Sustainability Indicators for Natural Resource Management & Policy

Working Paper 4

Natural Resource Management and Policy in Eastern Cape Province, South Africa: Overview Paper

EDITED BY
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The effects of policy and institutional environment on natural resource management and investment by farmers and rural households in east and southern Africa

(Department for International Development Research Project No. R7076CA)

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DEPARTMENT FOR INTERNATIONAL DEVELOPMENT
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CONTENTS

Introduction to Project and Working Paper Series

This is one in a series of working papers prepared as part of a research project on '*The Effects of Policy on Natural Resource Management and Investment by Farmers and Rural Households in East and Southern Africa'*.

This is a collaborative research project implemented by the Agricultural and Rural Development Research Institute[1], the Development and Project Planning Centre[2], the Economic Policy Research Centre[3], the Institute for Development Policy and Management[4] and the Centre for Agricultural, Food and Resource Economics[4]. The project is supported by the UK Department for International Development (DFID) under their Natural Resources Policy Advisory Department (NRPAD) research programme. The project commenced on 1 July 1998 and is to run for a three year period.

The overall goal of the project is to assist in the development of more effective, equitable and sustainable participatory management of renewable natural resources in sub-Saharan Africa. The purpose of the research is to identify the links between the sustainability of different farming systems and agricultural policy in South Africa and Uganda.

This is to be achieved through a series of case studies in Uganda and South Africa which will examine "the success and sustainability" of small and large scale systems from a range of perspectives including: farmers, communities, scientists, planners and policy makers. This will include the identification of criteria used to assess the "success" of these systems, and the adoption or development of verifiable and measurable indicators of this "success". The impacts of different polices on the degree of success of these systems will be assessed in terms of their effect on farmers' management of, and investments in, their natural resources, and in the development of sustainable rural livelihoods.

This report '*Natural Resource Management and Policy in Eastern Cape Province, South Africa: An Overview Paper'* is one in a series of the project working papers. It describes past and present policy in the Eastern Cape Province and the former Transkei and Ciskei homelands in regard to natural resource management broadly.

This research was funded by the Department for International Development of the United Kingdom. However, the findings, interpretations and conclusions expressed in this paper are entirely those of the author(s) and should not be attributed to the Department for International Development, which does not guarantee their accuracy and can accept no responsibility for any consequences of their use.

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http://les.man.ac.uk/jump/indicators.html

Project Working Papers to date

1. A Review of Indicators of Agricultural and Rural Livelihood Sustainability

2. A Framework for Research on Sustainability Indicators for Agriculture and Rural Livelihoods

3. Natural Resource Management and Policy in Uganda: Overview Paper

4. Natural Resource Management and Policy in Eastern Cape Province, South Africa: Overview Paper

5. Stakeholder Analysis and Local Identification of Indicators of Success and Sustainability of Farming Based Livelihood Systems.

SUMMARY

The Eastern Cape Province officially came into being during 1994 when South Africa was subdivided into nine new provinces and the East Cape was combined with the Ciskei and Transkei homelands. Large-scale spatial variability and short-term temporal variability are important components of the biophysical and socio-economic diversity of the Eastern Cape. Use of the natural vegetation for animal production dominates natural resource management in the Eastern Cape because crop production potential is limited. Land tenure in the province is diverse. The province covers 17 000 000 ha, of which 4 000 000 ha in the subtropical eastern half has a long history of communal, mixed farming by Africans. The drier, western and northern parts of the province have been used by white farmers of European origin for commercial livestock production over the last 200 years. Much of the remainder of the land consists of protected areas. In the early 1990s, two-thirds of the 6.7 million people in the Eastern Cape lived in the communal areas, where population density was 90 people km^{-2}, compared to 20 people km^{-2} in the rest of the province.

One of the main trends in natural resource management in the commercial farming areas is a shift from domestic livestock production to game farming. A major reason for this trend is to overcome the ecological constraints on commercial livestock production, i.e., drought and winter fodder shortages. The main trend in the communal areas is towards reduced dependence on agriculture and increased dependence on other sources of income, such as wages and pensions. While commercial farmers have access to well-established support systems for finance, marketing and information, the support for communal pastoralists is rudimentary. It is debatable whether privatisation of communal areas will promote increased agricultural productivity. In terms of nature conservation and water management, key constraints are the lack of personnel and finances.

Much of the commercially managed rangeland in the Eastern Cape is in good condition, relative to the communal areas. Stock reduction schemes during droughts effectively decreased livestock numbers in the commercial areas. Perhaps the greatest single factor responsible for shaping communal land-use was the Natives Land Act of 1913. Communal use of the rangelands has generally caused reduced productivity and increased soil erosion, which is reflected in the low quality of fresh water. The main agents of environmental degradation, however, are not necessarily livestock, as is popularly perceived, but include other factors, such as ploughing. The drier areas under communal grazing appear to be more prone to degradation, but the humid and sub-humid areas appear to be more resilient. “Betterment” planning in the 1950s and 1960s has not had the desired effect of preventing environmental degradation. Little is known about the impact and sustainability of natural resource management in protected areas.

The South African Constitution after 1994 gave the individual provinces major authorities and responsibilities with regard to legislation and regulation in areas such as soil conservation, pollution control, regional planning and rural development. The direction of the current national agricultural policy on rangelands is dubious, because it does not regard the high stocking rates and grazing pressure in the former homelands as a threat to natural resources, even though there is evidence that degradation has occurred. The Eastern Cape provincial policy aims to raise the level of agricultural production in the former homelands, based on sustainable use of agricultural resources, through market-orientated agricultural production and the assistance of resource-poor farmers. The main objective is to satisfy

household food security. The general vision of both the national environmental management policy and biodiversity policy is for a society that benefits from the conservation and sustainable use of biological diversity. The overall goal is sustainable development. The goal of the national water policy is to make water available to everyone who needs it.

Political and administrative factors have been important determinants of land-use/land-cover change in the Eastern Cape. The large-scale spatial variability, which can be attributed to the co-occurrence of contrasting land-use practises linked to contrasting socio-economic systems, and the short-term temporal variability demand adaptive forms of resource management to ensure sustainable natural resource utilisation. The highly variable knowledge of resource management in the Eastern Cape and the apparently weak knowledge of mechanisms need to be addressed. Until a reliable, predictive understanding of natural resource management is established in the Eastern Cape, it will be difficult to know how the natural resources of the province will be affected in the future.

1. OVERVIEW OF NATURAL RESOURCE MANAGEMENT

1.1. AGRO-ECOLOGICAL ZONES

(W. van Averbeke, P. Scogings, R. Bally, N. van Averbeke)

1.1.1. Introduction

The Eastern Cape Province officially came into being in 1994 when the political boundaries in South Africa were redrawn, and the country was subdivided into nine new provinces. Amalgamation of the East Cape and the Ciskei and Transkei homelands formed the Eastern Cape Province (Fig. 1.1). It consists of approximately 170 000 km^2, nearly 14% of the nation. A division of the Eastern Cape into homogeneous agro-ecological zones does not yet exist. Diversity in climatic and topographic conditions found in the province makes such a subdivision quite difficult. Differences in scale and criteria used to identify agro-ecological zones in the various former political entities that make up the province do not assist integration of the available information. There are also gaps in the information available. For example, there is not yet a soil map for Transkei. In this report we did not attempt agro-ecological zoning of the Eastern Cape, preferring to describe each important agro-ecological factor separately.

1.1.2. Geology

Most of the rocks found in the Eastern Cape are sedimentary in origin. Sandstones mudstones, and quartzites of Ordovician to Devonian age outcrop in the coastal belt from Port Elizabeth to Grahamstown. The rest is covered by sandstones and mudstones of Permian to Triassic age which are intruded by Jurassic-age dolerite dykes and sills (Truswell 1977).

1.1.3. Topography

Generally, the topography of the Eastern Cape is steep. About a third of the province consists of mountain ranges with large differences in local relief. Plateaus with medium to large differences in local relief cover just over half of the area (53.3%). Only a small part consists of relatively level plains (11.0%) and river valleys (4.6%). The valleys are usually deeply incised and the occurrence of level land of alluvial origin is generally limited and localised (van Averbeke and de Lange 1995). Broadly speaking, three altitude levels can be identified in the Eastern Cape. The first level is the coastal plateau. with an altitude of 300-500 m. It is separated from the midland plateau by a mountain range. The midland plateau has an altitude of about 1000-1200 m. A second mountain range separates the midland plateau from the highland plateau. The latter plateau has an altitude of about 1500 m. The most northern part of the province consists of a third mountain range, namely the Drakensberg Mountains. In the Eastern Cape, the highest Drakensberg mountain peaks reach an altitude of approximately 2500 m (van Averbeke and de Lange 1995).

1.1.4. Climate

The Eastern Cape is a climatically diverse area, both in terms of rainfall and temperature. However, 85% of the province falls within the arid or semi-arid aridity zones. Generally, rainfall increases from west to east, and coastal areas are wetter than inland areas. In most of

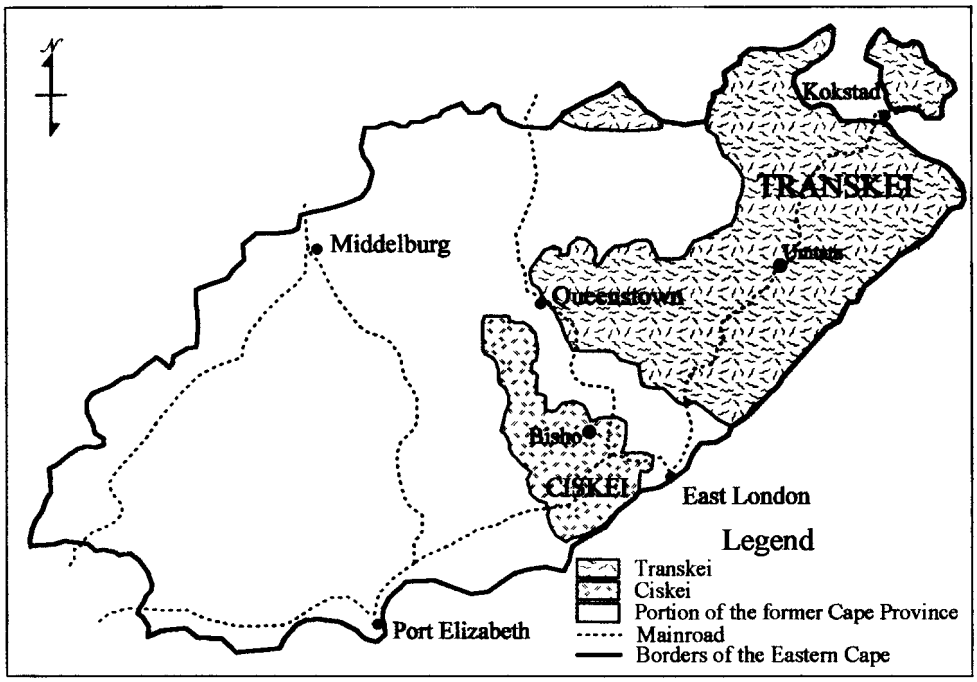

Fig.1 Eastern Cape Province in relation to the former Transkei and Ciskei

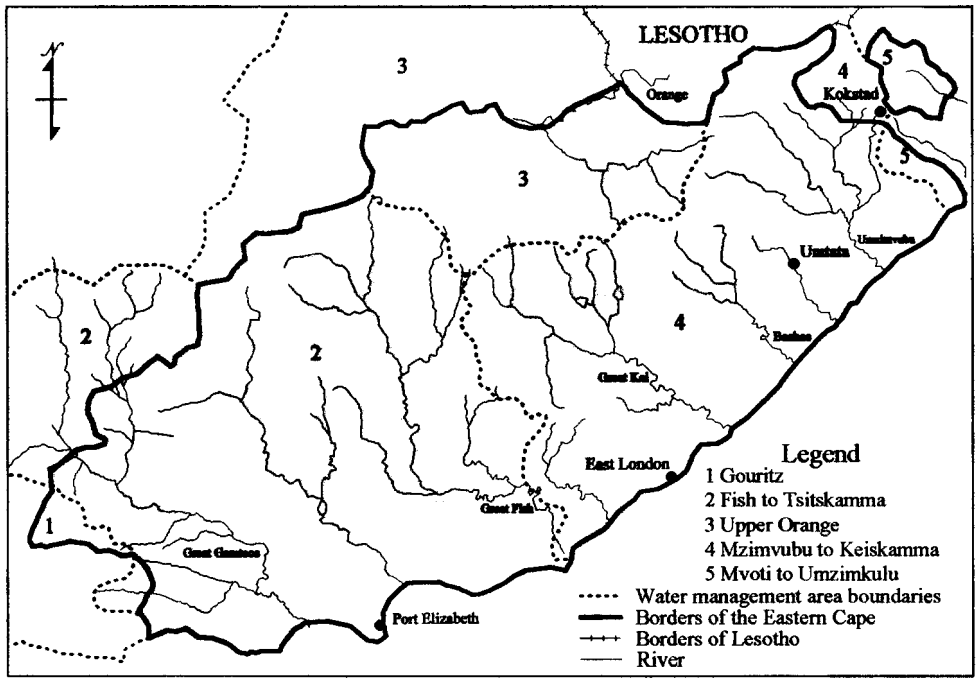

Fig.2 Water Management Areas in the Eastern Cape

the western half of the province the mean annual rainfall is less than 400 mm. The eastern half of the Eastern Cape is much wetter and the coast of Transkei as well as the mountainous districts of Maclear and Mount Fletcher have a mean annual rainfall that exceeds 1000 mm.

The Eastern Cape contains four rainfall regimes. The northern and inland parts of the province experience summer rainfall (Heydorn and Tinley 1980). The coastal areas of the Transkei and most areas south of a line running roughly east to west at the latitude of Umtata experience bimodal rainfall with early and late summer maxima. The coast on the extreme west receives year-round rainfall, while the headlands at Cape Recife and Cape St Francis are winter rainfall areas.

At a local level rainfall is influenced by topography. Over very short distances orographic effects may cause differences of several hundred millimeters in the annual amount of rain received, adding to the climatic diversity of the province.

Precipitation in the Eastern Cape occasionally occurs as hail, which may cause major damage to crops. The number of days with hail increases from less than one day per year in the southwest of the province to more than eight in the northeast.

Nearly all of the Eastern Cape is situated between 30^{o} S and 34^{o} S, ensuring high levels of irradiation during most of the year. Differences in potential evapotranspiration (PET) are caused mainly by differences in the degree of cloud cover (van Averbeke and de Lange 1995). The areas of highest rainfall coincide with areas of lowest PET, and vice-versa. High rainfall areas along the Transkei coast have a PET of about 1 250 mm per annum. In the driest parts of the province PET may exceed 2 250 mm per annum (Davies and Day 1986).

At a regional level, the duration of the frost period is probably the most important temperature-related agro-ecological factor. Generally, the duration of the frost period increases from south to north and follows increases in altitude. The eastern coastal strip is frost-free but in the northeastern mountains frost may occur during a period of 120 days.

In most of the Eastern Cape, water deficits are the main factor limiting plant growth. Low rainfall and high rates of potential evapotranspiration are the main cause.

1.1.5. Vegetation

There is no comprehensive study of the vegetation of the entire Eastern Cape Province, but Lubke *et al.* (1986) classified much of it on a scale of 1:250 000. Their map is based on the 1:1 500 000 map of Acocks (1953) and other early works. The work of Lubke *et al.* (1986) was used by Low and Rebelo (1998) to produce a 1:2 000 000 map of the vegetation of South Africa. This new map is available as an ARC/INFO database from the Department of Environmental Affairs and Tourism in South Africa.

The Grassland Biome covers 39.8% of the Eastern Cape, followed by the Nama Karoo (25.4%), Thicket (16.4%), Savanna (10.2%), Fynbos (6.0%), Forest (2.2%) and Succulent Karoo biomes (<0.1%) (Table 1.1). Combined, the Savanna, Grassland and Nama Karoo biomes cover 75.3% of the province, but only 5.5% of their total area is conserved (Low and Rebelo 1998). The Fynbos Biome is best conserved with 67.1% of its total area conserved, followed by the Thicket (23.7%), Succulent Karoo (17.4%) and Forest biomes (15.8%) (Low and Rebelo 1998).

