that nearly 57% of households and 64% of individuals in the Eastern Cape live in poverty. Approximately 2,2 million of these poor people are children. Poverty is, again, far higher in the former homelands, especially the Transkei. Pockets of poverty are also evident in the commercial farming areas, due to the poor employment conditions of commercial farm workers.

Table 5. 2: Characteristics of the poorest 20 per cent of households in South Africa, 1993

1. Expenditure	
Monthly adult equivalent (R)	118,9
Percentage of expenditure on food	59,0
Percentage of expenditure on maize	16,9
2. Employment and income source	
Unemployment rate (%)	53,4
Percentage of working age adults working	22,9
Percentage of households relying on pensions and remittances source of income	47,1
3. Race, location, household structure	
Percentage living in rural areas	80,7
Percentage living in Eastern Cape and Northern Province	52,0
Percentage living in KwaZulu Natal, Free State, North West and Mpumalanga	41,4
Percentage living in Northern Cape, Western Cape and Gauteng	6,6
Percentage Black	97,1
Average household size (number of people)	6,5
Percentage of female-headed households	48,4
4. Housing and access to services	
Percentage living in shacks or traditional dwellings	22,6
Percentage without access to electricity	84,9
Percentage without piped water to household	81,5
Percentage without modern sanitation	88,7
5. Education and health	
Percentage of household heads with no education	46,2
Percentage of household with less than primary education	31,9
Percentage of children below five who are chronically malnourished	37,5
6. Levels of satisfaction and priorities	
Percentage of households who are dissatisfied or very dissatisfied	74,1
Percentage who named job as a priority	57,8
Percentage who named piped water as a priority	44,2
Percentage who named food aid as a priority	34,3
Percentage who named housing as a priority	32,1

Source: RDP office, 1995

In 1994, at R2 626 per year in real terms, the per capita Geographic Gross Product (GGP) of the Eastern Cape was well below the South African average of R5 745. At only R24 770, the GGP per worker is also substantially lower than the national average of R32 161. When these figures are shown. it is interesting to compare the high per capita GGP levels of the extensive commercial farming areas with the high poverty gap figures in the same areas. This highlights the fact that the benefits from farming are not flowing to the workers. Again, the former homeland areas show predictably low production figures per person, with the exception of the Umtata and Butterworth service centers.

5.2.1.3 Access to social and economic services

Access to social services and economic services enable people to participate fully in the economy and in the community. This is particularly obvious in a rural context. Services such as water and energy enable rural people to spend more time in remunerative work, while communication services establishes a vital link between rural people and their urban families. In urban areas most services are within reasonable distances. However, people in rural areas often have difficulty accessing social services, while commercial services are even scarcer. Commercial services such as markets depend on an entrepreneur's ability to make profits. This is in turn influenced by the size of the target population as well as the availability of service infrastructure such as roads and communication networks. The dividing line between social and economic services has become blurred over time and no attempt is made to specify which services should be rendered by the state or by the private sector. The services discussed in this section are communication, energy, health, housing, transport, water and sanitation and welfare or social security.

5.2.1.4 Employment structure

Some provincial economies have a clear primary-sector focus, while others are more secondary or service oriented. Location quotients are one way of measuring the orientation of the economy. They show whether a certain sector is of above-average importance in a province compared with the country as a whole. As a result, they are also interpreted as a rough indication of the comparative advantage of an economy. A province's location quotient will be larger (smaller) than one where the province has a comparative advantage (disadvantage) regarding employment in a particular sector. This implies that the share of that sector in employment in the province will be greater (less) than the share of same sector in the total economy. It should be noted that a location quotient could provide only an indication of historical trends without taking the future potential into account. For instance, the development of a mine will have a significant effect on the quotient for mining in the area. In addition, a true reflection of comparative advantage is obtained only when all provinces have functioned optimally during the period under consideration. As this is clearly impossible, it is assumed that the distorting factors, which caused the sub-optimal performance, such as government subsidies, low productivity of labour and the like, are more or less homogenous throughout the country. The Eastern Cape has comparative advantages in employment in agriculture and transport. This implies that these sectors are relatively more important as employment creators in the Eastern Cape than in the aggregate South Africa. This trend is more or less in line with the size of these sectors in the Eastern Cape.

Another characteristic of the employment structure is the level of diversification. A diversified economy is less vulnerable to changes in the external environment, such as changes in gold price, and to fluctuations of the business cycle. The diversification or concentration of an economy is measured by the tress index. The closer this number is to 100, the more concentrated the economy, and *vice versa*. Over the period 1980 to 1991, the economy of South Africa became less diversified in terms of labour. While the relative importance of agriculture and mining as employment creators decreased, sectors such as finance and business services and community and social services became relatively more important. Consequently, the sectoral employment tress index of the economy of South Africa increased from 44% in 1980 to 45% in 1991.

5.2.1.5 Production structure

The nominal GGP of the Eastern Cape was R21 019,8 million in 1991. In rate (inflation adjusted) terms, the GGP was R18 338,0 million at 1990 prices. The Eastern Cape thus contributed 7,6% to the gross domestic product (GDP) of the country. This was more or less on par with the contributions of Mpumalanga (8,6%) and Free State (6,4%). The Eastern Cape's share of the GDP has increased since 1970, when its contribution was only 6,6%. During the period 1980 to 1991, the economy of the province achieved an average annual growth rate of 1,7%, compared with the national average of 1,3%.

As with the employment structure, the South African production structure has reduced its dependence on mining over the past decades. The resulting increase in the relative importance of the services-orientated or tertiary sectors is in line with international trends. Sectoral GGP tress index values show that this contributed to a decline in the diversity of the South African economy. The national tress index value increased from 36,0% in 1980 to 38,3% in 1991. The economy of the Eastern Cape, likewise, grew less diversified: its tress index increased from 43,2% to 51,3%. This occurred as a result of the growing importance of the two services sectors, as well as agriculture. The largest sectors in the Eastern Cape's economy are in order of size, community and social services, manufacturing, transport, finance and business services, commerce and agriculture, with shares ranging from 26,5% to 6,3% of GGP. The remaining sectors, construction, energy and mining, all contributed less than 4% to GGP.

The Eastern Cape has a lower GGP as result of two factors, these being that the migrant workers remit only part of their income to their families, and secondly the production structure of the province. In provinces where activities such as mining and electricity are dominant, a large proportion of the GGP accrues to companies in other provinces. In the Eastern Cape, in contrast, the dominant role of the services sectors, agriculture, trade and transport and even manufacturing, as well as the remittance from migrants, ensured that the province had an income to GGP ratio of 171,5% in 1991, which was the highest in the country.

5.2.1.6 Needs index

A theoretical allocation of resources can be based on a composite index of needs. Generally, an indicator of the population, income and status serves as a useful index. Based on the availability of data for all districts in the area and the focus on rural areas in this study, the non urban population, the poverty gap, and lack of access to sanitation (i.e. pit latrines, or no sanitation) were chosen. All indicators were afforded equal weight. In the Eastern Cape, the districts that are most in need of resources predictably represent parts of the former homelands. The 25 districts (i.e. one third) with the highest needs indices are ranked in descending order on the following page[6]. Non homeland districts would require less than one per cent of funding. The needs index is a blunt instrument. The funding demand does not imply that funding alone will make a difference to people's quality of life. Issues like institutional capacity, the history of an area (e.g. forced resettlements), community priorities, the economic base, economic prospects and the availability of natural resources are crucial factors in determining the potential success of external interventions (Most of the information on this (most of the information was source from: RDP Office, 1995) .

[6] The data in the table are the absolute figures, not the ratios used to derive the index.

Figure 5.1

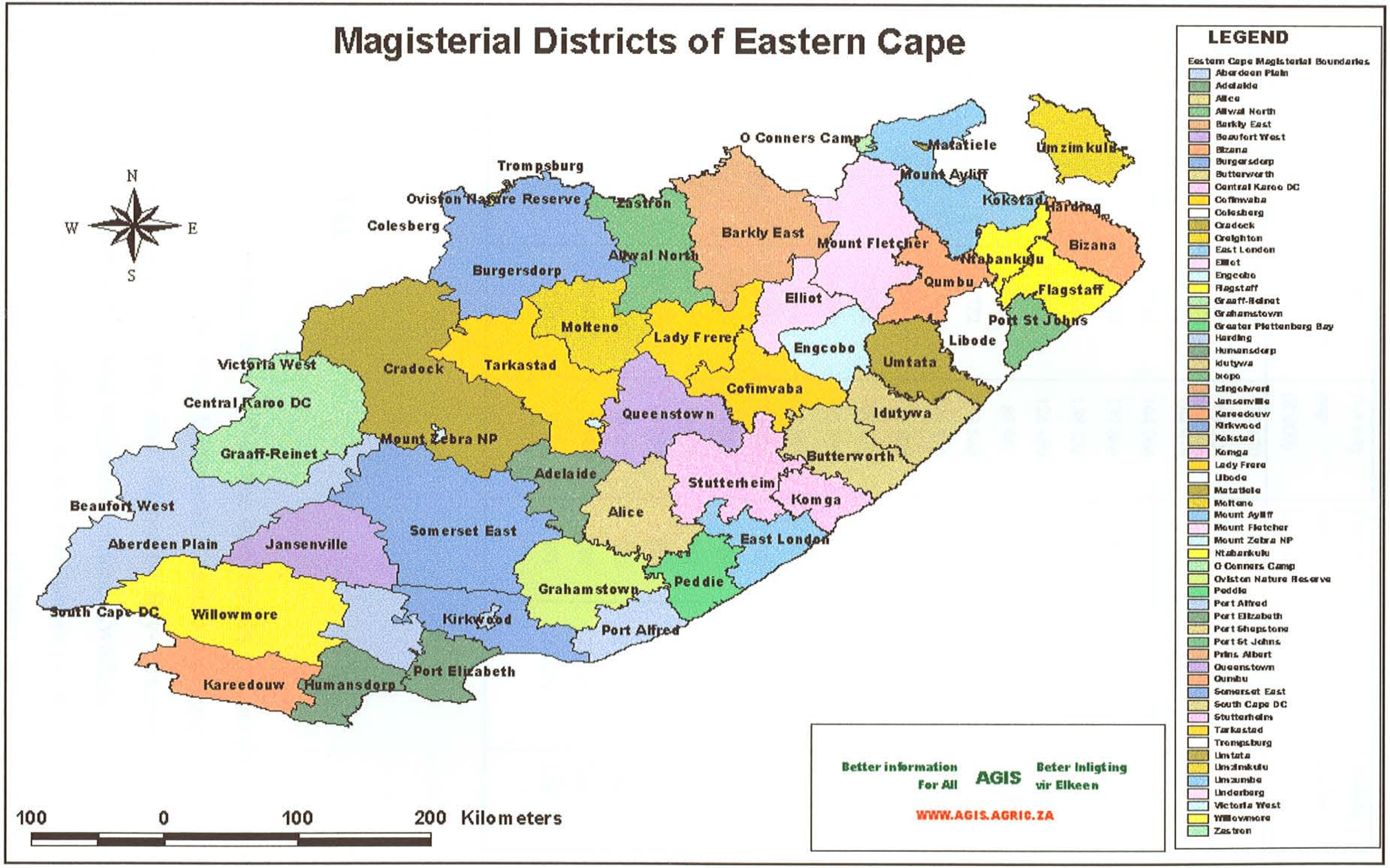

Magisterial Districts of Eastern Cape
N
S
W
E
Trompsburg
Oviston Nature Reserve
Colesberg
Zastron
O Conners Camp
Matatiele
Umzimkulu
Mount Ayliff
Kokstad
Harding
Barkly East
Mount Fletcher
Bizana
Ntabankulu
Qumbu
Flagstaff
Port St Johns
Libode
Burgersdorp
Aliwal North
Elliot
Molteno
Lady Frere
Engcobo
Umtata
Victoria West
Cradock
Tarkastad
Cofimvaba
Central Karoo DC
Queenstown
Idutywa
Mount Zebra NP
Graaff-Reinet
Adelaide
Butterworth
Stutterheim
Komga
Beaufort West
Alice
Somerset East
East London
Aberdeen Plain
Jansenville
Grahamstown
Peddie
South Cape DC
Willowmore
Kirkwood
Port Alfred
Port Elizabeth
Kareedouw
Humansdorp
100
0
100
200
Kilometers
Better information For All
AGIS
Beter Inligting vir Elkeen
WWW.AGIS.AGRIC.ZA
LEGEND
Eastern Cape Magisterial Boundaries
Aberdeen Plain
Adelaide
Alice
Aliwal North
Barkly East
Beaufort West
Bizana
Burgersdorp
Butterworth
Central Karoo DC
Cofimvaba
Colesberg
Cradock
Creighton
East London
Elliot
Engcobo
Flagstaff
Graaff-Reinet
Grahamstown
Greater Plettenberg Bay
Harding
Humansdorp
Idutywa
Ixopo
Izingolweni
Jansenville
Kareedouw
Kirkwood
Kokstad
Komga
Lady Frere
Libode
Matatiele
Molteno
Mount Ayliff
Mount Fletcher
Mount Zebra NP
Ntabankulu
O Conners Camp
Oviston Nature Reserve
Peddie
Port Alfred
Port Elizabeth
Port Shepstone
Port St Johns
Prins Albert
Queenstown
Qumbu
Somerset East
South Cape DC
Stutterheim
Tarkastad
Trompsburg
Umtata
Umzimkulu
Umzumbe
Underberg
Victoria West
Willowmore
Zastron

Table 5.3: Districts with the highest needs indices: Eastern Cape

Rank	Magisterial district	Rural population	Poverty gap (R'000)	Poverty per capita (R)	Households With pit or Latrines	Needs Index
1.	Flagstaff/Lusikiki	283 371	170 470	610	41 715	2,99
2.	Engcobo	207 028	189 206	997	31 547	2,76
3.	Umzimkhulu	156 056	184 915	1 202	33 411	2,57
4.	Umtata	218 110	144 064	552	31 980	2,49
5.	Matatiele/Maluti	187 240	139 866	820	25 423	2,48
6.	Lady Frere	206 028	138 332	562	28 679	2,40
7.	Bizana	171 572	126 459	753	29 576	2,31
8.	PortS. John	54 487	88 967	1626	13 664	2,19
9.	Qumbu	126 772	113 888	954	26 162	2,16
10.	Mount Frere	141 909	109 570	815	29 036	2,16
11.	Kokstad	138 659	104 708	808	30 126	2,13
12.	Mt. Fletcher	78 412	109 570	1329	22 238	2,11
13.	Barkly East/Sterkspruit	144 848	95 365	685	23 828	2,07
14.	Alice	170 671	100 904	395	30 199	2,02
15.	Cofimvaba/St. Marks	118 962	93 542	820	25 112	2,00
16.	Komga	123 331	84 207	709	26 077	1,94
17.	Butterworth/Tsomo	110 821	78 604	761	17 586	1,89
18.	Ntabankulu	101 579	83 351	829	21 710	1,87
19.	Nqamakwe	118 245	65 251	602	21 201	1,82
20.	Tsolo	98 413	77 088	780	21 108	1,81
21.	Libode	123 931	57 146	491	22 624	1,76

Source: RDP Office, 1995.

5.2.2 KWAZULU NATAL

KwaZulu Natal forms the eastern seaboard of the country. In the north, it borders Mozambique and Swaziland, with Free State and Lesotho forming the western border. The Pietermaritzburg, Durban and Richards Bay- Empangeni (Lower Umfolozi) areas are the commercial and industrial nodes. KwaZulu Natal contains the former homeland of KwaZulu, which is not contiguous – its districts were demarcated in a particularly haphazard way, certain of them consisting of several separate areas. The province is essentially dualistic, with a well-developed economic base in the former Natal area coexisting with high levels of poverty in the former KwaZulu. The 1991 land use pattern in KwaZulu was 10% arable, 76% grazing, 2% nature conservation and 4% forestry.

5.2.2.1 Population

KwaZulu Natal is the province with the largest population, in 1996 numbering 8,4 million, or 20,7% of the South African population. Between 1985 and 1996, the average annual population growth rate was 2,14%. At 100,1 people per km^2 its population density is well above the rational average and the level of functional urbanisation[7] is 52,9%. As in the two other provinces, the proportion of women in the population is quite high – just over 55% of the adult population is female. The adult women form significantly more than half the non-urban adult population, the main cause being male migration. In contrast to the other two provinces, migration to urban areas within the province is common, although some migration to other provinces, such as Gauteng, also occurs. Migrants in urban areas seem to be returning to the rural areas in greater numbers, probably as a result of inadequate skills compared with township residents. Daily and weekly commuting is also widespread. Large concentrations of women are also found to be associated with large-scale farming. In these districts, the number of non-urban people is quite small, generally below 30 000. Men tend to work in the urban areas of the district, leaving the women in the non-urban areas. There are also a number of female migrants, who tend to live in single or two-person households, often employed as seasonal or domestic workers, or in the informal sector. Fewer than 39% of the population is under the age of 15 and the fertility rate, at 2,8 is average. In non-urban areas, children under 15 are concentrated in the districts of the former KwaZulu. The small proportion of children in the commercial farming and industrial areas where there is a high proportion of female migrants is notable.

[7] Includes the official urbanisation numbers as well as people living in large settlements (semi-urban) or in the vicinity of an urban area who are dependent on that area for an income (peri-urban).

5.2.2.2 Poverty and human development

At 0,602, the HDI of KwaZulu Natal is below the national average. Despite its strong industrial, mining and agriculture-based economy, the population of the province is quite poor. According to both the BMR (R5 924 in 1994) and PSLD data base (R5 727 in 1993) the personal annual per capita income of KwaZulu Natal is significantly below average, although it is much higher than similar figures for the Eastern Cape and Northern Province. According to PSLD, almost 630 000 households (40%), or 4,2 million people (50%) in KwaZulu are poor. Approximately 2,2 million people are under the age of 15. The per capita poverty gap[8] which is again, far higher in the former homeland figures for these areas, are frequently double those of the surrounding areas. In the richer areas, at least 28% of households earn less than R5 000 per year, or among the poorest 20% of households in the country. In the homeland areas, more than two thirds and up to nine tenths of households earn less than this amount. Concerning internationally poverty guidelines, only 11,6% of individuals in KwaZulu Natal live in households earning less than R41 per capita per day. At R4 124 in real terms the per capita GGP in KwaZulu Natal was considerably lower than the average for 1994. KwaZulu Natal also has a below average GGP per worker (R25 521). High GGP per capita levels are recorded in the mining, commercial and industrial centres followed by lower levels in commercial farming areas. The former homeland areas, again, demonstrate predictably low production figures per person.

5.2.2.3 Access to social and economic services

KwaZulu Natal is the only one of the three provinces having an above average illiteracy rate (85,0%). Most of the highly skilled population lives in the urban areas, while illiteracy is prevalent among aged people and rural women. Illiterate workers are concentrated in the rural and commercial farming areas. At 37, the 1993 pupil-teacher ratio was the second highest in the country. School attendance compares

[8] The poverty gap measures how far all households in a district are below a poverty line of R840 a month for a family of four in urban areas and R740 a month for five people in rural areas.

poorly to the other provinces, and a full 11,3% of children aged 6 to 14 were not attending school at the time of the recent census. Stunting in the former KwaZulu is generally above the national average of 13 %[9]. Relative to the size of the population, medical facilities in KwaZulu Natal are above average. However, the distribution of these facilities is such that many people are still without adequate services. In 1992, there were 5,8 hospital beds per 1 000 population. The national average is 5,1 beds per 1 000. Over 2,8 million people are treated annually as out patients, excluding those in the former KwaZulu. There are more clinics in the rural than in the urban areas. The clinic to population ratios is low due to large population numbers. The size and staffing of the facilities at these clinics are probably less favourable than clinics in the formerly white areas. Districts such as Durban and Pietermaritzburg also have large facilities, although some of these are in a poor condition. Just over one-third of households in KwaZulu Natal have access to electricity and to water either on home or in site. In the former Natal areas, between 10 % and 30% of households have water at the home or on site. In the former KwaZulu, figures are below 5%. Access to sanitation is even poorer. On average, only 35% of households have flush or chemical toilets. The rest use buckets or pit latrines, or have no sanitation facilities at all.

5.2.2.4 Employment Structure

In 1994, 56% of the potential economically active population of KwaZulu Natal (aged 15 to 64) was actually economically active (i.e. employed, unemployed or in the informal sector). This was below the national participation rate of 59%. The subsistence agriculture sector in this province is relatively large, as is the number of people who depend on transfers such as remittances or pensions. According to the OHS[10], the labour force of KwaZulu Natal numbered 2,7 million in 1995, and was growing by about 81 000 per year. In 1994, the absorption capacity of the formal economy was 52,4%. This was close to the absorption capacity for South Africa as a whole, and was due to the sizeable formal economy of the region. Still, many

[9] The school entrants database indicates a national stunting average o f 13%. Most other surveys suggest a rate closer to 25%, but do not provide information on district level.
[10] This is an annual October Household Survey, which is conducted by the CSS.

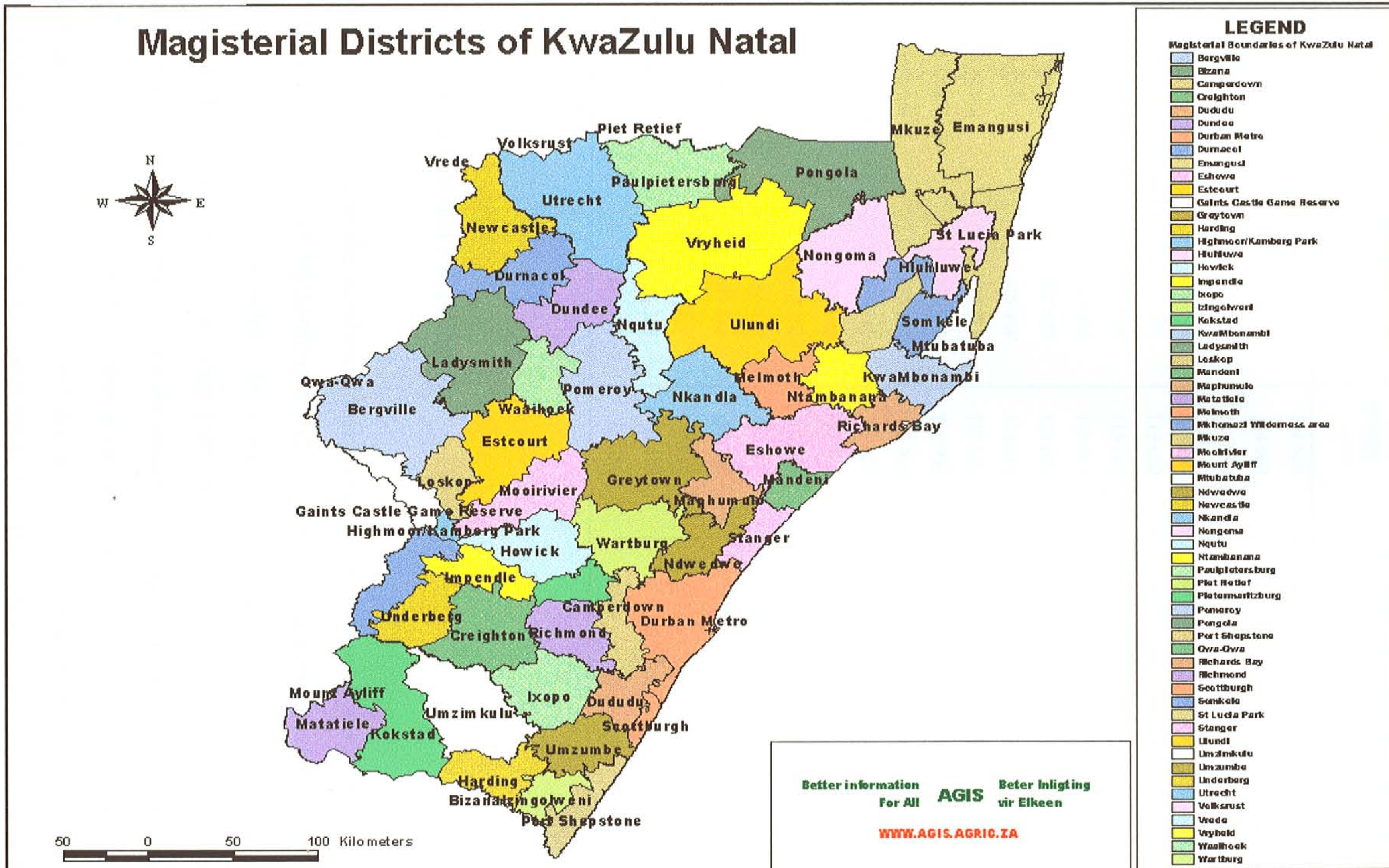
economically active people had to migrate in search of employment – on a 1: 1 male to female basis, the male absenteeism ratio in 1994 was nearly 16%. In contrast, in the former homelands between 11% and 25% of the adult population was able to find formal employment, while higher figures were recorded in those districts adjacent to the Greater Durban area.

5.2.2.5 Needs index

The geographical distribution of the needs index is shown in Table 5.4. Given the large number of districts in the province, the proportion of funding required by individual districts is quite low. The 10 districts (i.e. one-third) with the highest needs indices are ranked in the table in descending order[11].

[11] The data in the table are the absolute figures, not the ratios used to derive the index.

Figure 5.2


Magisterial Districts of KwaZulu Natal
N
W
E
S
Volksrust
Piet Retief
Vrede
Paulpietersburg
Pongola
Mkuze
Emangusi
Utrecht
Newcastle
Vryheid
St Lucia Park
Nongoma
Hluhluwe
Durnacol
Dundee
Nqutu
Ulundi
Somkele
Mtubatuba
Ladysmith
KwaMbonambi
Qwa-Qwa
Pomeroy
Melmoth
Nkandla
Ntambanana
Bergville
Weenen
Richards Bay
Estcourt
Eshowe
Greytown
Mandeni
Loskop
Mooirivier
Gaints Castle Game Reserve
Maphumulo
Highmoor/Kamberg Park
Howick
Wartburg
Stanger
Ndwedwe
Impendle
Camperdown
Underberg
Durban Metro
Creighton
Richmond
Mount Ayliff
Ixopo
Dududu
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Eshowe
Estcourt
Gaints Castle Game Reserve
Greytown
Harding
Highmoor/Kamberg Park
Hluhluwe
Howick
Impendle
Ixopo
Izingolweni
Kokstad
KwaMbonambi
Ladysmith
Loskop
Mandeni
Maphumulo
Matatiele
Melmoth
Mkhomazi Wilderness area
Mkuze
Mooirivier
Mount Ayliff
Mtubatuba
Ndwedwe
Newcastle
Nkandla
Nongoma
Nqutu
Ntambanana
Paulpietersburg
Piet Retief
Pietermaritzburg
Pomeroy
Pongola
Port Shepstone
Qwa-Qwa
Richards Bay
Richmond
Scottburgh
Somkele
St Lucia Park
Stanger
Ulundi
Umzimkulu
Umzumbe
Underberg
Utrecht
Volksrust
Vrede
Vryheid
Weenen
Wartburg

Table 5.4: Districts with highest needs indices: KwaZulu Natal

Rank	Magisterial district	Rural Population	Poverty gap (R'000)	Poverty gap capita (R)	Households with pits or latrines	Needs Index
1.	Ndwedwe	364 288	161 925	518	80 206	3,46
2.	Maphumulo	265 179	134 602	443	41 743	3,00
3.	Umzumbe	245 271	144 994	520	40 392	2,95
4.	Umbumbulu	298 975	114 004	475	57 539	2,95
5.	Impendle	218 958	119 632	496	36 948	2,78
6.	Ntambanana	259 736	115 669	583	36 636	2,77
7.	Nquthu	219 821	132 211	415	33 850	2,75
8.	Ezingolweni	227 437	124 023	607	38 493	2,71
9.	Bergville	215 964	114 319	607	32 341	2,67
10.	Greytown	175 256	117 558	538	30 498	2,67
11.	Mpumalanga	233 890	140 990	455	53 868	2.58
12.	Nongoma	190 333	95 933	560	25 432	2,49
13.	Ingwavuma	165 740	91 927	538	24 253	2,41
14.	Nkandla	150 926	84 346	402	22 743	2,35
15.	Eshowe	173 352	86 303	592	26 072	2,29
16.	Hlabisa	165 412	95 038	618	27 877	2,27
17.	Dududu	139 346	77 727	722	22 926	2,25
18.	Ladysmith	156 282	98 531	582	23 542	2,15
19.	Pongola	131 335	65 418	630	17 725	2,10
20.	Ubombo	130 203	62 539	485	17 623	2,07

Source: RDP Office, 1995.

5.2.3 NORTHERN PROVINCE

The Northern Province is the northern most section of the country and borders with Botswana, Zimbabwe and Mozambique. Mpumalanga, Gauteng and North West Province form its southern borders. It contains the former homelands of Venda, Gazankulu and Lebowa. These are important features since districts in the former homelands are generally worse off. To the east the Kruger National Park forms part of the Phalaborwa district, which is also a mining area. The Pietersburg area is the industrial node, while the western most districts are also mining based. In 1991 the land use pattern in developing farming areas (i.e. the former homelands) was 79% grazing, 15% arable and 4% nature conservation.

5.2.3.1 Population

In 1996, the population of the Northern Province numbered 4 929 368 (4,9 million) [*see Table 5.1*]. It is the province with the fourth-largest population. KwaZulu Natal, Gauteng and the Eastern Cape are larger in this respect. It could easily reach the estimate of 5,9 million people by the year 2000. This is based on an average annual growth of 2,3%. Estimates of the population growth rate for the year 2000 to 2005 point to a 2,19% per annum increase. In light of this, the population will approximate 6,7 million people by 2005.

