

Measurement and Perceptions of Desertification in South Africa

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Abstract: This paper describes the approach and results from the first national review of desertification of South Africa. Previous studies focused on the impact of farmers on privately-owned farms along the ecotone between the arid shrublands and semi-arid grasslands in the central interior of the country. This paper draws on the perceptions of over 450 agricultural extension officers and resource conservation technicians to provide a fundamentally different picture of the problem in South Africa. A detailed description of the workshop approach used in this national review is provided. Over 34 workshops were held across the country and a standard approach was used to gather information on land tenure, land use and soil and vegetation degradation. The results show that soil erosion is perceived to be greatest in the communal areas, especially where high levels of poverty are combined with susceptible biophysical environments. Although vegetation degradation is also highest in communal areas this relationship is not as strong as for soil erosion. The implications of these findings for the development of South Africa's National Action Programme to Combat Desertification are discussed.

Key words: Desertification, shrublands, grasslands, land use, land tenure, soil erosion, South Africa.

Although South Africa has a long history of desertification research, until 1999 no national review of the debate had been undertaken. Almost from the start of European colonization of the Cape in the mid-17th century, government officials warned of the dangers of the over-exploitation of natural resources (Shaw, 1875). In 1923, an extensive regional review of the state of South Africa's environment, following the devastating droughts of the second decade of the 20th century, revealed that, unless land use practices changed fundamentally, land degradation would increase (Anonymous, 1923). Land users paid no heed to the warnings of the Drought

Investigation Commission report and a second national investigation into desert encroachment in 1948 reiterated the warnings of the earlier commission (Anonymous, 1951). Changes in the vegetation, the Desert Encroachment Committee concluded, had occurred as a direct result of land use impacts, since little evidence could be found for changes in rainfall amounts or rainfall patterns in South Africa (Kokot, 1948). John Acocks, one of the most highly regarded South African ecologists of the 20th century, consolidated much of the early opinion about vegetation change in South Africa in his much-cited "Veld Types of South Africa" memoir

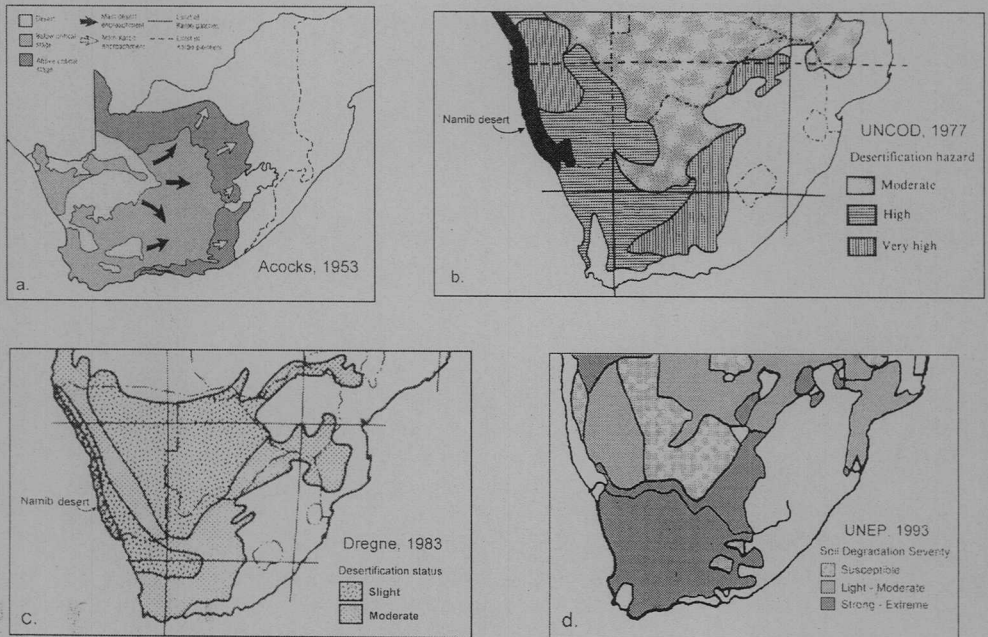


Fig. 1. Perceptions of land degradation in South Africa from 1953 to 1993 showing the influence of (a) Acocks' 1953 expanding Karoo hypothesis on subsequent international syntheses such as those of (b) UNCOD (1977), (c) Dregne 1983 and (d) UNEP (1993).