The vegetation in the Eastern Cape is diverse and transitional in nature. Twenty-nine of the 70 veld types in South Africa identified by Acocks (1953) occur in the province

Table 1.1. Biomes and vegetation types of the Eastern Cape (Low and Rebelo 1998)

Biome/Vegetation type	Area (km^2)	Proportional area (%)	Proportion conserved (%)
Forest Biome	**3 702**	**2.2**	**15.8**
Afromontane Forest	2 795	1.6	7.1
Coastal Forest	907	0.6	8.7
Fynbos Biome	**10 300**	**6.1**	**67.1**
Grassy Fynbos	6 107	3.6	16.7
Mountain Fynbos	2 317	1.4	49.3
S & SW Coastal Renosterveld	1 876	1.1	1.1
Grassland Biome	**67 666**	**39.7**	**2.8**
Afro Mountain Grassland	405	0.2	0.0
Alti Mountain Grassland	2 915	1.7	1.0
Coastal Grassland	2 709	1.6	1.1
Dry Sandy Highveld Grassland	3 321	1.9	0.0
Moist Cold Highveld Grassland	3 682	2.2	0.1
Moist Upland Grassland	31 884	18.7	0.2
NE Mountain Grassland	1 809	1.1	0.0
SE Mountain Grassland	20 670	12.1	0.4
Short Mistbelt Grassland	281	0.2	0.0
Nama Karoo Biome	**43 361**	**25.4**	**2.0**
Central Lower Nama Karoo	17 628	10.3	0.1
Eastern Mixed Nama Karoo	24 428	14.3	1.9
Great Nama Karoo	1 305	0.8	0.0
Savanna Biome	**17 446**	**10.2**	**0.7**
Coastal Bushveld/Grassland	570	0.3	0.0
Eastern Thorn Bushveld	9 235	5.4	0.5
Subarid Thorn Bushveld	7 625	4.5	0.2
Coastal-Hinterland Bushveld	16	0.0	0.0
Succulent Karoo Biome	**23**	**0.0**	**17.4**
Little Succulent Karoo	23	0.0	17.4
Thicket Biome	**27 988**	**16.4**	**23.8**
Dune Thicket	647	0.4	7.5
Mesic Succulent Thicket	1 931	1.1	5.3
Spekboom Succulent Thicket	2 387	1.4	0.5
Valley Thicket	14 615	8.6	2.5
Xeric Succulent Thicket	8 408	4.9	8.0
Total	**170 496**	**100.0**	**2.6**

(Low and Rebelo 1998). This is more than in any other province in South Africa. Similarly, the Eastern Cape has the highest number of vegetation types (27 out of 68), as defined by Low and Rebelo (1998). The transitional character of the vegetation in the Eastern Cape is exemplified by the Thicket vegetation, which has elements of all the biomes (Lubke *et al*. 1986). It is found mostly in the larger river valleys.

After the Western Cape, which has 8 925 plant species, the Eastern Cape has the highest number of plant species (6 164), closely followed by 6 141 in KwaZulu-Natal (Low and Rebelo 1998). One centre of plant species endemism, the Albany Centre, occurs entirely within the Eastern Cape Province, while portions of three other centres, namely the Eastern Mountain, Pondoland and Cape, also occur in the province (Cowling and Hilton-Taylor 1997).

Grasslands dominate the eastern half of the Eastern Cape and most of these (59%) are sour, i.e., the nutritional value declines substantially during winter. Sour grasslands occur

mainly in the most eastern, wetter part of the province and cover 22.5% of its area. These are important grazing, forestry and tourism and water catchment areas (Low and Rebelo 1998). Sweet grassveld occurs mainly in the drier, northern and central parts, covering 17.2% of the province. The sweetveld types are important for livestock grazing because of their good winter grazing value (Low and Rebelo 1998).

The Nama Karoo dominates the western half of the province. Nama Karoo is important for sheep and goat farming for the production of wool, mutton and mohair (Low and Rebelo 1998). A small area of Succulent Karoo (23 km^2) occurs in the southwest of the province. Succulent Karoo is important for ostrich farming (Low and Rebelo 1998).

Thicket may be the most species-rich formation of woody vegetation in southern Africa (Everard 1988). It is the biome of highest conservation value in the Eastern Cape and in most need of further research (Everard 1987). Thicket is extremely important for goat farming (Low and Rebelo 1998).

Of the savanna in the province 97% is comprised in almost equal proportions of sub-humid savanna in the southeast and semi-arid savanna in the southern-central part (Low and Rebelo 1998). Both vegetation types are important for livestock grazing.

The bulk of the fynbos in the Eastern Cape occurs in the southwest. Generally, fynbos in the Eastern Cape is grassier than in the Western Cape. Fynbos areas are important water catchment, tourism and grazing areas (Low and Rebelo 1998).

Forests occur in scattered patches along the coast and inland, the largest being in the southwest. Forests are important sources of wood and medicinal plants (Low and Rebelo 1998).

1.1.6. Soils

Soil water availability is a key factor in plant growth in the Eastern Cape. The soils of the province have mainly aridic and ustic moisture regimes (Soil Survey Staff 1975). The 600-mm mean annual rainfall isohyet separates these two water regimes. In the northwest of the province, where mean annual rainfall is less than 400 mm, soils are usually poorly developed and calcareous because of a lack of leaching. In the central part of the Eastern Cape, where the mean annual rainfall ranges from 400 to 600 mm, the soils usually have a neutral reaction but lime may still be present in the subsoil. Here, duplex soils (abrupt increase in clay content from surface horizon to subsoil) and pseudo-duplex soils (gradual increase in clay content from surface horizon to subsoil) are common. Where mean annual rainfall exceeds of 600 mm, mainly along the coast and in the east, soils have surface horizons that react acid.

Low infiltration rates, soil compaction, phosphorus deficiency, shallow rooting depth, soil alkalinity in the west and acidity in the east are the main factors that limit the potential of Eastern Cape soils.

1.1.7. Hydrology and water resources

The relatively narrow coastal plain backed by mountain ranges has resulted in a large number of small coastal river systems with occasional larger river systems penetrating into the drier hinterland. These systems drain towards the southeast, into the Indian Ocean (Noble and Hemens 1978). A considerable part of the province lies within the Orange River basin and drains inland. The Eastern Cape has no natural freshwater lakes of significant size, although many estuaries have become enclosed, forming lagoons.

Surface run-off varies from less than 3% of rainfall in the northwest to more than 12% in the southeast and can be as high as 22% in the Winterberg mountains. Surface run-off is more variable than rainfall and this variability increases with decreasing rainfall. Middleton and Lorentz (1988) stress the importance of taking into consideration the annual and seasonal variability of the run-off when estimating the water resources of an area.

1.2. NATURAL RESOURCE MANAGEMENT SYSTEMS

(P. Scogings, W. van Averbeke, P. Lent, R. Bally)

1.2.1. Introduction

Use of the natural vegetation for animal production dominates natural resource utilisation in the Eastern Cape, because crop production is limited by climatic, topographic and geological factors (de Wet and van Averbeke 1995; Vogel *et al*. 1996). There are three broad natural resource utilisation systems in the Eastern Cape. The province covers an area of about 17 million ha, and about four million ha has a long history of mixed farming by Africans with communal pastoralism as one of its key features. Most of this land is located in the eastern half of the province, and has a fairly wet subtropical climate. The west and large parts of the north and mid-south of the province are used by white farmers for commercial livestock production. Some of this land has been in the hands of whites for more than two centuries. Much of the remainder of the land consists of protected areas.

As noted above livestock dominates the agricultural scene in the Eastern Cape. Of surveyed farms, livestock are dominant products (accounting for 75% or more of income) on 74% of farms, horticulture dominates on 8%, field crops on only 1%. Mixed farm enterprises with no dominant income source account for 12% (de Wet and Van Averbeke 1995). This dominance is also confirmed by statistics (Table 1.2) showing that in 1991 livestock accounted for about three-quarters of the gross income from agriculture in the East Cape portion of the present province (Antrobus et al. 1994)

Nevertheless, in limited areas specialised farms are important. In some central coastal areas both pineapple and chicory production are widespread. In the Peddie area up to 3800 ha were formerly under pineapples. Citrus production is highly successful along several rivers where irrigation water is abundant, including especially the Sundays and Cat rivers. Overall, approximately 150 000 ha are under irrigation, but this includes some schemes devoted primarily to production of livestock fodder. Significant potential for further expansion of land under irrigation exists, especially in the former Transkei.

Present policy initiatives are stressing the importance of developing new crops and horticultural initiatives in the province. These include olives and hemp, and increased fruit production, among others (Press releases, *Daily Dispatch*)

Table 1.2. Gross income of East Cape agriculture in 1991*

Enterprise	Gross Income (million R)
Field crops	30
Horticulture	245
Livestock	890
Forestry	4
Other	1
TOTAL	1180

* Antrobus et al. 1994

1.2.2. African mixed farming

In the Eastern Cape, the mixed farming system practised by the Southern Nguni tribes had three components, namely production of livestock consisting mainly of cattle; crop production on one or more fields; and vegetable production in home gardens. In the traditional settlement pattern crop lands and other natural resources were arranged in close proximity to the homesteads. Among the tribes living in the Eastern Cape, this settlement pattern consisted of small clusters of homesteads occupied by close kin. However, in much of the land held by Africans in the Eastern Cape the traditional settlement pattern has been modified as a result of state interventions. The functional subdivision of the land held by African communities was one of the most important state interventions in this regard. This intervention is often referred to as 'Betterment Planning'. It involved the separation of land belonging to a community into three categories, namely residential, arable and rangeland. The dispersed clusters of homesteads were consolidated into a single village assigning a single residential plot to each household. Usually fences were erected by the state to physically separate the different land-use categories from each other, and also to subdivide the rangeland into camps. Most of the former Ciskei was subjected to Betterment Planning. Trollope and Coetzee (1975) reported that 78.7% of Ciskei had been demarcated into grazing, cultivated and residential areas, and that 86.5% of the planned area was under some form of range management. In 1988, 894 of the 1016 administrative areas in Transkei had been planned or were being planned (Transkei Land Reform Research Group 1995).

At present, there are three situations regarding the management of communal rangelands in the Eastern Cape (ARDRI 1996a; Scogings and Goqwana 1996):

1) Settlements that were never subjected to planning, where the traditional settlement pattern still prevails. In this situation livestock owners still make management decisions individually. The entire rangeland resource is grazed continuously.
2) Settlements that were planned and subdivided into the different land-use categories, but where fences dividing the rangeland into camps have been removed, causing the rangeland to be grazed continuously. Management decisions are left to the individual livestock owners who often hire herders to keep animals in designated grazing areas and away from the arable lands. Most of the planned settlements have reverted to this system of rangeland management.
3) Settlements that were planned and subdivided, but here the camp fences have been maintained. This enables protection of crops and rotational resting of selected grazing camps. Community organisations or their leadership make management decisions, but individuals maintain the right to negotiate and discuss management options. Research conducted by ARDRI in the central Region of the Eastern Cape in 1996 showed this situation to be quite rare.

Unlike the commercial ranching areas of the drier Eastern Cape rangelands, where livestock numbers have declined (Dean and Macdonald 1994), livestock numbers in the communal areas have generally remained stable for the last 50-100 years (and perhaps more), suggesting that the communal rangelands are fully stocked and have been for a long time, but per capita livestock ownership has dropped (M. Coleman, unpublished data; Beinart 1992; de Wet and van Averbeke 1995; Vetter *et al*. 1998). Not only are the communal areas fully stocked, but they may carry up to five times more stock than would otherwise be recommended for commercial farmers in equivalent vegetation types (de Lange *et al*. 1994; de Wet and van Averbeke 1995; ARDRI 1996b; de Bruyn *et al*. 1998; Goqwana 1998). Such high stock densities have been in place for 60-140 years (McKenzie 1982; Manona 1998).

While livestock are an important resource in the communal areas, their contribution to the cash economy is relatively small and, since the average holding of livestock per household is low (<8), communal pastoralists cannot be considered to be subsistence farmers (de Wet and van Averbeke 1995). Important functions of livestock ownership in communal areas are: draught power, milk, manure, status, investment, bride-price, ceremonial purposes, meat and cash sale. Domestic use does not always benefit the owner alone, but often a large sector of the community as well (de Wet and van Averbeke 1995). One-fifth of the people in the communal areas own about three-quarters of all livestock (de Lange *et al*. 1994; de Wet and van Averbeke 1995). These livestock owners are predominantly male and most have inherited the animals from their parents. The most important purchasers of livestock are migrant workers, businessmen, people with secure jobs, or those who acquire outside income from other employed members of the family (Scogings and Goqwana 1996).

The reason given by Trollope and Coetzee (1975) for the poor condition of the communal rangelands was overstocking, particularly with cattle and sheep, because of the lack of methods for assessing carrying capacity for livestock in the region. As a result of a training programme to teach pastoralists how to use range condition assessment techniques developed in the Ciskei region (Scogings *et al*. 1994), however, it was clear that more than two-thirds of communal pastoralists were not interested in assessing range condition in a way that is meaningful for commercial livestock production (Scogings *et al*. 1995, 1996). Range management (including concepts like range condition, overstocking, livestock ratios, stocking rate) is generally not familiar to communal pastoralists and range condition is assessed in terms of quantity of fodder, rather than quality (Scogings and Goqwana 1996).

Kraaling at night (for security) and dipping are the main management interventions made. In addition to the natural vegetation on the range, livestock feeds on stover and weeds found on arable lands, especially during winter. In cases of emergency, e.g., severe drought, livestock owners may purchase supplementary feed to keep their animals alive (de Wet and van Averbeke 1995; ARDRI 1996a,b; Bennett and Mbuti 1998; Vetter *et al*. 1998). Historically, local leaders might close grazing areas to allow the vegetation to recover, and the use of grazing areas is allowed only after permission has been sought (McAllister 1986).

With increasing human populations and unclear administration in most communities, the rangelands are threatened, especially in the rigidly planned areas (de Wet and van Averbeke 1995). In the early 1990s two-thirds of the 6.7 million people in the Eastern Cape lived in the communal areas, resulting in a population density of about 90 people km^{-2}, whilst the population density in the rest of the province at that time was only 20 people km^{-2} (Kruger 1995). Some people who do not own livestock see the rangelands as open spaces suitable for residential purposes and, in some cases, civic organisations have been known to demarcate residential sites in grazing areas without consultation (Scogings and Goqwana 1996). The

intensity communal rangeland use has decreased in some areas over the past 10 years, but the trend in the Eastern Cape is not clear (Hoffman *et al*. 1999)

1.2.3. Commercial farming

Commercial livestock production in the dry western areas is dominated by extensive small stock farming, especially for wool, mohair and mutton (Roux and van der Vyver 1988; de Wet and van Averbeke 1995). Commercial beef and milk production are found mainly in the higher rainfall areas in the northern and central parts of the province. Ostrich farming and poultry production are also important livestock enterprises (de Wet and van Averbeke 1995). Extensive commercial livestock production in the Eastern Cape is mostly based on rotational grazing systems (de Lange *et al.* 1994).

During the past decade or two commercial livestock production has shifted away from wool towards mutton and ostriches, but wool sheep and Angora goats have remained the main livestock enterprises (de Wet and van Averbeke 1995). During the 1990s there was also a shift from pure domestic livestock production to game farming, or a mixture of the two enterprises, in some areas (de Lange *et al.* 1994).

In the Eastern Cape, the commercial livestock production system differs markedly from the African production system. Key elements of the commercial system are rangeland management and supplementation (mineral licks, animal feeds and fodder production). During periods when fodder supplied by the natural range is deficient (i.e., winter months or dry season) commercial livestock producers prevent losses in condition and weight of their animals by supplying fodder and nutrient supplements. In many cases arable land is used to produce fodder crops. Some farmers improve their rangeland by planting fodder species into the natural vegetation (e.g., Atriplex in the Karoo region) (van Averbeke and de Lange 1995). Fire is an important management tool in the grassland and savanna areas. In the drier areas, fire is used mainly to control woody plants, but in wetter areas fire is used to stimulate the production of nutritious grass at the end of winter, as well as to control woody plants (Trollope 1989).

A second major difference between commercial and communal livestock production is in the degree of control over breeding. In the commercial system management is directed at improving the herd or flock by means of selection and culling, and the regular entry of superior genes (purchase of male animals or artificial insemination). Herd and flock improvement in commercial livestock production is usually in function of the animal's ability to produce the desired product, i.e., meat or wool. In communal areas this type of control over breeding is very difficult, because animals of different owners use the same range. Female animals mate with whatever male is available at the time, even if the male happens to have undesirable traits (van Averbeke and de Lange 1995). However, it could also be argued that the communal system encourages a degree of natural selection to occur, whereby mainly the most hardy and disease-resistant animals survive, allowing for a very different type of gene pool to be maintained.

Increasingly, game management is becoming an important natural resource management focus on private lands in the Eastern Cape. These management systems include the following:

- Game ranches: managed areas for the extensive production of free-ranging game on large fenced or unfenced, private or communal land, usually for recreational hunting or for products of wildlife, tourism, the sale of live breeding stock and for other non-consumptive purposes (Bothma and Teer 1993).