One of the factors contributing to the demographic momentum in the Northern Province is the prevalence of the youth. Over 41% of the inhabitants are younger than 15, making it the province with the second highest proportion of children in the country. Parents in urban areas often send their children to live with relatives in rural areas where a culture of learning is more prominent and schooling is relatively uninterrupted, while the cost of living is lower. Women make up 57% of the adult population. Most women live in abject poverty in rural areas in the former homelands of Venda, Gazankulu and Lebowa and have little, if any, access to family planning. The system of labour migracy that originated during the existence of the homelands is the main historical factor contributing to the large proportion of women in the province. In general, men are more mobile than women are and more likely to migrate (often temporarily) to neighbouring areas in search of employment. Men outnumber women in provinces, which offer employment in mining, agriculture or industry, such as Gauteng and Free State, while women tend to outnumber men in predominantly rural areas with poor economic prospects.

In comparison with the rest of South Africa, the population density in the Northern Province is above average at 45,6 people per km² [*see Table 5.1*]. The level of functional urbanisation is far below the national average at 32,4%. Between 1985 and 1994, the level of functional urbanisation increased by 7,5% per year, compared with the South African average of 3,3%. This was the highest urbanisation growth rate in the country.

5.2.3.2 Poverty and human development

As noted, the HDI of the UNDP uses life expectancy and adult literacy as indications of people's capacities, and income to symbolise their opportunities. At 0,470, the HDI of the Northern Province is the lowest of all the provinces. Average income levels in the Northern Province are far below the national level. The Bureau of Market Research (BMR) estimates the personal annual per capita income for South Africa at R8 148 (1994), while that of the Northern Province is only R2 288. According to the PSLD data base, the average annual per capita income for the country is R7 062, while that of the Northern Province is only R2 343, which is the lowest level of income among the provinces. Approximately 610 000 households, or 3,6 million people in the Northern Province are poor, that is nearly 62% of households and 69% of individuals. Children account for approximately 1,9 million of these people. From the study it can be seen that the per capita poverty gap[12] is, again, far higher in the former homelands.

The distribution of households earning less than R5 000 per year or the poorest 20% of households is also informative. In the deep rural areas, over three-quarters of all households fall within this category. The extent of poverty is highlighted by the fact that more than half the households in formerly white farming districts are poor. Poverty is markedly lower in the mining districts. In terms of international poverty guidelines, 34% of individuals in this Province live in households earning less than $1 per capita per day, and more than one third spend more than 60% of their income on food. On a per capita basis, the GGP of the Northern Province is higher than the level of personal income. This is mainly due to the dominance of mining and electricity in the production structure of the province – a large proportion of the GGP accrues to companies in other provinces. In 1994 the Northern Province had an income to GGP ratio of 81%. The per capita GGP in the Northern Province was the second lowest of all the provinces – at R1 746 per year in real terms, it was well below the 1995 South African national average R574. The Northern Province also has the lowest GGP per

[12] The low percentage of children in the Nebo, Sekhukhuni land districts is probably an anomaly due to census undercounting.

worker, namely R18 293. High levels are recorded in the mining and industrial mining and industrial centres, followed by lower levels in commercial farming areas. Again, the former homelands demonstrate predictably low per capita production figures.

5.2.3.3 Access to social and economic services

At 74,3% the official adult literacy rate in the Northern Province is significantly below the South African average of 82,8%. Although illiteracy occurs mainly among people who do not form part of the labour force, farm workers also lack basic education, as indicated by the high levels of illiteracy in the commercial farming areas of Potgietersrus and Soutpansberg. The existing education system perpetuates the problem – in 1993 the pupil-teacher ratio in the province was 35 pupils per teacher. Still, school attendance is relatively high, and in 1991 only 8,6% of children aged 6 to 14 did not attend school. Average life expectancy in the Northern Province is 62,9 years, which is not far below the national average of 63,2 years. However, other health status indicators are less positive. At 55,9 the infant mortality rate of the Northern Province is the second highest of all provinces, and is far higher than the national average of 41,8 per 1 000 live births. Stunting rates are generally above the national average of 13%. Medical facilities in the Northern Province are also inadequate. In 1992 there were only 4,7 hospital beds per 1 000 population as against the national average of 5,1 beds per 1 000. Nearly 400 000 people are treated annually as outpatients, excluding those in the former homelands. Most clinics are concentrated in the former homelands, but the bed-patient ratios remain low due to the large population numbers. Access to electricity is limited to less than one-fifth of households in the Northern Province. Only 14% have water either in the home or on site. In the farming areas, about one-quarter of households have water in the home or on site. In the former homelands, 6% or fewer have on site access. These communities also lack access to adequate sanitation, as only one-tenth have flush or chemical toilets.

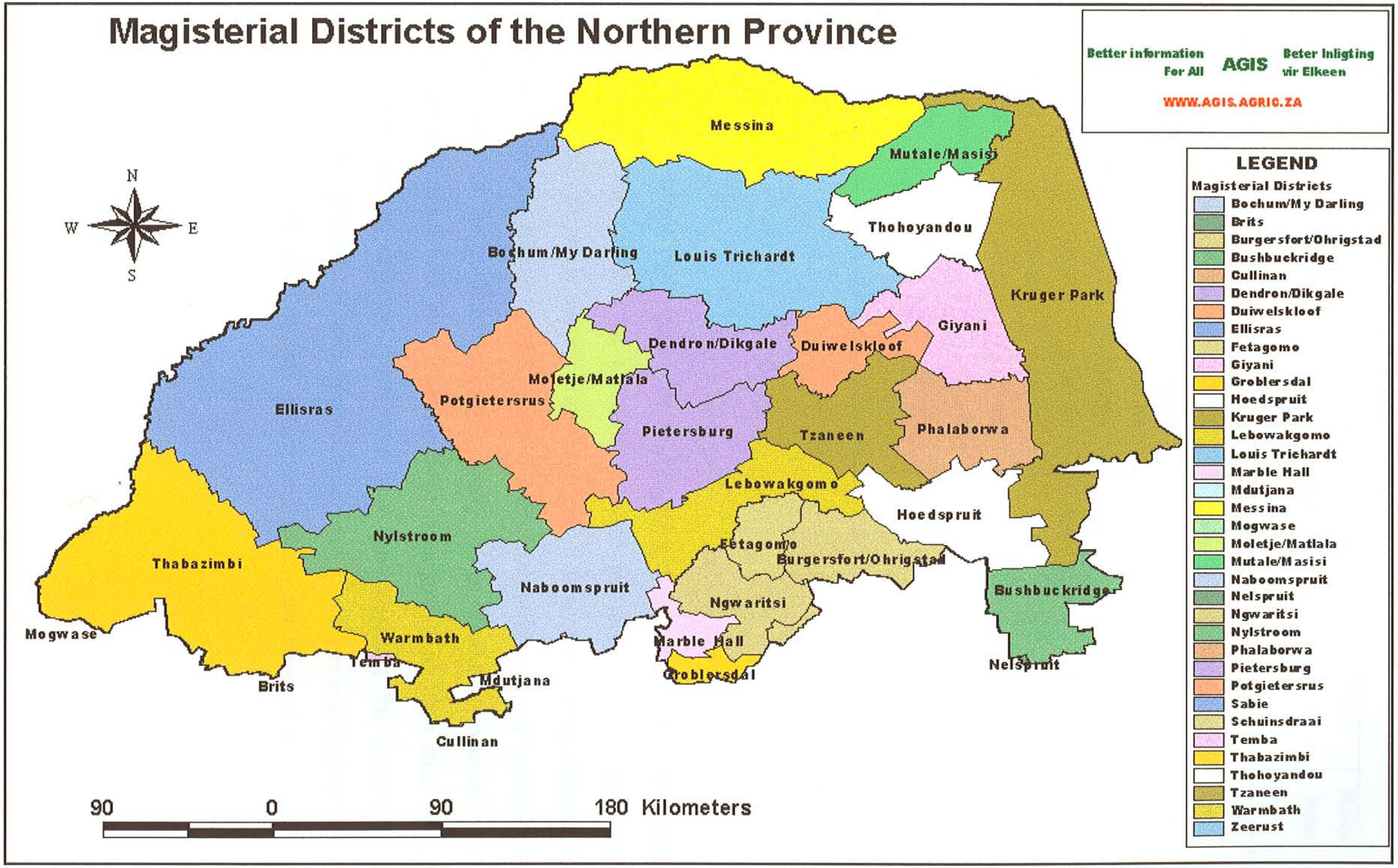
5.2.3.4 Employment structure

The Northern Province has a comparative advantage in employment in the agricultural sector. This sector is therefore relatively more important as an employment creator in the Northern Province compared with the aggregate for South Africa as a whole. This is a trend in line with the size of the sector in the province. Another characteristic of the employment structure is its level of diversification. A diversified economy is less vulnerable to changes in the external environment and fluctuations of the business cycle. The relative importance of agriculture and mining as employment creators in the province fell sharply from 1980–1994 sharply. The service sector's importance, however, increased dramatically leading to increased concentration. The province's economy also became increasingly less labour-intensive, requiring only 55 people to produce R1 million in GGP in 1994, compared with 87 people in 1980. The sectors most affected were agriculture, mining community and social services.

5.2.3.5 Needs index

The needs index, as defined previously, is reflected in Table 5.3. Districts in the former homelands are most in need of resources, with the exception of districts like Namakgale, which are adjacent to areas with high levels of economic activity. The table shows, in descending order, the top one-third of districts with the highest needs index. Funding requirements in non homelands districts are below 2%.

Figure 5.3



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Bochum/My Darling
Louis Trichardt
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Duiwelskloof
Moletje/Matlala
Potgietersrus
Ellisras
Pietersburg
Tzaneen
Phalaborwa
Lebowakgomo
Hoedspruit
Nylstroom
Thabazimbi
Fetagomo
Burgersfort/Ohrigstad
Naboomspruit
Ngwaritsi
Bushbuckridge
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Ngwaritsi
Nylstroom
Phalaborwa
Pietersburg
Potgietersrus
Sabie
Schuinsdraai
Temba
Thabazimbi
Thohoyandou
Tzaneen
Warmbath
Zeerust

Table 5.5: Districts with the highest needs indices: Northern Province

Rank	Magisterial districts	Rural Population	Poverty Gap (R'000)	Poverty gap Per capita (R)	Households with pits or latrines	Needs Index
1.	Potgietersrus	476 244	285 715	608	79 841	5.79
2.	Ngwaritsi/Sekhukhuni	433 005	300 730	720	85 221	5,75
3.	Marble Hall/Nebo	349 484	232 663	688	63 997	5,10
4.	Thabamoopo	363 563	230 498	602	65 811	5,08
5.	Bushbuckridge/Mhala	264 852	185 596	693	54 440	4,52
6.	Seshego	286 931	183 718	529	50 311	4,31
7.	Hoedespriut	233 331	149 181	669	44 109	4,22
8.	Duiwelskloof	214 514	137 108	679	38 694	4,13
9.	Giyani/Malamulele	196 079	127 465	696	35 591	4,05
10.	Thohoyandou	254 936	137 040	496	44 466	4,02

Source: RDP Office, 1995.

5.3 Conclusion

The needs index is a blunt instrument for highlighting the districts with the most poverty. Given that the number of districts in each province differs, no direct comparison of needs is possible among the provinces. It is worth noting that all the districts, which have the highest need indices, were formerly part of homelands. These highlight some of the main features of poverty in the three provinces of South Africa. Although circumscribed by the paucity of disaggregated data that would permit comparisons across districts, provinces and time periods, the descriptions provided illustrate that poverty is widespread, and provides a general indication of the location of the poorest communities, which are in urgent need of initiatives to eradicate poverty.

Chapter 6

LAND DEGRADATION

6.1 A conceptual framework

The study has used a very simple conceptual framework for understanding land degradation. As noted, land degradation incorporates the water, soil and vegetation resources of an area and includes a plethora of hydrological and ecological processes. Land degradation occurs as a result of the disruption of the normal functioning of these processes. The study concentrates primarily on climatic and human's roles during land degradation. In addressing the role that human influences play in the process of land degradation, the study focuses on several issues including the role of land use, demography, history, poverty and policy. While climate has a profound effect on the human society, the influence of both is mediated by biophysical characteristics of a particular area. South Africa is not a uniform, flat landscape but is characterised instead by considerable geological, topographic and bioclimatic variation across the country. For some of these variables, shallow gradients often exist while for others, abrupt transformations occur over relatively short distances. The same climatic or human impact is likely to have a very different outcome in different areas, largely dependent on the biophysical characteristics of the area. For example, the influence of a heavy downpour on a landscape is going to be very different for areas possessing different slope angles, slope lengths, soil textures and soil depths. It is thus through the biophysical characteristics of an area that the influence of climate and human society ultimately impacts on water, soil and vegetation resources. *Table 6.1* summarizes some of the most important biophysical characteristics influencing land degradation. The variables are, for the most part, very general in nature and poorly tested. Garland (1995) has warned against the uncritical acceptance of many biophysical variables. He has suggested that South African studies have frequently either modified them or rejected their values for use under local conditions. Despite this caution, it is suggested that it is of interest to list key variables, which may have an important moderating effect on the impact of the climate and land use on our environment.

Table 6.1. ***Source of the most important biophysical variables, which modulate the impact of climatic and land use factors on a catchment, landscape or region***

Variable	Description and influence
Rainfall erosivity	This is the product of the kinetic energy of falling rain (mass, diameter and velocity) of the raindrops and its intensity and duration. It describes the ability of raindrops to break up soil aggregates. It is measured in iso-erodents, which are lowest for the Western Cape and Northern Cape and highest for the Eastern Cape, KwaZulu Natal and Northern Province (Smithen & Schulze, 1982). Several studies have, however found it to be a poor predictor of erosion in South Africa (see Garland, 1995).
Geology	The parent material influences soil texture and therefore the erodibility of soils.
Topography	This includes measures of (i) slope steepness (in degrees) that influences raindrop splash, run-off velocity and (ii) slope length (the distance that water flows downhill) that influences the volume and velocity of run-off, which in turn affects the cutting power and transport capacity of run -off (Matthee, 1984). Although poorly researched in South Africa, the influence of slope steepness and length on soil erosion appears to be complex (Garland, 1995).
Soil erodibility	It defines the susceptibility of soil aggregates to detachment and transport. Largely the texture, structure, organic material, chemical content and infiltration capacity of a soil determine it. Some soils such as the duplex soils of KwaZulu Natal and parts of the Eastern Cape, with a permeable top soil overlying a relatively impermeable sub-soil, are particularly susceptible to soil erosion (Matthee, 1984). Garland (1995) highlights some difficulties of measuring soil erodibility.
Plant cover	Plants intercept and reduce the kinetic energy of water, which in turn influences soil erosivity. All things else being equal, the closer to the ground the canopy is, the more effective it is at reducing raindrop energy on the soil surface (Matthee, 1984). Snyman (1998) has demonstrated the importance of plant cover in influencing soil erosion. Plant covers influence sub-surface flow and in the riparian zones may also influence stream bank erosion and stability. The role of plants in facilitating chemical sedimentation has not been studied extensively in South Africa.

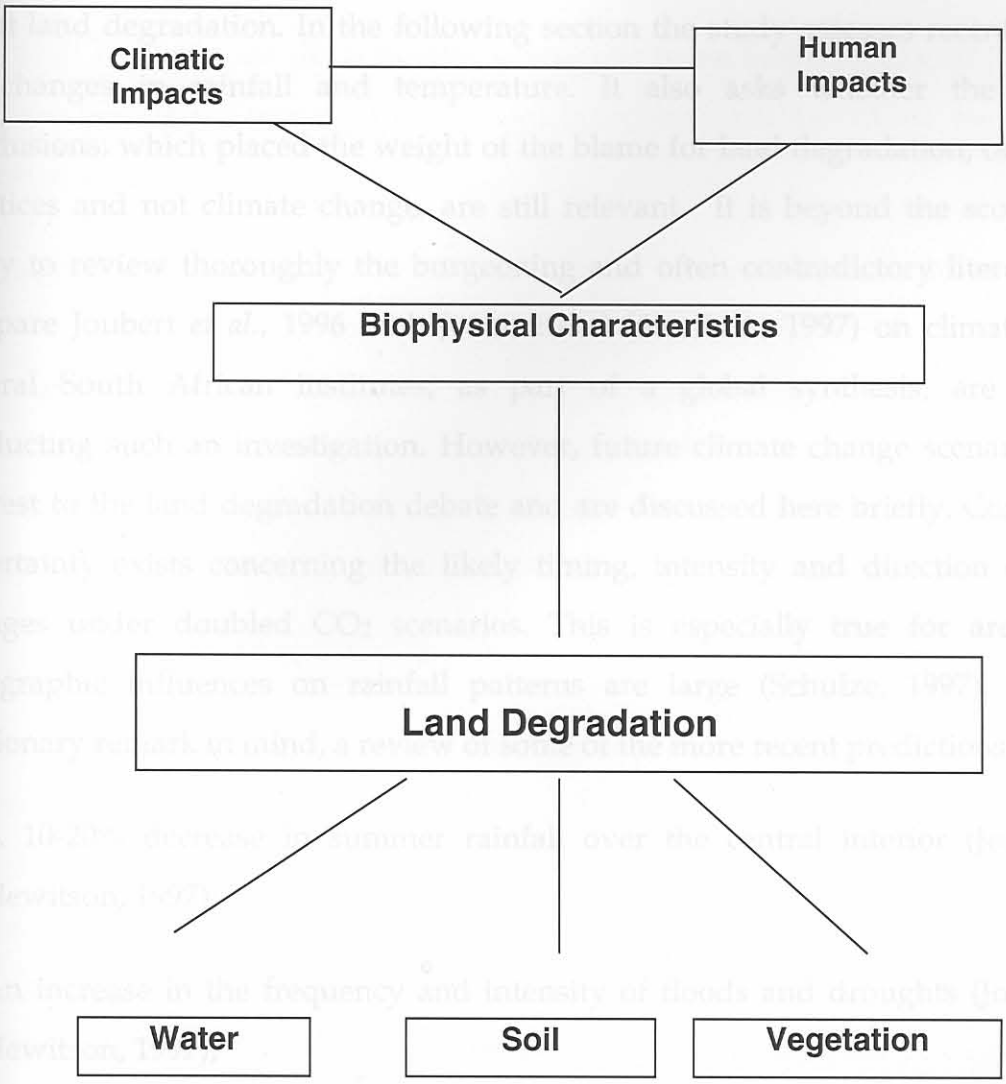

Figure 6.1. *A conceptual framework for showing how climatic and human impacts influence, through the biophysical environment, the hydrological and ecological processes associated with an area's water, soil and vegetation resources.*

6.2 The Role of Climate

It is extremely difficult to separate the influence of people and climate on land degradation. Despite this, the conclusion of most historical reviews and investigations in the past has been that it is people and their land use practices and not climate that should be blamed for the state of environment (Anon, 1923; Kokot, 1948; anonymous, 1951; Acocks, 1953 and Wilcocks, 1977). While prolonged drought may form a catalyst for desertification (Tyson, 1986), it has generally been stated that it is the removal of vegetation by overgrazing and trampling, subsequent soil erosion and the resultant impoverished hydrological status of the soil that ultimately bring about land degradation. In the following section the study assesses recent evidence for changes in rainfall and temperature. It also asks whether the historical conclusions, which placed the weight of the blame for land degradation, on land use practices and not climate change, are still relevant. It is beyond the scope of this study to review thoroughly the burgeoning and often contradictory literature (e.g. compare Joubert *et al.*, 1996 with Joubert and Hewitson, 1997) on climate change. Several South African institutes, as part of a global synthesis, are presently conducting such an investigation. However, future climate change scenarios are of interest to the land degradation debate and are discussed here briefly. Considerable uncertainty exists concerning the likely timing, intensity and direction of rainfall changes under doubled CO_2 scenarios. This is especially true for areas where topographic influences on rainfall patterns are large (Schulze, 1997). With this cautionary remark in mind, a review of some of the more recent predictions suggests:

- A 10-20% decrease in summer rainfall over the central interior (Joubert and Hewitson, 1997);
- An increase in the frequency and intensity of floods and droughts (Joubert and Hewitson, 1997);
- Gradual and linear increases in temperature with rising CO_2 levels, with mean temperatures 1,5 - 2,5^{0}C hotter than at present by 2050 (Joubert and Hewitson, 1997; Schulze, 1997), with an associated increased frequency of higher temperature episodes (heat waves) (Schulze, 1997);

The implications of these scenarios for land degradation, agricultural production and human society in general are profound. Hulme (1996) have suggested that some of the most important, as they relate to land degradation, are:

- Increased potential evapotranspiration rates of 5 - 20% across Southern Africa;
- An increase in runoff of up to 30% in the eastern parts of Southern Africa with an associated increase in the variability of runoff and consequently less reliability;

- A shift in biome distribution with grasslands being largely replaced by savanna vegetation due to increased runoff variability, less reliable runoffs, and increased temperatures;
- A significant impact on about 20% of Southern Africa's largest nature reserves.

In summary, long-term changes in rainfall patterns have still not been conclusively demonstrated. More time is needed to determine if the generally drier and hotter spell of the last 15 years is part of a sustained downward trend in our regional climate, or simply part of the expected inter-decadal variability. Current climate change scenarios suggest that we can expect less rain in the future and increased variability in rainfall amounts. For temperature there appears to be some consensus that there has been an increase and that this is probably in response to greenhouse gas increases. Temperatures are also likely to increase in the future with increasing CO_2 concentrations. Unlike previous investigations into land degradation in South Africa (e.g. Anonymous, 1923, 1951) this analysis suggests that climatic conditions, especially those since the late 1970s, might have had a more important influence on land degradation patterns than is currently acknowledged. In the past, much of the blame for land degradation has been placed on people's use or abuse of the soil and vegetation resources, without recognizing the often-subtle interactions that exist between climate patterns and land use. Certainly our custodianship of the land is important and we cannot ignore stark fence-line contrasts that can be attributed to management regimes. Moreover this is supported by the knowledge that despite the last 15 years, changes in the way people have used the land, have resulted in significant perceived improvements in soil and veld degradation rates in many magisterial districts. Climatic influences are however equally important and should not be summarily dismissed.

6.3 The Role of People

6.3.1 The nature of human influence

This study has identified an interdependent triangle of causative factors that underlies land degradation. Biophysical characteristics are the apex of the triangle that relates most directly to land degradation. Climatic and human-induced factors have a range of causative impacts on the status of land resources, and all three sets of factors influence each other in various ways. Of the three bundles of factors, those arising from human influence are probably the most complex to unravel.

Here the study will establish the nature of human influence on land resources, and provide a profile of the bundle of factors that form the triangle of causation:

- the central form of human influence is the use of land resources for productive purposes: agriculture, collection of plant resources for purposes like fuel and building, and, to a much lesser and more localized extent, mineral extraction and water collection;
- a secondary form of human influence is the use of land resources for other economic and social purposes that does not directly depend on resource extraction or interference with biotic processes: settlements, infrastructure and recreation;
- a tertiary set of influences is incidental but often significant. It comprises the unintended and often remote impacts of economic activity on land resources: for example, pollution of (sub)surface and atmospheric water resources by industry or river impoundment for urban water use;
- finally, and often more positive, is the set of influences associated with human efforts to enhance the natural environment: for example, natural resource management programmes within protected areas like nature reserves, or the South African government's current efforts to remove thirsty exotic plant species from catchments, *i.e.* the LandCare programme.

This assessment of the role of people in land degradation focuses on the central form of human influences: the use of land resources for productive purposes. Despite the common significance of the secondary and tertiary sets of influences outlined above, there is little evidence that their causative role in land degradation is remotely comparable to that of agriculture and resource extraction. The strongest potential impact that these non-productive uses can have, is when settlement and infrastructure consume land resources without appropriate planning or assessment of environmental effects. This is a significant problem in some parts of South Africa.

6.3.2 Influences on productive land use

At the heart of this analysis, and central to national debate about land degradation, is how people's agricultural and extractive resource uses may affect the status of the land. As will be shown in the study, it is a complex and frequently political set of issues. At the base of the arguments, however, are some crude realities. The way in which the soil is cultivated, exposed, covered and drained by farmers can have profound effects on rates of soil generation and soil erosion (both of which, of course, are natural processes). The way farmers farm can, help decide whether agricultural areas maintain, enhance or lose their productivity. Dongas are sometimes a natural phenomenon, but often reflect human mismanagement of the land. The way in which livestock graze the veld - for example, as stock species, numbers and timing of grazing can have a major impact on ground cover, soil loss and maintenance or decline of economically valuable plant resources (Turner and Ntshona, 1998). Direct human collection of plants for food, fuel, building materials and medicine can have an equally strong effect. What has to be explained, is why people use resources, through cultivation or extraction, in ways that enhance, maintain or damage the land. The causative influences on productive land use can be roughly categorized as follows:

- **production goals** are a fundamental determinant of how farmers use their land. In particular, the number and nature of economic purposes that the production is intended to fulfill, will explain the nature of the farming enterprise. A highly focused large-scale beef ranch, for example, can be compared with multipurpose cattle production in a marginal area. Cattle varieties, stocking and offtake rates, quantities and timing of grazing resource use, drought coping strategies and drought impacts on vegetation cover will all vary widely between the two situations and will offer different potentials for land maintenance or degradation. Similarly, the production goals of cropping enterprises can explain wide variations in agricultural practice, with concomitant variations in environmental risk. Highly capitalised cash crop monocultures may maintain key agronomic and financial variables in a precarious and often temporary balance, but may lead to fertility decline, soil pollution or soil erosion. Subsistence agriculture is often effectively a monoculture too, and may also lead to poor fertility maintenance and soil erosion. Indigenous or adapted multicropping systems that aim to meet a wider range of household nutritional requirements may generate much lower returns per unit of labour and contribute relatively little to national production of major staples, but be more effective in maintaining land resources;

- **environmental and agricultural knowledge systems** vary more widely than is sometimes realised, and have a significant influence on the ways in which land resources are used for productive purposes. At the risk of oversimplification, two broad 'systems' can be identified: the 'western' or 'scientific' body of environmental and agricultural knowledge, and the 'indigenous' or 'vernacular' knowledge systems that exist in rich profusion through much of human society. The western or 'developed' world - including, until recently, the dominant strata in South African society - has typically exaggerated the competence of the former type of knowledge and underestimated the latter, where it recognized it at all. Recently, more balanced appraisals of the two broad approaches to agricultural and environmental understanding have emerged. The depth and integration of vernacular ecological knowledge have come to be widely appreciated - sometimes even exaggerated. Neither kind of knowledge system is static, of course. For example, western agricultural science in semi-arid countries likes to react to the erosive power of water on cultivated soil with conservation techniques that diverted water off fields, sometimes causing new dongas in the process. Now, 'scientific' agriculture is increasingly recognizing the importance of techniques that keep water on cultivated soil but slow its movement and promote its absorption. Human influences on land status are directly affected by the ways in which people understand natural processes and appropriate agricultural practice;

- **technology** is one direct expression of agricultural knowledge systems. It also reflects the economic context within which land users work. Fencing is a simple technology that has major impacts on the way in which livestock production and veld use are organized. The extent to which it is used, depends on a variety of socio-economic factors such as costs and vulnerability to theft, as well as production goals and farmer knowledge about its advantages and drawbacks. In crop production, ploughing and cultivation technologies have major direct impacts on soil status and can variously stimulate or restrain soil erosion and soil compaction. Technologies for fertility promotion and pest control can enhance or destroy land resources. In other sectors, energy and building technologies in rural and urban areas can greatly affect rates and impacts of plant resource extraction from the natural environment;

- **the socio-economic context** provides a diverse, complex and interdependent range of determining influences over human impact on land resources, and helps to explain the disposition of production goals, knowledge systems and technology with which people use land resources. Key components of this context include:

    (a) **economic structures and relationships** within society exert a range of influences over land user behaviour. Product and credit prices, for instance, affect the discount rates that both commercial and subsistence producers apply in their farming and resource conservation practices. Labour costs affect the kinds of farming technology and the structure of farming enterprises through which land is used, and help determine human influences on natural resource status. A crude generalization would be that more labour intensive techniques are typically more compatible with natural resources conservation goals. The range and potential of alternative income generating opportunities in the local and national economy directly affect farming practices in both the commercial and the subsistence sectors. Another broad generalization, from international experience, about the opportunities facing land users is that the greater the risk of land degradation, the more important it becomes that the risks to such resources should be minimized;

(b) **social, political and institutional** factors are often hard to disentangle. One key issue around which they combine to affect land use practice, is **gender**. The differentiated ways in which the labour resources of women and men, and their respective authorities, are deployed and rewarded in land use and land management, help to explain what technologies, production systems, conservation practices and management arrangements function in a given landscape - and how they affect the conservation or degradation of land resources. Overall, **the political and institutional framework** within which people live and use, protect, manage and exploit will often drive the type of impact. In South Africa today, this framework is in flux. Indigenous systems of resource management through tribal authorities have lost much of their influence. There is an emerging commitment to more participatory and economically rewarding modes of resource use, however, this revised model is not yet fully in place.