(Acocks, 1953). In this document, Acocks showed graphically how the vegetation of South Africa had changed since AD 1400. He focused on changes along the xeric shrubland-grassland ecotone in the central part of the country. He argued that these environments had been substantially altered as a direct result of overgrazing and suggested that the more arid Karoo (shrubland) environments would extend northwards and eastwards into the higher rainfall grasslands if land use practices and overgrazing continued (Meadows, 2003).

This notion of a north eastwards expanding Karoo has dominated the desertification literature in southern Africa and has formed the template upon which all subsequent syntheses have been based

(Fig. 1). However, several recent studies (Dean *et al.*, 1995; Hoffman, 1995; Hoffman *et al.*, 1999; Hoffman and Ashwell, 2001; Meadows and Hoffman, 2002; Meadows, 2003) have reviewed this debate and argued that state intervention and changing attitudes towards land use in the Karoo region has reversed this trend over much of the area. Thus, there is currently little justification for the expanding Karoo hypothesis to dominate the desertification debate in South Africa in the same way it has done before (Hoffman and Ashwell, 2001).

Because of its political isolation from the 1970's to 1994, South Africans have generally not participated in earlier international desertification control efforts. For example, the 1977 United Nations

efforts (UNCOD, 1977) to address the issue of desertification in Africa had little influence in South Africa. Following democratic elections in the country in 1994, however, South Africans embraced international initiatives concerned with the environment. The United Nations Convention to Combat Desertification (UNCCD) (Anonymous, 1995) was one of several international conventions and agreements signed by South Africa in 1995. Obligations under the UNCCD include the development of a National Action Programme to combat desertification and it was to this effort that the Department of Environmental Affairs and Tourism (DEAT) turned its attention following ratification of the convention in 1997. As a first step in the development of a National Action Programme it became necessary to commission a national review of the desertification issue in South Africa. Following an open tendering procedure a consortium comprised of researchers from the National Botanical Institute, the Programme for Land and Agrarian Studies at the University of the Western Cape and the National Department of Agriculture embarked on a two-year study in order to provide a synthesis for DEAT.

With a limited budget and only two years in which to complete the study, it was decided that primary research to investigate the biophysical component of desertification would not be possible. Instead the research team decided to address the issue in three main ways. Firstly, a review of the literature concerning the degradation of South Africa's water, soil and vegetation resources was undertaken. Emphasis was placed both on the

peer-reviewed literature as well as on unpublished sources. Secondly, 34 workshops were held throughout the country in which over 450 agricultural extension officers, soil conservation officials and researchers participated. A structured questionnaire approach carried out in a workshop environment was formulated which incorporated techniques from the World Overview of Conservation Approaches and Technologies (WOCAT) (Liniger and van Lynden, 1998) and the research team's personal experiences in South Africa. The methodology is explained in more detail below. Each workshop lasted from six to eight hours and the information gathered was collated in data files and made spatially explicit through GIS tools. Finally, a series of detailed case studies were carried out in seven magisterial districts of South Africa to explore some of the main issues identified in the workshops and to derive more detailed information about some of the key drivers of land degradation. In this article we expand on the methodology used in the desertification workshops and share some of the results of this work.

A Workshop Approach to Mapping Desertification in South Africa

Since there was neither the budget nor the time to carry out primary research into the extent of land degradation in South Africa the research team opted for an assessment based on the perceptions of experts in the field. In developing this assessment, however, an approach was needed which could be used across the entire country, which was easily understood by literate and semi-literate field technicians and which could incorporate measures of

both soil and vegetation degradation. The research team looked to the WOCAT questionnaire survey as a starting point (Liniger and van Lynden, 1998) and substantially simplified the extensive series of questions utilized in this approach. The first requirement was to identify the appropriate scale upon which the workshops would be based. The research team opted for the use of magisterial districts since they had a large amount of associated information which had been collected through government census surveys since the mid-19th century. The 367 magisterial districts in South Africa have also formed the basis for several other investigations of desertification (Scott *et al.*, 1985) and comparative analyses were facilitated by adopting a similar scale and unit of measurement.