- Game farms: managed areas for the intensive production of game in small, fenced enclosures on private or communal land for the production of marketable game products.
- Conservancies: a group of game farms (ranches) whose owners have agreed to combine and share resources (Fuggle and Rabie 1996).

1.2.4. Protected areas

Historically, a significant portion of the natural resources in the Eastern Cape Province have been managed in protected areas subject to special management regimes established by law and regulation. The Eastern Cape Province currently possesses a variety of types of protected areas. International bodies, namely the International Union for the Conservation of Nature (IUCN) and the United Nations (UNESCO), have defined categories and types of protected areas.

In 1996 the Eastern Cape Province had approximately 42 protected areas, principally category IV, habitat and wildlife management areas, totalling 490 000 ha, under provincial jurisdiction. In addition, the Eastern Cape has three national parks under the control of the National Parks Board: Addo Elephant National Park (including the adjoining Zuurberg National Park), Mountain Zebra National Park and Tsitsikamma National Park These total about 122 000 ha (Eastern Cape Nature Conservation 1998b). Addo Elephant NP is undergoing a major expansion that will significantly increase this amount.

The Eastern Cape also contains 19 state forests and forest reserves (total of 15 564 ha) managed by the Department of Water Affairs and Forestry (Eastern Cape Nature Conservation 1998b). The forests contain significant tracts of indigenous forest and protect a variety of associated natural resources (Eastern Cape Nature Conservation 1998b). The value of these resources to the province seems to be unknown. However, because these reserves protect significant portions of both Afromontane forests and coastal forests their importance for protection of biodiversity is undoubtedly high.

In contrast, apparently no afro-alpine grassland is included in the protected areas of the Eastern Cape, although forest reserves could be extended to include some. This critical deficiency in protection of an important vegetation type is apparent elsewhere in South Africa as well. Much of this vegetation has been converted to forest plantations (Armstrong and van Hensbergen 1999).

There are 26 local nature reserves in the Eastern Cape Province, administered by municipal governments, and an additional 15 areas administered by Regional Services Councils. Finally, 20 Natural Heritage sites and 26 private nature reserves have been proclaimed (Eastern Cape Nature Conservation 1998c,d).

1.2.5. Water

Management of water has until recently been highly variable, often involving separate management strategies for different goals (e.g., different levels of quality and quantity). This type of management has usually been done by local authorities and has therefore lacked cohesiveness and a holistic approach. The introduction of river catchment management boards through Act 37 of 1998 should enable a more integrated approach.

1.3. POLITICAL BOUNDARIES AND PATTERNS OF NATURAL RESOURCE MANAGEMENT

(T. de Bruyn)

1.3.1. Political boundaries

Many of the political boundaries in South Africa and in the Eastern Cape came into being after the first all-inclusive election of 27 April 1994. New boundaries have meaning in relation to current governance. Old political boundaries are far more meaningful for explaining differences in the distribution of population, the location of economic activity and the patterns of natural resource management in the Eastern Cape and South Africa at large. Historically, political developments in South Africa gave rise to two worlds, namely a "wealthy white" and a "poor black" world. This dichotomy evolved as a result of the implementation of successive policies of segregation. In terms of access to and use of land, two acts in particular were responsible for racial discrimination and segregation, namely the Native Land Act, 1913 and the Native Trust and Land Act, 1936 (Republic of South Africa 1997). Implementation of these two acts not only had deep social, political and economic impacts of these policies, but also significant environmental impacts.

1.3.2. Patterns of natural resource management

The former white areas are, typically, privately owned, large farms, which were managed along commercial lines, as opposed to the communally managed black areas. The province has two major historically communal areas: the Transkei and Ciskei. These former homelands were consolidated and enlarged following the establishment of the South African Development Trust (SADT) in 1936 (Republic of South Africa 1997). Current land-use patterns in the former Ciskei generally follow those established by the "Betterment schemes". These schemes were introduced in the 1930's (Proclamation No. 31 of 1939 superseded by Proclamation No.116 of 1949) and implemented more energetically from the 1950's following the release of the Tomlinson report (Union of South Africa 1955).

1.4. LAND TENURE AND LAND-USE RIGHTS
(W. van Averbeke)

1.4.1. Introduction
For historical reasons, land tenure in the Eastern Cape is very diverse, especially in the area between the Fish and Bashe rivers. The settlement of this area by different African tribes, including the Mfengu, the amaGqunukwebe and the Xhosa, and also by people of European origin, brought about a mosaic of tenure systems that included freehold, communal tenure, and quitrent. Differences between freehold rights of African people and those of whites, and modifications to communal tenure added to the complexity over the years. Generally, the distribution of land tenure systems follows historical boundaries, and it is useful to discuss the matter accordingly.

1.4.2. Land tenure in the former East Cape
In the former East Cape portion, most land is held under freehold title. This form of tenure accords the owner full ownership with the freedom to alienate and use the land at will subject to statutory restrictions (Kruger 1995). Restrictions on land-use include zoning regulations and conservation legislation (e.g., the Conservation of Agricultural Resources Act). An estimated 1 to 2% of the 11 million ha in the East Cape is public land. Two types of public land exist, namely state and municipal land (Beinart and Kingwill 1995). State and freehold land may be subject to lesser forms of tenures, such as leasehold agreements, usufructary arrangements, servitudes and mineral rights (Kruger 1995).

Much of the land held by the state is forest or protected areas. The Department of Water Affairs and Forestry is in the process of privatizing the industrial forestland held by the state. In the Eastern Cape, this involves 72 341 ha of land planted to trees and the processing plants linked to these plantations (media release on state forest assets, 22 October 1999). Much of this forestland is situated in the former Cape Province, but there is also some in the former Ciskei and Transkei.

In the past, the state acquired another sizeable portion of land to consolidate the homelands of Ciskei and Transkei. Some of this land was never transferred to the homeland government for allocation, and remains in state hands.

Municipal land consists mostly of commonages that were established around the great majority of towns in the old Cape Colony. The commonages were necessary because towns people who did not own farm land needed access to grazing for milking cows and draught animals, such as oxen and horses (Beinart and Kingwill 1995). Originally, some of the commonages were initially quite large (10 000 ha), but over time they were reduced in size. Urban expansion absorbed some parts, and what remained was usually fenced in and let to commercial farmers as pasture land after World War II (Beinart and Kingwill 1995). A few were converted to conservation areas. There were several reasons for this change in land-use system. Firstly, access to commonage became less essential for the white population of rural towns in the Cape, and there was little consideration to make the commonage available to black people. Secondly, there was a growing perception that common access was environmentally destructive following the publication of the Soil Conservation Act, 1946. Lastly, municipalities found the administration of a limited number of long term leases more convenient than that of collecting monthly grazing fees from a large number of commonage users (Beinart and Kingwill 1995).

A third form of tenure applies to what were called “black spots”. Black spots were small pockets of land in the East Cape that were occupied by Africans who had successfully resisted their removal by the Apartheid government. Occupants of these settlements hold their land under quitrent title (Kruger 1995). This form of tenure is discussed in section 1.4.3.

1.4.3. Land tenure in Ciskei and Transkei

1.4.3.1. Introduction and historical background: Land tenure in central Eastern Cape (the Border/Ciskei and parts of western Transkei) is largely the result of colonial interventions. During the 18th and 19th century Africans and whites fought each other for control over this land. The first armed conflicts over land between the two groups occurred towards the end of the 18th century, and concerned control over the Zuurveld. This is the area of land situated between the Bushmans River and the Fish River, and it was cleared of all Xhosa tribes in 1811-1812. (Thompson 1991). During the first half of the 19th century, military conflicts with white farmers and colonial powers caused the Xhosa tribes to be expelled first from land west of the Keiskamma river and finally from land west of the Kei river (Thompson 1991). The Colonial Government also interfered with land situated between the Kei River and Bashe River. In 1847, the British annexed the land between the Fish and Kei rivers and made it a separate colony named "British Kaffraria". Its main function was to form a buffer zone between the Cape colony and the Xhosa nation (Thompson 1991). Since much of the land in British Kaffraria had been cleared of Xhosa people, it became available for resettlement. The Colonial government encouraged close settlement by Europeans and "loyal natives". The latter included Mfengu and Gqunukhwebe tribes who had joined the colonial forces in Mlanjeni’s War which lasted from 1850 to 1853 (Thompson 1991). Resettlement started in 1853 (Mills and Wilson 1952), and the form of tenure varied from group to group.

According to evidence collected by Mills and Wilson (1952) in Keiskammahoek District, it was mostly the chiefs who were responsible for choosing the form of tenure that would apply to their people. Three forms of tenure were granted, namely un-surveyed communal tenure, surveyed quitrent and freehold tenure. In Ciskei, the earliest grant of individual tenure to Africans was in Victoria East in 1849 by means of quitrent (Mills and Wilson 1952). The granting of farms to Africans on freehold tenure started in 1856 on a strip of land between Fort Hare and King Williams Town (Mills and Wilson 1952).

In the new colony, freehold land was also allocated to white settlers from 1865 onwards (Mills and Wilson 1952). However, the Land Act, 1913, and the Native Trust and Land Act No 18, 1936, placed restrictions on land ownership by whites in the Native Reserves. Provisions in the 1936 act resulted in buying out of the whites who owned land in declared "Native Areas" (Mills and Wilson 1952). The land thus acquired became the property of the South African Native Trust, which leased it to landless Africans (Mills and Wilson 1952). Thus, a fourth tenure system, usually referred to as "Trust Tenure" was introduced. In Ciskei, these four forms of tenure occur in close proximity to each other, and the overall distribution of land tenure systems is a complex puzzle. In western Transkei quitrent, freehold and communal tenure also occur next to each other, but the situation is not as complex as in Ciskei. The Colonial government did not influence land tenure significantly in the rest of Transkei. As a result most land in Transkei (85%) is held under communal tenure (Transkei Land Reform Research Group 1995).

1.4.3.2. Freehold tenure: Freehold tenure by Africans was very similar to that granted to Europeans settling in the East Cape, but alienation of the land by sale was subject to state

approval. There were also restrictions on land-use. For example, no person other than the grantee and his immediate family was allowed to reside on the land (Cokwana 1988).

1.4.3.3. Quitrent tenure: Quitrent tenure, like freehold, is also a form of individual tenure. In Ciskei, quitrent titles to surveyed plots were issued between 1849 and 1879 (Mills and Wilson 1952; Cokwana 1988). Quitrent title differed from freehold title in that annually a nominal rent was payable, and land alienation by sale was possible only when permission of the owner's family and of state had been obtained. Quitrent titles were based on the principle of "one man, one plot", and grantees were allocated a surveyed residential site, a surveyed arable plot usually about 4 to 6 ha in size, and user rights to a commonage (Mills and Wilson 1952). Usually, the different land allocations held by means of a quitrent title occurred on the terrain as physically separate entities and not as one consolidated block of land. Holders of freehold plots, on the other hand, resided on consolidated farms, but some freehold settlements also had a commonage allocated to them (Mills and Wilson 1952).

1.4.3.4. Communal tenure: The general principle of communal tenure is that members of a settlement share certain rights in the land attached to their settlement (Mills and Wilson 1952). During the past two centuries traditional communal tenure in Ciskei and Transkei has been modified in two important ways. Firstly, as land became scarce the right of access to full land allocations became subject to restrictions, causing landlessness especially in terms of arable land (Mills and Wison 1952; Yawitch 1981). Secondly, there was a progressive transfer of control over the allocation and enforcement of land rights from communities and their leadership (headman, chief) to the state and its agents (Yawitch 1981; Cokwana 1988; Westaway 1993). In the communal areas of South Africa, land rights are not necessarily equitably distributed. On the contrary, gender, social class, and the limited availability of land all contributed to the inequitable distribution of land rights and landlessness in these areas. At present, local institutions are no longer very effective in regulating the system of communal tenure, and many people farming on communal land consider the enforcement of land rights as problematic.

Under traditional communal tenure, and when land was still abundantly available, land grants were large. At that time, crop production was a female domain. Every married woman was entitled to a field, and rights over fields were the property of women and were commonly inherited along with her other property by her youngest son (Cokwana 1988). Later, when land became scarce, and men started to take part in cultivation, rights over fields came to be regarded as male property to be inherited by the eldest son (Cokwana 1988). Traditionally, forfeiture of land rights occurred when the holder left the settlement permanently. Other regulations were introduced to prevent land from being left fallow whilst other members of the community were in need of land. For example, the rule that a holder of an arable allotment forfeited his rights to that land when he failed to cultivate his land for three successive years.

In communal tenure, transfer of land rights from one individual to another has been possible. The most common way of transferring land was by means of inheritance - husband to widow, father to eldest son, or widowed mother to eldest son. However, a land right holder could also transfer his right to another community member, but only while he was still alive, and not by means of a will. Such transfers were possible only to members of the community who were eligible to hold land, and who were landless at the time of the transfer.

Where communal tenure applies, a full set of land rights refers to access to residential land, a garden, arable land, and rangeland. In Chata (Keiskammahoek District, Ciskei) during the late 1940s, Mills and Wilson (1952) found the mean size of an arable land holding to be 2.3 ha, the residential sites to range in size between 0.16 and 0.25 ha, and the gardens between 0.2 and 1.0

ha. The Chata community also had access to a total of 2635 ha of rangeland or 7 ha per household. At that time, nearly 30% of those eligible to hold land in Chata (married men and widows) were considered landless, because they had no field of their own.

1.4.3.5. Trust tenure: The Native Trust and Land Act, 1936 made provisions for the Native Trust to acquire land situated in proclaimed native areas that belonged to whites, and to redistribute this land to landless Africans. Trust-owned land was allocated on a system of leasehold tenure. An annual rental was payable by each plot holder in return for the rights to occupy and use the land. Land rights could be suspended by the state.

Before Trust Land was made available for settlement it was first planned and subdivided into functional blocks. Land deemed suitable for cultivation was subdivided into plots of more or less equal size. A separate consolidated area was demarcated for residential purposes and subdivided into building sites. The remainder was assigned to rangeland and subdivided into camps that were fenced off. Control over access to these camps was with officials of the Department of Agriculture, who opened or closed the camps as they saw fit (Cokwana 1988). Generally, trust tenure was regarded as the least secure of all. When "Betterment Planning" was implemented in settlements where land was held under communal tenure (and even quitrent tenure) it was often referred to as "Trust Planning".

1.4.3.6. Recent legislation: The Upgrading of Land Tenure Rights Act of 1993 makes provisions for the holders of quitrent land to convert their tenure to freehold free of charge. The Communal Property Association (CPA) Act of 1994 makes provision for the members of a CPA (communities or groups of people) to hold a registered title to land (similar to freehold), whilst allowing the association to make its own decisions about the allocation of ownership and user rights to the land. Thus far, this new form of common property tenure is used mainly by groups of landless people acquiring land under the Land Redistribution Programme of the 1994-1999 South African Government.

1.5. CHANGING MARKET INFLUENCES ON NATURAL RESOURCE MANAGEMENT

(A. Bediako, P. Lent, R. Bally)

1.5.1. Introduction

As South Africa made the transition to democratic government the World Bank (1994) summed up the characteristics of South African marketing systems at that time as follows:

- dominated largely by producer interest,
- complex network of marketing regulation,
- prominent domestic orientation in food crops and livestock,
- controlled input and output prices along with single channel marketing for most commodities have prevented competition and provided large scale farmers with an income guarantee,
- impact of domestic orientation of marketing and processing arrangements has generally been to the benefit of producers at the expense of consumers,
- welfare implications of the marketing environment for urban and rural poor have been negative.

1.5.2. Land markets

Subdivision acts and other restrictions to ownership transfer have been used to prevent the purchase of land by politically emancipated black populations. The Land Settlement Act of 1912 standardised the acquisition, exchange and disposal of state lands for white settlement. In the homelands, communal tenure was defined by proclamation R188 of 1969 as "unsurveyed land" or "permission to occupy". Elimination of the access to land through rentals or sales markets left the poor with few land access options (Binswanger 1996). The result was massive, poverty-driven, environmental degradation (van Zyl and Vink 1997).

Policy of the Ciskei government in the 1990's made the sale of state farmlands the sole responsibility of the then Department of Internal Affairs and Land Tenure and any other institution or organisation acted in advisory capacity only. For example, basic grazing land value was based on the ruling grazing fees (R5/ha/annum) approved per T/A9/6/3 (06357) dated 1/5/89. The average area required for grazing is five hectares per livestock unit (LSU). The General Post Office interest rate on capital was 10% based on the bank acceptance rate. This implied that earnings per R50 invested per annum amounted to R5. The opportunity cost of average grazing was thereforeR50/ha. Capital invested in land was therefore R250/LSU (5ha * R50).