(c) **land distribution arrangements** are an obvious reflection of the political dispensation in a country. Again, South Africa very clearly displays in its landscape the way in which land rights have been distributed and administered. The definition and distribution of land access rights would normally be considered an integral part of a land tenure system. There is however a cruder sense in which it is sometimes necessary to distinguish the way in which land access rights are distributed from the way in which tenure is structured. This is particularly true in South Africa. Other things being equal, the extent of productive land available to a land user group or population sector will significantly influence land use practice and the potential for land degradation. If land distribution arrangements specifically expand or reduce the areas available to different groups, this is likely to have direct impacts on spatial variation in land uses and land use impacts;

(d) **land tenure systems** reflect the economic, social, political and institutional conditions that prevail in a particular agrarian context. Internationally, there has been extensive debate about the relationship between land tenure and incentives to produce from and conserve the land. The central concern of this debate has been whether land users' rights to land resources are secure enough to make agricultural investment - including investments aimed at long term conservation benefits - worth their while (Turner and Ntshona, 1998). The focus of this debate has moved from the outward forms of tenure security (such as freehold versus 'communal' tenure) to the actual practices and perceptions of land authorities and land users. Commonly it has been shown that users in non-freehold systems do feel secure enough to invest in production and conservation; but that the detailed design of such systems, and a range of locally variable factors affecting their performance, will determine whether this is so in any particular instance. Conversely, it has been recognized that private ownership is not a guarantee for environmentally responsible behaviour. Freehold farmers may also be led by ignorance or external economic incentives into land degradation or land mining practices; and

(e) **rural livelihoods** structure and functioning is a useful way to formulate a focused perspective on how people use land and potentially contribute to its degradation. The livelihoods approach looks at the full range of assets, claims, rights, economic opportunities and economic activities that shape a household's quality of life: not just its income and consumption, but its broader ability to participate meaningfully in society. The strength of the livelihood concept in analysis of land use is that it fully recognizes the diversity of economic strategies and resource bases on which a rural household may rely.

6.3.3 Demography and land degradation

To invert the title of the now famous book by Tiffen *et al.*, (1994), Do more people mean more erosion? The original answer, based on the work of Malthus, would have been yes. Human populations would always outstrip the capability of land resources to feed them. Famine would bring human population into check, unless people took their own measures by delaying marriage or limiting their fertility. Writing in the late 18th century, Malthus assumed that the productivity of the land was generally fixed, and could not normally be enhanced by improved agricultural technology (Marquette, 1997a). Despite its antiquity, the argument that increasing human population densities in rural areas beyond a certain point will lead to degradation, is still intuitively appealing in many settings, including South Africa. Malthus did not ignore the possibility of agricultural inventions (such as the plough) increasing the productive capacity of the land (Marquette, 1997b), but the implication was that these were comparatively rare events. Most fundamentally, his argument suggested that the population size in a rural society would be determined by land capability and available technology.

The best known proponent of an alternative view is Ester Boserup (1965, 1981). She had the advantage of assessing the issue two centuries later (after the European agricultural revolution and during the Green Revolution) and of observing the very high human population densities and agricultural productivity in parts of Indonesia. The core of her argument is that population is the determining variable. As population densities increase, rural populations will respond with agricultural intensification, developing new technologies to attain the necessary increases in food production from their land. This is what Tiffen *et al.*, (1994) describes as happening in the Machakos area of Kenya over the past half century. Whether such intensification is sustainable or leads to land degradation, will depend on a range of local and external factors. Tiffen *et al.*, (1994) believe that the Machakos intensification is sustainable, and attributes this to "a conjunction of increasing population density, market growth [much produce is sold in Nairobi] and a generally supportive economic environment. The technological changes…were mothered by necessity"

(Mortimore and Tiffen, 1995). Adams and Mortimore (1997) quote a number of other instances of agricultural intensification in Africa, although they point out that, because of generally low population densities, such cases have been the exception rather than the rule on this continent. They also point out the risks and costs of intensification, and warn that a variable range of factors determine whether it happens at all or is environmentally sustainable.

Marquette (1997a,b) describes various approaches to explaining people-land relationships that go beyond the linear arguments of Malthus and Boserup. She quotes multiplicative perspectives, such as the 'I=PAT' equation which introduces the important consideration of standard of living, levels of consumption and hence environmental demand (a key issue in the grossly skewed consumption patterns). This equation proposes that *environmental impacts = (population size)• (level of affluence or per capita consumption)• (level of technology).* She goes on to quote mediating perspectives, which more explicitly recognise the range of socio economic and policy factors that may affect how a given rural population uses, conserves or degrades its land resources. Another, more direct approach (called development-dependency perspectives by Marquette) subsumes all explanation of local people-land relationships within an international and national theory of development and underdevelopment. In the millennium it is tempting to expand these arguments to take account of accelerating globalisation trends. Rural South Africans, for example, have long been directly affected by international economic trends through the gold price; but the current globalisation of food and other markets may add many new constraints to local economic growth and development options.

Much of this debate assumes relatively self-contained rural economies, within which land and environment relationships must be worked out according to local agrarian conditions. The key to applying and resolving the opposing arguments in circumstances is to recognise the diversity and only partly agrarian nature of the rural livelihoods whose performance may affect land resources. 'Mediating perspectives' are clearly necessary, even if we do not fully subscribe to the theories of dependency and underdevelopment. As this study will show, a variety of external political and economic forces have affected people-land relationships in the rural areas of this country; and a range of off-farm, sometimes geographically remote livelihood strategies are pursued by rural South Africans. This complicates the relationship between demography and land degradation.

6.4 Land Tenure: Favoured (FA) and Marginal Areas (MA)

Political history and the impact on land use and degradation are more starkly delineated in the South African national experience than in most other countries. In exploring the role of people in land degradation in South Africa, this analysis therefore begins with one of the starkest features of the bleak South African experience: the distribution of land rights among the population. It will show that racial distribution of land rights was gradually linked to a spatial distribution of racially defined rights in areas where different tenure systems were applied. This process of racial and spatial distribution has led to the division of the rural landscape and economy into large scale and small scale farming areas. The arrogation of land rights to the ruling white minority in South Africa passed through two phases. In the first phase, land was acquired through colonial conquest and settlement. Legislation played a supporting role in codifying tenure arrangements for the land acquired. In some circumstances, it was possible for limited Blacks to have land rights on the basis of these arrangements. In the second phase, following the consolidation of settler authority over the national territory, legislation played the leading role in extinguishing the few Black land rights in predominantly white owned areas, and in restricting Black land ownership to specified 'homeland' areas within which non freehold tenure systems were to operate. The colonial and apartheid history has created a patchwork of **marginal areas (MA)** within a matrix-comprised predominately of **favoured areas (FA)**. What is less known, however, is the precise location of these marginal areas and the quality of the biophysical resources and climatic environments associated with these marginal areas.

Despite numerous attempts, the study could not locate an up to date digital map of magisterial districts showing the proportion of the district managed under a marginal and favoured land tenure system. Available statistics often do not reflect the post-1994 situation. The information used here was derived from 12 degradation workshops held in the three provinces during 1999. At each meeting, participants were requested to estimate the percentage of the magisterial district, which was managed under marginal land tenure and the percentage that was managed under favoured land tenure system. The definition used was as follows: If an individual had property rights over a particular area and could sell the land for individual profit, then it was considered to be held under a form of favoured land tenure. The study suggested that the former TBVC states (homelands) and self-governing territories were largely managed under a marginal land tenure system, even though numerous favoured ventures might currently be underway within such areas. Participants at the workshops usually had little difficulty in assigning percentage values to the two different land tenure categories, as most districts were either under 100% favoured or 100% marginal tenure.

How can the areas comprising these two land tenure systems best be described? To answer this question, the study calculated mean values for each magisterial district for a suite of 31 variables, including those that defined the district in terms of its biophysical and climatic characteristics, land use practices, and its demographic, labour and employment and economic production characteristics *(Table 6.2)*. These variables are used to identify the important correlates of land degradation in South Africa. The biophysical and climatic variable were derived from a GIS analysis of several data sets contained in Schulze *et al.*, (1997) and van Riet *et al.*, (1997). Land use indicators were taken from the results of the degradation workshops. Stocking values were taken from the 1995/96 census of the Department of Agriculture. Demographic, labour and employment and economic production values were assembled from the DBSA's macro-economic reviews for each province, which were published, mostly in 1995, and which were derived predominantly from the 1991 and 1996 population census of South Africa.

*Table 6.2: Comparisons between the 262 magisterial districts which have more than 50 % of their surface area managed under a favoured land tenure system and 105 magisterial districts which have more than 50% of their surface area managed under a marginal land tenure system. Significant differences were tested using a non-parametric Mann – Whitney U test: NS = not significant different; *=p<0.05; ** = p< 0.01; *** = pp < 0.001*

Variable and Unit of measurement	Mean for Favoured districts	Mean Marginal districts	Test statistics
Biophysical variables			
Area (km²)	4 009	1 652	5.5***
Altitude (m)	1 094	816	5.6***
Slope (%)	1.3	1.7	- 3. 7***
Runoff (m³ per km)	54 759	84 452	-4. 6***
Erodibility index	11.5	9.5	4.8***
Fertility index	4.2	4.2	0.4NS
Climatic variables			
Mean annual rainfall (mm)	568	710	-5.8***
Coefficient of variation (%)	29.5	26.3	6.0***
Summer Aridity Index	3.7	3.2	5.9***
Ratio MAP: PET	1.2	1.3	-5.6***
# of grow days	47	63	-8.5***
Mean annual temperature (⁰C)	16.5	18.5	
Land use			
%Croplands	24	25	-2.3*
% Grazing	60	49	3.6***
% Commercial Forests	3	4	4.3***
% Conservation	3	1	2.6*
% Settlements	9	20	-11.9***
Stocking density (LSU/ha)	0.17	0.38	-9.7***
Demography			
Population density (#people/km²)	173	199	-8.9***
% Males	51	45	12.2***
% 15- 64 years	61	48	11.9***
% Rural	43	88	-12.7***
Labour and Employment			
% Unemployed	14	32	-10.9***
% Employed in agriculture	29	17	5.3***
Agric employment growth index	102	149	2.5*
# of dependents	1.	6.0	-12.5***
Economic production			
GGP per capita	6 946	1 599	13.2***
% Agric contribution to GGP	26.9	13.2	5.2***
% Annual growth in agriculture	0.1	4.2	-4.9***
% Annual growth in GGP	1.5	7.0	-9.4***

The results of this analysis show that FA and MA are significantly different in all but one of the 31 variables (*Table 6.2*). MA districts are, on average, smaller in size and are at lower altitudes than the favoured districts. They have significantly steeper slopes, greater run off and increased erodibility (Van Riet *et al.*, 1997). Soil fertility between the two land use systems is not significantly different. Land use differences derived from the degradation workshops suggest that marginal areas have, on average, more of their area used for crops, plantations, and settlements and less for grazing lands, conservation areas and/or mines.

The brief summary in *Table 6.2* of the population census shows, however, that human population density is significantly higher in marginal areas. (The somewhat surprisingly high value in *Table 6.2* for favoured districts is a result of the inclusion of Gauteng, Cape Town and the Durban metropolitan areas). There are also significantly fewer males in the marginal areas and fewer people in the economically active age category range from 15-64 years. MAs have, on average, more than twice as many people living in rural, as opposed to urban areas, when compared to the mean for FAs. Unemployment figures for the 1991 and 1996 census' are generally more than twice as high in MAs, with fewer people formally employed in the agricultural sector, even though this sector grew more rapidly in the marginal than in the favoured areas for the period 1981-1991 *(Table 6.2)*. On average, more than three times the number of people is dependent on single wage earner's salary in marginal areas compared with FAs.

Finally, a general poverty index, derived from the 1991 census, and defined as the GGP per capita, indicates that MAs posses an index more than four times lower than that of the FAs *(Table 6.2)*. The contribution of agriculture to the GGP in marginal magisterial districts is about half that of the FAs, although it is growing at a much higher annual rate (1981-1991) than for FAs. A significantly higher annual growth rate in GGP is experienced in MAs when compared to favoured areas for the period 1981-1991.

6.5 LAND USE PRACTICE

An understanding of land use patterns provides an important context for the understanding of degradation. In this section, the study first discusses the % area used for each of the six main land use types (LUT) within the three provinces and within FAs and MAs separately. Next it describes historical cropping and livestock practices and how the percentage area is perceived to have changed for LUT over the last 10 years. Finally, the study discusses perceived changes in the intensity of land use over the last ten years. The study recognizes six main land use types (LUT), defined in *Table 6.3* below.

Table 6.3: The six land use types (LUT) used in the participatory workshops. Definitions generally follow those in Linger & Van Lynden (1998).

Land use type	Definition
Crop land	Land used for the cultivation of crops, including fallow land (over the last 10 ears); land used for annual field cropping (e.g. maize, wheat, vegetables, lucerne), perennial field cropping (e.g. sugar cane, banana, pineapple); tree and shrub cropping (e.g. tea, grapes, apple, avocado, etc.)
Grazing land	Land used for animal production on natural veld (deserts, grasslands, woodlands) and includes planted pastures used for grazing animals. It also includes favoured wildlife ventures owned by individuals or farmer consortiums.
Commercial plantations	Land used mainly for commercial wood production and in some cases, protection.
Conservation area/or	Declared national, provincial, and municipal conservation areas as well as state land (e.g. South African National Defence Force property).
Settlement	Includes both rural settlements and urban areas, roads and construction sites.
Other	Predominantly mining areas and lakes or dams.

6.5.1 Land Use Patterns

Of the nine provinces, **cropping** occupies the greatest area in the Western Cape, the Free State, Mpumalanga and the North West Provinces. Because of its aridity, cropping forms the smallest proportion of the magisterial districts in the Northern Cape. For both favoured and marginal magisterial districts croplands occupy, on average, about a quarter of the surface area of each district. Districts, which are at the arid end of the gradient, tend to have a greater area of **grazing lands** or **veld** than the wetter magisterial districts. The Northern Cape and Eastern Cape (especially in the west) possess, on average, the highest proportion of grazing lands. The highly urbanised districts of Gauteng have less than 20% of their area used for grazing. In the favoured magisterial districts, nearly two-third of the area is used for grazing animals, while less than half of the MAs are comprising grazing lands. **Commercial plantations** occupy the greatest area in KwaZulu Natal and Mpumalanga, while they are absent from the Free State, Gauteng, and the arid Northern Cape and North West Provinces. **Conservation** areas comprise the greatest area in Mpumalanga and do not make up more than 3% in any other Provinces. Both the favoured and marginal areas have similarly low values for forests and conservation areas. It is not surprising that Gauteng possesses by far the greatest proportion of **settlement** area. The Northern Cape has particularly low settlement areas while all other provinces range between 5% and 14%. On average, the marginal districts contain about twice the settlement areas recorded in the favoured magisterial districts. Mining areas comprise the greatest proportion of the "**other**" category. Values are highest for Gauteng and to a lesser extent the North West Province and the Free State. The land use type "other" occurs in similarly low proportions in favoured and marginal areas. These land patterns are shown in *Table 6.3*.

Table 6.4: The mean values for each province and favoured and marginal districts used for each Land Use Type in each magisterial district (N=367 magisterial districts).

Province	The mean % area of a magisterial district used for each Land Use Type						
	No. of Dist	Croplands	Veld	Plantations	Cons	Settle	Other
Eastern Cape	78	20	64	5	1	10	0
Gauteng	22	22	19	0	1	50	8
KwaZulu Natal	51	17	58	8	3	13	0
Mpumalanga	30	30	46	8	7	7	2
Northern Cape	26	2	96	0	1	1	0
Northern Province	39	22	58	1	2	14	1
North West	28	30	54	0	1	11	3
Western Cape	42	36	43	4	3	13	1
Favoured districts[1]	262	24	60	3	2	9	1
Marginal districts	105	25	49	4	1	20	1

[1]A district is considered favoured if more than 50% of its area is managed under a commercial land tenure system and marginal if more than 50% of its area is managed under a communal land tenure system. This convention is used in all tables, which follow, unless specifically stated otherwise.

6.5.2 Area Trend

6.5.2.1 Cultivation and croplands

This section shows how the area of each land use type is perceived to have changed over the last 10 years, and provides the most important reasons for these changes. The major crops, in terms of area cultivated, in the favoured magisterial districts are maize, wheat, sunflower seeds and sugar cane. Together these four crops comprised more than 80% of the total cultivated area in South Africa in 1981 (when the last major agricultural census took place). Since 1990 the mean area cultivated has dropped to around 6.2 million ha. The combined production of these four crops has fluctuated considerably since 1980, following an impressive increase from 1911-1980. In 1997 production values were the highest on record, at just under 34.7 million tonnes. The patterns that are seen for the four most important cultivated crops are also reflected in **cropland** area trends. *Table 6.5* shows that over the last 10 years there has been a slight decrease in cropping area. This decrease has been greatest in Gauteng, the Free State and KwaZulu Natal, while the Northern Cape (especially for favoured areas along the Orange River), and the Northern Province have shown an increase in the area used for crops in the past 10 years. Overall, both favoured and marginal areas display declining cropping areas.

Table 6.5: The mean provincial, favoured and marginal) changes in area of each Land Use Type per magisterial districts over the last 10 years (N=367 magisterial districts). Change was scored by workshop participants on a scale of -2 (rapidly decreasing area of more than 2% per LUT per year) to +2 (rapidly increasing area of more than 2% per LUT per year)

Province	The mean change in area of each Land Use Type: 1989 - 1999						
	No of Dist	Croplands	Veld	Plantations	Cons	Settlements	Other
Eastern Cape	78	-0.3	-0.5	0.0	0.1	0.9	0.0
Free State	51	-0.4	0.0	0.0	0.0	1.0	0.0
Gauteng	22	-1.0	-0.9	0.0	0.0	1.2	0.1
KwaZulu Natal	51	-0.4	-1.0	0.5	0.0	1.0	0.0
Mpumalanga	30	0.1	-0.5	0.2	0.0	0.7	0.3
Northern Cape	26	0.5	-0.3	0.0	0.1	0.2	0.0
Northern Province	39	0.4	-1.2	0.0	0.0	1.2	0.1
North West	28	-0.3	-0.4	0.0	0.0	0.9	0.4
Western Cape	42	0.1	-0.7	0.0	0.20	0.7	0.0
Favoured districts	262	-0.2	-0.4	0.1	0.1	0.7	0.1
Marginal districts	105	-0.1	-1.1	0.1	0.0	1.4	0.0

Box 6.1: Reasons for decline in area of cropland are given as:

- An increase in settlements, commercial forest plantations and to a lesser extent in ecotourism ventures (including – commercial wildlife production or ecotourism ventures) that often occurs at the expense of croplands.
- The conversion scheme in favoured areas has meant that marginal croplands have been replaced by planted pastures;
- Input costs have risen dramatically over the last 10 years and it is now no longer economically viable to crop, especially in marginal areas where costs are sometimes high and risks often great;
- Droughts in the mid-1980s discouraged many farmers from cropping;
- Violence in some areas has meant that people are reluctant to spend lengthy periods in the fields and cultivation has declined as a result;
- Collapse of infrastructure (especially protective fencing) has made it more difficult to crop;
- Inadequate resources, such as ploughing implements and training and no access to loans to purchase equipment;
- Invasion of croplands by weeds has reduced the area.

Box 6.2: Reasons for increases in the area of croplands

- More irrigation water is now available;
- New crops (especially orchards) are being planted;
- Conversion of dense bushveld to croplands through active bush clearing programmes;
- People in the marginal settlement are demanding more land for their cropping needs in an attempt to sell their produce and combat poverty;
- Better technology and soil preparation methods have both also led to an increase in cultivated areas in some districts.

Box 6.3: The main reasons provided for decreases in grazing land

- An expansion of croplands on high potential soils, together with development of irrigated lands, orchards and the clearing of sometimes low potential grazing land;
- An expansion of commercial forests, conservation areas, and mining;
- Sand-mining in some areas has also physically removed grazing areas;
- Soil erosion of the veld has reduced the grazing area;
- Invasion of alien plants onto grazing lands;
- The growth and expansion of settlement were regularly cited as the most reasons for the decrease in grazing area in a district.

Box 6.4: The main reasons for increases in grazing land

- Conversion of marginal cropping area to planted pasture and veld, especially for the creation of conservation areas;
- Where irrigation water has been limited or problematic, previous croplands have become grazing lands once more.

6.5.2.2 Plantations, conservation, settlements and other

Commercial plantation areas are perceived to be increasing in nearly all magisterial districts which are suitable and the increases are similar for favoured as well as marginal districts *(Table 6.4)*. Perceptions are that it is more economic to change from beef to timber and there has been a major expansion of the forestry industry over the last 10 years. In the Eastern Cape where two magisterial districts show a decrease in forest area, the main reasons cited were that the theft of wood and the burning of plantations have reduced the area of commercial plantations. **Conservation** areas show an increase especially in the favoured magisterial districts of the country *(Table 6.4)*. This increase is primarily perceived to result from the acquisition of new areas or enlargement of existing conservation areas by the South African National Parks. There are no districts in South Africa where settlement areas are perceived to be decreasing *(Table 6.4)*. In the western parts of the country and in the favoured magisterial districts of several other provinces settlement areas were perceived to have changed very little over the last 10 years. In general, settlement area expansion was twice as great over the last 10 years, in the marginal magisterial districts compared to favoured districts. The increase in the area of **"other"** over the last 10 years, especially in the northern parts of the country, is largely as a result of new mines being opened, while decreases have resulted from closure of mines *(Table 6.4)*. New mines have generally been opened in favoured magisterial districts.

6.5.3 Intensity trend

A change in land use intensity refers to changes that have occurred in magisterial districts over the last ten years due to technical, infrastructural or management inputs for a particular land use type. For **croplands**, most magisterial districts show an increase in land use intensity and mean values for the provinces are positive in all cases, slightly more so in marginal than favoured areas *(Table 6.6)*.

The most common scenario for the **grazing lands** was a decrease in land use intensity in many districts, especially in marginal areas, and modest increases in the North

West Province, the Free State and the Northern Cape *(Table 6.5)*. In the marginal areas, the situation is very different.

***Table 6.6:** The mean values for each province and favoured and marginal districts for the change in land use intensity in the last 10 year within which each Land Use Type in each magisterial district (N=367 magisterial districts). The information provided by workshop participants and the change in land use intensity ranged from –2 (moderate decrease) to +2 (moderate increase)*

Province	Change in land use intensity; 1989-1999						
	Number of Dist	Croplands	Veld	Forests	Cons	Settle	Other
Eastern Cape	78	0.7	0.0	0.0	0.0	0.6	0.0
Free State	51	0.9	0.5	0.0	0.2	1.4	0.1
Gauteng	22	0.3	-0.4	0.0	0.0	1.5	0.0
KwaZulu Natal	51	0.9	-0.2	0.6	0.5	0.9	0.1
Mpumalanga	30	0.3	0.0	0.1	0.1	0.9	0.3
Northern Cape	26	0.5	0.5	0.0	0.1	1.0	0.1
Northern Province	39	0.8	-0.5	0. 1	0.1	0.2	0.1
North West	28	0.9	0.6	0.0	0.2	1.1	0.4
Western Cape	42	0.6	0.1	0.0	0.3	0.9	0.1
Favoured districts	262	0.6	0.2	0.1	0.2	0.9	0.1
Marginal districts	105	0.9	-0.4	0.1	0.1	1.1	0.1

***Box 6.5:** Increases in land use intensity for the croplands are as a result of:*

- Increased mechanisation driven in part by the introduction of new labour laws which encouraged large scale farmers to downscale their labour forces;
- Stubble cultivation and minimum tillage practices have increased;
- Increase in intensive and specialist crops such as peaches, cut flowers and berries
- More environmentally suitable and improved seed cultivators and varieties now being used;
- Better pest control, harvesting procedures and automated packing sheds;
- Better utilisation of irrigation following change to centre pivots and drip irrigation with the use of liquid fertilisers and better scheduling of irrigation water and drainage systems;
- Improved extension services, both from the government and from the private sector including the wide-scale introduction of soil testing;
- The role of demonstration plots, study groups and Farmers Associations have improved the skills of crop farmers, especially in the large scale sector;
- The drought relief funds (e.g. R35 million in the Northern Province for marginal and favoured farmers) have enabled farmers to invest in fertilizers.

Box 6.6: Increases in land use intensity of veld, which are mostly applicable to favoured districts, are as a result of:
• Better management systems employed, including the use of multi-camp systems and the adoption of research recommendations; • Improved extension provision and education as well as the use of demonstration farms and the initiation of study groups and Conservation Committees. All these initiatives have improved conservation awareness of large scale farmers; • Improved infrastructure, including water points, fencing;

Box 6.7: Here it was suggested that land use intensity has decreased largely as result of:
• The encroachment and invasion of settlements onto the grazing lands rendering it increasing difficult to manage livestock; • The removal of fencing materials, especially near informal settlements and collapse of general infrastructure in the marginal areas such as boreholes, windmills , dipping kraals, shreds; • Sheep and large stock theft has made both favoured and marginal livestock farming very difficult; • Increase in stock disease following withdrawal of government dipping schemes in the marginal areas; • The collapse in institutional control of the livestock industry in some marginal areas.

Land use intensity over the last 10 years shows very similar trends for favoured **plantations** and **conservation areas** *(Table 6.6)*. KwaZulu Natal shows the greatest increase in land use intensity for these two land use types and FAs and MAs are very similar. Although participants felt poorly informed of the details of land use practices in these two land use types, increases in land use intensity have mostly been as a result of improved infrastructure, and better management techniques whether plantation or conservation *(Table 6.6)*. Of the six land use types, changes in land use intensity trends over the last 10 years were greatest for **settlement** areas *(Table 6.6)*. Overall, values were higher for MAs than for FAs and were highest for Gauteng, the Free State and the Northern Province, where numerous housing projects are underway. They were lowest for the Eastern Cape, largely as a result of the lack of growth in settlements in the favoured magisterial districts.

In the mining or **"other"** areas, the perceptions of workshop participants were that land use intensity had also increased and that increases were similar for favoured and marginal areas. Increases in land use intensity trends over the last 10 years were as a result of improved rehabilitation techniques, better extraction methodologies using improved technologies and equipment.

6.5.4 Land Use Practices in the Favoured Areas

Land use patterns in the favoured areas are determined largely by prevailing ecological conditions. However, unlike in the marginal areas, there are also stringent rules governing land use practices on favoured lands. Laws compel individual landowners to follow strict guidelines when using the land. For example, the Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983) specifies that the cultivation of virgin soil is prohibited unless written permission is obtained from the National Department of Agriculture. Similarly, the cultivation of steep slopes, and cultivation on certain soil types in specified magisterial districts, are also prohibited without written permission. Specific instructions are also provided concerning general cultivation practices, the erection of soil conservation works, veld management practices, the development of Soil Conservation Committees and, more recently LandCare has been launched. In favoured areas, the South African government, primarily through the National Department of Agriculture, has also spent millions of rands to ensure that responsible land management occurs primarily through subsidy schemes, education programmes, and threats of heavy fines for those transgressing the law. Several other pieces of legislation, such as the Sub-Division of Agricultural Land Act, 1970, (Act 70 of 1970), further control about what landowners in favoured areas may or may not do with their land, also exit. All of these Acts and extension programmes, which have mostly been applied exclusively to favoured areas, have a bearing on the current conservation status of the agricultural resources in the favoured areas.

Throughout this analysis the study has suggested that, with notable exceptions, the agricultural resources of favoured areas are, generally speaking, not as degraded as those in marginal areas. Most importantly, in the majority of favoured districts the perception of agricultural personnel was that the resource conservation status has improved over the last ten years. The difference in the impact of agricultural land use practices between favoured and marginal land tenure systems is also not incidental.

In conclusion to this section we need to emphasise that for favoured areas, the impact of different agricultural practices on the conservation status is generally well understood. The research that underpins this knowledge has frequently been used to justify new state intervention strategies (e.g. Bruwer *et al.*, 1991). However, the current crisis in the agricultural extension service means that new ways of addressing resource conservation issues in the favoured areas of South Africa need to be developed. In addition, the shift in focus and financial resources to marginal farmers and to emerging small-scale favoured farmers suggests that the benefits enjoyed by the favoured agricultural sector are going to change. It remains to be seen what impact this is going to have on the food security situation.

6.5.5 Land Use Practices in the Marginal Areas

It has been shown above that the South African racial policy has changed the marginal areas of the country into crowded places. Finally, the study has used the available data to suggest that marginal area livelihoods over most of this century have involved a combination of sub-subsistence farming and sub-subsistence labour migration. That combination, overshadowed by hostile land use policies, necessitated heavy dependence on the land while inhibiting adequate investment of labour resources in sustainable production practice. The dependence of marginal area livelihoods on land resources has diminished, although the energy elements and other uses of organic matter in those livelihoods are probably maintaining significant levels of degradation to the present day.

Informed by the analysis in the previous sections (demography, land use policy and livelihoods), the study is now able to put the final link of the central causative chain into place. In this section, the study considers how all of these influences have been expressed in the actual land use practice of people in the marginal areas. It shall look

- Meanwhile, the soil conservation programmes that were imposed on large areas in association with 'betterment' schemes were of dubious technical benefit. Like conventional soil conservation programmes across the country, they did little to retain soil moisture or fertility. Instead, they concentrated on diverting water from fields, which could be disastrous if design errors or maintenance failures led to leaks or spillages. Dongas could easily be started by failed terrace systems. As a result, they often became at best ineffective and at worst positive agents of land degradation.

It must also be recalled that the challenge of sustainable crop production is particularly complex in the marginal areas because of the generally poor and erodible soils that predominate in some of these areas. Some arable land, notably in the former Transkei, is rich, productive and relatively easy to conserve. However, much arable land in marginal areas is susceptible to degradation with any but the best conservation farming practices.

