Chapter 1

Abiotic, biotic, and social aspects of grazing systems in the Southern Karoo (South-Africa) - objectives and frame conditions of a scientific students' excursion

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1.1 Introduction

Grazing of domestic livestock is shaping landscapes in many regions of the world. Selective grazing and high stocking rates of domestic animals had strong effects in arid regions in the past (OLFF & RICHIE 1998). Grazing management in the semi-arid South African Karoo had altered vegetation textures within a few decades (MILTON et al. 1992). The grazing caused decline of vegetation ground cover, and relative abundance of plants was shifted due to their palatability, also plant morphology changed under predation towards a higher proportion of wooden structures (MILTON et al. 1992).

As a representative example of such developments we selected the area around Prince Albert (north of the Swaartberge; South-Africa) for the investigations within our scientific students' excursion and had a particular look at piospheres around artificial waterholes, i.e., we studied the gradient of land use intensity from the waterhole (temporal high density of lifestock, trampling effects) to sites of increasing distance from the hole and thus supposedly less impact of lifestock.

Some of the basic ideas for research during the excursion have been derived from modelling papers by JELTSCH et al. (1996), who were working on piospheres in Northern South Africa, and by WIEGAND et al. (1995), who studied the vegetation dynamics of an ungrazed shrub ecosystem near Prince Albert (i.e. the same area on which part of our study was conducted: the 'Tierberg' site).

1.2 Research area: Prince Albert (Southern Karoo, South-Africa)

1.2.1 Geographical setting, abiotic and biotic frame conditions

Prince Albert is situated on the southern edge of the Great Karoo, 20 km north of the Swartberg mountain range (Fig. 1.1, taken from MILTON et al., 1992).

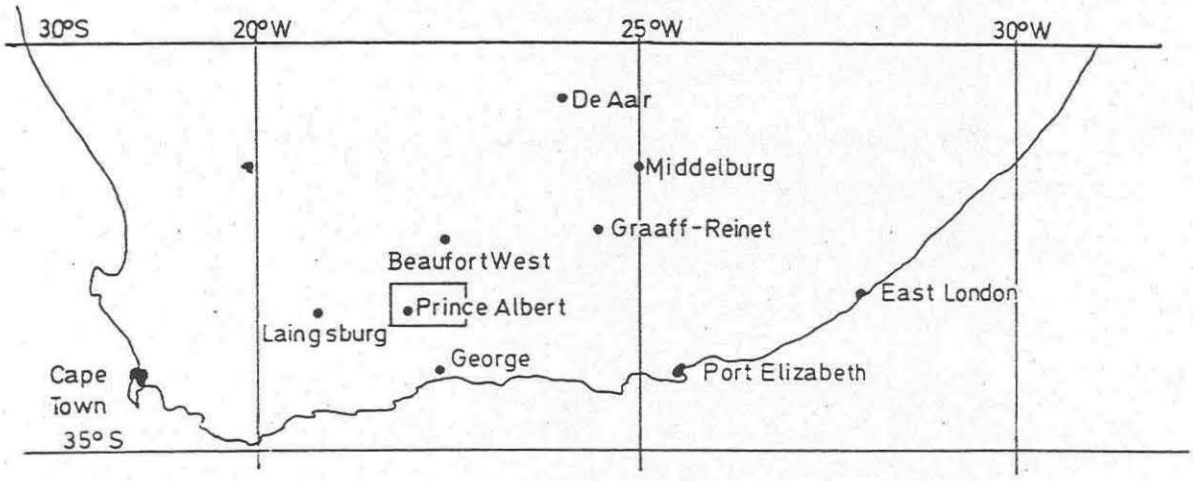


Figure 1.1: Geographical setting of Prince Albert, the research area of our excursion (from MILTON et al. 1992)

The mean annual temperatures of the study areas is 17.5°C, however, extreme daily variations occur, reaching from below 0°C up to more than 30°C.The average annual rainfall is 167 mm. The period from September to January is mostly dry, highest precipitation occurs between February and May. Winter rain falls are frequent but rarely strong. During summer thunderstorms, sometimes with hail, are rather common. These normally result in rapid runoffs and flash floods. Wind directions in the study area are south-east during summer and north-west in wintertimes (MILTON et al., 1992).