The economic analysis by the Republic of South Africa's Department of Development Aid at RA60 in Hewu and Mdantsane indicated that 87 LSU's were needed to produce R10 000 net farm profit. This was used as benchmark in determining land value. For example, the investment needed in grazing land to earn R10 000 per annum was R21 750 (R250* 87) for a 435 ha farm.

The basic value of arable land was R50/ha. Arable land was valued according to classes 1-3 based on Ciskei Agricultural Land Classification (land had an extra value in cropping potential if it occurred in rainfall zones of >600mm). Values for these three classes ranged from 75 to 150/ ha.

Land prices in the East Cape followed the pattern that prevailed in the former South Africa. Average price of land in the province was R792/ha in 1993/4 (Antrobus and Fraser 1998). According to van Schalkwyk and van Zyl (1998) land values in South Africa have been influenced by factors like returns, rents, financing, inflation, opportunity cost and perceived risk. They developed a structural model of land prices, which included the multi-dimensional effects of inflation on capital erosion, savings return erosion and real debt reduction, as well as the effect of changes in the opportunity cost of capital. In spite of the imposition of substantial *a priori* theoretical structure and extraneous information, Van Schalkwyk and van Zyl (1998) showed that the model fitted the data well compared to *ad hoc* econometric models. The results indicated the large price swings were chiefly explained by inflation rates and changes in real returns on alternative uses of capital.

1.5.3. Water markets

Government control over all water resources was gradually expanded through water legislation and regulation. Constitutional reform through the National Water Policy (Department of Water Affairs and Forestry 1997) converted all water rights to public property subject to government control. This has led to water rights not being adapted to hydrological circumstances and the lack of enforcement of legislation has led to encroachment of surface water rights, treatment of groundwater as open-access and, therefore, over-exploitation of water resources (Beckerberg 1997).

Demand for water was expected to grow by 38% in the Eastern Cape Province between 1980 and 2010 (Table 1.3.). In addition, urban and industrial demand in 1980 made up only 12% of total demand, whereas agriculture took up over 40% of total demand. By 2010 the

demands for urban and industrial use, as well as for agriculture, are expected to grow to 20% and 46% respectively. Estuary water demand is surprisingly high and variable, ranging from a low of 9% for the Sundays River catchment to 63% for the Transkei region (Department of Water Affairs 1986). Afforestation of upper catchments by pines elsewhere in South Africa has been estimated to reduce runoff by up to 50% (Wicht 1971).

Table 1.3. Types of estimated demand for water in the Eastern Cape Province for the years 1980, 1990, 2000 and 2010. Table calculated from Department of Water Affairs (1986). Figures in millions of cubic metres per annum

Type of estimated demand	1980	1990	2000	2010
Urban and industrial	339	457	596	769
Irrigation	1051	1221	1449	1657
Stock watering	63	70	77	85
Total water demand	2737	3017	3392	3780

1.5.4. Commodity markets

1.5.4.1. Historical analysis

A World Bank report (1994) showed that the bulk of agricultural products in South Africa were then marketed under schemes set up in terms of the Marketing Act of 1968. As of the early 1990s, about two-thirds of farm produce was marketed under the Marketing Act through various schemes:

- single-channel fixed price schemes, where producers are legally obliged to market their products through a board or its appointed agents and prices are fixed for each season,
- single-channel pool schemes, where producers market their products through a pool conducted by the board, which pay on receipt of the product,
- surplus removal schemes (also called price support schemes) and
- supervisory schemes.

The World Bank (1994:61) further described the situation in the early 1990's as follows:

> More than 75% of agricultural products in South Africa are sold under controlled marketing schemes set up under the Marketing Act of 1968 (originated from the Act of 1937) or related legislation. In 1990, poultry, meat, fresh vegetables, and fresh fruit sales for sale on the domestic market were among 23% that was uncontrolled. The 22 control boards and other marketing institutions that were established (15 are still in existence) used a wide variety of controlled mechanisms.

Examples of these controls included, production quotas; quality restrictions; price controls; monopoly marketing channels; restrictive licensing; import quotas; producer price subsidies for inputs and outputs, and consumer price subsidies for staple crops.

The former Ciskei and Transkei governments also maintained a variety of marketing boards and for export purposes these were linked to South African boards. In general these controls were phased out before or at the same time as their South African counterparts (World Bank 1994).

Significant economic costs have resulted from distortions introduced in the marketing and pricing environment in South Africa. Since the 1980s the government has attempted to reduce the excessive and costly public support for the current marketing arrangements; as a result there has been a considerable amount of deregulation.

The impact of these reforms has been uneven and awaits further analysis. Agricultural producer prices for most commodities have fallen in real terms, yet consumer prices have increased. The resulting increase in marketing margins poses somewhat of an enigma, caused in part by input cost inflation – the result of deregulated output market without concurrent deregulation in input, processing, and distribution markets. Other causes include declining productivity in food chain, the withdrawal of consumer and producer price control and supports, and relatively slow increases in competition in deregulated industries because of their high levels of concentration. Moreover, the bulk of farm produce is still marketed under controlled systems that regulate and reduce domestic competition and protect the domestic producers from international competition. The inefficiencies of the system are exposed not only by the increasing marketing margins of the official system, but also by the rise in parallel market activities – a phenomenon which is relatively new to South Africa markets.

For much of the 1920's farmers complained of depressed markets, low and unstable prices for agricultural products. As a result government took a number of commodity specific statutory initiatives with a view to helping farmers. Bayley (1999) has provided a summary of the key events which is reproduced here as Table 1.4.

The 1937 Marketing Act established a system whereby farmer-dominated control boards had all the powers necessary (subject to the approval of the Minister of Agriculture) for determining which persons should produce, handle, process and trade agricultural commodities, and at what price, or for what margin they should do so.

Bayley (1999) stated that by 1961/62 over 90% of total agricultural production was subject to marketing controls. Of these controls, the majority were managed through 17 schemes established under the 1937 Act and a minority through commodity specific legislation. Table 1.5, adapted from Bayley (1999), chronicles the key events in the decades after the 1937 act.

Table 1.4. Summary of important legislative developments affecting the South African agricultural marketing system (1910-1935). Adapted from Bayley (1999)

Year	Legislation
1912	The Land Bank Act.
1922	The Co-operatives Act.
1923	Beef export Bounties Act.
1924	Wine and Spirits Control Act.
1925	Amendment of 1922 Co-operatives Act to provide for compulsory co-operation.
1926	Sugar prices Act. Perishable Products Export Control Act.
1929	*The Wall Street Crash.*
1930	Wheat Importation Restriction Act. Dairy Industry Control Act. Agricultural Warehouse Act.
1931	Flour and Meal Importation Restriction Act. Mealie Control Act. Export Subsidies Act.
1932	Tobacco Control Act. Meat Trade Control Act.
1934	*The Viljoen Commission of Inquiry into Co-operation and Agricultural Credit.*

Source: Richards (1935).

Bayley (1999:9) goes on to list some significant themes characterising the South African agricultural marketing system from the 1920's to the 1980's, including:

- The increased marginalisation of the black farming sector;
- The high level of state support to the co-operative sector;
- The dominance of a small number of large-scale agro-processing companies;
- The capitalisation of statutory support into land prices;
- The ratchet effect of government intervention; and
- The use of marketing controls as vehicles for rent seeking (rent seeking stems from the behaviour of small pressure groups (farmers) that seek to transfer wealth under the aegis of the state).

Agricultural policy changed in the early 1980's, prompted by policy reforms outside of the agricultural sector. The liberalisation of the South African system from the 1970's led to real depreciation of the Rand in the 1980's, the scaling down of interest rate subsidies on loans from the Land Bank and increased pressure on government's budget. As a result, government subsidies to control boards system were withdrawn.

Table 1.5. The extension and initiation of controls under the 1937 Marketing Act

Year	Events
1937	The Marketing Act
1938	The Dairy Products Marketing Scheme (replaced by a new scheme in 1940), the Mealie Control Scheme (replaced by a new scheme in 1939 and 1940), the Wheat Control Scheme and the South African Dried Fruit Scheme.
1939	The Tobacco Control Scheme, the South African Deciduous Fruit Regulatory Scheme, the South African Citrus Scheme (replaced by a new scheme in 1947) and the Chicory Control Scheme.
1939-45	For much of the wartime period the powers and functions of the control boards were greatly expanded by the use of War Emergency Measures rather than the 1937 Marketing Act.
1944	The 1944-45 marketing year was the first time that the Mealie Control Scheme was used to enforce a single channel marketing system for maize.
1953	Establishment of Maize Board's Stabilisation Fund.
1951-57	Control boards instituted for potatoes, oilseeds, lucerne seed, eggs, rooibos tea, dried beans, drinking milk and banana.
1957	Sorghum incorporated into the Maize scheme.
1963	Canning Scheme (peaches, apricots and pears) established.
1968	Karakul Scheme established.
1972	Mohair Scheme and Wool Scheme established.
1974	Cotton Scheme established.

Sources: Van Rensburg (1962), MacDonald (1968), de Swart (1983) and Norton (1991). Other developments that reinforced the move away from regulated agricultural marketing included the following (LAPC 1993; Bayley, 1999):

- Pressure from farming and industrial interests which were critical of aspects of the control system;
- Legal challenges to control board schemes;
- The generally poor performance of the agricultural sector; and
- The moves towards a reduced degree of statutory intervention throughout the economy.

Over the past two decades various commodities have been deregulated at different times and at different speeds. Important developments of this deregulation can be summarised as follows:

- A large number of organisations have emerged to compete with Outspan and Unifruco in the export of citrus and deciduous fruit;
- There has been an acceleration in the establishment of new enterprises in the food and agricultural sector;
- The real value of South Africa's agriculture, in particular exports, has grown significantly;
- Real retail food prices have not increased since 1992, in spite of the Rand's depreciation in real terms between 1994 and 1998;
- There has been a shift in production patterns in response to changes in the relative risks and prices with which farmers are confronted;
- Real land prices have continued to fall in mid 1990's; and
- The establishment of agricultural futures market.

Some of the important marketing reforms up to 1993 are summarised in Table 1.6.

The deregulation trend has continued since 1993. With the exception of sugar, South Africa's domestic agricultural markets has now been fully deregulated. The control boards have been closed down, export subsidies have been stopped and the degree of protection from agricultural imports has been significantly reduced. According to Bayley (1999) the new system puts new responsibilities on government. He summarises these as follows:

- Providing market information (much of this formerly done by control boards)
- Competition policy (maintaining and fostering competition)
- Managing the trade regime (in particular tariffs)
- Policy consistency

Table 1.6. Important marketing reforms up to 1993 (from Bayley 1999)

Commodity	Reform
Maize	Prohibition on the building of grain silos repealed. Change in pricing policy (1987) and removal of price control on maize meal.
Winter Cereals	Phasing of bread price subsidy (by 1991). Abolition of remaining controls over the pricing of bread and flour, and registration of millers and bakers lifted.
Oilseeds	Abolition of import control measures on oil cake and fishmeal.
Wool, Sorghum and Leaf Tobacco.	Abolition of single channel marketing arrangements.
Deciduous Fruit	Free issue of domestic marketing permits.
Citrus Fruit	Domestic market control abolished (1990).
Red Meat	Restriction on the movement of livestock from uncontrolled to controlled areas was abolished (1992). Abolition of restrictive registration of producers, abattoir agents, butchers, dealers processors and importers.
Milk and butter fat	Abolition of consumer price control on fresh milk (1983) and butter and cheese (1995). Price stabilisation halted (1992).
Potatoes, Dry Beans, Eggs, Bananas, and Chicory	Control boards responsible for these products were closed down in 1993.
Wine	The production quota system was abolished in 1992.
Sugar	The cane quota system was reformed in 1990.
Ostriches	The Klein Karoo Agricultural Co-operative's single channel in terms of the Co-operatives Act terminated (1993).

Source: LAPC (1993)

1.5.4.2. Food Prices

Bayley (1999:7) reported that, "between 1975 and 1992 real food prices rose by approximately 25% as measured by the Consumer Price Index (CPI). Whilst there has been some fluctuation between 1992 and 1999, real food prices currently stand at approximately the same level as they were seven years ago".

However, different commodities have behaved differently. Again Bayley, (1999:7):

> The real prices of grain products are at approximately the same level as they were in 1993, while meat prices have fallen around 10% in real terms since their peak in 1994. The prices of other livestock products (milk, cheese and

eggs) as a whole have also fallen in real terms since their peak in 1992. The real prices of fats and oils have risen since 1994 although they are still far below their peak in the mid 1980's.

Balley (1999:8) further noted that:

> Such food price stability is all the more impressive when it is considered that liberalisation of agricultural marketing and trade has taken place in the context of an exchange rate that has weakened significantly in real terms over the past five years (the Rand/U.S. Dollar exchange rate fell approximately 40% in real terms between 1994 and late 1998). Furthermore, the South African agricultural sector is still in transition. Farmers have yet to adjust production patterns fully to the new circumstances, and farmers and processors alike are still increasing the extent to which they manage their price risk. Whilst there is scope for real increases in food prices in the short run, it is reasonable to expect real food prices to fall in the medium run.

1.5.5. Input markets

The input supply and financing of seasonal farming requisites and capital equipment to commercial farmers has largely been through private sector institutions. Prices of agricultural inputs and outputs have not increased proportionally. The period 1968 to 1974 was characterised by larger increases in product prices than in input prices. Since 1974, input prices have risen faster than product prices. Real net farm income increased by 181% from 1947 to 1991. Real input prices of machinery and implements increased steadily over the period 1970-1990, while the volume of these inputs increased from 1960 to 1981, but decreased steadily since then (World Bank 1994).

1.5.6. Capital markets

The growth of South African agriculture has been characterised by large scale, capital-intensive, production methods (World Bank 1994). Capital intensity is explained by the substitution of capital for labour because of high wages (van Zyl 1996).

Credit sources open to farmers include:

- The Land Bank (supplier of long-term credit for land purchases),
- Commercial banks and co-operatives (provide short-term credit), and
- The Agricultural Credit Board (the lender for insolvent or nearly insolvent farms).

Debt consolidation, tax legislation (making farm equipment cheaper), crop production credit to farmers who cannot acquire short-term credit as a result of adverse farming conditions, interest subsidy schemes etc., have led to liquidity problems, which have affected the financial standing of commercial agriculture in three ways (World Bank 1994):

- debt loads increased;
- loan arrears mounted; and
- sequestrations increased.

1.5.7. Labour market

Subsidised, low interest rates and various tax breaks encouraged the excessive substitution of capital for labour. The chronic labour shortages on white farms were formerly intensified by the emergence of the mining and manufacturing industries with their massive labour demands.

1.5.8. Nature conservation

The economic benefit of national parks is thought to be great, but has rarely been quantified. One study, cited by Kumleben *et al*. (1998), estimates that the income generated nationally by Addo National Park is R360 million. Presumably, most of this income benefits the economy in the Eastern Cape Province. Kruger National Park generates 3 to 5 billion Rand each year for the nation, yet the National Parks Board annual budget for the entire park system is only R375 million. Even less is known about the economic benefits of provincial protected areas.

In many parts of South Africa, including the Eastern Cape, game farming and ecotourism operations are replacing cattle farming. An informal estimate suggests that 500 000 ha have been converted to game farming in the province in recent years (E.C. Nature Conservation source). Concurrent with this shift from cattle to game farming is an increase in prices paid for farm land and ownership of properties is shifting from the traditional farming community to corporate or foreign ownership. The shift to game farming entails large changes in infrastructure, some of which make it highly unlikely that land-use practices will ever revert to cattle farming. Principal among these changes is the removal of internal fencing.

Another trend in South Africa is for the conversion to game farming and tourism on areas near nature reserves and game parks. The reserves form a core natural area and peripheral game areas are associated. Buffer areas around the core natural area may also include tribal lands but this management concept is far more developed elsewhere in Africa (Kiss undated). In some cases, experiments are underway to remove game fencing between reserves and adjoining farmers and develop conservancy type agreements. In other cases, fences remain, but limited co-operation and co-ordination is possible. In the Eastern Cape, there have been preliminary agreements in the Fish River and Kat River areas, among others.

Although market demand for game and game-related services is thought to be increasing, there is little information regarding the economic aspects of game ranching and game-related revenues from protected areas or private enterprises. Some estimates of total gross annual income have been made. These have estimated R1 374 million, of which about R1 000 million derives from the private game industry (Conroy *et al*. 1997). Approximately 6500 foreign hunters are said to spend R350 million annually in South Africa and the value of meat taken by 120 000 South African hunters each year is about R850 million (Conroy *et al*. 1997).