In the former Ciskei approximately 20% of rural households showed a "real interest" in farming (FRD, 1992). "Underfarming" is now widespread, though certainly not universal. In many of the former homelands, large areas of formally cultivated land have been abandoned and are now used only for low intensity grazing (or the expansion of settlements). In my judgment arable land use is rarely a significant cause of land degradation today. Overall the intensity of this land use has declined, and the more intensive field cultivation is better concentrated on stronger soils than was the case for most of this century. Despite some grazing of abandoned fields, some vegetation cover protects most of these areas. On land that is still cultivated, much can still be done to improve conservation farming practices, and sheet and gully erosion does continue. The key question for the future is whether evolving combinations of demographic and economic circumstances will once more increase the significance of food production in marginal areas livelihoods. If that happens – which it has not yet done – there will be a renewed possibility for widespread land degradation to be caused by field cultivation. There will also be greater scope for the introduction of feasible conservation farming practices. Therefore, now is the time for agricultural services to research and develop those practices, and to begin to introduce them to those emerging field users.

Garden cultivation

The cultivation of gardens has made little contribution to land degradation in marginal areas. Located close to homes (usually on the residential site), gardens have been the object of more labour intensive cultivation practices than fields. These practices would normally act to combat any land degradation that appears. Gardens have been the site of additional water provision to crops, if this is practiced at all. Except on steeply sloping village sites, it has not been normal to divert water soil conservation practice required for fields. Again, where it has happened at all, gardens have been the place where organic matter has been returned to the soil in the form of manure or (occasionally) mulches.

Livestock production

As this study shows, the marginal areas have higher livestock densities than the favoured areas. The debate on the contribution of livestock production and herding practice to land degradation has only recently begun to intensify, after many decades in which it was simply assumed that Africans' obsession with livestock numbers was the major cause of land degradation in the marginal areas.

There can be little doubt that stocking densities in many marginal areas have been a major cause of land degradation. 'Degradation' is certainly a subjective concept, implying deterioration below an agreed norm. The norm for one production system, such as beef ranching, may be very different from the norm for another system, such as multipurpose small herd production by the rural poor. Nevertheless, grazing and browsing in the mostly semi-arid environment of the former homelands have reduced large areas to the condition. The almost total lack of vegetation cover on some veld in these areas has caused extensive sheet and gully erosion and would challenge the optimism of even the most committed advocate of veld resilience.

briefly at different aspects of practice and consider what influence they have had on land degradation.

Field cultivation

Throughout most of this century, field cultivation in marginal areas has been conducive to land degradation. There are five reasons for this:

- rising population densities and land use policies described by this study forced increased cultivation of marginal or unsustainable land; for example, less fertile, more erodible soils, or fields on steep slopes;
- an ecologically excessive dependence on grain crop monoculture (sometimes for urban markets in the 19th and early 20th century, mostly for sub-subsistence purposes since the 1920s);
- in small scale farming systems where capital intensive practices are not feasible, sustainable conservation farming practices are labour intensive.

This study has shown that, despite their high human population densities, the marginal areas available for the agricultural labour force, which has been predominantly female, has had to be divided among a number of livelihood strategies, exposing arable farming practices to significant land degradation risks.

- Agricultural extension advice that might have made conservation farming practice more readily available to land users; has been unsuitable, unavailable or politically unacceptable to local people. There is some evidence that basic farmer ignorance about dangerous farming practices has played a role in land degradation – farming up and down slopes or on land that is too steep, for example. However, these fundamental mistakes have not been widespread. Most marginal area farmers have had a fair idea of the basics of soil conservation, but technically and economically feasible means of soil and water conservation - for example, by modified cultivation practices, crop mixes and maximum ground cover – have not been included in the agricultural extension messages that were presented to them. Furthermore, many marginal area farmers were so alienated by the political experiences of forced removals and 'betterment' that they were not inclined to listen to any agricultural extension content;

Table 6.7: Livestock numbers and grazing intensity in favoured farming areas, 1996

Region	Grazed Area	LSU	LSU/100ha
Western Cape	215 796 295	1 367 749	7.9
Northern Cape	22 060 697	1 799 939	8.2
Free State	8 341 534	2 798 837	33.6
Eastern Cape	10 394 399	1 961 894	18.8
KwaZulu Natal	3 150 337	1 326 947	42.2
Mpumalanga	3 116 843	1 303 880	41.8
Northern Province	4 635 338	785 769	16.9
Gauteng	708 739	354 941	50.0
North West	2 221 342	901 532	40.7

Source: DBSA, n.d, and 4.

Table 6.8: Livestock numbers and grazing intensity in marginal areas, 1993

Homeland	Grazed Area	LSU	LSU/100ha
Bophuthatswana	3 682 167	705 809	19.2
Ciskei	761 383	221 263	29.1
Gazankulu	607 236	200 256	33.0
KaNgwane	287 143	97 508	34.0
KwaNdebele	189 040	56 835	30.1
KwaZulu	3 015 680	1 588 167	50.7
Lebowa	1 856 098	601 454	32.4
QwaQwa	55 762	17 224	30.9
Transkei	3 847 483	2 200 239	57.2
Venda	594 202	138 152	23.2

Source: DBSA, n.d, and 4.

The residents of many marginal areas agree that their veld is degraded. This is concurrent with the obvious concern of outsiders who ask such questions. The environmental impact of livestock, and the implications of the veld condition productivity, are plain. At the same time, concerns about veld degradation are not high in people's overall ranking of their problems. Moreover, many people point to insufficient livestock numbers as the cause for their economic dilemma. They need more animals, not fewer, in order to be able to plough properly and meet their income requirements.

The study has also pointed out that the future role of people in the degradation or enhancement of land resources is uncertain. There are a number of scenarios: (1) globalisation and local growth of other economic sectors may reduce the intensity of rural land use further, probably slowing degradation; (2) a shift in global and national market relationships could stimulate increased rural resource use without allocating adequate labour and other resources to agriculture this could aggravate land degradation; (3) dwindling economic opportunities, deteriorating international terms of trade and continued population increases could lead to confusing local agricultural intensification. The economic circumstances and environmental impacts of livestock production in marginal areas arise directly from the land allocation history, demographic patterns, land use policy and consequent livelihood strategies employed that this study has briefly outlined. Livestock production has been one of the sub-subsistence economic strategies that marginal area residents have had to adopt, in combination with migrant labour, in order to survive. As with field crop production, they have had little opportunity to optimize their herd or veld management strategies for sustainability.

How those herd or veld management strategies should be optimized, is a matter of debate. The received wisdom of western science and ranching has been to limit stocking rates and rotate grazing. The economic strategy employed by marginal area residents has involved much higher stocking rates than the western paradigm would advise. Up to a point, it can be convincingly argued that these higher rates do not irretrievably 'degrade' the veld; and it can be pointed out that definitions of 'degradation' will vary according to production goals. That point has, however, been exceeded in many parts of the former homelands. Rotational grazing is broadly accepted by marginal area stockowners as a desirable practice. They often refer to it as part of their indigenous management system. Much attention in academic debate is being given to the spatial flexibility and tracking strategies that have made livestock production sustainable in many parts of semi-arid Africa. It has, however, been a century since such practices were possible in South Africa, and there is little chance of their becoming feasible in the near future. Ironically, they have become feasible in parts of the highly capitalised favoured ranching sector in Southern Africa, where livestock are trucked long distances to better-watered ranches in times of drought. The 'betterment' experienced and the political turmoil apartheid years have degraded or destroyed local range management institutions in many former homeland areas, leading to the substitution of open access over extensive grazing areas formerly governed by common property regimes. While academic and policy debates have yet to reach clarity on these matters, there is little doubt among most marginal areas stockowners that local range management institutions need to be rebuilt, and that they should focus on the enforcement of rotational grazing practice. Veld resilience is likely to be proved a reality in many areas if (as I suspect but cannot prove) stocking rates and grazing intensity begin to decline, although the reality of livestock production as a key agent of land degradation in the marginal areas during this century cannot be denied. In some places that degradation will prove to have been so severe that it is irreversible.

6.6 Land degradation in Marginal Areas (MA)

The strongest influence on policy for agriculture and conservation in the marginal areas has been an attitude rather than an explicit assumption or paradigm. As in much of the rest of Africa for most of the 20th century, this attitude has been pejorative. Because of the political dispensation, it has been primarily an attitude of white rulers about their black subjects. Implicitly rather than explicitly, it has been assumed that marginal area land users are both ignorant and irresponsible when it comes to caring for the land. It has been supposed that the African peasant farms only for tomorrow, and is too ignorant and uncaring to consider the longer-term implications of his actions for land degradation. (As throughout the continent, the reality of women as farmers has usually been ignored.)

Similarly, the Black stockowner has been seen as a greedy or unthinking exploiter of marginal rangelands for his private, short-term benefit - again with no consideration of the long-term trends or impacts relating to such practice. One of the commonest policy perceptions of marginal areas land use has been of stock owners obsessed with quantity rather than quality, seeking for 'cultural' reasons to maximize herd size regardless of the environmental consequences and with no economic motives in their stock keeping. As the national desertification audit shows, the reality of serious land degradation in the marginal areas is undeniable. The prevailing policy attitude has been that this is a tragedy of the commons. The dongas and veld degradation of these areas supposedly prove that group ownership and management of rangeland resources are environmentally untenable. Furthermore, the non-freehold systems under which arable land is held in the MAs, are widely believed to be an insuperable obstacle to sustainable land use. Linked to the policy attitude toward the marginal area land user as being ignorant and irresponsible, has been the standard policy reaction of using authority rather than education or incentives to achieve change.

6.7 Land degradation in Favoured Areas (FA)

Although the South African political dispensation had ensured that land users in the favoured areas were treated more indulgently than those in marginal areas, land degradation has long been recognized as a significant threat to white large scale agriculture, which usually prevails in those areas. Again, the dominant theory guiding land use and degradation policy in these areas is better described as an attitude or a mindset. Perhaps rooted in assumptions of European cultural and intellectual superiority when faced by the challenges of colonization, this dominant attitude has supposed that technical ingenuity can overcome environmental constraints. It has also assumed that original European models of private ownership of defined farm areas are an appropriate spatial framework for agricultural resource use in South Africa. Stimulated by the market incentives of a rapidly growing urban economy during the 20th century (themselves generously distorted by the political motives of government), this dominant mindset has therefore developed a fundamentally flawed strategy. It has used technology to coax more out of the environment than may be sustainable. It has imposed 'wet' agricultural practices and assumptions on a predominantly 'dry' country. It has assumed that fertilizers and irrigation can feed the nation with the foods it prefers from indifferent soils and in a semi-arid and unpredictable climate. It has assumed that the fenced ranching model is a viable means of meat production in this climate, despite the frequent need to resort to drought relief schemes and subsidies to make up the environmental shortfall.

While guided by these attitudes, policy has recognized that white farmers, too, can be technically ignorant or even irresponsible. The theory in the favoured areas has been that education and extension advice can usually overcome these obstacles. Until very recently, the large scale farming sector received the large majority of the total national extension effort - partly because of the political dispensation of resources, and partly because such effort was believed to be more fruitful in the large scale farming sector than in the marginal one. As in the marginal sector, however, policy for large-scale agriculture has also been guided by the theory that environmental irresponsibility should be punished. Both sectors have been dominated by the theory that farmers' environmental behaviour should be monitored, regulated and, if necessary, controlled by legal sanctions. Although large-scale farmers would usually be exposed to a process of guidance and persuasion when inspection showed them to be degrading the land, they were ultimately punished at law if the guidance and persuasion did not work. It is ironic how two opposing trends in environmental policing have crossed paths. A couple of decades ago, the environmental behaviour of the urban and industrial sectors was only loosely controlled. Air and water pollution was rampant. The environmental behaviour of small-scale and large-scale farmers was more tightly controlled, within a clear legal framework.

6.8 Rural Poverty and Land degradation

The analysis to date has shown that the nation's land allocation history has led to a spatially and racially skewed rural population distribution. The marginal or former homeland areas, comprising a small minority of the national territory, have comparatively high population densities but a lower than normal proportion of men of working age. In the lightly populated favoured areas, land degradation has been recognized and combated with success. Has the land allocation and demographic situation in the marginal areas led to land degradation, as high Black population densities have often been alleged to do? Or have more people led to less erosion through a process of sustainable agricultural intensification? This analysis went on to show that land use policies, while conducive to conservation in the favoured areas, were inimical to conservation in the marginal areas. The next link in the causative chain identified by this study is livelihoods. From what form the resources and economic activities have rural South Africans constructed their livelihoods? What degree of prosperity or poverty have these livelihoods offered them? To what extent have these livelihoods depended on natural resources use? Understanding the nature and extent of rural people's dependence on natural resources, will help us understand the ways in which they have used these resources and inform our arguments about whether such use has been conducive to land degradation.

The landless demographic majority in the favoured areas - farm labourers and other farm dwellers - has always lived in poverty. In recent generations, however, the predominantly white owners of land in this sector have enjoyed comparatively prosperous livelihoods. Like much of the apparent prosperity in the South African economy, this comfortable standard of living has been built on credit. Past and present large-scale farmers have often been heavily indebted, their prosperity more precarious than it seems. Sometimes this precariousness has led to land degradation as farmers overstocked or grew the wrong crops in the wrong places for too long. The situation was compounded during the Nationalist Party rule by subsidies that sometimes distorted production incentives in a manner that promoted severe environmentally damaging practices. This analysis argues, however, that conservation policy and programmes were at least partially successful in combating land degradation that emerged in the favoured farming sector. Once again, the main thrust of our inquiry must be towards the livelihood options in the marginal areas.

Most South Africans in the marginal areas live in poverty. May *et al.*, (1995) shows that the distribution of poverty in this country varies according to location, race, age and gender. They estimate that 36,4% of all South African households and 49% can be classified as poor. As *Table 6.9* shows, poverty varies significantly by race.

Given the history of dispossession outlined in this study, the poverty of Blacks is not surprising. The role of migrant labour in history is reflected in the distribution of poverty risk by gender (*Table 6.10*).

Table 6.9: Poverty by Race

Population Groups	% of People in Poverty	% of Household in Poverty	Poverty Share %
Blacks	60,9	43,6	95,4
Coloureds	28,2	21,7	4,4
Indians	2,0	1,1	0,1
Whites	0,7	0,3	0,2

Source: May et al., 1995.

Table 6.10: Poverty Risk by Gender

Gender	% of Adults in Poverty	% of Black Rural Adults in Poverty
Women	48,2	69,9
Men	43,7	64,3

Source: May et al., 1995

The role of South Africa's land allocation history and its migrant and urban labour system are also evident in the distribution of poverty between rural and urban areas, and in its distribution by province (*Table 6.11*).

The Eastern Cape and Northern Province show the highest proportions of households in poverty. This accords with the land allocation history of the Eastern Cape and Northern Province, which were the destinations for many forced removals and were among the provinces in which homelands were concentrated.

Table 6.11: Poverty Risk by Province

Province	People in poverty %	Household poverty %	Rural Blacks poverty %	Rural Black household poverty %
Western Cape	18,4	12,0	0	0
Northern Cape	58,6	40,2	50,0	50,0
Eastern Cape	74,7	62,6	86,3	76,1
KwaZulu Natal	51,2	31,8	63,4	44,4
Free State	63,0	47,7	78,5	55,1
Mpumalanga	46,8	30,0	53,0	33,8
Northern Prov.	71,4	55,5	74,9	61,7
North West	52,2	31,5	57,7	35,1
Gauteng	16,6	9,5	21,4	25,0

Source: May et al., 1995

Lipton and Lipton (1993) have argued that the apartheid-inspired land allocation history of South Africa "... far from leading to undue emphasis on agriculture - caused the Bantustans to be overpopulated but underfarmed". If the structure of the national economy and of rural poverty means that marginal area residents do not fully use their natural resource base (and assuming that natural degradation processes are not unusually vigorous), we would not expect to see the severe land degradation that is in fact so evident in most of this country's marginal areas. It is also plainly evident that much previously cultivated land - and not just those fields taken out of production by "betterment" - is no longer used. To understand this situation, we must look more closely at livelihood options in the marginal areas, past and present. A key to understand these livelihood strategies, lies in the land allocation history and land use policies outlined in this study. These meant that, with available technologies, most rural households in the marginal areas could not make an adequate living for arable holdings. Their farming is best described as sub-subsistence. These absolute land shortages helped to ensure that most households sent their able bodied men into migrant labour. The absence of these men altered the nature of farming and other resource use practices in which the remaining household members were able to engage. Migrant wages were low, but sub-subsistence wage employment combined with sub-subsistence and often-exploitative agriculture managed to sustain most marginal area households to enrich the mining and urban sectors in which rural African men laboured. Under this system, the first three generations of the 20th century saw a heavier dependence on crop and livestock production than what exists today. During this period land degradation, which alarmed visitors to native reserves early in the century, was steadily exacerbated.

More recently, conventional migrant labour opportunities have dwindled. Partly because of more enlightened policies, part of these industries' work force became sedentary, settling near mines and in the towns. Partly it is because of the rapid expansion of homeland populations, meaning that the proportion who may gain access to less rapidly growing migrant opportunities, had shrunk. Meanwhile, a recent study has also shown that only 26,1% of rural Black households have access to arable land (Carter and May, 1997). However, their definition of 'rural', drawn from official statistics, included areas that would better be described as 'peri urban'. Paradoxically, the apparent 'underfarming' of the homelands continues to grow - although this generalization is dangerous. In some marginal areas ploughed fields are rare. In others, industrious agrarian landscapes are the norm. Despite the shrinkage of the migrant labour system, other sources of income and other sectors of economic activity are expanding. For example, old age pensions and other social welfare payments are higher and more widely available than before. The retail sector, and especially informal trading, is booming in the small towns and villages of the former homelands. Dependence on farming and other uses of natural resources remains limited. So far, despite the continuing poverty of marginal area residents, agricultural intensification (with its risk of land degradation) is not the strategy being employed by the majority, but there are some livelihood strategies that continue to depend heavily on natural resource exploitation, as more detailed enquiry shows.

From these data, it can be concluded that livelihoods in the marginal areas do not currently involve levels of agricultural resource exploitation that match the apparent degradation in these areas. The areas of intensive agriculture are mostly those with a more productive resource base and that are less susceptible to degradation. The extensive areas of 'underfarming' are those with less productive, more fragile and often less significantly degraded resource bases. There has been a significant change in livelihood strategy in the marginal areas since about 1980. The livelihood strategy that dominated the homelands for most of the century - a combination of sub-subsistence, labour scarce farming with sub-subsistence, labour - has been in decline since roughly that date. It was the previously dominant strategy that imposed a significant agricultural dependence on most of the marginal area population without permitting sustainable production systems (adequate labour or appropriate conservation farming practices for example). While levels of dependence on conventional migrant labour have been in decline, the role of agriculture and natural resources in most livelihoods has not significantly increased. Instead, new forms of migrant labour, local and small town informal sectors, and state welfare payments, have filled the gap.

Meanwhile, there is one element of most marginal area livelihoods that has retained a significant dependence on natural resources until very recently. That element is energy. Although electrification is now proceeding apace in these areas, levels of wood fuel collection have remained high to date. It remains to be seen how much the availability of electricity will reduce this removal of biomass that is continuing to degrade land in marginal areas. The use of animal dung for fuel and plastering material remains widespread.

Crop residues are still generally used for animal feed rather than being ploughed back into the soil. Some aspects of natural resource use may be taking place at less destructive levels than earlier this century. But wood fuel collection and failure to return dung or crop residues to the soil remain dominant in many marginal area livelihoods and may still contributing actively to land degradation in these areas.

Table 6.12: Characteristics of different livelihood strategy classes in rural South Africa

Livelihood Strategy Group	% Households	Dominant Tact	(R) Mean Adult Income (median)	% Households with poverty risk	% Access to Land	% Access to Educated Labour
Marginalised	43%	Agriculture 80,6%	190,53(131	78,7	35,7	27,1
Dependent on welfare	11,5%	Transfers 94,4%	194,63(159	74,2	35,4	30,7
Dependent Remittances	25,1%	Remittances	196			
Dependent on wages from the primary labour market	19,8%	Wages 95,9%	415,03 (274)	42,3	10,1	15,5
Dependent on wages from the primary labour market	13,6	Wages 97,9%	506,65 (333)	28,7	10,2	53,3
Combining income sources, in which wages are derived from the secondary labour market	15,8	Even spread 20%- 30%	238,34 (177)	61,9	30,8	34,9
Combining income sources, in which incomes in excess of R1000/mont h are derived from entrepreneur ial activity	1,0%	Self employment 69,5%	631,39 (387)	23,6	28,4	59,5
Combining income sources, in which wages are derived the primary labour market	8,1%	Wages 71,5%	375,90 (266)	38,1	29,8	73,6

Source: May et al., 1995

It has been conventional to refer to the people of the marginal areas in southern Africa as 'farmers'. Analysis of their livelihoods, so dominated by migrant labour in the 20th century, shows that this is a misleading description. If anyone deserves the name in these areas, as Tomlison (1953) [13]pointed out, it is usually the women. Yet they are members of households whose dependence on agriculture has typically been partial. At the same time these partial 'farmers' have had to use the land without adequate labour, thus making the labour intensive practices often associated with sustainable small-scale agriculture impossible. They have needed to produce as much of the basic staple grains needed by their households as they could, so that there has been extensive monoculture across the marginal areas. Their access to farming equipment and technology that might optimize cultivation practice has been severely limited. Part time farming that is also maximum dependant on the land for staple grains is a livelihood combination that can easily lead to land degradation.

6.9 Summary and Conclusions

In this chapter the study has tried to untangle the complex bundle of factors at the human apex of the triangle of causation that explains land degradation, while the causative factors at the biophysical apex of the triangle are those that most directly explain the physical manifestations of land degradation. Human actions and circumstance in turn have a wide range of intricately interrelated, direct and indirect influences on the biophysical factors. In seeking to understand the key dimensions of the role people in land degradation, the study has been able to describe a central chain of causative links.

[13] The Tomlison Commission for the Socio-Economic Development of the Bantu Areas in 1953.

Chapter 7

MULTIVARIATE LAND DEGRADATION ASSESSMENT

7.1 Introduction

A set of thirty one (31) variables, which define each of the 367 magisterial districts in South Africa in terms of biophysical environment and climate, land use and land tenure systems, demography, labour and employment and economic production indicators, have been outlined. Some of these variables have been described in previous chapters and are, therefore, only briefly discussed here. Next, in three correlation matrices, the study relates these variables to the set of land degradation indices (soil degradation, veld degradation index) which were developed during the workshops. Using these variables, the study developed several multiple regression models to identify the suite of biophysical and socio-economic factors. Three separate models are developed for soil degradation, veld degradation and the combined index of land degradation. In each case, the first relates all magisterial districts to the index of degradation, while the second and third models identify important variables for FAs and MAs separately.

7.2 The Data Set

Method

(a) The variables used in this analysis, are grouped into six broad categories (*i.e.* biophysical variables, climatic, landuse, demography, labour and employment and economic production). The abbreviation used, a brief description of each variable, and the unit of measurement, are shown in *Annex.* 2. The degradation indices and land use variables were derived from the workshops. All biophysical and climatic variables, except runoff and erodibility, were calculated from data sets available from the GIS directories of the Computing Centre for Water Research (CCWR), which are explained in detail in Schulze *et al.*, (1997). Runoff and erodibility were calculated from the Environmental Potential Atlas (ENPAT, 1996) database (van Riet *et al.*, 1997). The mean values for each of 367 magisterial district were calculated using the ArcView GIS™. Demography, labour and employment, and economic production variables were taken from the nine statistical macro-economic reviews (one for each province) published by the Development Bank of Southern Africa in 1995.

(b) The soil **degradation index (SDI)** and **vegetation degradation index (VDI)** were added up to form a **combined degradation index (CDI)** of land degradation in South Africa. The SDI and VDI values are shown in *Table 7.1.*

Table 7.1: The mean values for each province and for favoured and marginal areas for the soil degradation index (SDI), veld degradation index (VDI) and combined index degradation (SDI =VDI) (N=367). The information is based on the perceptions of the agricultural personnel gathered during a series of workshops.

Province	**Number of magisterial district**	**Mean values for degradation index**		
		SDI	**VDI**	**SDI +VDI**
Eastern Cape	78	200	116	316
Free State	51	48	86	134
Gauteng	22	113	31	143
KwaZulu Natal	51	253	187	440
Mpumalanga	30	143	81	223
Northern Cape	26	92	140	232
Northern Province	39	255	189	444
NorthWest	28	149	122	270
Western Cape	42	77	93	170
Favoured districts	**262**	**102**	**96**	**198**
Marginal districts	**105**	**292**	**183**	**475**

c) The final analysis comprised a total of 348 magisterial districts. Seventeen highly urbanised districts in Gauteng, KwaZulu Natal and Western Cape, with 50% settlement and the two districts comprising the Kruger National Park (Soutpansberg and Pilgrim's Rest) were discarded.

7.3 RESULTS AND DISCUSSION

7.3.1 Correlation matrices

7.3.1.1 Full Data Set

Spearmans Rank correlation values between the degradation indices, land use, the biophysical and socio economic variables for the 348 magisterial districts used in the final analysis are shown in *Table 7.6*. Soil degradation and veld degradation indices are strongly related to each other and, in general, when a district contains high levels of soil degradation, high levels of veld degradation are also perceived to be present. Since the combined index of degradation is comprised of the sum of the soil and veld degradation indices, it is not surprising that it should be highly significantly correlated with both of these indices.

While the **soil degradation index (SDI)** is significantly correlated ($p<0.5$) with all but four of the 31 variables, it is most strongly related to the land tenure system, which defines the district *(Table 7.6)*. In fact, more than 50% of the variance in the soil degradation index can be explained simply by knowing the percentage area of a district that is managed under a favoured or a marginal land tenure system *(Table 7.6)*. Soil degradation is also strongly related to a suite of variables, which differentiate so clearly the favoured and marginal areas. For example, soil degradation appears most strongly correlated with the human, animal and settlement density which characterises the rural areas, where unemployment and poverty are prevalent and where a higher proportion of the economically active population, especially the males, are absent from the region. However, biophysical and climatic variables should not be ignored and the location of marginal areas generally with steeper slopes, less summer aridity, but with greater annual temperatures, should also be noted.

Compared with the soil degradation index, the **veld degradation index (VDI)** appears less significantly correlated with the variables shown in *Table 7.6*. It is also less significantly correlated with the land tenure system of the district, although many of the same variables emerge as significant correlates of both soil and veld degradation. The biophysical and climatic variables which are most strongly related to veld degradation are again slope and temperature while the percentage of a district used for grazing lands and stocking density are also positively related to veld degradation.

When the soil and veld degradation indices are **combined** into a single index, the strong correlation with the land tenure system is again evident *(Table 7.6)*. Slope and temperature remain the most significant biophysical and climatic correlates, while a very similar set of socio-economic parameters, that is related to soil degradation, also appears related to the combined index of degradation.

7.3.1.2 Favoured Areas (FA)

Although significantly correlated ($p<0.05$), the soil degradation and veld degradation indices are relatively weakly related in the 226 **FA**, *(Table 7.8)*. (In this analysis a magisterial district was classified as a favoured area if more than 80% of its area was managed under a large-scale land tenure system*)*. This suggests that areas, which are perceived to have relatively high levels of soil degradation, do not necessarily exhibit high levels of veld degradation in the FA. It is significant that only one of the socio-economic variables is correlated with the **SDI** in the favoured areas *(Table 7.7)*. Several variables, however, which describe the biophysical and climatic environment, together with a few land use factors, are significantly related to soil degradation. Large favoured magisterial districts which are at low altitudes and which possess steep slopes with infertile soils, possess significantly higher levels of soil degradation than others. Districts with high mean annual temperatures and more growing days are also more degraded. Soil degradation also appears negatively related to stocking density in the FA. Select magisterial districts in KwaZulu Natal (e.g. Weenen, Glencoe, and Kliprivier), in the upper reaches of the Sundays River Valley in the Eastern Cape (e.g. Aberdeen, Jansenville, Pearston, Graaff-Reinet), close to the Orange River in the west (e.g. Prieska, Britstown, Gordonia) and in the Little Karoo (e.g. Montagu, Oudtshoorn, Calitzdorp) have the highest index of soil degradation amongst the favoured magisterial districts.

The **VDI** in the FA is negatively related to altitude and positively related to temperature and the ratio of mean annual precipitation to evapotranspiration potential *(Table 7.7)*. It is also significantly related to districts, which are dominated by grazing lands with a low settlement area. Stocking density is not related to the veld degradation index. Favoured magisterial districts with high annual growth in the agricultural sector and the GGP in general, possess higher levels of veld degradation. Unlike for soil degradation, the top 10 favoured magisterial districts with the highest veld degradation indices are widely scattered throughout the country (i.e. Weenen, Marico, Britstown, Komga, Boshof, Koffiefontein, Messina, Oudtshoorn, Fraserburg and Hay).

The **CDI** in favoured areas is significantly correlated with low altitude, large district size, steep slope, low soil fertility and high mean annual temperatures *(Table 7.7)*. Favoured districts with large areas of grazing lands and low stocks densities, relatively smaller cropland area and settlements possess a higher combined index of degradation. Low population density, with a high proportion of people employed in the agricultural sector and an actively growing economy, is also a significant correlate.

7.3.1.3 Marginal Areas (MA)

Eighty-nine magisterial districts, (in which more than 80% of the area was managed under a marginal land tenure system), were used in this analysis *(Table 7.8)*. Of the three data sets (full data set, favoured districts only and marginal districts only), soil and veld degradation indices are the most closely related in the marginal areas. Marginal districts, which have a high soil degradation index, tend to also possess a high veld degradation index. **Soil degradation** in marginal areas was significantly correlated ($p<0.05$) with only four variables *(Table 7.8)*. These were high altitudes, steep slopes, a proportionately higher area of grazing lands in the district and high levels of poverty as expressed in the GGP per capita ratio. Magisterial districts with relatively high soil degradation indices were in the higher lying areas of the Eastern Cape (e.g. Herschel, Qumbu Mount Fletcher, Engcobo), KwaZulu Natal (e.g. Nquthu, Msinga, Nongoma, Nkandla) and the Northern Province (Naphuno 2, Mankweng, Schoonoord, Sekgosese 1).