> [comment: geology and soils of the area are not included in this introductory chapter, as they have been a major research object during the excursion and are dealt with in detail in chapters 3 to 5]

Based on climatic factors (46 % of precipitation during the winter months and a summer aridity index of 4.8), the study area falls into the interface between Succulent Karoo, Nama-Karoo and a succulent form of the Savanna Biome (RUTHERFORD & WESTFALL 1986).

The vegetation on the study region closely resembles the Little Karoo form of Karroid Broken veld on account of its high proportion of succulent species and low abundance of grasses (ACOCKS 1975). Geographically it falls within the Koup Karoo (HILTON-TAYLOR 1987).

1.2.2 Study sites of natural science working groups

The criteria for the selection of the research sites are a direct consequence of our objectives. Therefore we have been looking for sites which should differ in nothing but the grazing regime. Ideally we would have liked to conduct research on two grazing gradients (piospheres) and one area with no grazing.

Major problems however have been, that (understandably) not all farmers are really keen on having dozens of students on their land and that the areas of the many farmers who did not oppose to our endeavours always differed in several aspects. A major problem has been, that the grazing history of many rangelands is not well known and especially at present quite some of them seem to have been at least temporarily abandoned.

After all we selected two piospheres with a bit different history and one reference site. In the course of the activities it turned out to be impossible to really cover two grazing gradients within the set time frame, thus we decided to study only one and the reference site, in order to be able to do a more in-depth analysis and to experience (and teach) a broader spectrum of methodologies (always bearing in mind, that the same type of analysis should have been done on at least one or better some further piospheres to really achieve scientifically sound results).

Two study sites have been analysed: "Sandrivier" and "Tierberg". Both are situated on the southern edge of the Great Karoo (33 ° 10' S, 22 ° 17' E), 20 km north of the Swartberg mountain range. "Sandrivier" study area is located on a plain between some little hill ranges, about 18 km east of Prince Albert. "Tierberg" (actually the Tierberg Karoo Research Centre with an area of approximately 100 ha; see MILTON et al., 1992) lies about 26 km east of Prince Albert at 800 m above sea level in the 5 km wide and 80 km long valley of the Sandrivier, which flows east along a syncline in folded Ecca shale beds for approximately 60 km before joining the Gamka river. Tierberg was selected as a reference site for its flatness and homogeneity of vegetation in comparison to the grazed area Sandrivier. Tierberg is drained by six small washes, which join a single drainage line running SSW, but the surface water is present in the area only during heavy rainstorms, when run-off is rapid and muddy rivers incise the washes and drainage line. The research centre itself is an exclosure out of grazing since 1987 and lies on the Tierberg farmland that itself has a history of moderate grazing (see MILTON et al., 1992, for further details).

A general map of the study areas Sandrivier and Tierberg and the position of the examination sites A to E in Sandrivier is given in Figure 1.2.