The next problem addressed by the research team concerned the difficult issue of defining what is meant by desertification. It was decided at the outset that, wherever possible, the research team would refrain from asking participants at the workshops to provide answers to general questions such as: "Is your magisterial district desertified or not?" Such general descriptions are unhelpful and subject to considerable personal bias and subjectivity. Instead, a *pro forma* was developed which enabled the team to ask specific questions about particular land use practices in each of the magisterial districts and to establish the reasons for the answers (Tables 1 and 2).

Agricultural extension officers and resource conservation technicians were chosen as the groups most appropriate to comment on the extent of land degradation

in each magisterial district. Not only does this large group of professionals usually possess an extensive knowledge of their regions, but studies have shown that they also provide a viewpoint of degradation transitional between the pessimism of researchers and the optimism often associated with farmers and other land users (Roux, 1990). The 34 workshops were held in the regional headquarters of the Department of Agriculture in each of the nine provinces and participants were encouraged to join from the surrounding areas.

Following an initial introduction to the objectives of the workshop participants were asked to estimate, on a percentage basis, the extent of each magisterial district farmed under a communal or private tenure land use system (Table 1) (Fig. 2). This distinction is important in South Africa since the political and land use histories have been fundamentally different over the last 300 years with important implications for land degradation. Communal areas generally have a far higher human population density and on average support almost double the concentration of livestock compared to privately owned farms (Hoffman *et al.*, 1999).

Each magisterial district was then divided into six dominant land use types. Discussions about the extent of each land use type (as a percentage) and the changes in area and the intensity of land use over the last 10 years were undertaken. Simple numeric indices such as -1, 0, +1, etc., were used to denote changes that have occurred either in the area of each land use type or in the intensity of land use over the last 10 years. This was necessary

Table 1. Data sheet used for determining land use trends and status of natural resources during the 34 degradation workshops

Name:		District:			Region:			Province:			% Commercial	% Communal					
Land Use																	
Land Use Type (LUT)	Area (% of district)	Area Trend	Intensity Trend	Type	Degree	Extent	Severity	Rate	Soil Index	Type	Species	Degree	Extent	Severity	Rate	Veld Index	
Crop land																	
Grazing land (Veld)																	
Commercial forest																	
Conservation																	
Settlements																	
Other																	
Total area	100 %								Total soil degradation index								Total veld degradation index
												Total for both indices					

Table 2. Data sheet used for recording the reasons for changes in land use area, intensity and soil and veld degradation in the 34 degradation workshops

Area Trend		Reasons for LUT Area:	
Land Use Type (LUT)		Decreasing	Increasing
Cropland			
Grazing land			
Forest (Commercial)			
Conservation			
Settlements			
Other			
Area Intensity		Reasons of LUT Area Intensity:	
Land Use Type (LUT)		Decreasing	Increasing
Cropland			
Grazing land			
Forest (Commercial)			
Conservation			
Settlements			
Other			
Severity Rate		Reasons for Soil Degradation:	
Land Use Type (LUT)		Decreasing	Increasing
Cropland			
Grazing land			
Forest (Commercial)			
Conservation			
Settlements			
Other			
Severity Rate		Reasons for Veld Degradation:	
Land Use Type (LUT)		Decreasing	Increasing
Grazing land			