The **VDI** was significantly correlated with nearly half of the variables used in this analysis *(Table 7.8)*. Districts with low mean annual rainfall and relatively high summer aridity and low runoff amounts generally showed higher levels of veld degradation than others. Land use appears a particularly important influence on veld degradation. The VDI was correlated with 5 of the eight land use variables, although land use variables were also frequently co-correlated. Marginal magisterial districts with relatively large areas of veld and conservation or state lands, small areas of cropland, small favoured forest areas and small settlements areas generally had higher levels of veld degradation. Finally, districts, which had higher levels of unemployed men, particularly within a formal agricultural sector that was not growing (although GGP growth itself was high), also showed higher levels of veld degradation. Magisterial districts in the Northern Province (Mutual, Praktiseer, and Schoonoord), KwaZulu Natal (Nkandla, Pholela, Mahlabathini, Nongoma, and Nquthu) and the Northwest Province (Lehurutshe, Madikwe) were among the worst ten marginal districts in terms of veld degradation.

None of the five climatic variables and none of the four demographic variables were significantly correlated with the **combined index** of soil and veld degradation *(Table 7.8)*. High altitude areas with steep slopes, small area of croplands and favoured forests and large areas of grazing lands had higher combined degradation values index values. Marginal area magisterial districts with a high level of unemployment and with a low percentage of people employed in a formal agricultural sector that showed low annual growth, generally possessed higher CDI values. High levels of poverty, as shown by the GGP per capita index, were also correlated with the combined degradation index value. Six KwaZulu Natal districts (Nkandla, Nquthu, Nongoma, Pholela, Mahlabathini and Msinga), three Northern Province districts (Mutale, Schoonoord and Praktiseer) and one Eastern Cape district (Herschel) comprise the top ten districts in terms of combined degradation index values.

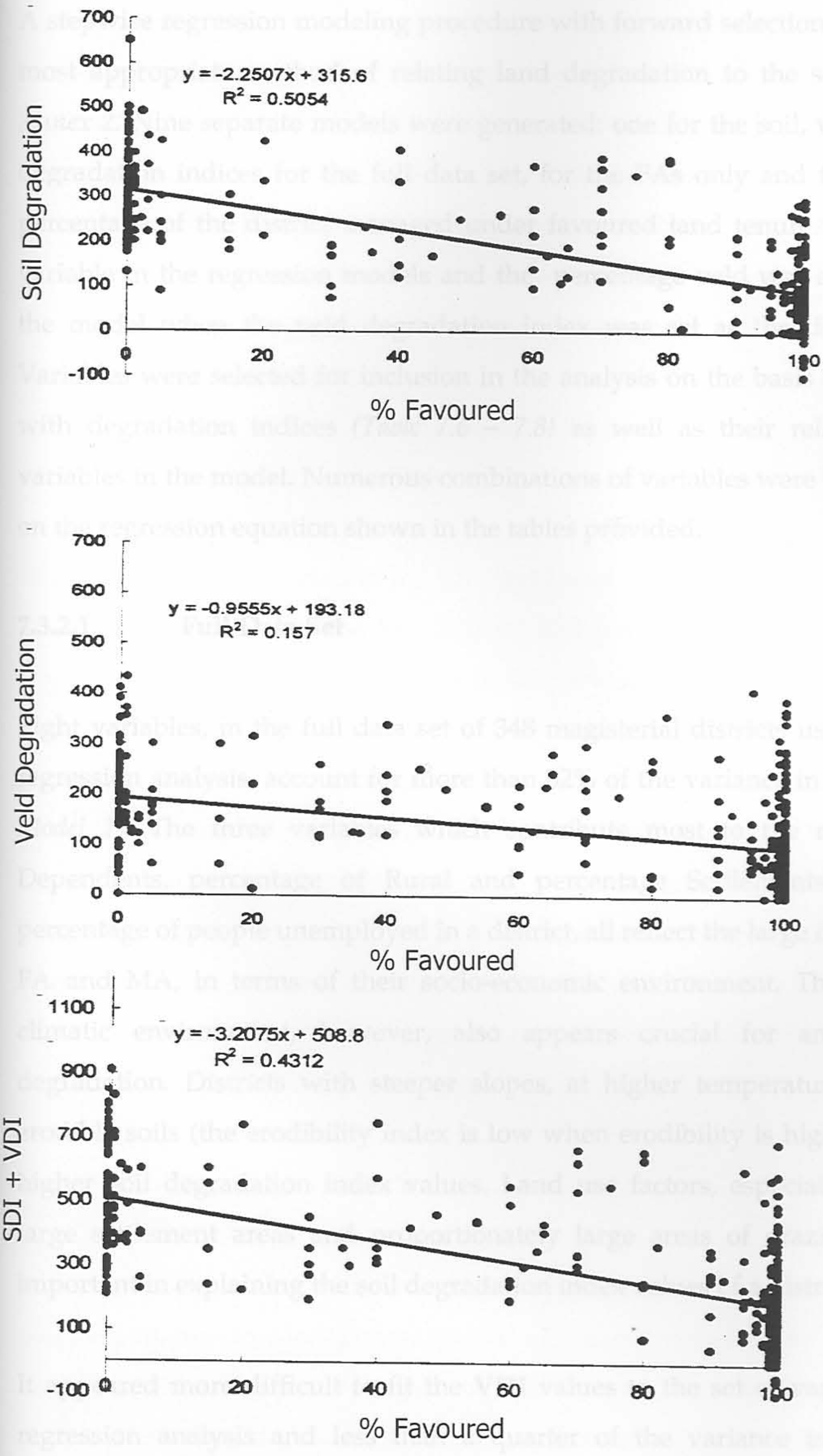

Figure 7.1 Relationship between the % of a district managed under a favoured land tenure system and three indices of degradation. p<0.001 in all cases

7.3.2. Predicting Land Degradation

A stepwise regression modeling procedure with forward selection was chosen as the most appropriate method of relating land degradation to the suite of variable in *Annex 2*. Nine separate models were generated: one for the soil, veld and combined degradation indices for the full data set, for the FAs only and for MAs only. The percentage of the district managed under favoured land tenure was excluded as a variable in the regression models and the percentage veld was also excluded from the model when the veld degradation index was set as the dependent variable. Variables were selected for inclusion in the analysis on the basis of their correlation with degradation indices *(Table 7.6 – 7.8)* as well as their relationship to other variables in the model. Numerous combinations of variables were tried before setting on the regression equation shown in the tables provided.

7.3.2.1 Full Data Set

Eight variables, in the full data set of 348 magisterial districts used in the stepwise regression analysis, account for more than 52% of the variance in the **SDI** *(Table 7.2, Model 1)*. The three variables which contribute most to the model (number of Dependents, percentage of Rural and percentage Settlements) as well as the percentage of people unemployed in a district, all reflect the large distinction between FA and MA, in terms of their socio-economic environment. The biophysical and climatic environment, however, also appears crucial for any model of soil degradation. Districts with steeper slopes, at higher temperature and with more erodible soils (the erodibility index is low when erodibility is high *(Annex 2)* posses higher soil degradation index values. Land use factors, especially proportionately large settlement areas and proportionately large areas of grazing lands are also important in explaining the soil degradation index values of a district.

It appeared more difficult to fit the **VDI** values to the set of variables used in the regression analysis and less than a quarter of the variance is explained in the regression model in *Table 7.2 (Model 2)*. Biophysical and climatic factors appeared the most important predictors of veld degradation, with the percentage of people unemployed in a magisterial district, the only significant socio-economic variable selected in the regression equation. Districts with steep slopes, high mean annual temperatures, yet low MAP:PET ratios and high levels of unemployment also possess high veld degradation index values. For the **CDI** *(Model 3)* many of the same variables already mentioned were included in the model. Stocking rate, however, is included for the first time, although it accounts for only a small fraction of the variance in the data. A mixture of socio-economic, biophysical, climatic and land use factors all appear important in accounting for nearly half of the variance in the combined degradation index data set.

7.3.2.2 Favoured Areas (FA)

The three regression models for **soil, veld** and the **CDI** *(Table 7.3. Model 4-6)* are different from those for the full data set and the marginal areas in two important ways. First, they account for far less of the variance in the data than the others with only 15%, 9% and 28% of the variance in the soil, veld and combined index values being explained in the respective models. Secondly, biophysical and climatic variables (especially mean annual temperature and slope), are the most significant factors to account for degradation in the favoured districts. Land use factors, such as a high proportion of grazing lands or veld in the district, as well as stocking rates, also appear significant for the combined degradation index. However, no demographic, labour and employment or economic production factors contributed significantly to any of the three-degradation model in the FA.

7.3.2.3 Marginal Areas (MA)

Although less than 20% of the variance is explained in the model *(Table 7.4, Model 7)* **soil degradation** in MA appears greater on steeper slopes in low rainfall areas. The significant contribution to soil degradation of the biophysical and climatic environment should, therefore, not be underestimated in MA. The **VDI** *(Model 8)* is best explained by low rainfall, steep slopes, a higher number of grow days, fertile soils and a high degree of poverty. This suggests that very poor MA in which people are possibly more reliant on the grazing areas to augment their livelihoods, are more prone to veld degradation than others. The steeply sloping, sweetveld areas, which generally possess lower rainfall and more fertile soil, are particularly susceptible. The final model *(Model 9)* for the **CDI** suggests that the absence of a formal agricultural sector may also be an important predictor of land degradation in the marginal areas. Other than this difference the model is very similar to that for veld degradation although it explains close to half of the variance in the data for 89 MA.

Regression model summary

Table 7.5 summarizes the results of the nine regression models outlined earlier. It shows which variables are consistently the most important predictors of land degradation for the full data set and independently for districts managed under favoured or marginal land tenure systems. It is clear that the biophysical climatic environments are both important predictors of land degradation, irrespective of land tenure system. Slope appears the most important variable while mean annual temperature is significant in the full data set and when favoured areas are considered separately. Low mean annual rainfall replaces temperature as the most important climatic factor when marginal areas are analyzed. Erodibility, fertility, MAP: PET and the number of grow days were important but inconsistent in their value as significant predictive variables of land degradation. Of the land use variables, only the proportional contribution of grazing lands and settlements appeared important, while the stocking rate contributed a little, and only in two of the combined degradation index models.

The only demographic variable to contribute significantly to any of the models was the percentage of the population living in a rural environment. This variable, together with the number of dependents and the GGP per capita ratio, distinguishes the marginal and favoured areas. It does not necessarily mean that, because none of the other demographic factors were included as significant variables in any of the models, they are not important in land degradation issues. The previous chapter has examined the role of population density and the absence of labour on land degradation. In this analysis, however, they appeared poor predictors of land degradation, population density and the absence of labour. Three indices, all linked to issues of poverty, emerged fairly frequently, and often very significantly, as contributors to the degradation models. The percentage of people unemployed, the number of dependents and GGP per capita ratio all appeared important and often in very different combinations of factors. The role of poverty, and the subsequent reliance on natural resources as a "safety net", is poorly understood and written about in the land degradation literature. The way in which poverty translates into direct impacts on the natural environment, is not well known. Finally, the single contribution of the number of people employed in the formal agricultural sector as a significant factor in one of the models, suggests that the formal agricultural sector may have an important role to play in influencing the severity and rate of land degradation, even within the marginal areas.

Table 7.2: Results from stepwise regression models which relate biophysical, climatic and socio-economic variables to soil degradation, veld degradation and a combined index of degradation for 348 favoured and marginal magisterial districts in South Africa. The t-statistic for all variables in the model is significant at p<0.05

Variable	Coefficient	Std Error	t-statistic	R-squared
Soil Degradation Index (SDI)(MODEL 1)				
Constant	**-250.2950**			
#DEPENDENTS	7.3987	2.9768	2.4855	0.3258
%RURAL	1.0380	0.2434	4.2648	0.3874
%SETTLEMENTS	2.4123	0.5898	4.0903	0.4188
SLOPE	31.2002	5.4574	5.7170	0.4519
TMEAN	14.2129	2.9980	4.7408	0.4845
%VELD	0.5262	0.2568	2.0485	0.5053
%UNEMPLOYED	1.4861	0.5586	2.6602	0.5154
ERODIBILITY	-4.0821	1.5406	-2. 6496	0.5252
Veld Degradation Index (VDI) (MODEL 2)				
Variable	**Coefficient**	**Std Error**	**t-statistic**	**R-squared**
Constant	**-129.2789**			
TMEAN	**18.1592**	**2.7304**	**6.6507**	**0.1044**
SLOPE	37.6698	6.9974	5.3834	0.1681
%UNEMPLOYED	1. 6268	0.4115	3.9532	0.2091
MAP:PET	-116.2645	42.0193	-2.7669	0.2264
Combined Degradation Index (VDI) (MODEL 3)				
Variable	**Coefficient**	**Std Error**	**t-statistic**	**R-squared**
Constant	-683.1599			
%RURAL	1.5100	0.35777	4.2214	0.2601
%UNEMPLOYED	3.6257	0.7809	4.6432	0.3418
SLOPE	59. 0938	8.5719	6.8939	0.3864
TMEAN	33. 7084	4.8292	6.9801	0.4404
%VELD	1.7880	0.3404	5.2521	0.4714
LSU/HA	177.4147	57.7479	3.0722	0.4856

Table 7.3: Results from stepwise regression models which relate biophysical, climatic and socio-economic variables to soil degradation, veld degradation and a combined index of degradation for 226 magisterial districts in South Africa which have more 80% of their surface area managed under a FAVOURED land tenure system. The t-statistic for all variables in the model is significant at $p<0.05$

Soil Degradation Index (SDI)(MODEL 4)				
Variable	**Coefficient**	**Std Error**	**t-statistic**	**R-squared**
Constant	**-211.5759**			
SLOPE	16.2044	5.8673	2.7618	0.1502
TMEAN	20.5466	3.8017	5.4046	0.0715
ERODIBILITY	-4.8561	1.5273	-3. 1795	0.1210
Veld Degradation Index (VDI) (MODEL 5)				
Variable	**Coefficient**	**Std Error**	**t-statistic**	**R-squared**
Constant	**-129.6238**			
TMEAN	**18.2396**	**4.0242**	**4.5325**	**0.0751**
SLOPE	12.6522	6.3734	1.9851	0.0912
Combined Degradation Index (VDI) (MODEL 6)				
Variable	**Coefficient**	**Std Error**	**t-statistic**	**R-squared**
Constant	-804.4170			
SLOPE	38. 5714	9.2623	4.1643	0.2565
TMEAN	46. 4866	6.2802	7.4021	0.1101
%VELD	2.1074	0.3301	6.3833	0.2162
LSU/HA	271.3085	91.7193	2.9580	0.2848

Table 7.4: Results from stepwise regression models which relate biophysical, climatic and socio-economic variables to soil degradation, veld degradation and a combined index of degradation for 89 magisterial districts in South Africa which more than 80% of their surface area managed under MARGINAL. The t-statistic for all variables in the model is significant at p<0.05

Soil Degradation Index (SDI)(MODEL 7)

Variable	Coefficient	Std Error	t-statistic	R-squared
Constant	363.0127			
SLOPE	62.8009	13.8232	4.5431	0.1081
MAR	-0.2398	0.0794	-3. 0185	0.1935

Veld Degradation Index (VDI) (MODEL 8)

Variable	Coefficient	Std Error	t-statistic	R-squared
Constant	177.6677			
MAR	-0.4105	0.0666	-6.1649	0.1736
SLOPE	59.0663	12.0574	4.8988	0.2895
#GROWDAYS	2. 0049	0.5495	3.6487	0.3227
FERTILITY	20.8928	6.29344	3.3198	0.3648
GP/CAP	-0.0271	0.0137	-1.9830	0.3769

Combined Degradation Index (VDI) (MODEL 9)

Variable	Coefficient	Std Error	t-statistic	R-squared
Constant	-683.1599			
AGREMPLOYED	-2.9309	1.3518	-2.1682	0.1001
GGP/CAP	-0.0791	0.0257	-3.1493	0.2094
SLOPE	59. 0938	8.5719	6.8939	0.3864
MAR	-0. 5611	0.1363	-4.1177	0.3434
FERTILITY	41.3966	10.9421	3.7832	0.4189
#GROWDAYS	2.2551	1.0992	2.0516	0.4472

*Table 7.5. The percentage contribution of biophysical, climatic and socio-economic variables to the total R^2 value for each of nine stepwise regression models developed to explain the levels of soil degradation, veld degradation and a combined index of soil plus veld degradation in all the magisterial districts of South Africa (n=348) (minus the highly-urbanised districts), in favoured districts (>80% favoured (n=226)), and in marginal districts (>80%marginal (n=89)). The total R^2 value (*100) for each model is also shown. Negative values indicate the variable was negatively related to the related to the dependent factor.*

Variable	All districts			Favoured (>80%)			Marginal (>80%)		
	SDI	VDI	SDI+VDI	SDI	VDI	SDI+VDI	SDI	VDI	SDI+VDI
<u>Biophysical</u>									
AREA									
ALT									
SLOPE	6	28	9	19	18	14	56	29	14
RUNOFF									
ERODE	(-) 2			(-) 33					
FERTIL								11	17
Climatic									
MAR									
SAI							(-)44	(-)44	(-)16
MAP: PET		(-) 8							
GROWDAYS								8	
TMEAN	6	46	11	48	82	39			
Landuse									
%CROPS									
%VELD									
%FOREST	4		6			37			
%CON									
%SET									
%OTH	6								
LSU/HA			3			10			
Demography									
%MALE									
%15-64									
%RURAL									
Labour & Employment									
%UNEMPLOY	12		54						
AGREMPLOY									
LABGROWTH									
#DEPEND	2	18	17						(-)22
Economic production									
GGP/CAP									
AGRTOGGP									
AGROWTH	62								
GGGPGROW								(-) 8	(-)24
Total %	100	100	100	100	100	100	100	100	100
Total $R^2 \cdot 100$	52.2	22.6	48.6	15.0	9.1	28.5	19.4	37.7	44.7
Model #	1	2	3	4	5	6	7	8	9

Table 7.6 Spearmans Rank correlations of degradation indices with biophysical, climatic, landuse, demographic, labour and employment and economic production variables. Degrees of freedom are 348 and for significance levels of $p<0.05$; 0.01 and 0.001, r-0.105 0.137 and 0.175 respectively

Degradation Indices																																		
SDI	SDI																																	
VDI	0 472	VDI																																
SDI+VDI	0 869	0 828	SDI+VDI																															
Biophysical variables																																		
AREA	-0 178	-0 005	-0 097	AREA																														
ALT	-0 256	-0 260	-0 333	0 134	ALT																													
SLOPE	0 321	0 245	0 0 337	0 134	0 246	SLOPE																												
RUNOFF	0 190	0 118	0 178	0 362	0 257	0 597	RUNOF																											
ERODE	-0 263	-0 133	-0 254	0 038	0 082	0 342	0 157	ERODE																										
EFERTIL	-0 106	-0 006	-0 067	0 182	0 286	0 280	0 216	0 286	FERTIL																									
Climatic variables																																		
MAR	0 279	0 096	0 204	0 462	0 000	0 474	0 797	0 041	0 160	MAR																								
SAI	-0 342	0 080	0 229	0 313	0 318	0 237	0 533	0 058	0 040	0 837	SAI																							
MAP:PET	0 314	0 226	0 318	0 358	0 375	0 679	0 808	0 127	0 224	0 748	0 430	MAP:PET																						
GROWDAYS	0 338	0 148	0 272	0 236	0 023	0 201	0 063	0 039	0 023	0 397	0 618	0 096	GRWODAYS																					
TMEAN	0 401	0 340	0 448	0 076	0 692	0 108	0 015	0 064	0 150	0 029	0 025	0 126	0 543	TIMEAN																				
Land use																																		
MERCIAL	0 649	0 472	0 654	0 262	0 319	0 271	0 322	0 214	0 045	0 371	0 373	0 395	0 344	0 465	MERCIAL																			
%CROPS	0 023	0 109	0 087	0 202	0 030	0 050	0 260	0 161	0 046	0 323	0 168	0 234	0 135	0 033	0 205	%CROPS																		
%VELD	0 061	0 267	0 124	0 531	0 137	0 032	0 365	0 286	0 235	0 438	0 310	0 334	0 275	0 128	0 205	0 607	%VELD																	
%FOR	0 217	0 134	0 211	0 135	0 232	0 541	0 650	0 034	0 184	0 612	0 387	0 604	0 055	0 029	0 338	0 138	0 206	%FOR																
%CON	0 005	0 033	0 008	0 192	0 157	0 043	0 025	0 151	0 090	0 047	0 097	0 089	0 002	0 132	0 007	0 015	0 014	0 027	%CON															
%SET	0 406	0 086	0 275	0 635	0 143	0 049	0 293	0 053	0 206	0 467	0 426	0 323	0 431	0 260	0 529	0 213	0 648	0 151	0 091	%SET														
%OTH	0 149	0 156	0 208	0 060	0 212	0 270	0 149	0 393	0 047	0 052	0 135	0 140	0 260	0 019	0 161	0 132	0 629	0 181	0 023	0 167	%OTH													
LSU/HA	0 310	0 230	0 299	0 311	0 118	0 150	0 434	0 191	0 188	0 525	0 535	0 357	0 255	0 018	0 528	0 149	0 228	0 302	0 119	0 390	0 132	LSU/HA												
Demographic																																		
%UNEMPL	0 314	0 094	0 219	0 753	0 209	0 090	0 386	0 114	0 228	0 559	0 428	0 426	0 446	0 283	0 468	0 282	0 656	0 173	0 079	0 816	0 194	0 414	POPDEN											
%MALE	0 492	0 253	0 450	0 165	0 165	0 253	0 117	0 444	0 122	0 088	0 061	0 174	0 013	0 117	0 525	0 002	0 045	0 080	0 114	0 285	0 383	0 399	0 196	%MALE										
%15-64	0 450	0 249	0 425	0 008	0 012	0 129	0 033	0 407	0 218	0 021	0 112	0 054	0 038	0 084	0 516	0 031	0 177	0 041	0 171	0 118	0 389	0 454	0 008	0 846	%15-64									
%RURAL	0 529	0 378	0 535	0 0003	0 089	0 215	0 239	0 212	0 080	0 294	0 400	0 276	0 353	0 373	0 670	0 209	0 062	0 281	0 033	1 238	0 195	0 491	0 099	0 498	0 653	%RURAL								
Labour& employment																																		
%UNEMPL	0 375	0 233	0 361	0 238	0 037	0 006	0 031	0 258	0 145	0 084	0 154	0 011	0 225	0 185	0 489	0 103	0 041	0 092	0 150	0 340	0 183	0 385	0 359	0 359	0 660	0 620	0 294	%UNEMPL						
AGREMPL	0 162	0 074	0 116	0 475	0 099	0 121	0 001	0 096	0 119	0 127	0 092	0 058	0 265	0 163	0 242	0 068	0 300	0 168	0 035	0 579	0 276	0 109	0 697	0 697	0 070	0 150	0 247	0 392	AGREMPL					
LABAGROW	0 086	0 043	0 069	0 147	0 055	0 033	0 048	0 035	0 003	0 007	0 013	0 021	0 163	0 116	0 096	0 020	0 021	0 0221	0 062	0 118	0 066	0 013	0 172	0 172	0 124	0 075	0 007	0 295	0 331	LABAGROW				
#DEPEND	0 471	0 290	0 463	0 059	0 060	0 161	0 092	0 417	0 185	0 076	0 135	0 002	0 085	0 123	0 562	0 047	0 142	0 069	0 172	0 165	0 394	0 503	0 089	0 089	0 836	0 943	0 618	0 699	0 049	0 115	#DEPEND			
Economic production																																		
GGP/CAP	0 496	0 312	0 485	0 197	0 138	0 168	0 130	0 324	0 132	0 154	0 195	0 174	0 204	0 255	0 610	0 093	0 008	0 082	0 136	0 267	0 332	0 458	0 221	0 221	0 737	0 826	0 666	0 692	0 010	0 140	0 856	GGP/CAP		
AGRTOGP	0 206	0 076	0 145	0 442	0 126	0 071	0 034	0 129	0 153	0 214	0 186	0 123	0 316	0 238	0 260	0 019	0 351	0 035	0 027	0 595	0 316	0 110	0 707	0 707	0 019	0 200	0 181	0 244	0 857	0 204	0 125	0 116	AGRTOGGP	
AGROWTH	0 213	0 267	0 278	0 023	0 155	0 245	0 154	0 096	0 202	0 046	0 010	0 170	0 029	0 129	0 238	0 080	0 084	0 180	0 043	0 084	0 200	0 002	0 044	0 044	0 174	0 123	0 222	0 053	0 007	0 182	0 134	0 095	0 139	AGROWTH
GGGROW	0 405	0 387	0 458	0 116	0 244	0 228	0 200	0 162	0 154	0 147	0 138	0 255	0 189	0 321	0 456	0 066	0 001	0 144	0 052	0 282	0 149	0 149	0 248	0 248	0 321	0 251	0 394	0 235	0 206	0 031	0 263	0 261	0 141	0 645

Table 7.7 Spearmans rank correlations of degradation indices with biophysical climatic, land use demographic labour and employment and economic production variables for magisterial districts which have 80% or more of their land surface managed under favoured land tenure systems. Degrees of freedom are 244 and for significance levels of p<05 0 01 and 0 001 r= 0124 0 162 and 0 206 respectively

Degradation Indices																																
SDI	SDI																															
VDI	0 144	VDI																														
SDI+VDI	0 714	0 729	SDI+VDI																													
Biophysical variables																																
AREA	0 125	0 145	0 207	AREA																												
ALT	0 158	0 230	0 321	0 088	ALT																											
SLOPE	0 167	0 144	0 237	0 077	0 279	SLOPE																										
RUNOFF	0 055	0 037	0 031	0 410	0 075	0 510																										
ERODE	0 040	-0 003	0 091	0 162	0 017	0 358	ERODE																									
FERTIL	-0 184	-0 006	0 105	0 162	0 342	0 366	0 308	FERTIL																								
Climatic variables																																
MAR	0 046	0 037	0 069	0 514	0 312	0 283	0 163	0 214	MAR																							
SAI	0 128	0 078	0 037	0 272	0 638	0 055	0 081	0 083	0 771	SAI																						
MAP:PET	0 095	0 154	0 147	0 337	0 217	0 0627	0 028	0 308	0 663	0 224	MAP:PET																					
GROWDAYS	0 198	0 025	0 074	0 118	0 347	0 386	0 131	0 194	0 382	0 722	0 099	GRWODAYS																				
TMEAN	0 254	0 222	0 340	0 167	0 677	0 142	0 257	0 156	0 186	0 176	0 042	0 284	TIMEAN																			
Land use																																
MERCIAL	0 082	0 025	0 170	0 055	0 148	0 143	0 071	0 032	0 151	0 127	0 238	0 079	0 219	MERCIAL																		
%CROPS	0 132	0 034	0 177	0 226	0 061	0 118	0 243	0 015	0 278	0 148	0 298	0 136	0 022	0 254	%CROPS																	
%VELD	0 058	0 259	0 289	0 556	0 010	0 118	0 464	0 301	0 503	0 268	0 370	0 260	0 093	0 112	0 621	%VELD																
%FOR	0 087	0 088	0 103	0 096	0 171	0 520	0 121	0 381	0 522	0 212	0 601	0 131	0 023	0 309	0 130	0 191	%FOR															
%CON	0 136	0 058	0 101	0 101	0 210	0 146	0 073	0 120	0 019	0 047	0 229	0 056	0 182	0 208	0 093	0 124	0 146	%CON														
%SET	0 003	0 190	0 211	0 552	0 155	0 121	0 355	0 275	0 530	0 369	0 068	0 341	0 051	0 091	0 33	0 691	0 072	0 008	%SET													
%OTH	0 015	0 110	0 136	0 209	0 203	0 277	0 422	0 52	0 269	0 327	0 199	0 404	0 106	0 017	0 215	0 413	0 022	0 025	0 443	%OTH												
LSU/HA	0 143	0 016	0 141	0 286	0 478	0 132	0 006	0 259	0 472	0 499	0 231	0 234	0 339	0 157	0 417	0 0221	0 095	0 067	0 225	0 092	LSU/HA											
Demographic																																
%UNEMPL	0 057	0 098	0 171	0 727	0 041	0 007	0 386	0 267	0 660	0 405	0 442	0 330	0 032	0 138	0 397	0 756	0 202	0 028	0 728	0 411	0 347	POPDEN										
%MALE	0 028	0 065	0 036	0 039	0 028	0 150	0 432	0 181	0 222	0 281	0 060	0 358	0 296	0 216	0 228	0 350	0 208	0 034	0 285	0 486	0 055	0 295	%MALE									
%15-64	0 055	0 031	0 014	0 275	0 251	0 126	0 401	0 415	0 253	0 088	0 199	0 211	0 333	0 144	0 144	0 523	0 206	0 116	0 510	0 478	0 160	0 582	0 704	%15-64								
%RURAL	0 057	0 162	0 150	0 346	0 111	0 036	0 095	0 227	0 088	0 242	0 181	0 189	0 138	0 172	0 250	0 115	0 173	0 082	0 276	0 149	0 201	0 361	0 097	0 332	%RURAL							
Labour& employment																																
%UNEMPL	0 120	0 102	0 109	0 129	0 195	0 168	0 216	0 296	1 130	0 018	0 093	0 015	0 244	0 124	0 292	0 263	0 296	0 154	0 103	0 190	0 088	0 009	0 455	0 382	0 44	%UNEMPL						
AGREMPL	0 115	0 138	0 200	0 412	0 016	0 127	0 182	0 137	0 181	0 073	0 102	0 083	0 080	0 048	0 094	0 290	0 085	0 059	0 477	0 329	0 015	0 570	0 206	0 561	0 783	0 260	AGREMPL					
LABAGROW	0 036	0 113	0 077	0 156	0 033	0 004	0 003	0 089	0 032	0 005	0 148	0 041	0 118	0 009	0 032	0 047	0 123	0 113	0 069	0 029	0 068	0 158	0 136	0 047	0 236	0 291	0 260	LABAGROW				
#DEPEND	0 055	0 003	0 017	0 217	0 197	0 026	0 431	0 437	0 262	0 127	0 217	0 204	0 316	0 116	0 146	0 503	0 229	0 142	0 476	0 480	0 168	0 503	0 721	0 929	0 189	0 501	0 414	0 135	#DEPEND			
Economic production																																
GGP/CAP	0 028	0 024	0 039	0 007	0 096	0 005	0 272	0 351	0 351	0 044	0 093	0 079	0 111	0 007	0 005	0 266	0 158	0 060	0 298	0 394	0 119	0 309	0 506	0 705	0 284	0 404	0 404	0 070	0 690	GGP/CAP		
AGRTOGP	0 017	0 061	0 084	0 346	0 055	0 080	0 308	0 228	0 286	0 191	0 102	0 251	0 151	0 008	0 056	0 338	0 036	0 002	0 487	0 420	0 029	0 638	0 376	0 694	0 581	0 035	0 035	0 186	0 593	0 598	AGRTOGGP	
AGROWTH	0 000	0 178	0 134	0 175	0 135	0 342	0 229	0 153	0 041	0 152	0 148	0 260	0 089	0 018	0 106	0 192	0 259	0 063	0 172	0 215	0 182	0 225	0 041	0 017	0 091	0 182	0 182	0 216	0 043	0 151	0 283	AGROWTH
GGROW	0 043	0 190	0 179	0 118	0 194	0 334	0 219	0 129	0 035	0 096	0 217	0 191	0 003	0 009	0 161	0 128	0 252	0 084	0 085	0 170	0 140	0 100	0 038	0 099	0 046	0 158	0 158	0 102	0 109	0 199	0 049	0 563