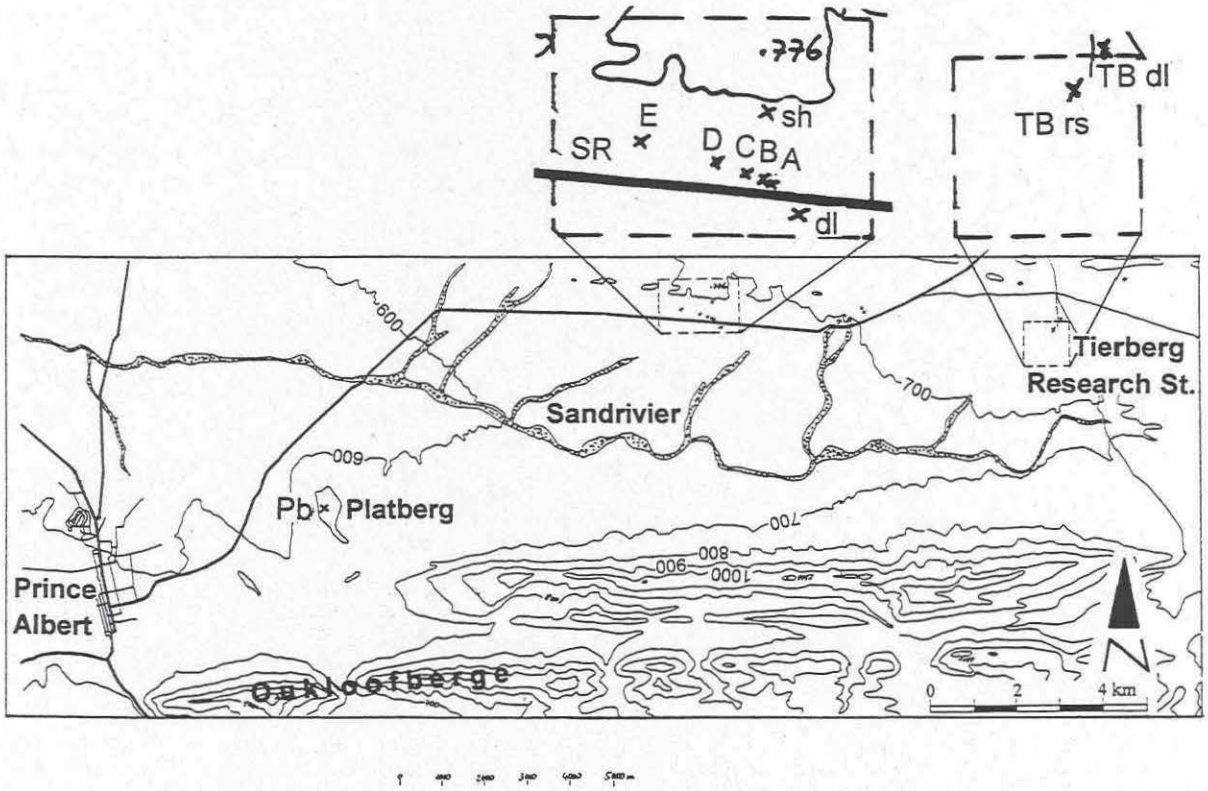


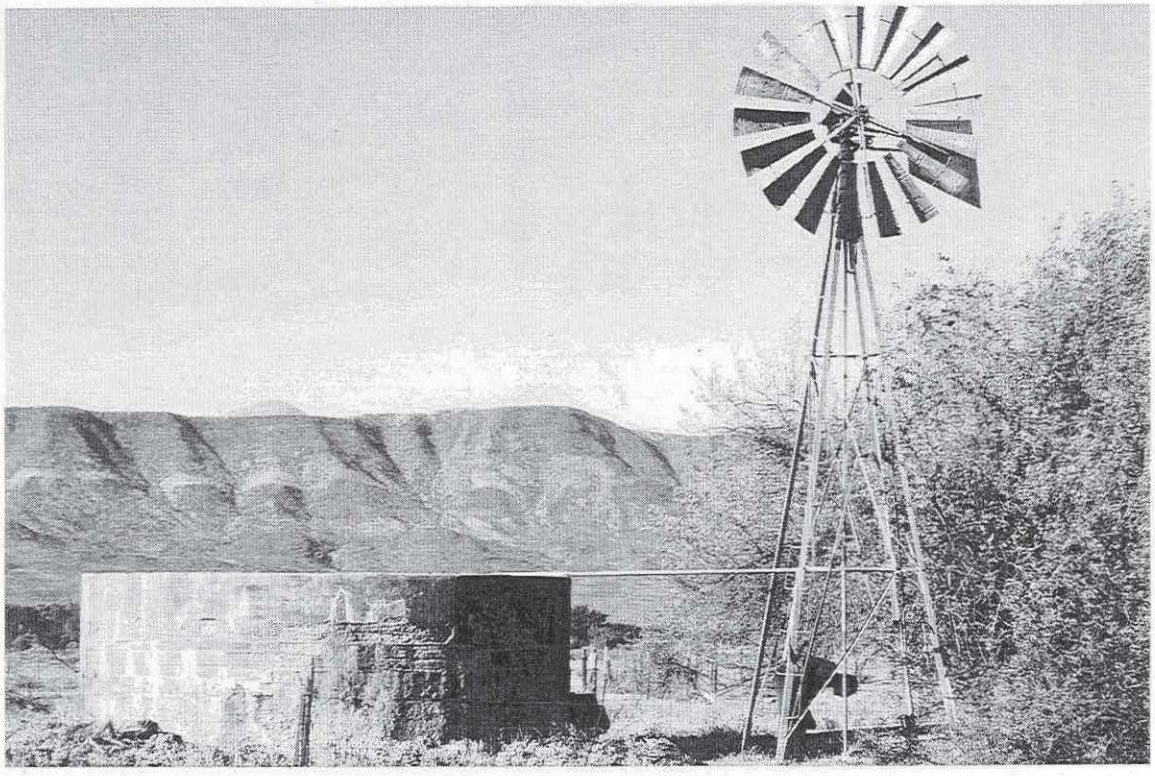
Figure 1.2: Overview of the study areas Sandrivier and Tierberg and the position of the examination sites A to E in Sandrivier