The Professional Hunters Association of South Africa estimated that hunting in South Africa generated in excess of R117 million in 1996 (*Daily Dispatch* 3 Mar., 1998). In the Eastern Cape, in the year ending October 1997, professional hunting contributed R38.5 million to the economy. Overseas hunters coming to the Eastern Cape are predominantly from the United States. These hunters spend about R1715 daily and non-hunters accompanying them spend R980 daily. The above figures do not include biltong sales, live animal sales or other uses. Another estimate puts the total value of the hunting industry to the province at R60 million annually, including the money spent on taxidermy (Ramsden 1997).

2. DYNAMICS AND CONSTRAINTS IN NATURAL RESOURCE MANAGEMENT

2.1. HISTORICAL CHANGES IN NATURAL RESOURCE MANAGEMENT
(P. Scogings, P. Lent, N. van Averbeke, T. de Bruyn)

2.1.1. Rangelands
Political and administrative factors have been more important than biological ones in determining land-use change in the Eastern Cape (Fabricius *et al*. 1996).

2.1.1.1. Commercial: One of the most significant trends in natural resource management in many commercial farming areas of South Africa in the past two decades has been a shift from conventional domestic livestock production to game farming. This trend is evident in the Eastern Cape Province although the magnitude of change apparently has not been as great as in the northern part of the country. Halse (1983) believed that in the Eastern Cape, game farming was stimulated by the prolonged drought in the late 1960s. This was followed by stock reduction schemes and low cattle prices in the early 1970s. Some of the land now used for game farming was also marginally used for merino sheep in the past.

South African law has traditionally treated wild animals as having the status of *res nullius*, that is, they belong to nobody, but can be subject to ownership if someone manages to control them, as with fencing. Thus the great emphasis in each province on obtaining certificates of enclosure, or some comparable certification, legally establishing that effective control was in place. As the game industry grew in South Africa, the issue of loss of ownership became increasingly important to the industry. For example, if a valuable animal such as a rhinoceros managed to escape from control of an owner, private or public, did the ownership then cease?

Past law provided very little enforcement in terms of game theft. The Game Theft Act, 105 of 1991, dramatically changed the former common-law rules in that regard and strengthened the ability of farm owners and enforcement agencies with regard to game theft. This new legislation provided a further stimulus for the game farming industry. It clearly resulted from a policy initiative in response to the new realities of rural economics.

2.1.1.2. Communal: The main trend in the communal areas is that of reduced dependence on agriculture. While livestock are an important resource in the communal areas of the Eastern Cape, their contribution to the cash economy is relatively small (de Wet and van Averbeke 1995). An example of evidence for the declining importance of agriculture in the rural areas of Ciskei is that in the village of Melani, near Alice, half the people had no stock and cropping was declining (Manona 1998). People rely on external sources of income for survival. The livelihoods of people in the Peddie District of rural Ciskei depend overwhelmingly on state transfers, such as pensions and grants, which act as disincentives for agricultural production and resource management (Ainslie *et al.* 1997). In this manner, agriculture is becoming an increasingly peripheral activity among rural people. Hence, the management of natural resources is not a high priority to them.

2.1.3. Water resources
Before 1827, water resources management was in the hands of “Landrost en Heemraden”, who were groups of farmers whose function was to regulate water use. These bodies were also in charge of settling disputes where there were competing claims. In 1827 the bodies were abolished and it was left to the Supreme Court to settle disputes. The principles used by the court were a mixture of Roman-Dutch, English and French water rules. One of these rules was the distinction between private and public waters and the other was the concept of “riparian” ownership. Private waters were available for use to the owners of the land on

which they were found and riparian owners got proportional rights to the water in public rivers. The state played no role in the management of water until the commercial and the domestic sectors started competing for water use. In 1912 the water law was rationalised under the Irrigation and Conservation Waters Act. Because the Court previously dealt mostly with irrigation disputes, the act was used for compiling irrigation rules. With the increase in industrial development it was necessary to update the law which resulted in the formation of the Water Act of 1956.

With the formation of the 1956 act, the state took an active role in regulating water use. At the request of riparian communities, irrigation boards, which controlled the use of public water, could be established by the Minister. The boards could build dams and canals for irrigation purposes and regulate the water use from such structures. Capital costs of such schemes were covered by subsidies from the government and loans from institutions such as the Land Bank. Rates were charged to each member to repay the loans.

Where there was a need for the supply of water in bulk to local authorities, the Minister established water boards. The function of such a board was to oversee the efficient supply of water to local authorities who in turn supplied water to individual consumers. The consumers were charged a tariff to cover the cost of the water board.

The National Water Act of 1998 establishes the requirement of a national water resource strategy which provides the framework for the protection, use, development, conservation, and management of water resources for the country as a whole, as well as within regional and catchment levels. Catchment management strategies are also specifically required, to be developed by individual catchment management agencies.

The Act also recognises that there are considerable gaps in information needed for water resource management and sets out steps to close these gaps. The first of these steps is the establishment of a classification system to determine types of water resources, followed by the application of this system to determine the class and resource quality objectives for significant water resources.

Following from the above, is the concept of the Reserve, which is defined in part as “the quantity and quality of water required (a) to satisfy basic human needs..., and (b) to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource”. Reserves must be determined for all significant water resources. The balance of the Act deals with procedures and mechanisms to ensure the sustainable management of the quantity and quality of water resources.

2.2. PRODUCTIVITY IN CURRENT NATURAL RESOURCE MANAGEMENT (P. Lent, R. Bally)

2.2.1. Rangelands

On just under 10.4 million ha of grazed commercial farming areas, grazing intensity was nearly 2 million LSU, or 0.19/ha in 1981, according to DBSA (n.d.). Livestock numbers in the same year on communal areas was estimated at 221 263, or 0.29 LSU/ha for the Ciskei and 2.2 million LSU (0.57 LSU/ha) for the Transkei. How these stocking rates compare with sustainable levels or carrying capacity was not stated. Indeed, there is a surprising lack of information to compare actual and recommended stocking rates, especially for specific farms in the commercial sector.

Little information is available regarding productivity of game farms in the province. Fairall *et al*. (1990) evaluated a mixed merino sheep and springbok enterprise on a karoo farm located just outside the western border of the Eastern Cape. The farm has run 3000-4000 sheep and about 1300 springbok since 1968. Total meat production with springbok was higher than with sheep alone. Twenty percent of the springbok population is cropped annually, although it is thought that this could be increased to 29% annually. Dressed weights of springbok carcasses for marketing are 10 kg and up. No indication of long-term sustainability is available, although the premise is that an enterprise based on two-species cropping is more likely to be sustainable than one based solely on merino sheep.

Some evidence is available to support the notion that overall animal production will increase with a mixture of grazing and browsing species. Aucamp et al. (1983) examined the effects of increasing abundance of Acacia karoo on this relationship. They estimated that in the so-called false thornveld of the Eastern Cape that total forage yield (combined grass and browse production) would peak at about 800 kg DM/ha at a tree density of 856/ha. However, grass production declined from a maximum of approximately 675 kg DM/ha as tree density increased from zero.

2.2.2. Water

Mean annual runoff (MAR) data are given for 85 river systems in the Eastern Cape region by Noble and Hemens (1978). For the old Transkei, (between the Mtamvuna and Great Kei rivers) the total MAR is 7 504 million cubic metres. For the so-called Border region (between the Great Kei and Tyolomnqa rivers) MAR is 1 234 million cubic metres (an under-estimate due to data gaps), while for the former Ciskei (between the Tyolomnqa and Great Fish rivers) the figure is 180 million cubic metres. Finally for the western part of the Eastern Cape Province (from the Great Fish river to the western boundary), the total MAR is 1 492 million cubic metres. This makes a total MAR of 10 410 million cubic metres for catchments that drain into the Indian Ocean. By way of contrast, the MAR for the whole Orange River catchment is some 9 500 million cubic metres (Noble and Hemens 1978).

An estimated 890 million cubic metres of groundwater could be abstracted annually from the main drainage regions of the Eastern Cape (Department of Water Affairs 1986). The groundwater resources of the Eastern Cape are relatively limited, and they are not a significant resource for either urban or irrigation purposes (McCallum 1988). This is due to both low yields and high salinity contents. Nevertheless, ground water is an important source for many smaller towns, and of particularly great value in the large, arid portions of the province. In addition, the coastal areas between Cape Padrone and Port Alfred make extensive use of ground water from coastal dunes.

2.3. KEY RESOURCES AND CONSTRAINTS FOR CURRENT SYSTEMS OF NATURAL RESOURCE MANAGEMENT
(P. Scogings, T. de Bruyn, P. Lent, R. Bally)

2.3.1. Rangelands

2.3.1.1. Ecological constraints and resources: Rangeland degradation was implicated by Trollope and Coetzee (1975) as the main ecological factor limiting livestock production in the communal areas. What this means, effectively, is that there is a severe fodder shortage, especially towards the end of the winter dry season or during droughts. This was identified as being the main ecological constraint on agriculture in communal rangelands countrywide It is well known that large numbers of livestock in the communal areas die during droughts, unless they have access to key resource areas (e.g., crop residues and roadside reserves) or supplementary food (Scogings *et al*. in press).

The low primary productivity of degraded rangelands was also implicated as the main constraint on natural resource management in the commercial rangelands of the drier parts of the Eastern Cape (Dean and MacDonald 1994). Livestock production in the Eastern Cape is particularly sensitive to droughts and it is not always possible to reduce stock numbers during a drought (especially if supplementary feeding is subsidised, as was the case in 1982/83) (Roux and van der Vyver 1988). Stock reduction schemes during the 1992/93 drought, however, effectively decreased livestock numbers in the commercial sector of the Eastern Cape (de Wet and van Averbeke 1995).

2.3.1.2. Institutional constraints: A major reason for the current trend to change from livestock to game farming is to overcome the ecological constraints on commercial livestock production, i.e., drought and winter fodder shortages, by making better use of various resources by diverse animal populations. Having reduced the impacts of ecological constraints, financial and institutional constraints become important. For example, the Eastern Cape Department of Economic Affairs, Environment and Tourism has done little to establish guidelines on hunting and game farming in the province and also has done nothing to promote the industry. Obtaining export permits for trophies from the province is also a major policy and administrative deficiency.

While commercial farmers have access to a well-established support system for finance, marketing and information, the support for communal pastoralists is rudimentary (Scogings *et al*. in press). Much of the decline in the condition of Transkei grasslands was blamed by livestock owners on the weakening of local institutions (Kepe 1997), which presumably implied that access to grazing was not controlled and, therefore, overgrazing occurred. A study of local-level institutions in natural resource management in Ciskei, highlighted the following constraints (Ainslie *et al*. 1997):

- the significant degree of population mobility between urban and rural areas,
- the lack of infrastructure and rural poverty in the province.
- the collapse of agricultural support for farmers
- the dependence on state transfers (e.g., pensions), which acted as a disincentive for agricultural intensification and resource management efforts
- local differentiation in socio-economic status, which contributed to the lack of coherence in local, collective resource management actions.

- overcrowding and landlessness, which lead to increased pressure on the natural resource base
- migrant labour practices depleted communities of decision-makers, which affected implementation of resource management decisions
- socio-economic differentiation in the utilisation of the natural resources (e.g., poorer households rely on firewood and water, wealthier households utilise more grazing and arable land)
- no formal structures for natural resource management existed.

Anim and Lyne (1994) concluded that increased private ownership of land would lead to greater economic efficiency and more equitable distribution of land in Ciskei. On the other hand, increased access to marketing channels, rather than individual ownership of land, may increase productivity (Pienaar 1995). Reasons for and against privatisation are:

1) For privatisation:

- the provision of services and development is more difficult on land which has no legally secure status or ownership
- privatisation has evolved naturally in some areas near towns or cities where an active land market has developed as a result of market-related agricultural production.

2) Against privatisation:

- communal land allows free access to residential and agricultural land to the poor
- there is no conclusive evidence from Africa that individualisation of land ownership increases agricultural productivity. Other factors such as access to markets, credit and quantity and quality of land appear to be more important
- the social structure associated with communal land-use provides an important safety net for the poor
- land has often been less crowded compared to some privately owned black areas.

2.3.2. Protected areas

In terms of provincial nature conservation, key constraints are the lack of personnel and finances. Policy and management skills are generally lacking. Constraints on natural resource management in protected areas are, therefore, more institutional (administration and funding) than ecological. Key resources in protected areas are the biodiversity and tourism values.

2.3.3. Water

Constraints include factors such as poor finance, lack of adequately trained staff, growing water consumption, lack of fundamental information and an unpredictable climate in a setting of global climate change.

The 1998 National Water Act sets clear constraints on further irrigation development, since the principle of the Reserve in particular requires the establishment of quantities and qualities of water required for the maintenance of ecological functioning of all affected components of a water resource system.

3. PERSPECTIVES ON THE SUSTAINABILITY OF NATURAL RESOURCE MANAGEMENT

3.1. EVIDENCE FOR ENVIRONMENTAL DEGRADATION UNDER CURRENT NATURAL RESOURCE MANAGEMENT
(P. Scogings, R. Bally, P. Lent)

3.1.1. Commercial rangelands
Much of the commercially managed rangeland is in good condition relative to the communal areas (Palmer *et al*. 1997, 1998), but the decrease in stocking rates in the drier areas over the last 100 years has been interpreted as an indication of reduced rangeland productivity (Dean and MacDonald 1994). It is possible, however, that reduced stock numbers in these areas are the result of the government's stock reduction and drought subsidy policies during the 1970s and 1980s (Hoffman 1997).

Degradation in the commercial areas is mainly in the form of bush encroachment and the replacement of palatable grasses by unpalatable ones in the wetter vegetation types (grassland and savanna) and desertification in the drier vegetation types (karoo and succulent thicket) (Trollope *et al*. 1989). It is generally felt that much of the succulent thicket vegetation has been irreversibly destroyed by commercial goat and ostrich farming and is better suited to wildlife utilisation (Hoffman and Cowling 1990; Stuart-Hill 1992; Moolman and Cowling 1994; Kerley *et al*. 1995). This is because goats prevent the vegetative regeneration of the main succulent species, *Portulacaria afra*, but larger herbivores, such as elephant, stimulate the spread of *P. afra* (Stuart-Hill 1992).

Bush encroachment (especially involving *Acacia karroo* and fynbos species) in grassland and savanna areas has been caused by heavy grazing, together with reduced burning and reduced browsing, while the replacement of palatable grasses with unpalatable grasses is the result of selective grazing (Trollope *et al*. 1989). The increase in bush density has led to increased farming with goats (Aucamp *et al*. 1984).

Karoo shrub encroachment in the drier areas has been caused by overgrazing (Trollope *et al*. 1989). There is, however, evidence that inter-annual variation in summer rainfall interacts with grazing to determine shifts between shrub and grass dominance in the drier areas. High summer rainfall promotes grass cover, unless grazing is heavy, while low summer rainfall reduces grass cover and leads to shrub dominance (Hoffman 1997; O'Connor and Bredenkamp 1997; Palmer and Hoffman 1997).

3.1.2. Communal rangelands
In a broad study of range condition in the Eastern Cape Province (using satellite derived indices), Palmer *et al*. (1997) found that 0.5 million ha in the province was in good condition, 10.6 million ha in moderate condition and 2.6 million ha in poor condition. The last was mostly in the communal areas, which also had the lowest biomass, compared to commercial systems (Palmer *et al*. 1998). Not only was biomass production reduced, but biodiversity and landscape heterogeneity were also reduced by communal grazing, especially in drier areas (Fabricius 1997).

There is evidence of increased soil erosion in Ciskei and Transkei. Soil erosion was described as critical in Transkei in the 1950s, with 30% of the entire territory described as badly eroded, 44% as moderate and 26% free of erosion (Union of South Africa 1955). Steyn (1988) estimated that 47% of the area was moderately to severely eroded. The relative contributions of each of the many factors that contribute to soil erosion, however, have not been established. As yet, it is impossible to state which land-use practices, or combinations of

land-use practices, have caused most of the erosion. In the communal area of the Yellowwoods catchment, grazing lands decreased by 4.5%, cultivated lands increased by 12.3% and areas of moderate to severe erosion doubled over the period 1975-1984 (Weaver 1988). Soil erosion rates in the Roxeni basin, Ciskei, over three years from 1983 to 1986 were 20 times higher than that expected for the area and the average for South Africa (Weaver 1989). The high erosion rates were attributed to the cultivation and grazing practices and high rainfall following a drought (Weaver 1989).