*Table 7.8 Spearman rank correlations of degradation indices with biophysical climatic land use demographic labour and employment and economic production variables for magisterial districts, which have 80% or more of their land surface managed under **marginal** land tenure systems. Degrees of freedom are 244 and for significance levels of p<05 0 01 and 0 001 r= 0124 0 162 and 0 206 respectively*

Degradation Indices

SDI	SDI		
VDI	0 557	VDI	
SDI+VDI	0 892	0 858	SDI+VDI

Biophysical variables

AREA	0 022	0 161	0 112	AREA					
ALT	0 227	0 204	0 244	0 278	ALT				
SLOPE	0 313	0 051	0 230	0 048	0 229	SLOPE			
RUNOFF	0 011	0 313	0 156	0 052	0 261	0 590	RUNOFF		
ERODE	0 159	0 075	0 048	0 069	0 093	0 263	0 289	ERODE	
EFERTIL	0 106	0 058	0 111	0 227	0 031	0 002	0 123	0 360	FERTIL

Climatic variables

MAR	0 066	0 302	0 138	0 084	0 125	0 693	0 876	0 271	0 108				
SAI	0 049	0 239	0 079	0 000	0 143	0 691	0 754	0 119	0 069	SAI			
MAP:PET	0 109	0 202	0 032	0 181	0 259	0 567	0 602	0 220	0 051	0 639	MAP:PET		
GROWDAYS	0 119	0 207	0 176	0 057	0 296	0 129	0 130	0 280	0 348	0 109	0 037	GRWODAYS	
TMEAN	0 110	0 135	0 002	0 114	0 611	0 475	0 299	0 373	0 371	0 299	0 101	0 764	TIMEAN

Land use

MERCIAL	0 133	0 022	0 061	0 203	0 167	0 119	0 174	0 367	0 220	0 156	0 150	0 169	0 097	MERCIAL							
%CROPS	0 155	0 584	0 399	0 154	0 125	0 010	0 299	0 121	0 083	0 244	0 109	0 028	0 080	0 064	%CROPS						
%VELD	0 214	0 755	0 514	0 212	0 075	0 162	0 368	0 133	0 055	0 384	0 317	0 167	0 255	0 041	0 751	%VELD					
%FOR	0 179	0 407	0 309	0 057	0 035	0 429	0 629	0 336	0 273	0 434	0 343	0 556	0 594	0 090	0 253	0 370	%FOR				
%CON	0 009	0 218	0 135	0 346	0 104	0 451	0 292	0 247	0 064	0 281	0 163	0 243	0 337	0 127	0 255	0 222	0 306	%CON			
%SET	0 020	0 326	0 181	0 262	0 160	0 0074	0 122	0 079	0 097	0 081	0 241	0 131	0 087	0 201	0 075	0 537	0 017	0 084	%SET		
%OTH	0 086	0 085	0 009	0 223	0 024	0 106	0 227	0 310	0 130	0 056	0 061	0 317	0 332	0 185	0 105	0 039	0 307	0 225	0 152	%OTH	
LSU/HA	0 145	0 165	0 017	0 098	0 069	0 516	0 727	0 500	0 319	0 566	0 455	0 203	0 456	0 218	0 180	0 232	0 556	0 362	0 027	0 387	LSU/HA

Demographic

%UNEMPL	0 119	0 019	0 070	0 625	0 248	0 014	0 058	0 100	0 307	0 060	0 198	0 233	0 207	0 241	0 079	0 095	0 207	0 175	0 247	0 130	0 123	POPDEN			
%MALE	0 020	0 251	0 117	0 292	0 106	0 315	0 389	0 458	0 212	0 329	0 205	0 335	0 364	0 153	0 136	0 184	0 563	0 101	0 021	0 226	0 496	0 388	%MALE		
%15-64	0 056	0 112	0 020	0 236	0 006	0 104	0 157	0 391	0 272	0 021	0 044	0 252	0 194	0 230	0 029	0 032	0 355	0 056	0 089	0 311	0 294	0 410	0 688	%15-64	
%RURAL	0 152	0 057	0 086	0 153	0 111	0 275	0 360	0 166	0 021	0 344	0 206	0 067	0 026	0 310	0 016	0 001	0 169	0 009	0 056	0 039	0 387	0 227	0 610	0 454	%RURAL

Labour& employment

%UNEMPL	0 172	0 313	0 264	0 128	0 140	0 025	0 137	0 151	0 115	0 003	0 126	0 320	0 183	0 026	0 251	0 348	0 322	0 035	0 196	0 076	0 053	0 005	0 089	0 059	0 109	%UNEMPL			
AGREMPL	0 172	0 380	0 283	0 292	0 038	0 302	0 482	0 246	0 127	0 301	0 219	0 427	0 374	0 050	0 232	0 258	0 651	0 651	0 148	0 306	0 374	0 432	0 651	0 658	0 473	0 310	AGREMPL		
LABAGROW	0 150	0 316	0 267	0 236	0 041	0 134	0 284	0 168	0 159	0 045	0 214	0 614	0 425	0 036	0 055	0 206	0 505	0 505	0 236	0 245	0 202	0 017	0 318	0 327	0 012	0 349	0 310	LABAGROW	
#DEPEND	0 072	0 151	0 035	0 153	0 068	0 307	0 309	0 350	0 027	0 221	0 084	0 185	0 251	0 279	0 175	0 079	0 360	0 360	0 127	0 309	0 374	0 317	0 674	0 765	0 558	0 002	0 349	0 185	#DEPEND

Economic production

GGP/CAP	0 270	0 128	0 230	0 055	0 047	0 288	0 289	0 084	0 051	0 320	0 070	0 214	0 013	0 295	0 012	0 166	0 026	0 026	0 161	0 214	0 166	0 421	0 042	0 218	0 336	0 487	0 469	0 262	0 205	GGP/CAP		
AGRTOGP	0 106	0 173	0 147	0 195	0 109	0 199	0 33	0 032	0 157	0 250	0 167	0 104	0 092	0 054	0 054	0 017	0 268	0 268	0 045	0 032	0 181	0 269	0 355	0 322	0 390	0 479	0 009	0 251	0 251	0 311	AGRTOGGP	
AGROWTH	0 045	0 142	0 084	0 130	0 079	0 119	0 261	0 373	0 252	0 203	0 075	0 033	0 137	0 030	0 217	0 165	0 318	0 318	0 150	0 138	0 064	0 361	0 228	0 307	0 312	0 142	0 022	0 265	0 265	0 275	0 156	AGROWTH
GGGROW	0 064	0 324	0 190	0 196	0 032	0 176	0 410	0 385	0 372	0 296	0 092	0 255	0 355	0 060	0 236	0 277	0 516	0 516	0 361	0 038	0 137	0 469	0 268	0 446	0 388	0 181	0 064	0 014	0 014	0 352	0 142	0 746

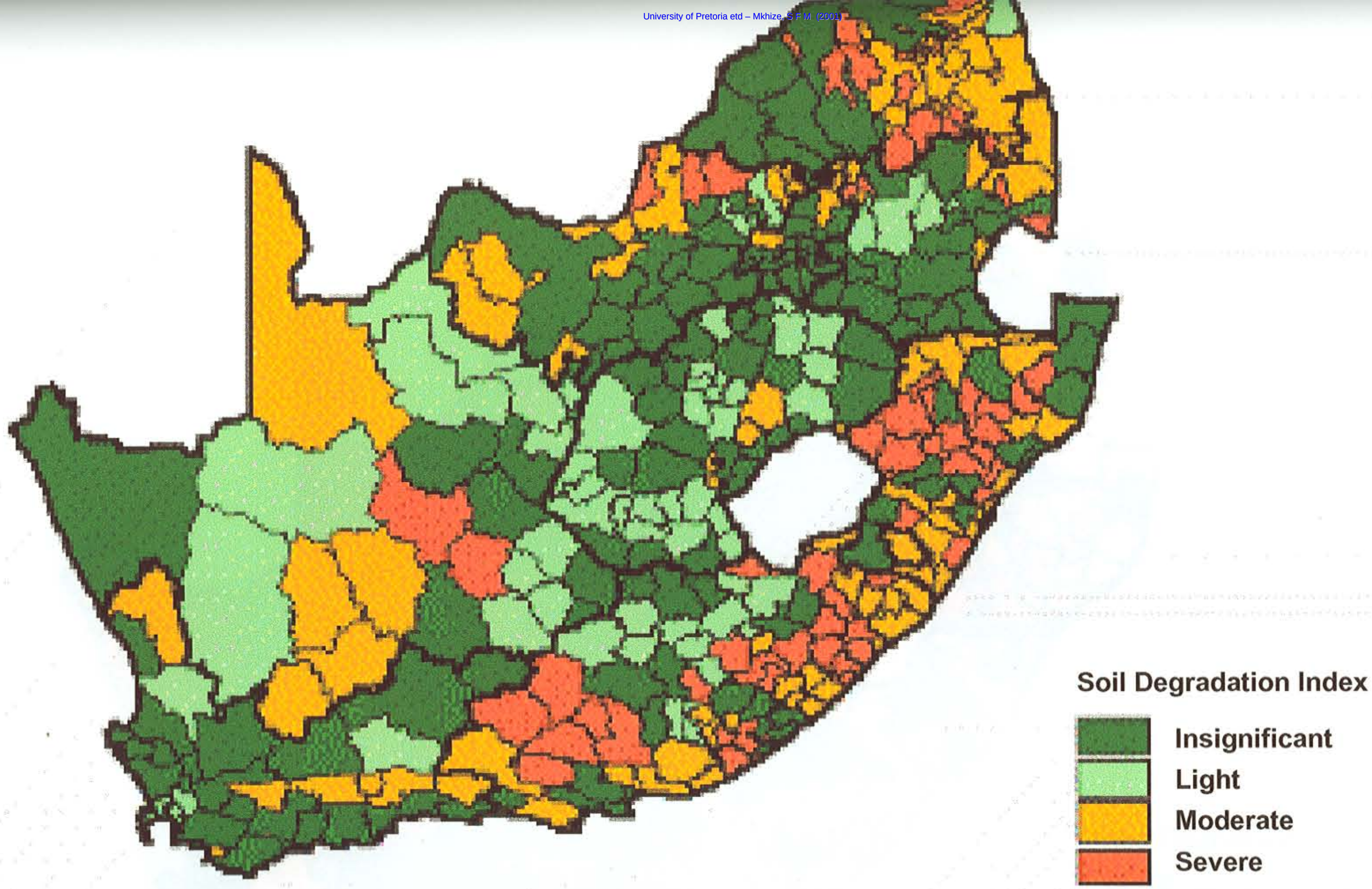

Figure 7.2: Magisterial Districts identifying degradation scores (soil degradation index)

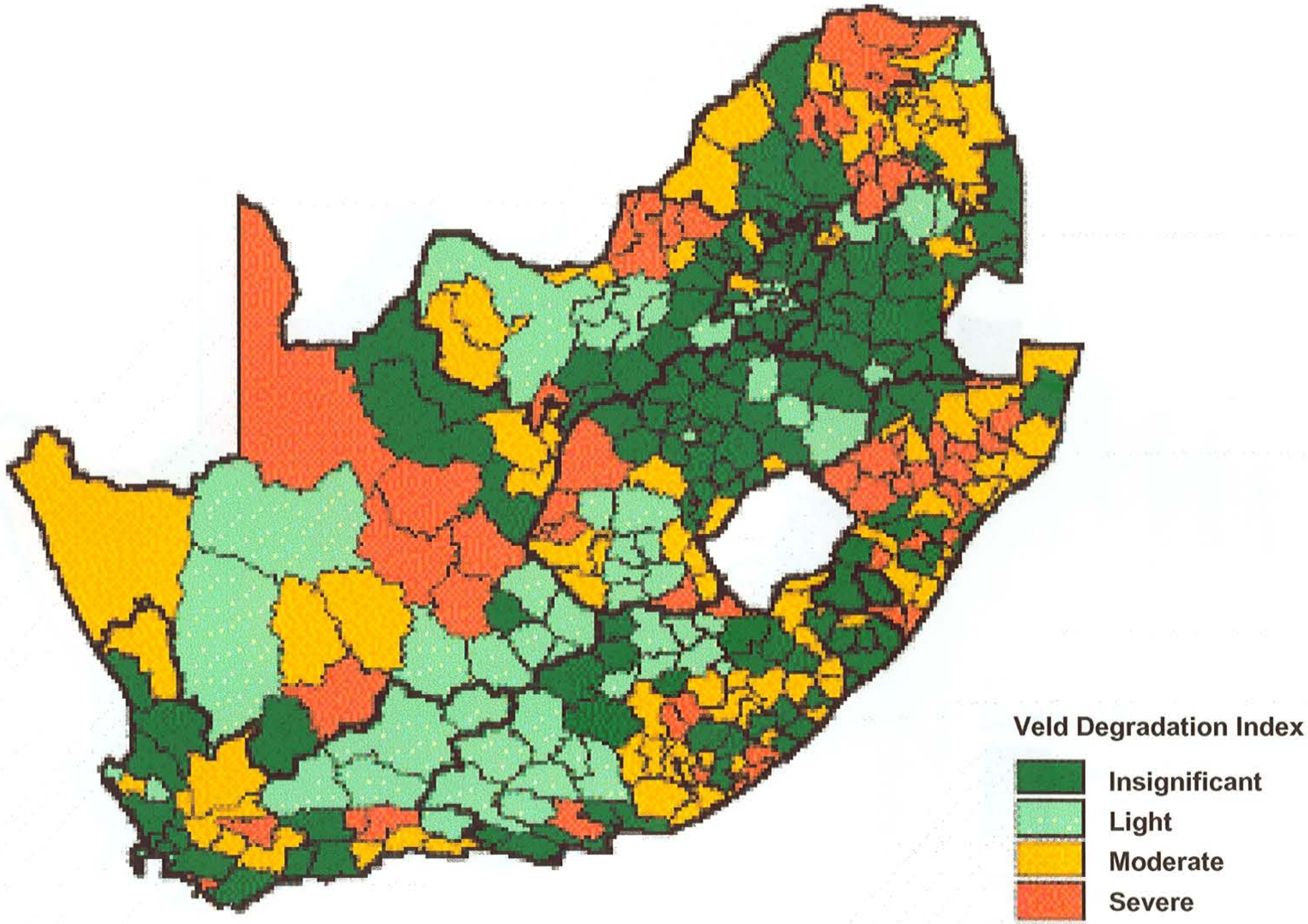

Figure 7.3: Magisterial Districts identifying degradation scores (veld degradation index)

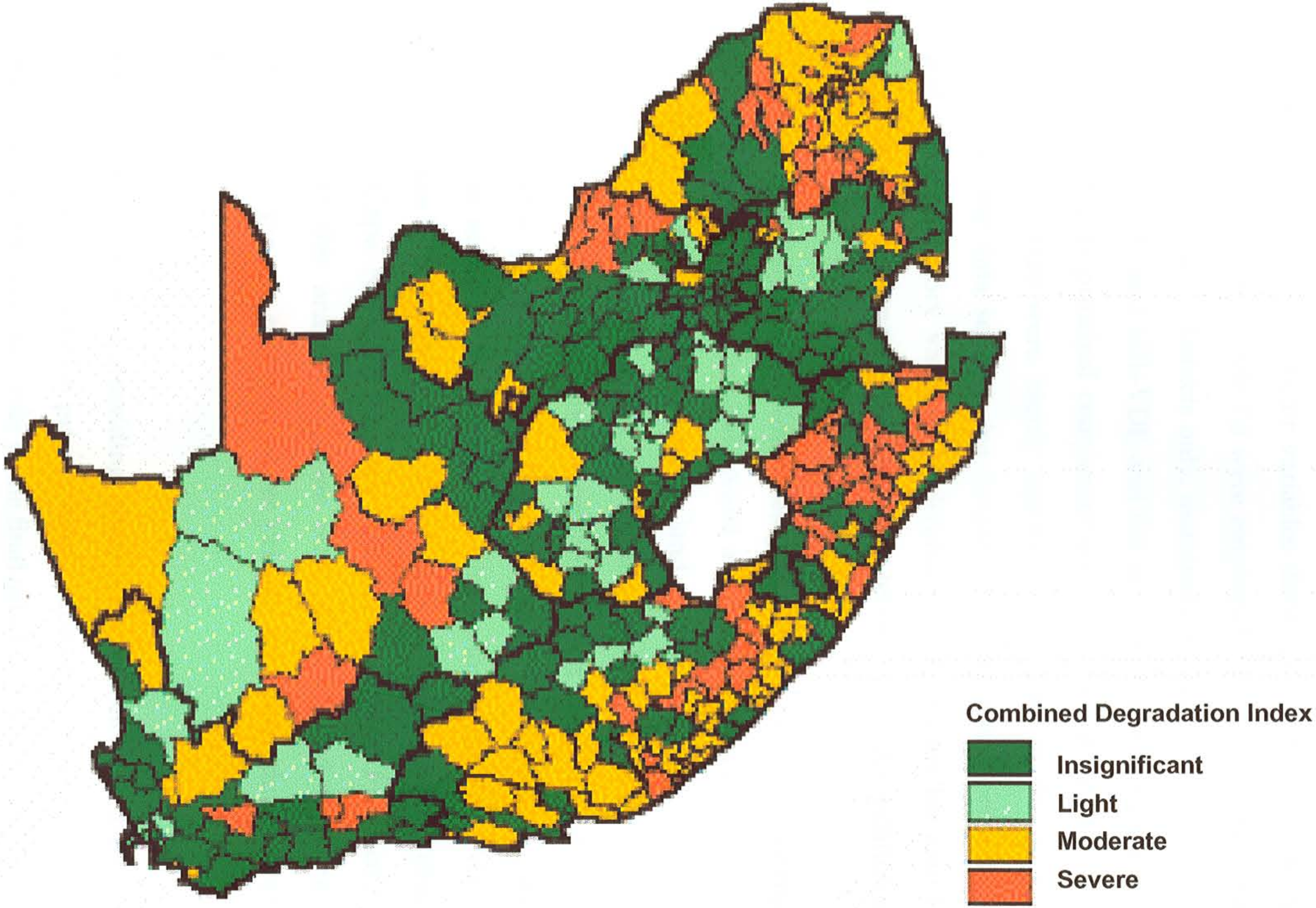

Figure 7.4: Magisterial Districts identifying degradation scores (combined degradation index)

7.4 The selection of land degradation priority areas

In this analysis both the degradation scores generated from the workshops as well as the important predictor variables developed in the nine regression models and outlined in *Table 7.5* were employed. In three separate analyses, (full data set, favoured districts only, marginal districts only) the degradation indices (SDI, VDI, and SDI+VDI) and the set of relevant predictor variables were subjected to principal component coordination analysis (PCA). In all cases the first axes were highly significantly related to the degradation gradient in the data set but also frequently incorporated other factors as significant explanatory variables. Individual district scores for axis 1 were then used to rank the magisterial districts in terms of their degradation status.

The results indicate that when considering all districts, as well as the marginal areas, the Eastern Cape, KwaZulu Natal and the Northern Province possess districts with the highest levels of land degradation. The North West Province, and to a limited extent also Mpumalanga, have one or two priority districts. When considering the FA on their own, it is again KwaZulu Natal which features prominently in the analysis. The Northern Cape also dominates in terms of the number of high priority districts. Magisterial districts in the Little Karoo of the Western Cape as well as isolated districts in the Eastern Cape, Northern Province and the North West Province are also important. In this analysis the Free State, Gauteng and to some extent Mpumalanga possess relatively fewer priority land degradation areas than other provinces.

Despite the attempts at providing some level of scientific rigour to the selection of high degradation priority areas, additional factors not considered here, will play an important role in the final set of districts selected as priority areas. Institutional capacity, levels of conflict within a district and rehabilitation potential are only some of the many factors, which could be considered by provincial and national degradation programmes. It is not a trivial task to decide on the districts and areas within the districts, which are most deserving of attention. Limited budgets make the selection and prioritisation of key areas even more crucial.

Table 7.9: The 17 magisterial districts in (Eastern Cape, KwaZulu Natal and Northern Province) identified as being priority areas in terms of their current and potential degradation status as determined by their soil, veld and combined degradation scores as well as by their values for key degradation predictor variables identified in the regression models in Table 7.4. Degradation scores and values for predictor variables were subjected to Principle Components Analysis. The 17 districts with the highest scores on Axis 1 are shown below. Axis reflects the land degradation gradient in the data set

All districts	Favoured (>80%)	Marginal (>80%)
(n =348)	(n =226)	(n =89)
Eastern Cape (8)	Eastern Cape (1)	Eastern Cape (1)
Engcobo	Komga	Herschel
Middledrift		
Herschel		
Mount Ayliff		
Mount Fletcher		
Mqanduli		
Qumbu		
Xhora		
KwaZulu Natal (7)	KwaZulu Natal (4)	KwaZulu Natal (8)
Mahlabathini	Glencoe	Mahlabathini
Maphumulo	Kliprivier	Maphumulo
Msinga	Ngotshe	Msinga
Nkandla	Weenen	Ndwedwe
Nongoma		Nkandla
Nquthu		Nongoma
Weenen		Nquthu
		Pholela
Northern Province (5)	Northern Province (2)	Northern Province (8)
Mutale	Messina	Mankweng
Naphuno 2	Phalaborwa	Mokereng 2
Praktiseer		Mutale
Schoonoord		Nebo
Sekgosese		Praktiseer
		Schoonoord
		Sekgosese 1
		Seshego

7.5 Conclusions

The picture of land degradation, which has emerged from this analysis, differs from earlier studies in several important ways. The focus of the land degradation debate has historically been on the arid and semi-arid areas. While it has raised the profile of the desertification debate nationwide, it has also prevented other degradation issues from emerging from fuller synthesis of the problem. The study suggests that while biophysical environment and climatic and human impacts are all-important influences, land degradation ultimately occurs within the key natural resources of water, soil and vegetation. They all deserve equal status until such time as the interrelationships between all three are better understood and proper hierarchies of control, influence and interaction are developed. Until now, vegetation degradation has been the dominant player in the land degradation debate. This conceptual and theoretical imbalance needs to be addressed. National databases are still being developed and the rural and marginal areas have been severely neglected in the past.

The study has shown that soil degradation is perceived as being significantly greater in the marginal areas than in the FA. The map generated from the study suggests that it is largely in the MA, and especially the grazing lands which are situated along the steep slopes of the escarpment in the eastern parts (Eastern Cape, Northern Province, and KwaZulu Natal) that the problems are greatest. The analysis suggests that magisterial districts can, in fact, exist as islands of degradation in a relatively broad matrix of less degraded rangeland. Each district is different and possesses a unique suite of biophysical, climatic, socio-economic and historical characteristics. All these issues are important if we are to understand the problem of land degradation.

Although vegetation is significantly greater in MA than in FA, the relationship is not as tightly coupled to the land tenure system as it is for soil degradation. When soil and vegetation were considered together in a single combined index of degradation the Eastern Cape, KwaZulu Natal and Northern Province were the three provinces with the highest levels of degradation. All have significant areas managed under a marginal land tenure system. Overall, combined soil is perceived to be more than twice as great in MA than in FA.

In this study the biophysical environment is perceived as a filter through which climatic and human impacts have an effect on water, soil and vegetation resources. The exact nature of the biophysical environment, however, appears an important determinant of land degradation in both FA and MA. The regression models in this study suggest that areas with steep slopes, low annual rainfall total (especially in marginal areas) and high temperatures, are significantly more degraded than other districts. The biophysical environment should therefore not be ignored in assessments of land degradation and especially in developing action programmes to deal with the problem. Climatic impacts on land degradation are difficult to assess. Historically, South Africans have rejected the hypothesis that changing climatic patterns, especially rainfall, are responsible for land degradation. This study finds continued support for this view but also notes that the last fifteen years, and especially the first half of the 1990s, have been unexpectedly dry. It is still not certain whether this is part of "normal" interdecal variability or whether there has been a significant and sustained decline in rainfall, which will continue into future.

Studies on changing temperatures suggest that there has been an increase in mean annual temperatures over Southern Africa this century and this is likely to rise even more into the future as a result of changes in green house gases. This is likely to impact severely on the land degradation status since both high temperature and low rainfall are significantly related to high levels of soil and vegetation degradation. There is an urgent need to better understand the interrelationship between climate and degradation. A complex and interrelated bundle of factors defines the role of people in land degradation in South Africa. While biophysical factors most directly explain the physical manifestations of land degradation, human actions and circumstances have a wide range of intricately interrelated, direct and indirect influences on the biophysical factors. In seeking to identify and understand the key of the role of people in South African land degradation, the analysis has been able to describe a central chain of causative links.

The nation's land allocation history must be our starting point. Rooted in South Africa's political experience, this history does much to explain the distribution, economic opportunities and land use practices of the rural population. Most directly, the history of land allocation leads to national demography and settlement patterns as the second causative link in the chain. The spatial variations in population density gender balance and age distribution between areas of favoured and marginal land tenure directly influence the ways in which land is used. However, the linkages between demography and land use practice (and hence, potentially, with land degradation) are not direct. Whether higher population densities have led to sustainable agricultural intensification or land degradation depends on two intermediate links in the chain of causation. The first of these is the land use policy that successive South African governments have applied. This analysis shows that in the favoured farming areas, this policy was at least partially conducive to sustainable land use; but that, in the MAs, it was not. The fourth link in the chain, and the second intermediate link between demography and land use practice, is the nature of rural livelihoods. Influenced by demography, economics and land use policy, the structure of marginal area livelihoods is shown to inhibit sustainable land use. The period when these livelihoods were most conducive to land degradation, may now be over. Many marginal areas are now significantly 'underfarmed'. Biomass extraction for fuel purposes, however, remains a significant threat to the natural resource base.

The most direct human contribution to land degradation, and hence the final link in the causative chain the study has identified, is land use practice. Influenced most directly by the structure and status of livelihoods, and in turn also by land policy, land use practice in the favoured farming areas has been to some extent. While farmers have contributed to widespread land degradation, conservation policies have had at least some effect in slowing that degradation and enhancing sustainable land use practice. In MA, the status of livelihoods and policy for most of this century has meant that field crop cultivation, livestock raising and the collection of fuel and other plant material have been conducive to land degradation. The above analysis does not suggest that favoured areas should now be abandoned. On the contrary, the approach should be strengthening our understanding of land degradation processes and the causes for the whole country. The interaction between favoured and marginal areas will become increasingly important in the future.

Finally, when analysed on a provincial basis, the Northern Province and KwaZulu Natal emerged as the two provinces with the highest mean CDI values followed by the Eastern Cape (*Table 7.1*). MAs in the Northern Province are perceived as being severely degraded, often for very different reasons. In many instances some of the most degraded districts, in the country are located adjacent to magisterial districts which are perceived to be relatively undegraded. Although there are many exceptions to the general rule, it appears that marginal areas in South Africa are perceived to be more degraded than favoured areas if soil and vegetation degradation are the assessment criteria.