Picture 6: The piosphere of Sandrivier (March 1998)

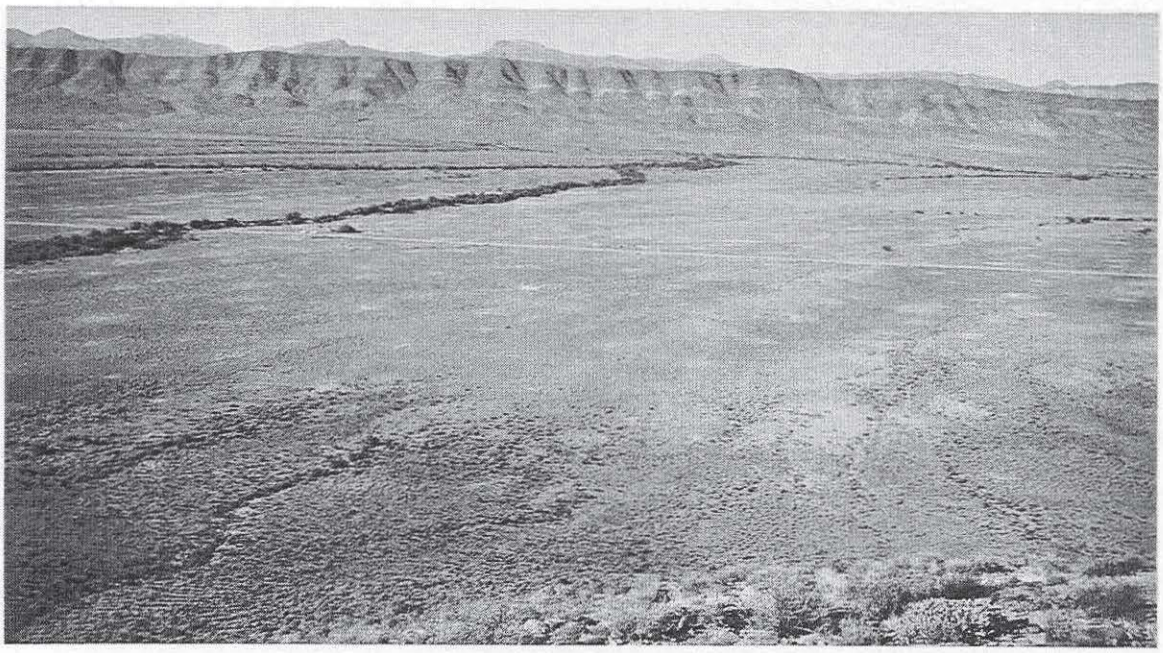
In the research area two different habitat types can be distinguished: the plains with small, perennial shrubs and bare ground between them as the water runoff sites, and the drainage lines with higher shrubs and trees as the water run-on sites. Habitat types differ in vegetation height and structure and species composition (MILTON et al. 1992). Drainage lines serve important ecological functions, they offer food and nesting material for birds, hides and shelter for wild and domestic mammals, and shadow during daytime. Washes, somehow intermediate between plains and drainage lines in plant species composition, were treated together with drainage lines in this study.