The popular perception has been that overgrazing has caused the widespread increase in soil erosion in the communal areas, e.g., Trollope and Coetzee (1975), Forbes and Trollope (1991). Recently, though, there has been a move towards blaming the widespread cultivation of land, more than high stock densities, for serious soil erosion in the communal areas. Interpretation of aerial photographs of the Tyume catchment, Ciskei, at 10-15 year intervals from the 1930s to the 1990s has indicated that most of the serious soil erosion, which covers 18% of the catchment, is closely related to cultivation between 1880 and 1920 (M. Coleman unpubl. data; Kwena Productions 1998). Subsequent to being excised the cultivated lands revegetated, with the consequence that, to the unaccustomed eye, the land appears to be eroded grazing land.

Similarly, and also in support of the move away from entirely blaming livestock for land degradation, a recent study that compared the vegetation in communal and commercial systems in the Tyume catchment indicated that range condition may not be as bad as what is usually perceived (de Bruyn 1998). Such observations validate Acocks' (1975) assertion that non-selective grazing in the same area had not caused degradation. Also, in the high rainfall areas of the Transkei, communal rangelands have shown no change in species composition after at least six decades of heavy, continuous grazing (McKenzie 1982). The condition of the coastal grasslands, however, has declined in places as a result of heavy grazing and frequent burning (Kepe 1997).

In the drier Herschel area, however, range condition is unequivocally worse than in neighbouring commercial farming areas (M.W. Goqwana unpubl. Data; Hoffman *et al*. 1999). These observations confirm Trollope's (1974, 1976) observation that the semi-arid areas are more degraded than the humid areas. In the drier areas, heavy grazing is likely the main cause of degradation. However, the distinction is not that simple and is confounded by slope, soil type and land-use system in the wetter areas. For example, the wetter Guquka grazing area with its steep slopes, was found to be in worse condition than the drier Koloni grazing area, which was planned and maintains a type of rotational grazing on gentler topography (ARDRI 1996a).

In addition, deforestation and heavy grazing on steep slopes have led to degradation in Transkei (Laker undated) and intense, long-term, wood collecting has substantially degraded the forest and thicket vegetation in parts of Ciskei (Lane 1988). Average annual wood consumption in the Amatola basin of Ciskei is about one ton per capita (Bembridge and Tarlton 1990). Thus, frequent fires, heavy grazing on steep slopes, deforestation and extensive cultivation have been important contributors to degradation in wetter areas. In both wet and dry areas, soil type is important in determining degradation (Laker undated).

The impacts of betterment planning have only recently started to receive attention. Despite earlier perceptions that betterment had improved rangeland condition (Forbes and Trollope 1991), betterment does not appear to have achieved its goals. In some cases, betterment has reduced agricultural production (de Wet and Leibbrandt 1994) and it does not appear to have had any beneficial effects on the condition of the resource base, compared to other forms of communal land-use in an area (Goqwana 1998). Compared to a commercial grazing system, two neighbouring communal grazing areas where betterment was not maintained were in

poorer condition, but still moderate to good (de Bruyn 1998). Biomass was lower and the grass sward was shorter and leafier in the communal areas, but biomass productivity was reduced in only one of the communal areas.

One negative effect of betterment was the encroachment of woody plants, especially *Acacia karroo*, into some of the grasslands of Transkei and Ciskei (Trollope and Coetzee 1978; Forbes and Trollope 1991; Goqwana 1998). Bush encroachment resulted from betterment planning because the use of fire was reduced and goat numbers were reduced, according to the plans (Trollope and Coetzee 1978).

Although bush encroachment is undoubtedly widespread, deforestation is likewise occurring. Consumption of fuelwood in both the former Ciskei and Transkei areas far exceeds harvestable yield. This deficit is most severe in the more densely populated Ciskei where an annual firewood consumption of 603 000 tonnes is estimated (Mander and Quinn 1995) and this is thought to be more than three times greater than annual yield (Hoffman *et al*. 1999).

In part because of the large proportion of communal land in the Eastern Cape, the province is rated as the third worst in terms of overall land degradation among the provinces of South Africa (Hoffman *et al.* 1999).

3.1.3. Protected areas

Very little work has been done to identify or measure degradation on protected areas. Indeed, studies like that of Evans *et al*. (1997) have used the vegetation in game reserves as a standard for assessing degradation on adjacent lands under other land-uses without baseline data regarding changes on the reserves. Perhaps the best documented degradation in a protected area of the Eastern Cape is that caused by elephants in Addo Elephant National Park (Novellie *et al*. 1991).

Loss of indigenous forest land may be significant but it has not been measured in the Eastern Cape. Denudation of forest and woodlands for firewood has been of enormous impact in Kwa-Zulu Natal where many proclaimed forests have simply disappeared (Gandar 1983).

3.1.4. Water

High erosion rates result in very high sediment loads entering rivers. As a consequence there is an average loss of reservoir capacity of just under 10% per decade in the Eastern Cape (Department of Water Affairs 1986). Indeed, this province has large areas where over 1000 tonnes of sediment are produced annually for every square kilometre of land (Department of Water Affairs 1986). Hart (1988) gives an analysis of the Buffalo River, which runs from the Amathole mountains to the sea at East London, where it forms that city's harbour. Along the river's 120 km length, its flow is punctuated by four dams, sewage effluent enters the river at three sites, industrial effluents are added at two sites, diffuse runoff enters the river along most of its length and water is abstracted for urban and industrial consumption at a further two sites (Hart 1988). At one abstraction site, mineral content of the water increased four-fold over a four year period, mirroring a general deterioration in the water quality of the system (Hart 1988). Finally the estuary receives pollutants from the harbour and tributaries draining East London's industrial area (Watling 1988).

3.2. CRITERIA FOR SUCCESS IN NATURAL RESOURCE MANAGEMENT

(P. Scogings, R. Bally)

3.2.1. Rangelands

Criteria for success will depend on the objectives of the land user. In communal areas, the main criterion for success is total animal numbers. In commercial areas, the main criterion is production per hectare, i.e., profit.

3.2.2. Protected areas

Criteria for success in nature conservation are the maintenance of biodiversity and sustainable harvesting. Game farming, however, would have similar criteria to commercial livestock farming, i.e., profit from hunting and tourism.

3.2.3. Water

Attempts have been made to develop a river conservation assessment scheme for South Africa, notably the River Conservation Scheme (RCS) (O'Keefe *et al*. 1989). The RCS is a computer programme which poses up to 58 questions, covering any aspects of rivers pertinent to their conservation. The questions are weighted according to relative importance and to their positive or negative impact for conservation. Table 3.1. lists the more important attributes of the RCS programme.

Table 3.1. Major attributes of the River Conservation Scheme. Default weightings indicate relative importance of each attribute in the programme. Positive and negative numbers indicate whether the attribute is advantageous or disadvantageous. Reproduced from O'Keefe *et al*. (1989)

Attribute	Default weighting
Percentage of flow that is sewage effluent	-12
Level of erosion in the catchment	-9
Number of mainstream dams	-8
Number of introduced fish species	-8
Mean population density in the catchment	-7
Extent of rubbish	-6
Importance of angling	-4
Importance as a migration route	5
Habitat diversity in the catchment	11
Number of indigenous macrophytes	12
Percentage unregulated river	14
Number of endemic fish species	17
Percentage natural vegetation in the catchment	18

3.3 DEBATES ABOUT THE ACTUAL AND POTENTIAL SUSTAINABILITY OF CURRENT RESOURCE MANAGEMENT
(P. Scogings, T. de Bruyn, N. van Averbeke, P. Lent)

3.3.1. Introduction
The term "sustainable development" has come to be so broadly and vaguely defined as to make it almost meaningless (Lewis 1993). The previous government of South Africa claimed that it was promoting sustainable development; the present government does likewise. Lewis notes that sustainable development ideologues tend to reduce life to a mere economic equation. So long as the same number of outputs can be taken from an area over a long term it is assumed to be "sustainable".

3.3.2. Rangelands
Although recommendations exist for commercial livestock farmers, based on research on the impacts of different grazing systems in the grassland, savanna, thicket and karoo vegetation types of the Eastern Cape, very little seems to have been published on the extent to which the recommendations are actually followed (What grazing systems are in general use and how do stocking rates relate to carrying capacity?). In the commercial areas, it is implicitly assumed that the application of recommended stocking rates will be a productive and sustainable form of management. This has not been adequately tested.

In the communal areas, it is widely assumed that the high stocking rates and continuous grazing lead to overgrazing and accelerated soil erosion (i.e., not sustainable). These are manifested in terms of reduced rangeland productivity and poorer species composition (unproductive species replacing nutritious and productive species). These notions are being increasingly challenged (de Bruyn 1998, Goqwana 1998), although there is also increasing evidence of environmental degradation in communal areas (Vetter *et al*. 1998; Goqwana unpublished data). It would appear that under certain conditions, communal grazing does lead to degradation but not always. The drier areas under communal grazing appear to be more prone to degradation, as opposed to the humid and sub-humid areas, which appear to be more resilient (Trollope and Coetzee 1978; Scogings *et al*. in press).

In the commercial sector, there is a danger of over-sell for the game industry. Many people assume that environmental sustainability will be improved with game farming. There is little concrete evidence that game farming actually maintains or enhances biological diversity. Even sustainability of natural resources in nature reserves has not been subject to testable hypotheses.

3.3.4. Water

With the political changes in South Africa, there was a growing awareness that the increased exploitation of water resources, as well as the intensification of water quality degradation, necessitated a fresh approach to water management. What emerged from the research and debate was the need for sustainable water use, which calls for a consumption rate that is equal to or exceeded by the rate of replenishment. The concept of "Integrated Water Resource Management" (IWRM) is seen as a strategy for achieving equitable access to, and sustainable use of, water resources by all stakeholders while maintaining the integrity of water at the catchment scale. Such an institutional model would be based on a system of integrated environmental management within a framework of an integrated legal system.

For the IWRM to be effective, there must be a shift from centralised control to representative management. There is the notion that the ideal water management unit is the catchment and river basin. Complications arise when a catchment falls in the jurisdiction of several administrative regions or where a river basin is shared by different provinces. It is suggested that the Department of Water Affairs should establish Catchment Management Agencies (CMA). While the Department would remain the custodian of all water resources, the CMA's would be in charge of day to day management. It is also important to give the stakeholders an opportunity to elect representatives on CMA's in order to optimise public participation.

4. POLICY AND INSTITUTIONAL FRAMEWORKS FOR NATURAL RESOURCE MANAGEMENT

4.1. INSTITUTIONAL FRAMEWORKS
(P. Scogings, P. Lent, R. Bally)

4.1.1. Introduction

Since 1994, the governmental frameworks of Transkei, Ciskei and the rest of the Eastern Cape have been combined, with greater or lesser degrees of success. These provincial departments fall under the respective national departments. The South African Constitution after 1994 gave the individual provinces major authorities and responsibilities with regard to legislation and regulation in diverse areas such as soil conservation, pollution control, population development, regional planning, tourism and urban and rural development (Fuggle and Rabie 1996). Further, several acts passed by the national legislature assigned responsibilities or jurisdictions for specific environmental matters to the individual provinces (Rabie 1997). Thus, the involvement of the individual provinces in environmental matters now extends beyond that provided for in the former constitution. However, the new constitution leaves parliament with considerable authority to enact legislation that will prevail over provincial legislation, and some people have criticised the provisions of the constitution

and recent national legislation that they believe will lead to fragmented and confused environmental protection.

4.1.2. Rangelands

The management of rangelands for livestock production falls under the Eastern Cape Department of Agriculture and Land Affairs, which is linked to the national Department of Agriculture and Land Affairs. The provincial department consists of a number of directorates, including: Applied Research and Training, Extension, Land Administration, Land-use Planning, Finance, Engineering, Youth and Gender, Veterinary Services and Administration. The head office is in Bisho, but there are regional offices in Umtata, East London and Port Elizabeth. Within each region are sub-regions, within which are district offices from which extension services are meant to operate.

Within the province, there are also non-governmental organisations, such as environmental agencies, development forums, community organisations, common property associations, farmers' unions and co-operatives.

4.1.3. Protected areas

Prior to 1994, the role of the provinces was largely limited to nature conservation. Authorities for provinces to act in such matters had been strengthened in 1986 by devolution of certain executive functions from the central to the provincial governments, as described in the Provincial Government Act of 1986 (Schwella and Muller 1996). These included increased provincial responsibility for marine resources, for example. For the Cape Province, provincial authorities were spelled out in various Nature and Environmental Conservation Ordinances. At the same time, however, the central government in 1989 had continued to emphasise its primacy in environmental matters.

The institutional framework for resource management in protected areas is characterised by rapidly declining provincial budgets for management of protected areas and for nature conservation in general. Several provinces have decreased funding for provincial parks by 20-30%, or more, in the past two to three years. The Kumleben Report (1998) concluded that the financial structuring for nature conservation countrywide is totally inadequate. Only 0.3% of the national fiscus is allocated to biodiversity conservation. In general, provinces are devoting less than 1% of annual budgets to environmental needs and only a small portion of that goes to nature conservation.

4.1.4. Water

The institutional framework with regard to water management falls within the Ministry of Water Affairs and Forestry which oversees the Department of Water Affairs and Forestry. The section dealing with water consists of three Directorates, namely the Directorate of Water Services, the Directorate of Hydrology and the Directorate of Water Resource Management. Regional offices serve different sections of the country; that covering the Eastern Cape is located in King William's Town. Finally, the government framework includes a highly effective co-ordinator and sponsor of research into water-related problems, namely the Water Research Commission.

On a more local level, water usage and monitoring is regulated by Transitional Local Councils and District Councils in the urban and rural areas respectively. Finally, attempts are being made to co-ordinate water management through catchment-based management boards, although these are currently still being put in place.

The Water Services Act of 1997 has a number of objectives, including:

- ensuring that all have access to basic water supply and sanitation services necessary to human health and well-being (thereby fulfilling certain constitutional obligations),
- setting national standards and norms for water services and tariffs,
- ensuring the proper planning of water services,
- the clarification of the institutional frameworks for water services, and
- the promotion of effective water resource management and conservation.

This Act is in the form of framework legislation, giving the overall skeleton of the law in broad outline which empowers the Minister to draw up regulations which fill in the details. Thus, as a result of this Act, the Minister and his Department have considerable powers, although any regulations promulgated are reviewed by Parliament.

The Water Services Act of 1997 compels local government to take reasonable measures to provide water to meet minimum needs of people living in the supply area, on the basis, however, of sustainability. It allows the Minister to set norms, standards and appropriate tariffs to be followed by water service providers. The duties and functions of water service authorities are set out, as well as the responsibilities of local government (which does have the freedom, however, to delegate functions while retaining responsibility). The Minister is also responsible for the establishment of water boards and water service committees. Both the Minister and the Province must monitor the performance of every institution involved with providing water services. Finally, the Act obliges the Minister to set up a national information system which will inform the further development of water policies and resources.

The National Water Act of 1998 recognises, *inter alia*, the need for integrated management of all aspects of water resources in the context of uneven national distribution, the need for equity of access and the need for the protection of the quality of water resources to ensure their sustainability. The Act covers aspects such as:

- water management strategies (including both a national resource strategy and catchment management strategies),
- the protection of water resources (including their classification, the classification of water resources and resource quality objectives, the setting aside of a reserve for human needs and sustainable ecosystem functioning, prevention of pollution, and the control of emergency incidents),

- the use of water (including the regulation of water use, considerations and other requirements of authorisations, existing lawful water uses, stream flow reduction activities, controlled activities, and licensing procedures and conditions),
- financial provisions (focussing on water use charges and financial assistance),
- catchment management agencies (covering their establishment, governance and operation)
- water user associations (covering their establishment and functioning)
- advisory committees, international water management, government waterworks and dam safety,
- access to and rights over land (including entry and inspection, servitudes, and waterworks and personal servitudes)

The Act of 1998 thus essentially fulfils the intentions, complements and fills in detail to the framework legislation provided by the Water Services Act of 1997 regarding monitoring, assessment and information, appeals, dispute resolution, offences and remedies.

4.2. POLICIES ON NATURAL RESOURCE MANAGEMENT
(T. de Bruyn, P. Lent, N. van Averbeke)

4.2.1. General environmental management
The Environment Conservation Act of 1989 represented the first true attempt at holistic environmental management in South Africa. New bodies such as a Committee for Environmental Management and The Council for the Environment, the latter being advisory to the Director General: Environmental Affairs, were established or given new statutory authorities. Among other roles, these bodies were to help co-ordinate environmental policies and decisions among ministries. At the same time recognition was made of the fact that responsibilities for environmental matters such as pollution control were poorly spread among several ministries. Efforts to resolve these administrative problems largely ground to a halt because of the growing awareness that a new constitution for the nation was coming.