Chapter 8

DISCUSSION AND GENERAL CONCLUSIONS

8.1 Introduction

The study has raised many questions on: the interpretation of "marginal lands"; the advisability of using very coarse-grained indicators of biophysical capability of land as a basis for programming the agricultural research activities; the credibility of estimates relating to rural population and land types; and, what is meant by poverty eradication with respect to its links to research delivered by the national agricultural research system. In summing up, the study finds that the definition of "marginal" depends on so many qualifiers that it becomes meaningless in an operational sense. This is illustrated by the fact that land can be "marginal" depending on:

- its use;
- its natural biophysical **characteristics;**
- its **location relative to infrastructure** such as roads, railroads, harbours, and cities;
- **the institutional and policy context which influences access of inhabitants to land, water, credit, markets, outside inputs;**
- **population pressure;**
- **technology development;**
- taking advantage of **niche opportunities.**

Lands move out of and into marginal status depending on which of the above dimensions are applied in the definition. (*It only makes sense to define "marginal land" in terms of a clearly defined, specific situation*).

8.2 Poverty Process on MA

The study considered the forces driving the processes, which retain people in poverty on MAs, in terms of the inter-relationships between the resources and knowledge available to these people and their incentive to use them for sustainable enhancement of livelihoods. This relates to the question of constraints of the poor to access knowledge, natural resources, markets and off-farm income opportunities (including the option to migrate). Constraints are generally regarded as rooted in institutions and policies. MA, because of characteristics such as their isolation, perceived low and risky productive potential and the insignificant economic and associated political power of their inhabitants, typically has been neglected by central government. As a result, only limited public investment has been made in education, health, infrastructure, etc. Little interest has been shown in determining the aspirations of marginal people or their knowledge of how to cope with harsh environments as a basis for focusing public action responses to their capabilities and needs. In view of the high costs of providing quality non marginal rural areas, industry, services, it would be sufficient to attract migration on a scale which would increase the resource base (and income) per capita for the residual population.

Populations in many MA are increasing in absolute numbers in spite of migration, and the increase is likely to continue, probably at a decreasing rate, for some decades. Without investment in the "resource base" of these people, with expanding populations the expectation can only be progressive extension of poverty and degradation of the soils and forests on which they depend for a large part of their sustenance. In agriculture, inappropriate research has been blamed for not taking into account indigenous knowledge and the opportunities and constraints, which apply to the site-specific characteristics of MAs. Thus, it is asserted that few research results have led to widespread or significant improvement in the welfare of marginal people. This is undoubtedly true in many instances, but is merely one symptom of the underlying cause of marginality, i.e. the institutional and policy arrangements. Without any negotiating leverage by marginal communities on the decision-makers responsible for the amount and type of investment in MAs, these investments tend to be small and poorly adapted to the requirements of the people. This applies equally to agricultural and extension investments (and other areas such as education, health or infrastructure) which have been unable to respond to complex diverse requirements for sustainable exploitation of opportunities deriving from natural resources and value adding micro-enterprises. However, the problem is not technology as such. It is rather the institutional arrangements which determine: what and how agricultural research and extension is carried out, together with the whole range of support services (credit, roads, communications, schools, etc.); resource entitlements; the functioning of markets; and local capacity to manage their own affairs (Jodha, 1995).

8.3 Recommendations for Future Research

Although it is clear that by discarding the biophysical criteria for defining ML, it is violating the spirit of the terms of reference. By redefining the issues in terms of MAs which may occur on any combination of FL and ML, the issue of poverty eradication is being placed in a **global** context, rather than being confined to marginal lands and the rural poor who derive a large part of their livelihoods from them, and who *a priori* are believed to have been by-passed by the Green Revolution. Nevertheless, it is sustained that this is merely another way of cutting the pie. The key question is still where are the concentration of poor who have been by-passed and ignored by the previous regime and who were missed by agricultural research and other priorities of the country. The criterion for distinguishing the by-passed from the non-by-passed rural poor is different. One way to reduce the scope of a "marginal lands" study in the initial stages, would be to exclude any consideration of MAs on the vast areas classified as FL. One might justify this on the grounds that these are the areas which most clearly have benefited from the previous order - if there is residual poverty in this area, this could be addressed as part of a countrywide rural poverty study, however, the conclusion is that because of:

⇒ heterogeneity of ML and FL in landscapes,

⇒ the likely overriding importance of institutions in defining MAs,

⇒ the linkages between MAs and non-MAs in poverty eradication within MAs,

⇒ the critical importance of income in poverty eradication which dictates a research focus on : food and non-food products (and associated value added); opportunities and constraints to off-farm sources of earnings (not incorporated in the definitions of FL and ML), and

⇒ the likelihood that definition of MAs on non-favoured areas will probably spill over into definition of MAs and FALs, again because of country or region specific institutions driving the poverty process, it would be more efficient to specify MAs without regard to an arbitrary distinction between biophysically favoured and marginal lands.

In addition to the role of favoured lands in poverty eradication for present and future rural populations in MAs, there is also the question of research directed to the poor on favoured lands themselves. This is a fundamental strategic question for the South African agricultural research in terms of the balance among research investments, which address a range of rural population target groups from a poverty eradication perspective. There is a continuum from investments designed to: rehabilitate the productive capacity of the resource, i.e. reverse the degradation process; conserve the "state" of resources, and implicitly their yield capacity; and enhance yields. The first two are land improving investments; the third is "technological change" (Scherr and Yadav, 1996).

It is evident that priority of research related to poverty eradication in all areas (favoured and marginal) through changes in the cultivated area, employment and income generated on FAs by reducing shifts to lower productivity, investment in productivity increase, human capital, physical infrastructure and institutional change, should be judged by the cost- effectiveness of research expected to have poverty eradication impacts for the various target groups. The study has made us to realise that we are a long way from specification of these target groups. Nevertheless, the linkages and dynamics of movement among classes of land and changes in the numbers and location of rural poor, dictate that any strategy of rural poverty eradication on marginal lands take into account the social cost-effectiveness of research favoured lands, and should incorporate the spillovers to other areas. The framework for cost-effectiveness analysis is discussed in *Box 8.1*.

BOX 8.1

Conceptual Framework for Analyzing Research Investments in Poverty Eradication in a Marginal Lands Context

Targeting research investment to a given area of marginal land, A.

In a *sustainable poverty eradication context*, but with a focus on production crops (food, livestock, forest or fish), the contribution of national agricultural research "I" to poverty eradication can be formulated conceptually as follows:

$$\{(A_I) \times (Y_I)\} \times (I_{pop}) + OF_I + S_I = G_I \qquad (1)$$

where,

A_I = size of area that benefits from agricultural research i.

Y_I = average *sustainable* net income (or net benefit or use value) increase per unit area due to agricultural research i (where "sustainable " incorporates the environmental protection constraint; and "net" income means benefits actually captured by the farmer net of associated costs of achieving the benefits; the benefits can come from policy gains as well as productivity increases; values appropriately adjusted to present value (PV) terms through use of appropriate discount rate).

I_{pop} = index for number of poor people gaining or benefiting from (Ax Y_I), weighted for: (a) degree of poverty affected (e.g. proportion "poorest of the poor"); and (b) extent to which those other than the producers of (Ax Y_I);

OF_I = measure of net gain from off-farm activity in A due to research i, weighted for the extent to which poor people benefit from the gain (again, in PV terms);

S_I = spillover impacts, or externality impacts (in PV terms);

G_i = measure of gain from research in, (which, given the left side of the equation, is a measure of production increase, or net income increase, due to the research, weighted for a poverty alleviation objective);

As mentioned, this formulation considers poverty eradication impacts with a focus on agricultural, forestry, or fisheries production. If we limit consideration to marginal agricultural lands (MAL), then A of course would reflect the particular MAL area being considered. However, as discussed below, the formulation will be used to look (at least conceptually) at types of land (both FAL and MAL).

In this format, we are asking the following question: given the potential area for crop x or y, what kind of per hectare income increase could be generated by research related to this crop? (Obviously, in order to identify relevant A, we have to have some particular crop in mind.)

Targeting research investment to a given marginalised population

We can also change the formulation to make the primary objective be poverty eradication. This then would be primary determinant of G_i for a given agricultural research investment, i, in terms of a given target population of poor or marginalised people (some farmers, some perhaps not). If one takes a poor people focus and looks at research investment from that perspective, then the following formulation might be more appropriate:

$$(P_{OPi} \times Y_{pop}) + Si = G_I \quad (2)$$

where,

P_{Opi} = population of poor people targeted by research i; population could be associated with any number of characteristics that relate to poverty)

Y_{pop} = average per capita net benefit flow gain for Pop_i due to agricultural research i (such research could be focused on crops and other things that could generate benefits)

S_i and G_i = as before, except G now is expressed in terms of poverty eradication measure;

Given the above formulations, which equally to "marginal" as to 'non marginal" lands, there is no necessary reason why, for a given ($A_i \times Y_i$) or ($P_{OPi} \times Y_{pop}$), the national agricultural research should be interested more in marginal versus non marginal lands, except *if the marginal lands (defined by A) have proportionally larger populations of poor people who can gain from changes due to the research*[a], i.e. the I_{pop} that applies is higher; or Pop_i for the marginal lands is higher, other things being equal. These Ipop and Pop_i conditions define "marginal areas" (MA) used in the study regardless of whether the lands on which this lives is biophysically marginal or favoured.

From a strategic public investment point of view, maximizing returns (G) per unit of scarce research resource ($R) may be regarded as a rational criterion for allocation; (where $R is amount invested to get the response G). Thus, we have a measure of *research investment efficiency* as follows:

[a] Also, aside from question of research efficiency, there is a question of distribution of benefits. This is taken into account by the question above through I_{pop} and the discount rate used.

<u>Research investment efficiency.</u> This could be measured by Gi per $ of South African government research funds and associated research expenditure, when both are appropriately discounted to the same point in time:

$$(G_i \;/\; \$R_i) \qquad = \text{research efficiency;} \tag{3}$$

We would want to find that set of research opportunities that maximizes G for the research budget (i.e. we would seek to maximize the net present worth of the research investment).

We can further modify this formulation to look at the *social cost-effectiveness* of research investments - where should be the ultimate objective sought, once we have eliminated all those potential research investments that have $G_i < \$R$.

<u>Social cost -effectiveness or "impact".</u> ($G_i/\$R_i$) only considers the efficiency element, i.e. production of the research results. The real aim is to get research in place in the farmer's fields or in the forest or on the grazing lands. Thus, we need to introduce $\$E_i$ or the extension and transfer costs, to come out with an array of opportunities ordered on the basis of:

$$G_i/\$R_i + \$E_i) \tag{4}$$

Adding $E to the equation assumes that the South African agricultural research community is interested in research applied on the ground as an ultimate test of success - the $E may not come from the from the South African government, but has to considered, since it is a necessary cost of getting research in use. This also raises a question on the need for research into institutional determinants of $E.

Finally, we also have the strategic question of equity, or distribution of benefits, as a criterion for allocation. If the calculations of Gi in relation to $R and $E do not produce results that are acceptable, then the decision-makers need to go back and discuss and possibly readjust Ipop or the discount rate.

(I have decided to put this formulation only as an annex, since it represents only the beginning of thinking for a broader discussion of priority setting. However I feel it worth being included and tried in the study, since it does provide a conceptual perspective on the differences and similarities that exist when one focuses on a land/productivity measure of research return versus a poverty eradication measure).

The dilemma of research on MAs as vis-à-vis FAs has been characterised by de Wit (1990) – "well endowed areas because are able to meet demands at relatively low prices…this marginalises less endowed regions because their terms of trade are eroding. Scarcity of funds, and lack of political power of (these) areas makes it unlikely that the transfer of money that would be needed to revert such marginalisation processes will occur in the foreseeable future.... Agricultural research which is oriented to improvement of least endowed areas may open up new possibilities in some situations. However, in many cases its results are more readily applied in areas that are better off." Accepting this premise, a key issue is the weighting of poverty in the formula discussed in *Box 8.1*.

With the above in mind, the study comes up with the following first recommendation:

<u>*Recommendation 1:*</u> *The National Department of Agriculture (NDA) and the Agricultural Research Council (ARC) need to sharpen their strategic focus on poverty eradication, particularly in setting priorities for research related to marginal areas. A prerequisite is development of a geo-referenced database linking biophysical land conditions with poverty, and incorporating the processes that produce it (i.e. the dynamics of poverty).*

In order to meet this challenge, it would need to develop a database relevant to the design assessment of options that lead to more effective impacts on income of the rural poor in highly diverse marginal areas. Elements of this database will be the soil, climatic and terrain conditions. However, it came out from the study that there are many other elements which are equally or more important - production systems, human capital, market access and infrastructure, institutional and policy constraints and the number and location of the rural poor with respect to some or all above characteristics. A logical place to start this activity, would be the ARC –Institute for Soil, Climate and Water, and the Directorate Land Resource Management (D: LRM) expertise on the geographic areas within which they deal; perhaps initially by developing an intuitive GIS which can be progressively improved by formal and informal methods. The issue of site specificity, diversity and complexity must be addressed to identify points of entry, which are relevant and consistent with the national agricultural research scale. The question here is the extent to which agricultural research may move towards targeting site-specific (or through a typology, situation-specific) rural poverty through research which meets the "public goods" criterion. Meeting this recommendation is regarded as a prerequisite to action on the three other recommendations prescribed in this study. The study is convinced that the national agricultural research and scientific expertise coupled with their field experience in most, if not all, of the diverse MAs, represent a unique resource in coming to grips with the information/analytical challenge.

8.4 The Role of NDA in Removing Constraints

It is now clear that the nature and causes of the poverty found on MAs vary widely with the type of conditions, which determine marginality of the rural population. Thus, there are significant differences between the poor farmer on the mountainous hillsides of the Drakensberg, the farmer surviving on the fringes of the Kruger National Park or in the Limpopo Basin, and the farmer on the drylands of the Transkei woodlands. The solutions to eradicate poverty for the inhabitants of these diverse lands are as varied as the situations encountered. However, there are some common threads – some common requirements and opportunities – that relate to most of the diverse rural poverty situations encountered. These involve the actions that are necessary to deal with the resource, knowledge, and incentive constraints that are the fundamental barriers to poverty eradication. Thus, the study has identified three types of requirements that all situations have in common:

- **Reforming policies and institutions.** This involves improving the social, institutional, and physical infrastructure (access to markets and market information; price policies; access to credit and essential purchased inputs establishment and strengthening of markets; improved property rights; improved roads, communications, transportation, and so forth);

- **Generating and diffusing new improved technologies.** This applies to crop, livestock, forestry, agroforestry, and fisheries. The new technologies need to fit the various biophysical and institutional characteristics and constraints of the diverse agricultural and associated lands;

- **Diversifying land use systems and income opportunities.** This includes increasing access to off-farm employment (e.g. through forestry, fisheries, and agro-industrial opportunities associated with improved postharvest technologies, small-scale enterprise development, etc.).

It is emphasized that it generally takes integrated action in all three areas to break the 'vicious circle' of poverty and to move a marginal population along the development path. Because these three basic requirements are common in principle and concept (although not in operational detail) for nearly all marginal land-poverty types, they provide promising areas in which to search for the public goods research opportunities, which are the focus of the agricultural research supported by the government.

8.5 The way ahead for the NARS

The road to poverty eradication for the poor living on MAs is a rocky and twisting one. Negotiating it would require concerted effort by many parties, hopefully working in concert and in a coordinated and effective way together. The role of NARS will be a major and crucial one. What it can do, is essential to the process. Basically, the study sees the NARS as being able to move further in three main directions:

(a) It can provide support to policy and institutional reform, through its work on the identification of poverty processes and constraints to its eradication; work in the area of identifying, locating, and classifying the areas and types of poverty for which it is best equipped to address; and work in the area of policy and institutional strengthening.

(b) It can continue with its mainstream work with commodity improvement in agriculture, forestry, agroforestry, and fisheries, but with added emphasis on breeding and agronomic work related to the needs of MAs conditions, e.g. drought tolerant varieties, work on integrated soil nutrient and water balances and utilization, work on IPM and other more environment friendly approaches to agricultural intensification and improvement (e.g. organic production practices).

(c) It can continue on the path of increased support to natural resources management research, and research related to land use diversification and land use systems approaches to the problems of MAs.

It became clear that a focus on poverty eradication brings with it a number of challenges related to the identification, development and organization of research. Poverty eradication as an over-arching objective, implies a set of actors and a set of actions that go far beyond the areas in which the government has strengths. The key to success is the establishment of the right kinds of partnerships. Its focus on systematic accumulation and dissemination of information and on methodology for addressing complex site-specific rural poverty situations should provide the necessary legitimacy to attract other actors. Thus, the study recommends that:

<u>Recommendation 2:</u> *The agricultural role players should establish new forms of partnerships in order to effectively address their roles in a broader poverty eradication strategy related to those who live in marginal areas.*

The study convinces that the poverty eradication focus can help provide impetus for development of innovative and effective approaches to partnerships. Such partnerships will depend on finding complementary sources of funding for all partners involved. It would also imply development of incentives for long-term collaboration and cooperation, since poverty eradication is an evolutionary process.

There is considerable pressure to expand research designed to reduce the rate of resource degradation, which has led to encroachment on forests, salinisation, loss of wetland and erosion. Results are manifested in severe shortages of fuelwood, the drying up of springs and streams, loss of valuable and relatively unique sources of genetic diversity. For example, some of the richest areas of biodiversity in the St Lucia area, in KwaZulu Natal, are under threat of disappearing due to changes in land use management. Better information is needed on degradation processes, couched in the context of issues related to fragility and resilience, and to consideration of issues related to pollution, biodiversity loss and loss of other environmental services. Thus, the study puts forth the following two recommendations:

<u>Recommendation 3:</u> *The cluster departments (NDA, DWAF, DEAT) should develop improved mechanisms by which it can be involved with other partners in generating and interpreting improved scientific evidence on: (i) the extent and magnitude of the impacts of agriculture, forestry and fisheries on the degradation or enhancement of natural resources and consequences for production and food security; and (ii) the linkage between poverty and observed resource degradation.*

<u>Recommendation 4:</u> *Expanded collaborative mechanisms and activities should be developed among the cluster departments and their partners to help focus research and institutional strengthening on issues related to adoption, adaptation, and utilisation of research results that so far have remained unused.*

The main concern is that recommendations related to expansion of research particularly on technologies, should be realistic and should take into account the problems in dissemination and adoption of such research. In a poverty eradication context, the poor would not benefit from more research if the results merely sit on the shelves of the scientists and their agencies. This recommendation links closely to the discussion in the following section related to developing a better understanding of the aspirations and incentives of the poor from MAs.

8.6 GENERAL CONCLUSION

Finally the study confirmed three of the four tenets of conventional wisdom, of which the first is: marginal lands are defined in biophysical terms which establish them as having low inherent productivity for agriculture; being susceptible to degradation; and involving high risks for agricultural production. The study raises four key issues, which will guide future research and resource allocation, decisions for reducing poverty in these marginal lands:

- *Potential of biotechnology and agroforestry for the marginal lands*

One of the defining features of the Green Revolution was that the new seeds fared better with complementary input packages including water, fertilisers, and chemicals for crop protection. Hence, there was complementarity between the new technologies and quality of the resource endowment. For this reason, Green Revolution innovations were better suited for favoured agricultural lands, and research for marginal lands appeared to offer a lower rate of return. Subsequent innovations, with a perspective on the poor and marginal lands, sought to help substitute for resources rather than pursuing complementarities. These innovations can, for example, complement pesticide use (genetic resistance), fertilisers (nitrogen fixation), tillage practices, and water (drought resistance). Biotechnology, e.g., genetic maps and markers, possibly GMOs, now offers the promise of making it faster and less costly to achieve these goals. Following this logic, technological innovations derived via biotechnology and applied to particular contexts through GIS mapping, may promise higher rates of return for marginal areas than earlier technology did. How this potential will materialise, thus deserves significant attention.

- *Determinants of poverty*

Poverty in marginal lands is a complex phenomenon, where access to productive assets, public goods investments, institutional arrangements, and cultural and social factors are all-important determinants. Hence, a cautious analysis of the determinants of rural poverty in marginal areas needs to be made, with a full accounting of the role of different factors including the biophysical context and the technological practices used. Caution, however, must be exercised, as a technological solution may not be the most cost-effective. It is quite possible that other constraints are more limiting on welfare than productivity in resource use as determined by technology. Hence, a comprehensive effort needs to be made to identify the specific determinants of poverty in marginal lands as well as the return from investing in agricultural research compared to other types of interventions such as infrastructure, improved control over assets (human capital in particular), and designing the institutional framework. Understanding the potential of agricultural technology for the MAs consequently deserves a broad interdisciplinary effort before resources are committed to research on technological innovations specialised to these areas. Given the large degree of heterogeneity of situations, this research needs to be done at the local level, followed by comparative analysis to seek broader generalisations.

- *Locus and mapping of the poor*

Having access to reliable and well-documented data on the number and location of the poor is essential in identifying viable strategies to eradicate poverty. Several institutions are already engaged in activities to identify specific areas of poverty concentration and to map their agroecological characteristics.

- *Marginal Lands and Water*

Again the government is well positioned to address water/land/poverty linkages beyond irrigation. Water insecurity appears to be a main poverty feature in marginal lands of arid areas and hillsides. Improvement efforts for marginal lands should continue to recognise explicitly the scope for supply and demand of water, the management of its use, and access to water especially by the poor.

SUMMARY

RURAL POVERTY AND LAND DEGRADATION: A Determinant Study for Natural Resource Management in Marginal Lands of South Africa

The study is driven by the objectives of reducing poverty, enhancing food security, and promoting sustainability in the management of natural resources. Its terms of reference calls for suggested priorities for research in these areas and an assessment of the appropriate balance of effort between marginal and favoured lands. It focuses on the three poorest provinces: Eastern Cape, KwaZulu Natal and Northern Province. Interviews, analysis of relevant documentation and participation in the form of 12 workshops with agricultural personnel served as inputs.

The review of poverty took cognisance of the multi-faceted nature of poverty, the socio-economic conditions that support it and the processes that perpetuate poverty. The income, basic needs, food security, livelihood strategies, human development, and approaches are discussed, and the districts identified as poorest were all part of the former homelands. More than half of the labour force is unemployed, and nearly half of the households depend on transfers as their primary sources of income. The poorest 20% of households are mainly rural. Lack of disaggregated data for comparison across districts, provinces and time periods are problematic. Nevertheless, they provide sufficient guidelines for identifying the most deprived communities where intervention aimed at poverty eradication, are most needed.

A broad definition of land degradation is provided; the focus is on the physical or biological effects, with land-use methods seen as the ultimate causes of degradation. Looking at causes of land degradation, many factors are involved. For example, the influence of climate, especially long-term changes in rainfall patterns for South Africa, has still not been conclusively

demonstrated. Thus, the role of people as a driver remains difficult to unravel. This context provides a diverse, complex and interdependent range of determining influences that translate to human impacts on land resources. The bulk of the study's assessment of the role of people in land degradation refers to South African theory and experience, and the nature of this experience dictates that the analysis distinguish between 'favoured' and 'marginal' areas.

Poverty and land degradation: It failed to provide support for a view implying that the poor are the prime cause of resource degradation on ML. In reviewing the data presented on the location of poverty, poverty incidence and the allocation of government resources to ML and FL, the study concludes that the inconsistencies and lack of data about the underlying site-specific forces driving the poverty process, this invalidates the use of general conclusions for guiding strategy towards poverty eradication on marginal lands.

Finally, the study comes to grips with site specificity and the biophysical and non-biophysical elements, which explain poverty in order to design research in the expectation that poverty impacts can be evaluated. It closes by raising four key issues and recommendations, which will guide future research and resource allocation decisions for reducing poverty directly or indirectly in marginal lands; these revolve around the potential of biotechnology and agroforestry, for marginal lands, determinants of poverty, locus and mapping of the poor, and marginal lands and water.

BIBLIOGRAPHY

ACOCKS, J.P.H. 1975. Veld types of South Africa Memoirs of the Botanical Survey of South Africa No. 40. Pretoria. Botanical Research Institute.

ADAMS, W.M. AND M.J. MORTIMORE. 1997. Agricultural intensification and flexibility in the Nigerian Sahel. *The Geographical Journal* 167, 150 - 160.

AGRIFUTURA. 1995. *Agrifutura*, 1994/95. University of Stellenbosch. Stellenbosch.

AINSLIE, A. 1997. Rural livelihoods and local level natural resource management in Peddie district. Grahamstown: ISER, Rhodes University.

ANDERSON, J. R. AND J. THAMPAPILLAI. 1990. Soil Conservation in Developing countries: Project and Policy intervention. Policy and Research Series No.8 Policy Research and External Affairs. World Bank. Washington DC.

ANONYMOUS. 1923. Final Report of the Drought Investigation Commission. Government Printer. Cape Town. U.G. 49-'23.

ANONYMOUS. 1951. Report of the Desert Encroachment Committee. Government Printer. Pretoria. U.G. 59/1951.

ANONYMOUS. 1986a. Agricultural Development Programme of the Highveld Region. Government Printer. Pretoria.

AUERBACH, R. 1997. People and South African Integrated Catchment Management. Water Research Commission Report No.684/1/97.

BEINART, W. 1984. Soil erosion, conservationism and ideas about development: a southern African exploration, 1900 - 1960. *Journal of Southern African Studies* 11: 52 - 83.

BEINART, W. 1996. Soil erosion animal and pasture over the longer term: environmental destruction in South Africa. In Leach, M and R. Mears (eds): The lie of the land. The International African Institute, London.

BINSWANGER H.P. 1989. "Brazilian Policies that Encourage Deforestation the Amazon". World Bank Environment Department Paper No. 16. Washington DC.

BLAIKE, P.1985. The political economy of soil erosion in developing countries. Longman Group; Harlow.

BLAIKE, P. AND H. BROOKFIELD. 1987. "Land Degradation and Society". Methuen & Co., London.

BOND, P. 1998a. Uneven development, in P O'Hara (ed.), "The encyclopedia of political economy". London: Routledge.

BOSERUP, E. 1965. The condition of agricultural growth. London: Allen and Unwin.

BOSERUP, E. 1981. Population and technological change. Chicago: University of Chicago Press.

BOUCHER, K.1991. *The effect of pineapple cultivation on factors influencing soil erodibility in the eastern Cape, South Africa.* Unpublished MSc thesis. Rhodes University, Grahamstown.

CARTER, M. AND J. MAY. 1997. Poverty, livelihood and class in rural South Africa. Paper delivered at the Land and Agriculture Policy Centre conference on Rural Poverty and Sustainable Livelihoods. Johannesburg.

CENTRAL STATISTICAL SERVICE, 1991. Agricultural survey. Pretoria: CSS.

CENTRAL STATISTICAL SERVICE, 1994. Gross Geographic Product at factor incomes by kind of economic activity and magisterial district, 1991 Statistical Release P0401. Pretoria: CSS.

CHATURVEDI, S.1996. "Rural enterprise development: the Stutterheim experience in South Africa". Manual prepared for the Stutterheim Development Foundation. Stutterheim:

CHUTTER, F. AND J. ROUSSOW. 1992. The management of phosphate concentrations and algae in Hartebeesport Dam. Water Research Commission Report No. 289/1/92

COOPER A. 1996. Soil conservation policy in South Africa, 1910- 1992: The 'Human Dimension'. Unpublished Ph.D. thesis, University of Natal, Durban.

CROSSON P. R. AND J. R. ANDERSON. 1992. "Resources and Global Food Prospects: Supply and Demand for Cereals to 2030". World Bank Technical Paper No. 184, World Bank. Washington DC.

CROSSON, P. R. AND J. R. ANDERSON. 1993. "Concern for sustainability: Integration of Natural Resources and Environmental Issues in the Research Agendas of NARS". ISNAR Research Report No.4. The Hague.

DAY, J.A. AND J.M. KING. 1995. Geographical patterns, and their origins, in the dominance of major ions in South African rivers. *South African Journal of Science* 91: 299-306.

DBSA, n.d. Land use, agricultural productivity and farming systems in southern Africa. Midrand: DBSA: unpublished paper.

DE VILLIERS, JM. 1962. *A study of soil formation in Natal.* Unpublished Ph.D. Thesis. University of Natal.

DE WET, C. J.1990. The socio-ecological impact of development schemes in the 'homelands' of South Africa. *South African Journal of Science* 86: 440 – 447.

DE WIT, C. T. 1990. "Understanding and Managing changes in Agriculture" in J.W.G. Jones (ed.) System Theory Applied in Agriculture and the Food Chain, Elsevier.

DEPARTMENT OF AGRICULTURE (NATAL REGION). 1991. Erosion studies using natural runoff plots. Facet progress report for 09/91. Unpublished report.

DURAIAPPAH, A. 1996. "Poverty and Environmental Degradation: A Literature Review and Analysis". CREED Working Paper Series No. 8, IIED. Amsterdam.

EDWARDS, P.J.AND D.M. SCOTNEY. 1978. Site assessment for pasture production, *Proceedings of the Grassland Society of South Africa*, 13: 65-70.

EASTERN CAPE SOCIO-ECONOMIC CONSULTATIVE COUNCIL (Ecsecc). 1998. *Local economic development in the Eastern Cape: a people-driven option.* Unpublished discussion document.

FAN, S. AND P. HAZELL. 1997. "Should India Invest More in Less Favored Areas?" IFPRI, EPTD Discussion Paper No 25, April 1997. Washington DC.

FAO. 1989. "Soil Conservation for Small Framers in the Humid Tropics" FAO Soil Bulletin 60, Rome.

FAO. 1995. "Special Programme on Food Production in Support of Food Security in LIFDCS: Advisory Note on participatory Analysis of Constraints and Opportunities".

FAO. 1996. "Lessons from the Green Revolution – Towards a New Green Revolution" FAO Technical Background Doc. 6, World Food Summit, 13 – 17 November 1996, FAO, Rome.