On the study sites four types of habitat have been distinguished: plains, heuweltjies, washes and major drainage lines with different species and plant cover (compare chapter 7). The differences of vegetation in runoff lines (plains with small, perennial shrubs and bare ground between them; and heuweltjies - nutrient rich patches about 13m in diameter, probably of zoogenic origin - compare e.g. LOVEGROVE & SIEGFRIED 1989, MILTON & DEAN 1990, and also chapter 6) and runon lines (drainage lines with higher shrubs and trees; and washes, which are somehow intermediate between plains and drainage lines in plant species composition) can at least partly be explained by their soil moisture status. In addition, soil chemistry – nutrient status of heuweltjies is 3-5 times higher than the surrounding plains (compare chapter 6 by KAHLE et al.) – and, of course, grazing of domestic livestock influence the vegetation features (compare chapter 7 by BAUER et al.).

The general plant community is characterised by evergreen and deciduous succulents (*Ruschia* spp., *Malephora lutea, Augea capensis, Brownanthus ciliatus* etc.) and by taller non-succulent shrubs such as *Pteronia* spp., *Galenia fruticosa* and *Osteospermum sinuatum*. Underneath the shrubs there are few annual forbs and between the single shrubs interspaces with no vegetation.



Picture 7: Windmill of waterhole of the Sandrivier study area (March 1998)



Picture 8: Overview of valley with Sandrivier study area (March 1998)

1.2.3 Study sites of social science working group

Quite different from the approaches of the natural scientists, social scientists are less confronted with detail work on farmers field. Rather they are confronted with the main actor himself: the farmer. Not surprisingly, the social science group had to conduct many interviews which of course results in a large number of "study sites". One precondition here has been the willingness of the farmers - as well as other actors confronted with the agricultural and administrative sector - to give information about the conditions the are working in and their personal views on aspects like the general development. See chapter 2 by HOFFMANN et al. For a more detailed account of the methodology and all other aspects of the activities of the social science group.

1.3 Participants

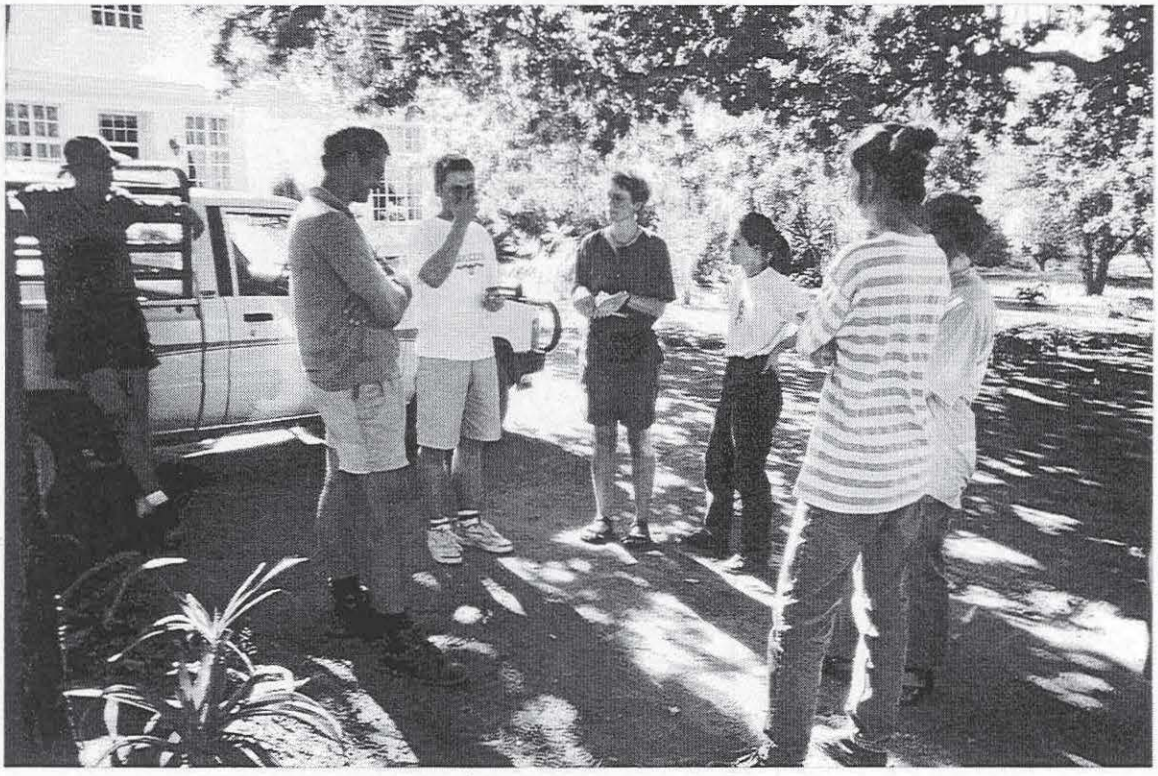
The excursion was organised by university teachers of