The Environment Conservation Act of 1989, as amended in 1992, allowed for interdicts and abatement notices to stop or deter environmental damage and pollution. Land owners could also receive compensation for restrictions imposed upon them to advance environmental management. Limited opportunities for aggrieved citizens to seek judicial relief on environmental matters were also instituted. However, requirements to gain "standing" remained restrictive (Rabie *et al*. 1996). Overall, Rabie (1996) characterised environmental legislation through 1992 as enabling, but not requiring, executive actions to protect the environment in South Africa. This general statement was particularly true with regard to integrated environmental management and an environmental impact assessment process. Legally enforceable broad regulations were never promulgated (Preston *et al*. 1996)

4.2.2. Commercial rangelands
Du Toit *et al*. (1991) outlined the evidence of resource degradation in the commercial farming sector of South Africa, which led to the enactment of various legislative efforts to prevent abuse (e.g., the Conservation of Agricultural Resources Act, 43 of 1983). The White Paper on Agricultural Policy tabled in 1984 contained no detailed proposals on optimum use of natural agricultural resources, but gave rise to the endorsement of the National Grazing Strategy (NGS), the product of an intensive effort by scientists and organised agriculture to ensure

productive, yet sustainable, land-use. The NGS made provision for the enactment of Act 43 of 1983.

Act 43 of 1983 (Republic of South Africa 1983) aimed to: "control the utilisation of the natural agricultural resources of the Republic in order to promote the conservation of the soil, the water sources and the vegetation and the combating of weeds and invader plants". The act established guidelines for a number of land-use issues, including: weed and invasive plant control, the use of fire, animal numbers and grazing capacities, soil conservation measures, rangeland restoration and water resource management. Subsidies for soil conservation works, repairs after natural disasters, stock reduction during droughts, weed control and the formation of conservation committees were also announced.

The objective of the 1990 Disaster Drought Relief Scheme (Republic of South Africa 1990), was the efficient use of state funds to assist commercial farmers in times of disaster drought and to ensure optimal natural resource use by farmers. Planning pro-actively for droughts was encouraged by improving pastures over the long term. Assistance was to be granted to farmers that had conserved pro-actively, as opposed to a system of rescuing farmers in trouble, owing to a lack of coping measures. Farmers were expected to reduce stock as droughts developed and not to exceed long-term grazing capacities on a farm. Assistance was rendered following a points-based scoring system. Financial assistance included the maintenance of a nucleus breeding herd, stock reduction incentives, rebates on stock feed transport and a lease scheme for hiring additional grazing. Between 1987 and 1998 over R 800 000 000 was spent on major drought subsidy schemes.

Hoffman *et al.* 1999 review the history or these various government policies and schemes aimed at preventing or reversing veld degradation, especially in reference to the Karoo region. In general, these schemes seem to have had mixed results, and good cost-benefit analyses are lacking. The eastern Karoo was the region judged to have benefited most.

4.2.3. Communal rangelands

Perhaps the greatest single factor responsible for shaping communal land-use was the Natives Land Act of 1913. This act decreed that, based on racial classification, non-whites were not permitted to own, rent or share-crop land in South Africa. Because of this act "Millions of black people were forced to leave their ancestral lands and resettle in what quickly became over-crowded and environmentally degraded reserves" (Republic of South Africa 1997). Furthermore, under the Native Trust and Land Act, 1936, "black people lost even the right to purchase land in the reserves" (Republic of South Africa 1997). The homelands were consolidated and enlarged following the establishment of the South African Development Trust (SADT) in 1936 (Republic of South Africa 1997).

Current land-use patterns in the former Ciskei generally follow those established by the Betterment Schemes, which were recommended to prevent "land abuse" and to develop the "Bantu" agricultural industry (Union of South Africa 1955). These schemes were introduced under Proclamation 31 of 1939, superseded by Proclamation 116 of 1949, and implemented after the release of the Tomlinson report (Union of South Africa 1955). Through these schemes, land in the tribal areas was allocated for residential, grazing and cropping areas. The traditional settlement pattern, one of scattered rural dwellings over the landscape, was consolidated into more defined villages, while cropping and grazing areas were demarcated and fenced off. The reduction of livestock was also recommended in betterment areas.

The Transkei Agricultural Development Act, No. 10 of 1966, and the Ciskei Agricultural Development Act, No 14 of 1989 (Republic of Ciskei 1989), were almost identical. The Ciskei Agricultural Development Act aimed to "provide for the conservation of the soil, the veld and water sources, the improvement and control of livestock, the combating of weeds

and invader plants and the development of agriculture generally in Ciskei". Enforcement measures included expropriation of land or payment of penalties. It is unclear to what extent these measures were used.

Soil conservation schemes were to be established and maintained by the state and included provisions regarding:

- the carrying capacity of the land and the number of livestock that may be grazed thereon,
- demarcation of fencing, rotational grazing schemes and the restriction of the numbers of livestock to graze the paddocks,
- livestock improvement and the regulation of kinds of livestock deemed unsuitable,
- land-use allocation into arable, grazing and residential areas,
- limitations on the use of natural resources (e.g., cutting trees, grazing, etc.),
- the use of fire in rangeland,
- weed or invader plant eradication,
- subsidies for soil conservation, veld rehabilitation or stock reduction schemes on private land,
- restrictions on ploughing,
- prevention of salination and waterlogging of irrigated land,
- protection of cultivated soil against water and wind erosion,
- protection of water courses and wetlands.

The Green Paper of the Eastern Cape Provincial Department of Agriculture (Province of the Eastern Cape 1997a) has as its objective to raise the level of agricultural production in the former homelands, based on sustainable use of agricultural resources, through market-orientated agricultural production and the assistance of resource-poor farmers. The main objective is to satisfy household food security. Livestock farmers are encouraged to accept droughts as natural phenomena and have low-risk management strategies, including stock reduction during droughts. Greater emphasis is placed on small-scale farming with appropriate technology research and extension. The use of marginal land is discouraged and rehabilitation programmes will be implemented at the cost of land users who are responsible for degradation. Security of tenure is seen as important to ensure productive and sustainable land-use. Appropriate livestock breeds, feedlotting and the introduction of game are proposed management alternatives. Sustainable range management is mentioned but not described. Subsidies for soil conservation works (in accordance with the Conservation of Agricultural Resources Act, 43 of 1983) would be made available for emerging and communal farmers, if required.

The land redistribution policy of the Eastern Cape Provincial Government includes references to sustainable agricultural production, while ensuring food security and self sufficiency (Province of the Eastern Cape 1997b). Farms are to be planned and farm sizes depend on the agricultural production potential. The aim is to have privately owned farmland for full-time farming by previously disadvantaged people. Extension services will be made available to ensure sustainable land-use practices are used. It will be required of the lessee "to ensure that soil and ground erosion is combated". Restrictions on animals are also provided for. How this is to be calculated is not made clear but will presumably depend on the livestock carrying capacity of the farm. Fire is also regulated.

A number of other acts which affect land-use or redistribution, but which have no reference to environmental issues or sustainable land-use practices, include the following:

- the Upgrading of Land Tenure Rights Act, 112 of 1991 (Republic of South Africa 1991),

- the Draft Land Rights Bill of 1998 (Republic of South Africa 1998a),
- the Restitution of Land Rights Act, 22 of 1994 (Republic of South Africa 1994).

4.2.4. Protected areas

The Ciskei Nature Conservation Act, No. 10 of 1987 (Government of Ciskei 1987), and the Transkei Environmental Conservation Decree of 1992, (Government of Transkei 1992), which dealt with nature conservation issues, were very similar, but the Ciskei act allowed more local participation. These acts aimed for the conservation of species and biodiversity and the management of nature reserves and water catchments.

4.2.5. Water

After the Landrost en Heemraden bodies, whose function was to regulate water use, were abolished in 1827 it was left to the Cape supreme court to resolve disputes, which meant that the court had to devise principles to decide between competing claims. Because the South African climate was different from that of Europe the judges had to come up with principles that were a mixture of Roman-Dutch, English and French water rules. One of these rules was the distinction between public and private rivers and the other was the concept of "riparian ownership" where landowners on the banks of rivers were the only ones entitled to water rights. The court developed principles where riparian owners got proportional rights to the water in public rivers. Private rivers were available for use to the owners of the land on which they were found. Domestic water needs had priority over industrial use.

As noted in 2.1..4, with the increase in industrial development after the Second World War it became necessary to update the law, which resulted in the formation of the Water Act of 1956. While the 1956 act did not contain any racially discriminatory clauses, the riparian principle implied that most black people did not have access to water. The distinction between public and private waters limited the powers of intervention by the state and prevented integrated catchment management. The act did not recognise the economic value of water as it allowed riparian owners to use public water irrespective of whether the use was economical or in the best interest of the public. With the political changes, it was felt that the law was inadequate for the provision of water to all South Africans and it was replaced by Act 36 of 1998.

The current legislation (Water Services Act of 1997 and National Water Act of 1998) enshrine a new set of principles which include a constitutional right guaranteeing equity of access to basic water supply and sanitation services necessary to human health and well-being, as well as the principle of the Reserve (see 4.1.4) to ensure both this and the sustainable ecological functioning of water resources. This legislation also approaches national water resources holistically, while making allowances for regional circumstances. In particular, the intention is to manage water resources based on catchments (Fig.2, p.10) rather than on political boundaries (the latter often cutting directly across catchments since they often follow water courses rather than catchment boundaries). To perform this new management task, the legislation requires the establishment of catchment management agencies, whose role it is to develop and manage water resources holistically on a catchment basis.

4.3. POLICY GOALS

(P. Scogings, N. van Averbeke)

4.3.1. Rangelands

At national level, agricultural policy aims for more equitable distribution of land and better household food security on the basis of sustainable resource use (Republic of South Africa 1995, 1998b). In particular, the vision of the Eastern Cape agricultural policy is "A highly efficient and economically viable, market-directed farming sector, characterised by a wide range of farm sizes, which will be regarded as the economic and social pivot of rural Eastern Cape and which will influence the rest of the economy and society" (Province of the Eastern Cape 1997a).

To achieve the stated vision, the main objectives of the Eastern Cape agricultural policy are to:

- Increase agricultural production in the former homelands in order to export basic foods, but to do this on a sustainable basis of ecological integrity, economic viability and socio-political acceptability,
- Make agricultural production market-orientated,
- Focus financial support on resource-poor and beginner farmers to enable them to buy land, and
- Provide support to farmers in production, marketing, financial aid, institutional infrastructure, technology development and training.

4.3.2. Environmental management and biodiversity

The visions of both the national environmental management policy and biodiversity policy are similar. The general vision is for a society that lives in harmony with its environment and benefits from the conservation and sustainable use of biological diversity (Department of Environmental Affairs and Tourism 1997a,b).

Within the overarching goal of sustainable development, national government has identified seven strategic goals for achieving environmental sustainability and integrated environmental management (Department of Environmental Affairs and Tourism 1997a):

- Effective institutional framework and legislation
- Sustainable resource use and impact management
- Holistic and integrated planning
- Participation and partnerships in environmental governance
- Empowerment and environmental education
- Information management
- International co-operation

The biodiversity policy has six goals (Department of Environmental Affairs and Tourism 1997b). They are to:

- Conserve South Africa's biodiversity
- Use biological resources sustainably and minimise adverse impacts on biodiversity
- Ensure that benefits derived from the use and development of South Africa's genetic resources serve national interests
- Expand the human capacity to conserve biodiversity, to manage its use, and to address factors threatening it
- Create and implement conditions and incentives that support the conservation and sustainable use of biodiversity
- Promote the conservation and sustainable use of biodiversity at the international level.

4.3.3. Water

A clear statement of current policy reads: "The Department of Water Affairs and Forestry views its function as that of being custodian of a limited national resource in a society with growing, diversified and competitive economy. Its major goal is to ensure the ongoing, equitable provision of adequate quantities and qualities of water to all competing users at acceptable degrees of risk and cost under changing conditions. This will be accomplished by the judicious management and conservation of the available resources in consultation with all user groups, even across international boundaries, so as to maximise their collective utility" (Muller, 1993; DWAF, 1996).

4.4. POLICY PERFORMANCE
(P. Scogings, P. Lent, R. Bally)

4.4.1. Rangelands
The 1913 Land Act has led to widespread degradation in the Eastern Cape, and there is no convincing evidence that the Betterment Plans succeeded in the areas where they were implemented and still exist.

Stock reduction schemes during the 1992/93 drought effectively decreased livestock numbers in the commercial sector of the Eastern Cape (Roux and van der Vyver 1988; de Wet and van Averbeke 1995).

Based on a survey of extension agents and other managers Hoffman *et al*. (1999) compared the overall soil and veld degradation in all 348 magisterial districts of South Africa. Of the 20 districts judged to be most degraded, eight are in the Eastern Cape Province. Only one of these (Komga) is predominantly commercial rangelands.

Indications that policies for game farming are not performing well are that:

- Industry representatives continue to cite uncertainty arising from the fact that the provincial Department of Economic Affairs, Environment and Tourism has done little to establish guidelines on hunting and game farming in the province and also has done nothing to promote the industry, leaving the latter entirely to industry associations and individual businessmen.
- The great difficulties in obtaining export permits for trophies originating in the Eastern Cape Province is frequently cited as a major policy and administrative deficiency. Hunters want the processing of export permits to occur within the province (Ramsden 1997).

4.4.2. Water
Not much is known about the performance of water policies. Minimum flow requirements for rivers and estuaries is still the subject of considerable research effort (mostly sponsored by the Water Research Commission) and, therefore, the actual availability of water for different uses is still in the process of being determined. On the other hand, efforts are being made to compel chronic violators of water quality requirements to either comply or face prosecution.

4.4.3. Woodlands
DWAF (1997) notes that previous forestry policy in South Africa has strongly emphasised closed canopy forests and neglected woodlands. Projections for fuelwood deficits nation-wide are alarming. Fuelwood demands affect both protected areas and woodlands within communal areas. Commercial rangelands are also not immune. No effective policy is in

place. Planted woodlots provide only about 1% of fuelwood demand nation-wide (Hoffman *et al*. 1999).

4.5. DIRECTIONS OF POLICY AND INSTITUTIONAL REFORM
(T. de Bruyn, P. Scogings, P. Lent, N. van Averbeke)

4.5.1. Rangelands
The direction of the current national agricultural policy on rangelands is dubious. The high stocking rates and grazing pressure in the former homelands are not regarded as a threat to natural resources (Republic of South Africa 1998b). This contradicts the statement in the current land policy that the 1913 Land Act led to "environmentally degraded" homelands (Republic of South Africa 1997). Both views are equally naïve in their generality. There is evidence that degradation has occurred in some, but not all, the former homelands and the conditions that lead to degradation are not fully understood, except that arid and semi-arid areas appear to be the most susceptible to high stocking rates (Scogings *et al*. in press). In addition, the current agricultural policy is self-contradictory when, on one hand, it disregards the potential threat of high stocking rates on natural resources and, on the other hand, proposes limitations on livestock numbers to ensure sustainable resource use. The land policy also proposes means of preventing the degradation of redistributed land through unsustainable use.

Policy on forest plantation (industrial forests) could also impact on Eastern Cape rangelands. The province is considered to contain large potential for further afforestation and expansion of such land use (DWAF 1997). Such expansion would not only mean direct loss of grazing loss but has environmental implications including water run-off.

Communal tenure will likely continue to be the preferred form of tenure, since it allows equitable access to land (for either agricultural or residential purposes). Various models of communal tenure are likely to be developed for the allocation of land rights among community members and to manage common resources. This will be done with the participation of all affected parties. The reason for strengthening tenure rights is to increase the personal security of land users and to stimulate growth and investment. The latter, however, is not only affected by tenure, but by access to markets, as well (Pienaar 1995). The challenge to the government is to find flexible legal and administrative ways to ensure equitable land tenure.

4.5.2. Protected areas
Kumleben *et al*. (1998) make specific proposals for improving the financial situation of protected areas. Among other things, the authors recommend more use of "parastatal" bodies (statutory boards) for management purposes.

Policies are being instituted that will provide local communities with opportunities to participate in the management of protected areas and to receive economic gains and or access to resources within the protected areas. The policy in the Eastern Cape has moved slowly but has included the establishment of community forums for many conservation areas. These are still forming and many details remain to be addressed. In some cases, funds are already being set aside for the benefit of local communities (as, for example, a portion of fees charged to hunters on conservation lands). However, in at least two cases, these funds are being withheld because the administrative bodies have not yet been properly constituted or because distribution formulae have not yet been agreed on.