FAO. 1996. "Women Feed the World", FAO Fact Sheet, World Food Summit, 13-17 November 1996, FAO, Rome.

FAO. 1996. "World Agriculture: Towards 2010". N. Alexander, (ed.), John Wiley and Sons.

FITZPATRICK, RW. 1978. Occurrence and properties of iron and titanium oxides in soils along the astern seaboard of South Africa. University of Natal, Pietermaritzburg. Department of Soil Science and Agrometeorology. Unpublished Ph.D. Thesis.

FOSTER, J., GREER J., AND E. THORBECKE. 1984. "A Class of Decomposable Poverty Measures". *Econometrica 52: 761-766*

FRD, 1992. "Rural Poverty Alert: challenging science and technology". *FRD Report Series.*

FREEBAIRN, D.K. 1995, "Did the Green Revolution Concentrate Incomes? A Quantitative Study of Research Reports". *World Development*. Vol.23, pp 265-279.

FUGGLE, .R.F AND M. A. RABIE. 1992. *Environmental Management in South Africa.* Cape Town: Juta & Co.

GARLAND, G.G. 1988. "Experimental footpath soil losses and path erosion risk assessment in the Natal Drakensberg". Unpublished Ph.D. thesis, University of Natal, Pietermaritzburg.

GARLAND, G.G. 1995. Soil erosion in South Africa: technical review. National Department of Agriculture. Pretoria.

GREY D. AND O. JACOBS (n.d). The impact of harvesting on forest site quality. Unpublished Report.

GREPPERUD, S. 1997. "Poverty, Land Degradation and Climate Uncertainty". *Oxford Economic Papers.* October 49 (4) 586-608.

HELLAWELL, J.M. 1986. Biological indicators of freshwater pollution and environment management. Elserivier Applied Science; London.

HILL, KAPLAN, SCOTT INCORPORATED, 1987. Ciskei National Development Plan. Johannesburg: Hill, Kaplan, and Scott Incorporated.

HUMAN SCIENTIFIC RESEARCH COUNCIL (HSRC). 1991. Education Foundation. Reference in Posel, D and J, May. A sub-regional study for KZN: a poverty profile of the JSB regions.

IFAD. 1992. "The State of World Rural Poverty; An Inquiry into Its Causes and Consequences" by Jazairy, I., M. Alamgir and T. Panuccio. New York University Press New York.

INTERGRATED PLANNING SERVICE (IPS). 1997. Local economic development in the Bergville District, November 1997.

JODHA, N.S. 1991. "Rural Common Property Resources and Rural Poor in Dry Regions in India". *Economic and Political Weekly*, 21: 1169-1181.

JODHA, N.S. 1991. "Sustainable Agriculture in Fragile Resource Zones: Technological Imperatives". *Economic and Political Weekly.* Vol. 26 (13).

JOUBERT, A.M. AND B.C.HEWITSON. 1997. Simulating present and future climates of southern Africa using General Circulation Models. *Progress in Physical Geography* 21: 51- 78.

KANBUR R. 1987. "Measurement and Alleviation of Poverty". IMF Papers. Washington DC.

KANBUR R. 1990. "Poverty and the Social Dimensions of structural adjustment in Cote d'Ivoire". Social Dimensions of Structural Adjustment in Sub-Saharan Africa: policy Analysis. The World Bank. Washington DC.

KASSIER, W.E, 1988. Marketing potential of irrigation crops in Region D. Stellenbosch: University of Stellenbosch.

KOKOT, D.F. 1948. An investigation into the evidence bears on recent climatic changes over southern Africa. Irrigation Department Memoir. Government Printer, Pretoria.

KUMAR, S. AND D HOTCHKISS. 1988. Consequences of Deforestation for Women's time allocation Agricultural Production and Nutrition in Hill Areas of Nepal. IFPRI Research Report No. 69, October.

LAKER, M. C. 1993. Human-induced soil degradation in Africa. Proceedings of the Veld Trust Jubilee Conference, Pretoria, November 2-4,pp.76-86.

LE MAITRE, D., BOSCH, J AND W. LESCH. 1993. Management of riparian zones for water yield and quality. In: Boucher, C. and C. Marais (eds.), Managing Fynbos Catchments for Water. Proceedings of a workshop held on 30 November 1993 at Stellenbosch, SA. *FRD Programme Report Series* 24. pp 88-98.

LIGGIT, B.1988. . An investigation into soil erosion in the Umfolozi catchment. Unpublished MSc thesis. University of Natal, Pietermaritzburg.

LINIGER, H AND G VAN LYDEN. 1998. WOCAT: A framework for the evaluation of soil and water conservation. Questionnaire on the SWC map. World Overview of Conservation Approaches and Technologies, Bern Switzerland.

LIPTON M. 1997A. "Accelerated Resource Degradation by Agriculture in Developing Countries? The Role of Population Change and Response to it". In S.A. Vosti and T. Reardon (eds.) "Sustainability, Growth and Poverty Alleviation". Johns Hopkins University press, Baltimore.

LIPTON M. 1997B. "Exogenous Interest Rates, Technology and Farm Prices versus Endogenous Conservation incentives and Policies" In S.A. Vosti and T. Reardon (eds.) "Sustainability, Growth and Poverty Alleviation". Johns Hopkins University Press, Baltimore.

LIPTON, M. AND M. LIPTON. 1993. Creating rural livelihoods: some lessons for South Africa from experiences elsewhere. *World Development* 21: 1515-1548.

MAHER, G.1990. Phase two of the small catchment project at La Mercy. *Proceedings of the South African Sugar Technologists Association*. June.

MAKALIMA JOHNSTON ASSOCIATES. 1997. Stutterheim; draft structure plan. Unpublished document for the Stutterheim Transitional Local Council. East London.

MAKHANYA. 1993. The use of SPOT images for mapping rural settlements and land degradation in the less developed areas of South Africa. *ITC Journal* 3: 276 – 281.

MARQUETTE, C.1997a. Population and environment relationships in developing countries: a select review of approaches and methods. Bergen: Christian Michelsen Institute. *Working Paper* 1997: 15

MARQUETTE, C.1997b. Turning but not toppling Malthus: Boserupian theory on population and environment relationships. Bergen: Christian Michelsen Institute. *Working Paper* 1997: 16

MASON, S.J. 1996. Climatic change over the Lowveld of South Africa. *Climatic Change* 32: 35 - 54.

MASON S.J. AND M.R. JURY. 1997. Climatic variability and change over southern Africa: a reflection on underlying processes. *Progress in Physical Geography* 21: 23-50.

MATTHEE, J.F. 1984. A Primer of Soil Conservation. Government Printers: South Africa: pp 1-125.

MAY, J. 1996. Assets, income and livelihoods in rural KwaZulu Natal, in Lipton, M and F Ellis (ed.) " Land labour and livelihoods in rural South Africa".

MAY, J. 1996. Poverty, livelihoods and food security in South Africa. Proposal.

MAY, J., CARTER, M AND D. POSEL. 1995. The Composition and Persistence of Poverty in Rural South Africa. Johannesburg: LAPC.

McPHEE, P.J, SMITHEN, A. A., VENTER, C. J. HARTMANN, M. O. AND C. T. CROSBY. 1984. The South African rainfall simulator programme for assessing soil loss and runoff. Pro. National SA Hydrology Symposium. pp 352-363.

MINK, S.D. 1993. "Poverty, Population and Environment". World Bank Discussion Paper No. 189. Washington DC.

MORTIMORE, M.J. 1989. "Adapting to Drought: farmers, Famines, and Desertification in West Africa". Cambridge University Press, Cambridge.

MORTIMORE, M.J. AND M. TIFFEN. 1995. Population in environment and time perspective: the Machankos story. In: Binns, T. (ed.) People and environment in Africa. John Wiley and Sons Chichester. pp 69-89.

NELSON M. 1997. "Report of the Study on CGIAR Research Priorities for Marginal Lands". CGIAR TAC Secretariat, FAO, TAC Working Document.

NICHOLSON, G. 1995. Environmental report of the KwaZulu Natal Priority Study. Development Bank of Southern Africa, Halfway House.

NOORGARD.G. 1994. Development *Betrayed.* London: Routledge.

OLDEMAN, L.R., VAN ENGELEN, V.W.P., AND J.H.M. PULLEN. 1991. The extent of human – induced soil degradation. In Oldeman L.R., Hakkeling R.T.A., and W.G. Sombroek (eds). *World map of the status of human-induced soil degradation: an explanatory note.* ISRIC, Wageningen: pp 27-33.

PAGIOLA, S. AND J. DIXON. 1997. "Land Degradation Problems in El Salvador". Annex 7. El Salvador Rural Development Study Report, No 16253-ES. World Bank, Washington DC. August.

PHILLIPS, P.J. 1973. The Agricultural and related development of the Tugela basin and its influent surrounds. Pietermaritzburg: The Town and Regional Planning Commission, Natal.

PIERI, C. 1995. "Land Quality Indicators". Washington, DC: World Bank Discussion Paper No.315.

PLATFORD, G. 1982. The determination of some soil erodibility factors using a rainfall simulator. Proceedings of the South African Sugar Technologists Association, June.

POSEL, D. AND J, MAY. 1995. A sub-regional prioritisation study for KwaZulu Natal: a poverty profile of the Joint Services Boards regions.

PRESIDENT'S COUNCIL, 1991. Report of the three committees of the President 's council on national environmental management system. Government Printer, Cape Town.

RECONSTRUCTION AND DEVELOPEMNT OFFICE. 1995. Key indicators of poverty in South Africa. Pretoria: Government printers.

REDFORD, K., R. GODSHALK AND K. ASHER. 1995, "What about Wild Animals? Wild Animal Species in Community Forestry in the Tropics". FAO Community Forestry Note 13. FAO. Rome, Italy. 96pp.

REPETTO, R., W. MAGRATH, M. WELK, C. BEER AND F ROSSINI. 1989. *Wasting Assets*. World Resources Institute, Washington DC.

REPUBLIC OF SOUTH AFRICA. 1966. *Constitution of the Republic of South Africa 1966*. Government Printer, Pretoria, South Africa.

ROWNTREE, K.1991. An Assessment of the potential impact of alien invasive vegetation on the geomorphology of river channels in South Africa. *Southern African Journal of Aquatic Sciences* 17: 28-43.

ROUX P.W. 1990. The general condition of the veld in the Republic of South Africa. In: *"Save our Soil"*. Proceedings of the Veld Trust Conference on the conservation status of agricultural resources in the Republic of South Africa.

SCHERR, S.J. n.d. *"Is Soil Degradation a Threat to Developing Country's Food Security?"* Food Agriculture, and the Environment Discussion Paper. IFPRI. Washington DC.

SCHERR, S., L. A. JACKSON AND P. TEMPLETON. 1995. "Living on the edge: Crafting land use policies for the tropical hillsides in 2020". Paper presented at the workshop on Land Degradation in the Developing World: Implications for Food, Agriculture, and the Environment to the year 2020". IFPRI. Annapolis, MD, USA. April 4-6.

SCHERR, S.J. AND S. YADAV. 1996 "Land Degradation in the Developing World: Implications for Food, Agriculture, and the Environments to the year 2020". IFPRI. Annapolis, MD, USA.

SCHOEMAN, J.L., AND D.M. SCOTNEY. 1987. Agricultural potential as determined by soil, terrain and climate. *South African Journal of Science* 83: 260-268.

SCHULZE, RE. 1982. *Agrohydrology and climatology of Natal.* Pretoria: Water Research Commission.

SCHULZE, R. E., MAHARAJ M., LYNCH, S.D., HOWE, B.J., AND B. MELVIL-THOMSON. 1997. *South African Atlas of Agrohydrology and Climatology.* Water Research Commission: Pretoria. pp 1- 276.

SCOTT, D.F., LE MAITRE, D.C. AND D.H.K. FAIRBANKS. 1998. Forestry and streamflow reductions in South Africa: A reference system for assessing extent and distribution. Water SA 24 (3): 187-1999.

SIMPSON, D. E. 1991. Quantification of the effect of land-use on runoff water quality in selected catchments in Natal. Unpublished report No. 237/1/91. CSIR, Pretoria.

SMITHEN, A.A AND R. E. SCHULZE. 1982. The spatial distribution in Southern Africa of rainfall erosivity for use in the universal soil loss equation. *Water SA* 8: 74-78.

SOUTH AFRICAN BROADCASTING CORPORATION. 1993. "The Stutterheim Forum". Video documentary. Johannesburg: SABC.

SOUTH AFRICAN GOVERNMENT. 1997. *White Paper on Environmental Management Policy for South Africa.* Department of Environmental Affairs and Tourism. Pretoria, South Africa.

SOUTHERN AFRICAN LABOUR AND DEVELOPMENT RESEARCH UNIT (SALDRU), 1995 Statistics on living standards and development. Cape Town SALDRU

SOUTHGATE, D. 1988. "The Economics of Land Degradation in the Third World". World Bank Environment Department Working Paper No. 2. Washington DC.

STATISTICS SOUTH AFRICA. 1998. The People of South Africa Population Census, 1996. *Census in Brief, Report* No1: 03-01-11(1996), Statistics South Africa, Pretoria.

SNYMAN .H.A. 1998. Dynamics and sustainable utilisation of rangeland ecosystems in arid and semi-arid climates of southern Africa. *Journal of Arid Environment* 39:645-666.

TECHNICAL ADVISORY COMMITTEE OF THE CGIAR (TAC). 1997. "Priorities and Strategies for Soil and Water Aspects of Natural Resources Management in the CGIAR". FAO. Rome

TIFFEN, M., MORTIMORE, M.J. AND F GICHUKI. 1994. More people, less erosion: environmental recovery in Kenya. John Wiley and Sons, Chichester.

THOMPSON, M.1996. A standard land-cover classification scheme for remote – sensing applications in South Africa. *South African Journal of Science* 92: 34-42

VAN DE WALLE, D. 1996. "Infrastructure and Poverty in Vietnam". LSMS Working Paper No. 121, World Bank. Washington DC.

VAN RIET, W., CLASSEN, P., VAN RENSBURG, J., VAN VIEGEN, T. AND L. DU PLESSIS. 1997. Environmental Potential Atlas for South Africa. Van Schaik, Pretoria.

VAN RENSBURG, H. 1992. Soil is life. South African Panorama. 80 - 83.

VELOZ, A., SOUTHGATE, D., HITHUSEN F, AND R. MACGREGOR. 1985. "The Economics of Erosion Control in a Subtropical Watershed: A Dominican Case." Land Economics 61 (2): 145-55

VERSVELD, D.B., LE MAITRE, D.C. AND R.A. CHAPMAN. 1998. *Alien invading plants and water resources in South Africa: a preliminary assessment.* Water Research Commission. Pretoria. TT99/98

VERSTER.E, DU PLESSIS, W., SCHLOMS, B.H. A. AND R.F. FUGGLE. 1992. Soil. In: In Fuggle & M. A. Rabie. (eds.) Environmental management in South Africa. Juta & Co., Cape Town.

VOGEL, C.H. 1989. A documentary-derived climatic chronology for South Africa, 1820 - 1900. *Climatic Change* 14: 291 - 307.

VON BRAUN, J. 1997. "The Links between Agricultural Growth, Environmental Degradation and Nutrition and Health: Implications for Policy and Research". In S. Vosti and T. Reardon. 1997. "Sustainability, Growth, and Poverty Alleviation: A policy and Agroecological Perspective". The Johns Hopkins University Press, Baltimore. pp 66-78.

VOSTI, S AND T. REARDON. 1997. "Sustainability, Growth, and Poverty Alleviation: A policy and Agroecological Perspective". The John Hopkins University Press, Baltimore.

WALTON, M. 1997. "A note from the Poverty Sector Board". Mimeo to all Bank Staff. August. World Bank Washington DC.

WASSON, R. 1987. "Detection and measurement of land degradation process" in Chisholm and Dumsday (eds.) *Land degradation: Problems and policies.* Cambridge University Press. London.

WEAVER, A. 1989. Rainfall erosivity in the Ciskei: its estimation and relationship with observed soil erosion. *The SA Geographer* 17: 13 – 23.

WILCOCKS, J.R.N. 1977. *Desert encroachment in South Africa.* Unpublished MA thesis. University of the Witwatersrand, Johannesburg.

ANNEX 1

Poverty Indices

The selection of an appropriate level of welfare is reflected in the choice of a cut-off or poverty line. Apart from the selection of a poverty line, the measurement of poverty generally focuses on computing three indices. These reflect:

(a) The prevalence or incidence of poverty as measured by the fraction in the total population living below the poverty line i.e. *the head-count* ;

(b) The intensity of poverty reflected in the extent to which the income of the poor lies below the poverty line, as measured by the differences between the two, i.e., *the poverty gap;*

(c) The degree of inequality among the poor in such a way that income transfers from the worse among the poor to the less poor should raise measured poverty and vice versa, i.e., *the severity of poverty index.*

Foster, Greer and Thorbecke (1984) have suggested a useful general index that meets these requirements. Their class of poverty indices takes the following form:

$$P = \frac{1}{N}\sum_{i=1}^{q}[(Z_p - Y_i)/Z_p]^{\alpha}$$

where Z_p denotes the poverty line, Y_i the expenditure or income of the I-the poor household (or individual), N the total number of households and q the number of households whose expenditures or incomes are below the poverty line and expenditure or income of the poor as a fraction of the poverty line $[Z_p - Y_i]/Z_p$, raising it to a power α and then summing over all poor units. Not only does the index take into account the prevalence and intensity of poverty; it may also be used to reflect the degree of inequality among the poor by varying the value of the α parameter.

Thus, if α=0, index $P_{\alpha \text{ becomes}}$ $P_0 = q/N$, which has been referred to as *the head-count index*. It reflects the proportion of total population lying below the poverty line, i.e. the proportion of poor in the total population. This measure is indifferent to the extent of poverty of the poor. It is only sensitive to their number and reflects the prevalence of poverty.

Alternatively, with α=1, the poverty index P_{α} becomes:

$$P_1 = \frac{1}{N}\sum_{i=1}^{q}[Z_p - Y_i]/Z_p = IP_0$$

where I is the "income gap ratio", i.e. the mean income gap of the poor (Z_p - Y) where $Y = \Sigma Y_i / q$ is the mean expenditure (income) of the poor expressed as a fraction of the poverty line. Thus, P_1 is the income gap ratio multiplied by the head-count index. This index gives a good measure of the extent or intensity of poverty as it reflects how far the poor are below from the poverty line. It may also be used to show the amount of income, under perfect targeting, that needs to be transferred to the poor to close the poverty gap in order to eradicate poverty. However, P_1 is insensitive to income distribution among the poor. Income transfers between the poor will leave P_1 unchanged. For this to be reflected in the index, greater weight has to be given to the poorest units. This can be achieved by setting α=2.

If α=2, the poverty index becomes

$$P_2 = \frac{1}{N}\sum_{i=1}^{q}[(Z_p - Y_i)/Z_p]^2$$

P_2 is the mean squared proportionate poverty gap. This index is not easy to interpret as compared to P_0 and P_1. However, it has the advantage of reflecting the degree of inequality among the poor, in the sense that the greater the inequality of distribution among the poor and thus the severity of poverty, the higher is P_2.

This class of poverty indices is additive. It permits the summing up of poverty indices for various subgroups in the population.

ANNEX 2

Abbreviations, descriptions and units of measurement for the degradation indices and 31 variables (grouped into six broad categories) used to develop the predictive models of land degradation in South Africa

Abbreviation	Variable name and description	Units
Degradation indices		
SDI	Soil degradation index	index value
VDI	Veld degradation index	index value
SDI + VDI	Sum of soil and veld degradation indices To give a combined index	index value
Biophysical variables		
AREA	Area of the magisterial district	km^2
ALT	Altitude: Mean height above sea level	m
SLOPE	Mean percentage change in altitude over A 1'X 1' "o	%
RUNOFF	Runoff intensity calculated as the mean Annual runoff per secondary catchment	million m^3
ERODIBILITY	An index of erodibility determined by slope, Soil type, rainfall intensity and land use	1(high)-20 (low)
FERTILITY	Soil fertility as a function of the clay content And base status of the soil	0(low)-9 (high)
Climatic variables		
MAR	Mean annual rainfall	mm
SAI	Summer aridity index defined as the sum of the mean precipitation for the four hottest months of the year	mm
MAP: PET	The ratio of mean annual precipitation Potential evapotranspiration	-
TMEAN	Mean annual temperature	mm
GROWDAYS	Duration of the moisture growing season	# of days
Land use		
MERCIAL	% area of the magisterial district managed Under a favoured land tenure system	%
% CROPS	% area of the magisterial district used for crops	%

Continued : ANNEX 2

% VELD	% area of the magisterial district used for grazing lands	%
% FOR	% area of the magisterial district used for commercial forests	%
% CON	% area of the magisterial district used for conservation areas and state land	%
% SET	% area of the magisterial district used for human settlement	%
% OTH	% area of the magisterial district used for other land use practices (e.g. mining, lakes)	%
LSU/HA	1995/96 stocking density (no. of cattle, sheep Goats and equines calculated in Large Stock Units)	LSU/ha
Demography		
POPDEN	Population density: 1991 census	# of people/km^2
%MALE	% composition of males in the population	%
% 15-64	% composition of people between 15-64 years of age in the population	%
%RURAL	% composition of people located in rural areas	%
Labour and employment		
%UNEMPL	% of the labour force which is unemployed	%
AGREMPL	% of the formally employed labour force which is Employed in agriculture, forestry and fishing sector	%
LABAGROW	The employment growth performance index of the agriculture, forestry and fishing sector % of the provincial average	index value
#DEPEND	The total dependency ration. i.e. the number of people dependent on a household head	# of people
Economic production		
GGP/CAP	Gross geographic product per capita	Rands/person
AGRTOGGP	% contribution of agriculture, forestry and Fishing sector to the GGP	%
AGROWTH	% average annual growth in agriculture, forestry Fishing sector : 1981-1991	%
GGPGROW	Total % average annual growth in GGP: 1981-1991	%

ANNEX 3

Proposed Definitions of Land Types

Definition	Biophysical Constraints	Socio-Economic Constraints
Favoured land: Land having no or moderate limitations to sustained application under a given use. Moderate limitations will reduce benefits but an overall advantage will be gained from the use of inputs. Wide options for diversification. With roper management, risk of irreversible damage is low.	No or moderate constraints related to soil, climatic and terrain conditions. Soil fertility, if adequately maintained, is favourable. Relatively reliable rainfall and/or irrigation water.	The level of yields depends not only on favourable biophysical conditions, but also on accessibility to inputs, market and credit facilities, and beneficial output/input ratios.
Marginal land: Land having limitations, which in aggregate are severe for sustained application of a given use. Increased inputs to maintain productivity of benefits will be only marginally justified. Limited options for diversification without the use of inputs. With inappropriate management, risks or irreversible degradation.	Soil constraints (low fertility, poor drainage, shallowness, salinity), steepness of terrain, unfavourable climatic conditions[14].	Absence of markets, difficult accessibility, restrictive land tenure, smallholdings, poor infrastructure, and unfavourable output/input ratios.
Fragile land: Land that is sensitive to land degradation, as a result of inappropriate human intervention. Sustained production requires specific management practices. Land use is limited to a narrow choice of options.	Soils of low fertility, erodible, steep terrain, and high groundwater levels, flood-prone.	Population pressure, food deficits, competition for land from other sectors, unavailability or high cost of inputs.
Degraded land: Land that has lost part or all of its productive capacity as result of inappropriate human intervention[15]. Various forms and degrees of degradation, both reversible and irreversible, may occur. Rehabilitation of reversible forms of degradation requires investment.	Erosion, salinisation, fertility depletion, lack of adequate drainage on soils and terrain prone to deterioration.	Population pressure, land shortage, inadequate support to agriculture, lack of institutional framework, high cost of rehabilitation, lack of investment.

[14] The soil, The soil, terrain and climatic constraints applicable to marginal lands are described in Annex 1. The constraints may apply separately or cumulatively.

[15] A distinction needs to be made between reversible and irreversible forms of degradation. Some soils are vulnerable to nutrient depletion, but are sufficiently resilient for soil fertility to be restored through good management.

ANNEX 4

Imperatives for Poverty-Oriented R &D and Dominant Characteristics of Current Research for MAs

1. MA Context and R &D Imperatives	2. Dominant Features of R & D by NARS/others and Gaps between (1) and (2)
A. Imperatives of Soil and Slope Related Constraints (e.g., erodibility, fragility, low fertility, low depth, etc.): **Technology** for **Resource** building, stabilizing, upgrading, protection, conservation; **Crop types:** shallow rooted, nitrogen fixing; annual-perennial compatibility, favouring intensive-extensive land uses; strengthening integrated framing systems including the use of CPRs.	Considerable R & D results on soil-moisture conservation measures; agroforestry, crops (coarse grains, legumes to suit MAL). But work less oriented to local situations; focus on intensification ignoring extension and system context; not enough learning from indigenous systems; impacts in scattered pockets; domination of product-centered over resource-centered R & D.
B. Imperatives of Water-related Constraints (e.g., short and fluctuating growing season, frequent drought etc.): **Moisture management:** small-scale water harvesting, moisture conservation measures; Crops resistant to moisture uncertainty and scarcity; flexible input regimes; potential for multiple usage and salvage value as well as diversification.	Considerable results on drought resistant varieties; water conservation. But not oriented to their role in farmers' overall strategies against moisture uncertainty, scarcity and diversification; water-harvesting/ moisture conservation technologies developed but their adoption still limited both due to scale factor and need for group action, as well as inability to link them with total farming system.
C. Imperative of diversity based opportunities and constraints: Site-specific Technologies **for crops and resource management to suit soil/slope/moisture and infrastructural diversity – involving crops/livestock/vegetation; focus on minor crops, niche opportunities, common property resources, etc., in a "systems framework".**	Work focused on limited and their attributes (e.g., grain yield and not total biomass), ignoring the need for diversification, and harnessing location-specific niche with high pay-off; limited learning from traditional systems for adapting to limitations and opportunities of MAs.
D. Imperatives of biophysical conditions related to social processes: Strong agro-ecosystem social system linkages to shape choice and design of production options and practices as a part of diversified farming system; Institutional arrangements for resource-use regulation.	Despite good work on farming systems, research has been persistently top-down disregarding indigenous systems and participatory approaches, resulting, resulting partly from subdiary role of social science; inadequate attention to institutional aspects.

Source: Adapted from Jodha (1991)

Data sheet used for recording the reasons for changes in land use area, intensity and soil and veld degradation in the 12 degradation workshops

		Reasons for LUT Area	
Land Use Type (LUT)	Area Trend	Decreasing	Increasing
Cropland			
Grazing Land			
Forest (Commercial)			
Conservation			
Settlements			
Other			

		Reasons for LUT Area Intensity	
Land Use Type (LUT)	Area Trend	Decreasing	Increasing
Cropland			
Grazing Land			
Forest (Commercial)			
Conservation			
Settlements			
Other			

		Reasons for soil degradation	
Land Use Type (LUT)	Area Trend	Decreasing	Increasing
Cropland			
Grazing Land			
Forest (Commercial)			
Conservation			
Settlements			
Other			

		Reasons for veld degradation	
Land Use Type (LUT)	Area Trend	Decreasing	Increasing
Grazing Land			

ANNEX 5

Data sheet used for determining land use trends and status of natural resources during the 12 degradation workshops.

Name:	District:	Region:	Province:	% Favoured	
				% Marginal	

Land Use				Soil Degradation						Veld Degradation							
Land Use Type (LUT)	Area (% of district)	Area Trend	Intensity Trend	Type	Degree	Extent	Severity	Rate	Soil Index	Type	Species	Degree	Extent	Severity	Rate	Veld Index	
Cropland																	
Grazing land (veld)																	
Forestry (commercial)																	
Conservation																	
Settlements																	Total for both Indices
Other																	
Total Area	100%	Total soil degradation index								Veld degradation index							

Area Trend

-2: rapidly decreasing (>2% per year)
-1: decreasing (0-2% per year)
0: stable over last 10 years
1: increasing (0-2% per year)
2: rapidly increasing (>2% per year)

Intensity Trend

-2: Major decrease
-1: Moderate decrease
0: No major changes
1: Moderate increase
2: Major increase

Type of soil degradation

Water
Wt: Loss of topsoil by sheet erosion
Wd: Rill, gully, donga erosion

Wind
Et: Loss of topsoil by wind
Ed: Deflation hollows & dunes
Eo: Overflowing (deposition)

Degree of soil (&veld) degradation

1: Light	Somewhat reduced productivity, restoration possible. Biology intact
2: Moderate	Greatly reduced productivity, major improvements required for restoration
3: Strong	Not reclaimable at farmer level, major engineering works required.
4:Extreme	Not reclaimable, beyond restoration. Biology fully destroyed.

Extent

1: Infrequent (0-5% of LUT)
2: Common (6-10%)
3: Frequent(11-25%)
4: Very Frequent (26-50%)
5: Dominant (>50%)

Severity

Degree		Extent (% of LUT) 1 (0-5%)	2 (6-10%)	3 (11-25)	4 (26-50%)	5 (>50%)
Light	1	1	1	2	2	3
Moderate	2	1	2	3	3	4
Strong	3	2	3	3	4	4
Extreme	4	2	3	4	4	4

Rate

-3: Rapidly decreasing
-2: Moderately decreasing
-1: Slowly decreasing
0: No changes in 10 years
1: Slowly increasing
2: Moderately increasing
3: Rapidly increasing

Type of veld degradation

Ls: Change in composition
Be: Bush encroachment (species)
Ap: Alien plants (species)
Lc: Loss of cover
Df: Deforestation
Ot: Other