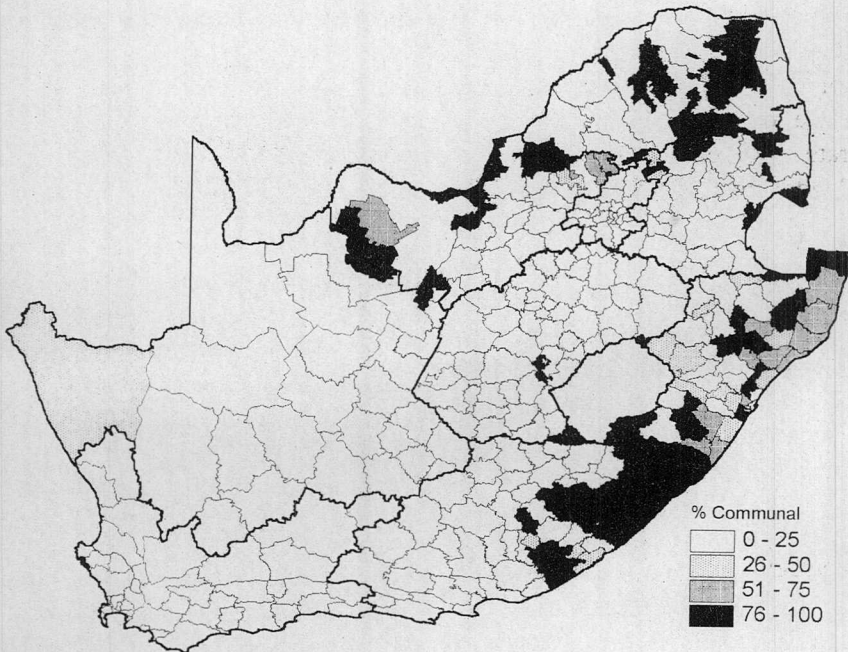


Fig. 2. The distribution of communal areas in South Africa. The percentage of a magisterial district that is managed under a communal land tenure system is shown.

because a diversity of experience, expertise and level of numeracy existed amongst workshop participants and a common approach had to be adopted across the country.

Following this discussion on land use, the definitions for different types of soil erosion were conducted. Soil erosion was divided into erosive and non-erosive forms and sub-categories within each of these were elaborated upon. The use of photographs and text explanations helped to clarify and calibrate different groups of workshop participants. The degree and extent of soil erosion for each of the land use types was assessed and the severity derived from the matrix in Table 1. A critical assessment was made of the rate

of soil erosion for each land use type in each magisterial district over the last 10 years. If the rate had increased (i.e. soil degradation had become "worse") the participants were asked to provide either a +1 or a +2 score, depending on the degree of increase in this rate. A decline in the rate over the last 10 years would yield a negative value. Reasons for the answers given were written on a separate sheet (Table 2).

From these values, an index of soil degradation was calculated for each land use type as follows:

$$\sum \text{Percentage area of each land use type} * (\text{severity of soil degradation} + \text{rate of soil degradation}).$$

For example, in the magisterial district of Cofimvaba in the Eastern Cape Province, the area of the croplands was calculated as 35% of the total area. When the severity (2) and rate (+2) of soil degradation in the croplands are added together and multiplied by the area of croplands this amounts to a soil degradation index of 140 for croplands. Adding the indices for each of the different land use types provides an overall soil degradation index for the magisterial district which can then be compared with indices from other, similarly assessed magisterial districts.

A similar approach was adopted for assessing vegetation degradation in each magisterial district. Six main types of vegetation degradation were defined, including a change in vegetation cover and species composition, alien plant invasions, bush encroachment, deforestation and an "other" category (Table 1). Vegetation degradation was only considered on the natural rangelands (i.e., the "veld" land use type). The degree and extent of each of the main forms of vegetation degradation were assessed through consensus discussions and the severity of each was calculated from the matrix in Table 1. The rate for vegetation degradation over the last 10 years was also assessed and a vegetation index calculated in the same way as that of soil degradation:

$$\sum \text{Percentage area of veld} * (\text{severity of vegetation degradation} + \text{rate of vegetation degradation}).$$

Summation of the soil degradation index and the vegetation degradation index results in the computation of a combined

degradation index for each magisterial district.

This approach enables one to compare magisterial districts across the entire country and to analyze the two components of degradation, namely soil and vegetation degradation. It proved a robust method of assessment when several magisterial districts were being compared in one workshop. However, calibration across regions was more difficult and it was essential that one individual of the research team attended all workshops to ensure appropriate levels of calibration.