However meritorious the goals may be, there are dangers that these community demands may put more stress on the limited resources and budgets, as well as promoting inappropriate use of the areas in some cases. A further approach is to promote the development of buffer zones on communal or privately owned lands surrounding core conservation areas.

By law and international treaties, both the national government and the provincial authorities are committed to policies that maintain biological diversity. However, there has been no systematic effort to develop a strategy for that resource management objective in the province, nor has there been an assessment of the costs, or the most cost-effective ways, of achieving biodiversity goals. An example of this disconnection between law and policy is evident with regard to afforestation programmes. Policies regarding afforestation of montane grasslands in the province require critical re-examination.

4.5.3. Water

The Department of Water Affairs and Forestry views its function as custodian of a limited national resource in a society with a growing, diverse and competitive economy. Its major goal is to ensure the ongoing, equitable provision of adequate quantities and qualities of water to all competing users at acceptable degrees of risk and cost under changing conditions. This will be accomplished by the judicious management and conservation of the available resources in consultation with all user groups, even across international boundaries, so as to maximise their collective utility.

The purpose of the new act (Act 36 of 1998) is to ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled in ways which take into account, among other factors:

- meeting the basic human needs of present and future generations
- promoting equitable access to water
- promoting the efficient, sustainable and beneficial use of water in the public interest.

To fulfil the above, a national water resource strategy will be put in place, which will provide a framework for the protection, use, development, conservation and management of all water resources. The strategy will be reviewed from time to time and will be binding to all institutions performing duties related to water management.

5. METHODS AND CONCLUSIONS

5.1. SUMMARY OF METHODS USED TO OBTAIN DATA ON NATURAL RESOURCE MANAGEMENT

(P. Scogings, R. Bally)

5.1.1. Terrestrial resources

Assessments of the impacts of commercial land-use systems on the terrestrial natural resources have mainly been by inventories of natural resources, which may or may not have compared different forms of commercial grazing management with each other in long-term, controlled experiments on research farms and private land (Table 5.1). Assessments of the impacts of communal land-use on the natural resources have included inventories of natural resources and questionnaire/interview surveys, both of which may or may not have compared different forms of communal resource management with commercial forms. Comparisons

have also been made among commercial, communal and conservation areas. Natural resource inventories have been ground-based or remote (aerial photography or satellite imagery).

Table 5.1. Methods used to obtain data on terrestrial natural resource management

Parameter	Methods	References
Soil erosion	Historical air photographs, sedimentation rates	Weaver 1988,1989; Coleman unpubl. Data;
Plant production/biomass	Satellite images	Lane 1988; Palmer *et al*. 1997,1998
	Long-term livestock numbers	Dean & MacDonald 1994
	Disc pasture meter or moveable exclosures	Danckwerts 1982; de Bruyn 1998; Goqwana 1998
	Reference photographs	Stuart-Hill 1991; Scogings *et al.* 1994
	Woody plant size or growth	Aucamp *et al*. 1980; Teague *et al*. 1981; Teague 1988a,b, 1989a,b; Teague & Walker 1988; Ras 1990; Stuart-Hill & Aucamp 1993; Scogings *et al.* 1996; Scogings 1998
Woody plant frequency	Point surveys, transects or quadrats	Teague *et al*. 1981; Stuart-Hill *et al*. 1986; Stuart-Hill 1995; Scogings *et al*. 1996; Scogings 1998
	Reference photographs	Stuart-Hill 1991; Scogings *et al.* 1994
	Historical air photographs	Goqwana 1998
Plant cover	Satellite images	Scogings *et al*. 1995
	Line intercept or point survey	Novellie & Bezuidenhout 1994; Milton *et al*. 1995; Fabricius 1997
Plant species frequency	Point surveys, transects or quadrats	Vorster 1982; Cowling 1984; Trollope 1984; Everard 1987; Willis & Trollope 1987; Cawe & McKenzie 1989a,b; Palmer 1989, 1991; Palmer *et al*. 1990; Martens *et al*. 1990; Shackleton *et al*. 1991; Stuart-Hill 1992; Geldenhuys 1993; Berry *et al*. 1994; Moolman & Cowling 1994; Novellie 1988; Novellie & Bezuidenhout 1994; Scogings *et al*. 1994; Milton *et al.* 1995; O'Connor & Roux 1995; de Bruyn 1998; Goqwana 1998
Biodiversity	Species counts	Fabricius 1997; Armstrong & van Hensbergen 1997,1999

Plant nutritional quality	Chemical analyses	Teague 1989c; Ras 1990; Scogings *et al*. 1996; Scogings 1998
Plant species utilisation by game and livestock at various localities	Direct observation of plants or animals, faecal analysis or fistulation	Novellie 1988; Teague 1989c; de Bruyn & Scogings 1994; Mapuma *et al*. 1995; Mbuti *et al*. 1996; Mogorosi *et al*. 1996; Raats *et al*. 1996; Haschick & Kerley 1996, 1997; Gøthesen 1997; Bjelland & Grøva 1997

5.1.2. Aquatic resources

See Table 5.2. for a summary of methods used to obtain data on aquatic natural resource management.

Table 5.2. Methods used to obtain data on aquatic natural resource management

Topic	Techniques	References
Geochemical survey of groundwater	Chemical analyses of groundwater	Bond 1946
Compilation of coastal aquifer information	Literature survey	Campbell *et al*. 1992
Textbook on freshwater ecosystems	Review	Davies & Day 1986
Management handbook for water resources	Compilation and review	Department of Water Affairs 1986
Effects of waste disposal on groundwater	Compilation and review	Englebrecht 1993
Water quality of the Buffalo river	Chemical analyses, compilation	Hart 1988
Overview of coastline of the Cape Province	Compilation and review	Heydorn & Tinley 1980
Geohydrological characteristics of water bearing formations	Field surveys and laboratory analyses	Kok & Simonis 1989
Conservation of rivers	Compilation and review	O'Keefe *et al*. 1989
Water quality of the Buffalo river catchment	Chemical analyses, biological and social surveys	O'Keefe *et al*. 1996
Hydrology of the Eastern Cape	Compilation and review	McCallum 1988
Surface water resources of the Eastern Cape	Compilation and review	Middleton & Lorentz 1998
SA inland water ecosystems: research needs	Compilation and review	Noble & Hemens 1978
Development of groundwater quality monitoring strategy	Strategy development	Parsons & Tredoux 1993
Effects of freshwater input on estuarine biota	Field studies	Scharler *et al*. 1998
Metal studies in coastal environments	Compilation and review	Watling 1998
Effects of vegetation on run-off from catchments	Field studies	Wicht 1971

5.2. EXISTING OR PLANNED RESEARCH
(P. Scogings, R. Bally)

5.2.1. Terrestrial resources

A one-day workshop held at the University of Fort Hare in October 1995 identified specific gaps in the current, documented knowledge of Eastern Cape communal rangelands (Scogings, 1996). The key gaps related to understanding the soil-climate-plant-animal-human interactions and processes of change in the communal rangelands (specifically plant and livestock population dynamics and productivity). A key action suggested (among others) was to construct a working model of communal rangeland systems. The same applies to other forms of natural resource management in the Eastern Cape. Because of the nature of the meeting at which this information was compiled much of the current and planned research identified here is on plant-animal interactions (Table 5.3). Thus we make no claim that the list is complete or balanced in nature.

Table 5.3. Existing or planned research activity on terrestrial natural resource management in the Eastern Cape

Topic	Researchers	Institution
Grazing systems and patch dynamics at Kroomie	JE Danckwerts, JC du Toit	Range & Forage Institute, Natal University
Soil erosion in communal areas	M Duma	Rhodes University
Grazing systems, primary production and diversity at various localities	AR Palmer, A Ainslie, FJ Killer	Range & Forage Institute, Rhodes University
Impacts of browsers on woody plants at Fort Hare	WSW Trollope, PF Scogings, SP Nobatyi, A Hester	Fort Hare University, Macaulay Land Use Research Institute (UK)
Impacts of grazers on grass plants at Fort Hare	M Mapuma, C Marriot,	Dohne Agricultural Development Institute, Macaulay Land Use Research Institute (UK)
Impacts of fire on vegetation at Fort Hare	WSW Trollope, WJ Bond	Fort Hare University, University of Cape Town
Impacts of grazing on insect populations at Fort Hare	P Dennis, S Wallade	Macaulay Land Use Research Institute (UK), Fort Hare University
Impacts of communal grazing at Melani and Dyamala	TD de Bruyn	Fort Hare University
Use of arable lands by livestock in the communal areas of Guquka and Koloni	J Bennett, C Mbuti	Coventry University (UK), Agricultural & Rural Development Research Institute
Degradation and impacts of communal grazing in Herschel	MW Goqwana, S Vetter	Fort Hare University, University of Cape Town
Impacts of communal grazing at Koloni	MW Goqwana	Fort Hare University
Desertification of Valley Bushveld at Addo	GIH Kerley	University of Port Elizabeth
Impacts of *Acacia karroo* encroachment at Kei Road	FO Hobson	Dohne Agricultural Development Institute
Impacts of bush clearing at Kei Road	M Mapuma, TG O'Connor	Dohne Agricultural Development Institute, Natal University
Diet selection and foraging behaviour of goats at Fort Hare	JG Raats (and students), J Derry, A Illius, I Gordon	Fort Hare University, Edinburgh University, Macaulay Land Use Research Institute (UK)

5.2.2. Aquatic resources

Much of the existing or planned research on aquatic resources is on water quality (Table 5.4).

Table 5.4. Existing or planned research activity in the Eastern Cape on aquatic natural resource management

Research Programme	Investigators
Ecological impacts of interbasin transfer schemes in dryland environments	University of Cape Town – Zoology Dept.
Appropriate low cost sewage treatment using the advanced algal high rate oxidation pond	Rhodes University – Dept. of Microbiology
Community participation and education in water resources management and environmental awareness	Amanzi Esizwe
Effects of water supplies, handling and usage on water quality and quantity in relation to health indices in the Eastern Cape Province	University of Fort Hare – Dept. of Development Studies
Guidelines for the evaluation of water resources for rural development with an emphasis on groundwater	Rhodes University – Institute of Water Research
Identifying suitable water sources for rural development projects	Rhodes University – Institute for Water Research
Rapid capacity building programme for management of water and waste services at district council and local authority levels	University of Port Elizabeth – Institute for Development and Planning
Aquatic plants of southern Africa	National Botanical Institute
Biodiversity, life history and biogeography of aquatic macroinvertebrates (specialising in aquatic insects) and their role as indicators of ecosystem health and environmental change in southern Africa	Albany Museum
Conservation and biodiversity of freshwater fishes in southern Africa	JLB Smith Institute of Ichthyology
Identification of diatoms and their use in the assessment of water quality	University of Port Elizabeth – Botany Dept.
Reproduction in aquatic invertebrates: patterns, processes and control	Rhodes University
Use of indigenous riverine organisms in applied toxicology and water resource quality management	Rhodes university, Institute for Water Research
Botanical importance rating of estuaries in former Ciskei and Transkei	University of Port Elizabeth – Botany Dept.
Decision support for the integrated management and conservation of estuaries	University of Natal – Institute for Natural Resources
Effects of land use on estuarine water quality	University of Port Elizabeth – Institute for Coastal Research
Feasibility of using the ecoregions approach in water quality management	Department of Water Affairs and Forestry – Institute for Water Quality Studies
Freshwater requirements of plant communities in different types of estuaries	University of Port Elizabeth – Botany Dept.
Geomorphological approaches to riparian zone management and rehabilitation	Rhodes University
Geomorphological research for the conservation and management of southern African rivers	Rhodes University – Geography Dept.
Implications of interbasin water transfers for the genetic integrity of donor and recipient river basins using selected taxa	University of Cape Town – Zoology Dept.
Management of aquatic weeds in Port Elizabeth's water supply dams: a GIS approach	University of Port Elizabeth – Institute for Coastal Research
Tolerances of selected macroinvertebrates from the Buffalo River (Eastern Cape, South Africa) to components and dilutions of textile effluents	Rhodes University – Institute for Water Research
Water quality and aquatic faunal studies in the Umzimvubu catchment, Eastern Cape, with particular emphasis on species indicators of environmental change	Rhodes University – Institute for Water Research
Role of land use on the dynamics of four small semi-permanently closed estuaries	University of Fort Hare – Zoology Dept.

Afforestation effects: a re-analysis of the South African catchment afforestation experiment data	CSIR
Assessment of ambient groundwater quality on a national scale in the Republic of South Africa	Department of Water Affairs and Forestry
Hydrosalinity studies in the Eastern Cape	Rhodes University – Institute for Water Research
Legal framework to provide for the effective management and sustainable utilisation of South Africa's groundwater resources	Department of Water Affairs and Forestry
National groundwater quality study	Department of Water Affairs and Forestry - Geohydrology
Regional geohydrological characterisation of the coastal primary aquifers	Department of Water Affairs and Forestry – Geohydrology
Regional geohydrological characterisation of the Karoo Basin	Department of Water Affairs and Forestry - Geohydrology
Regional geohydrology of the Humansdorp / Cape St Francis area	Department of Water Affairs and Forestry – Geohydrology
Effects of climate change on water supplies	Eskom
Drought cycle risk	Eskom
Dynamic modelling to investigate the regional climate response to global change	University of Cape Town – Dept. of Environmental and Geographical Studies
Evaporation from the Orange River: quantifying open water resources	CSIR - Forestek
Local, regional and global climate change	Eskom
Modelling variability in the Agulhas current system and its influence on South Africa's climate	University of Cape Town – Dept. of Oceanography
The ocean's role in South Africa's rainfall	University of Cape Town – Dept. of Oceanography
Feasibility of using a risk based approach to setting integrated environmental objectives for protection of water resources	Rhodes University – Institute for Water Research
Incorporation of economic considerations into quantification, allocation and management of the environmental water reserve	University of Natal, Institute for Natural Resources
Sewage disposal from septic tanks in coastal dunes along the eastern and southern Cape coast	University of Port Elizabeth – Institute for Coastal Research
Biological monitoring of surface waters	Eskom
Comparison of water use of selected invasive and indigenous riparian plant communities	CSIR - Environmentek
Control of dam siltation in South Africa	BKS Incorporated
Control of reservoir sedimentation in South Africa	BKS Incorporated
Integration and application of daily flow analysis and simulation approaches within South Africa	Rhodes University – Institute for Water Research
Linking abiotic and biotic data on South African rivers	University of Cape Town – Zoology Dept.
Surface water quality of South Africa: an eleven year overview	Department of Water Affairs and Forestry – Institute of Water Quality Studies
Framework for the introduction of waste discharge systems in South African catchments	Stewart Scott Incorporated
Appropriate management of urban runoff in South Africa	Witwatersrand University – Dept. of Chemical Engineering
Coastal pollution: pathogenic micro-organisms	Univ. Pretoria – Dept. of Med. Virology
Health impact of waterborne viruses and methods of control in high risk communities	Univ. Pretoria – Dept. of Medical Virology
Holistic water quality management in catchments of South African harbours	Steffen Robertson & Kirsten Consulting Engineers

5.3. CONCLUSIONS
(P. Scogings and P. Lent)

Large-scale spatial variability, which can be attributed to the co-occurrence of contrasting land-use practises linked to contrasting socio-economic systems (communal and non-communal), and short-term temporal variability (strong seasonal and climatic contrasts) are important components of the Eastern Cape environment and demand adaptive forms of resource management to ensure sustainable rangeland utilisation (Scogings and Goqwana 1996). In addition, political and administrative factors are more important than biological ones in determining land-use/land-cover change in the Eastern Cape (Fabricius *et al*. 1996). The highly variable availability and reliability of knowledge of rangeland utilisation in the Eastern Cape and the apparently weak knowledge of mechanisms need to be addressed. The enormity of key gaps indicates that sufficient understanding does not yet exist, although sufficient information might well exist, i.e., there are plenty of descriptive data, but little mechanistic understanding.

Until a reliable, predictive understanding of natural resource management is established in the Eastern Cape, it will be difficult to know how the natural resources of the province will be affected in the future. Scogings *et al*. (1995) recommended that a broad, collaborative programme, which integrates research and development activities in the Eastern Cape and places emphasis on identifying patterns and key processes in natural resource management, be established to address such questions. Thus, with predictive understanding, appropriate management practices can be developed to promote the sustainable utilisation of natural resources in the Eastern Cape.

In addition to our weak understanding of bio-physical and socio-economic systems in the province we are in the midst of a period of extremely rapid policy change. The facts, taken together, make it extremely important that natural resources system being monitored especially closely in the coming years.

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