Desertification in South Africa: Perceptions of Local Experts

Contrary to the findings of surveys carried out in the mid-twentieth century (Fig. 1) the eastern Karoo was not perceived as a region exhibiting significant levels of either soil or vegetation degradation (Figs. 3 and 4). This could be either because the eastern Karoo, relative to other regions in South Africa, does not exhibit high levels of degradation or that the last 50 years have seen significant change in land use practices and subsequent restoration of formerly degraded areas. The general consensus among workshop participants was that state interventions, farmer study groups and the reduction in livestock numbers in particular (Hoffman *et al.*, 1995), have played a large role, leading to the improvement of vegetation condition and reduction in soil erosion in the region in the last 50 years. It is likely that the attention drawn to the area following Acocks' publication (Acocks, 1953) played an important role in this process.

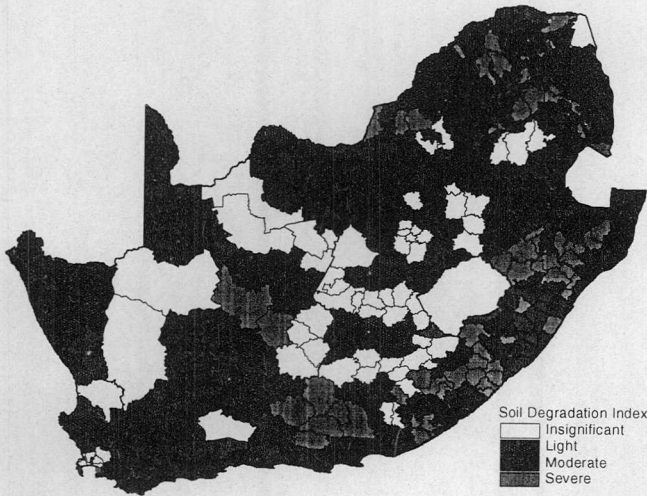


Fig. 3. A soil degradation index for each of the 367 magisterial districts in South Africa. The four categories (insignificant, slight, moderate and severe) are calculated as one or two standard deviations above or below the mean value for the country. For example, magisterial districts shown as having insignificant levels of soil degradation were scored as two standard deviations below the mean country value while districts possessing a moderate level of soil degradation scored one standard deviation above the mean value.

A general perception amongst the participants at the workshops was that it is in the communal areas of South Africa where land degradation is greatest. In particular, workshop participants felt that, even today, high levels of soil erosion continue unchecked in the communal areas (Fig. 3), particularly along the steep slopes of the escarpment in the eastern parts of South Africa. This is a novel finding and one which differs markedly from previous reviews (see also Nicholson, 2001).

There was less of a general consensus among workshop participants concerning vegetation degradation (Fig. 4), although they generally perceived communal areas

to exhibit higher levels of vegetation degradation than privately owned farms. Some magisterial districts, however, such as in the central parts of the Karoo, have become invaded by alien plants (especially *Prosopis* spp.) and such magisterial districts, which are wholly in the hands of private land owners, ranked high in terms of the levels of veld degradation in the district.

When soil and vegetation indices were combined in a single index, communal areas generally emerged with significantly higher values than privately owned farms (Fig. 5). One factor which contributed to high degradation scores was the perception among workshop participants that the rates

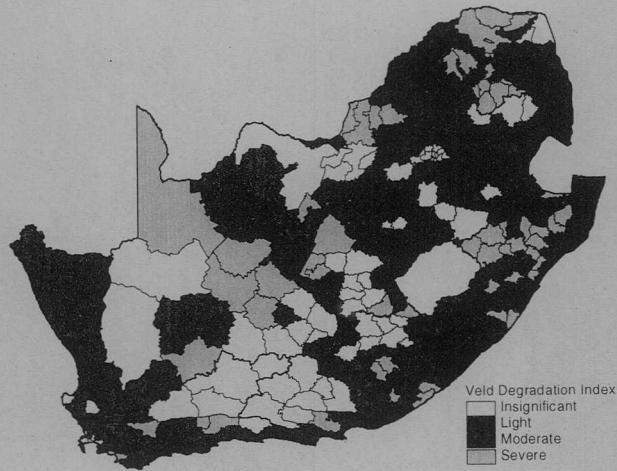


Fig. 4. A vegetation (or veld) degradation index for each of the 367 magisterial districts of South Africa. See Figure 2 for an explanation of the legend.

of either soil or vegetation degradation had continued unchecked or even increased over the last 10 years in many of the communal areas of South Africa. In magisterial districts with a predominance of privately-owned farms, however, significant strides had been undertaken by individual farmers and agricultural extension officers. General perceptions were that rates of degradation had either not changed or had slowed significantly over the same time period. Although not quantified, factors which were stated as most important in reducing degradation levels were the creation of farmer study groups in a region, active agricultural extension officers, the development of comprehensive farm-level management plans and several state intervention schemes such as the stock reduction scheme, which began in 1969 in many regions in the central part of South Africa (Hoffman *et al.*, 1995). Workshop participants felt, that for the communal

areas, a lack of infrastructure, too little land and subsequent overcrowding, poor management systems, lawlessness and the general neglect of the area by state structures responsible for agricultural development, were all factors that contributed to increased levels of land degradation.

A step-wise regression analysis which related soil, vegetation and combined degradation indices to a suite of 31 biophysical and socio-economic parameters revealed that both are important predictors of land degradation in South Africa (Hoffman and Todd, 2000). In general, magisterial districts with steep slopes, erodible soils, high temperatures and with a largely poor, economically under-developed rural community displayed higher degradation indices. However, the complex interplay between these factors was not investigated in any detail. Although poverty and degradation are generally considered closely interrelated (Anonymous,

2002), the exact nature of the relationship is often difficult to determine (Hoffman, 2003).

South Africa's National Action Program to Combat Desertification

The findings of the national assessment of land degradation in South Africa were distributed widely to national, provincial and local stakeholders. This was done via the final report (Hoffman *et al.*, 1999), a popular book (Hoffman and Ashwell, 2001) and provincial information sheets. The publication of this material and all information from the workshops, including a bibliographic collection consisting of more than 2,000 southern African land use and land degradation references, is also available on the internet (www.nbi.ac.za/landdeg). The integration of this information into the National Action Programme (NAP)

began in mid-2002. The Department of Environmental Affairs and Tourism (DEAT) contracted a consortium of consultants led by the Council for Scientific and Industrial Research (CSIR) to prepare a draft NAP which was tabled before the World Summit on Sustainable Development (WSSD) held in Johannesburg in August 2002. While the information derived from the national assessment has informed and set the context for the NAP, this program is of necessity focussed on the implementation of strategies to combat land degradation rather than understanding the extent and causes. Of major significance is the emphasis within the NAP on poverty alleviation and a focus on resource-poor land users. This approach highlights the shift in thinking among policy makers away from the eastern Karoo as the desertification focus. It suggests that the main findings

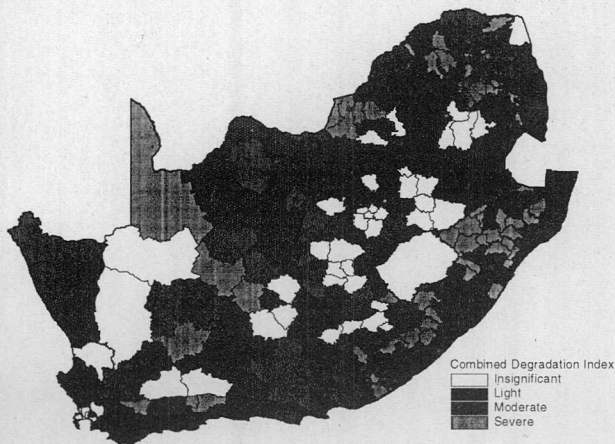


Fig. 5. A combined index of degradation for each of the 367 magisterial districts in South Africa incorporating both soil and vegetation degradation (See Figure 2 for an explanation of the legend).

of the desertification audit which emphasizes the need to tackle a wide range of land degradation problems primarily in the communal areas of South Africa, have been taken seriously.

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