- UFZ - Centre for Environmental Research Leipzig-Halle (J. SETTELE, K. & T. WIEGAND),
- Justus-Liebig-University Giessen (J. HOFFMANN, C. SCHÄFER),
- Martin-Luther University Halle (R. JAHN)
- Brandenburg-Technical-University Cottbus (D. VETTERLEIN; now Martin-Luther University Halle), and
- University of Jena (J. SAMIETZ).

The students (compare list of contributors and participants on page 5) represented the following university courses:

- agriculture (with specialists in plant production, agro-ecology, environmental safety, human nutrition and sociology),
- biology (emphasis: nature conservation, botany, zoology), and
- environmental engineering (esp. soil conservation).

Picture 9: Introduction to Karoo ecology by Sue MILTON (March 1998)



Picture 10: Interviews with farmers of Prince Albert area (March 1998)

1.4 Objectives of the investigations

The experience of interdisciplinary and scientifically as well as socially relevant research was the major objective of the two-week field study. This had to be achieved by confronting students and supervisors with the problems of people living in a system with rapid and fundamental changes. Based on long-term experience in the region of Sue MILTON and Richard DEAN, it was possible to investigate a broad variety of aspects of this landuse system. The task also has been to put results of such detailed work back into the landscape ecological frame later on, and to prepare a public presentation of the results, which was given in Prince Albert (our main investigation area) as well as at the University of Capetown (UCT) at the end of our stay. Additionally, a temporal cooperation of our group with an international students' group from UCT, doing a field course on disturbance ecology in and around Prince Albert and supervised by Sue MILTON and Richard DEAN, added additional flavour to the whole interdisciplinary and intercultural undertaking!

1.5 Working groups

Field work was conducted in several working groups:

Socioeconomy: As new developments are only possible with the people implementing them, work of this group was of overall relevance for all other groups. The main task was to get some ideas about the frame conditions and the farmers' own view of their future. Reliable information on some of these aspects is essential for future activities and scenarios of development. The detailed results of the group are summarised by HOFFMANN et al. in chapter 2 of this volume.

Geology and Soils: Main task of this group was the characterisation of the different soil types and their impact on land use potential. The results are summarised in three contributions. First an overview on the regions geology by JAHN (chapter 3), then the soil data itself by RÖßNER et al. (chapter 4) and finally a specific analysis of the root distribution on some of our research sites by DRATH (chapter 5).

Nutrients: Members of this group made in depth analyses of the nutrient conditions in areas of different grazing intensity. The results are summarised in KAHLE et al. (chapter 6).

Botany & point pattern: Analysis of changes in species composition and abundance in relation to landuse intensity was the main task of the botany group. Their results are summarised in BAUER et al. (chapter 7) and in BOßDORF & SCHURR (chapter 8).

Zoological groups: Three smaller groups worked on specific aspects of the zoology: the first one on the fractal dimensions of vegetation and their relevance for arthropod communities (see chapter 9 by HELD et al.), the second one on small mammals in grazed and ungrazed areas (chapter 10 by ECCARD & WALTER), and finally a brief inventory on butterflies mainly around Tierberg was made (chapter 11).

1.6 Presentation of activities and results

Smaller presentations have been done on several evenings in March 1998 in Prince Albert, while the main presentation took place in early April 1998 at UCT (University of Capetown), for which practically all participants have shown the findings of the two weeks' research.

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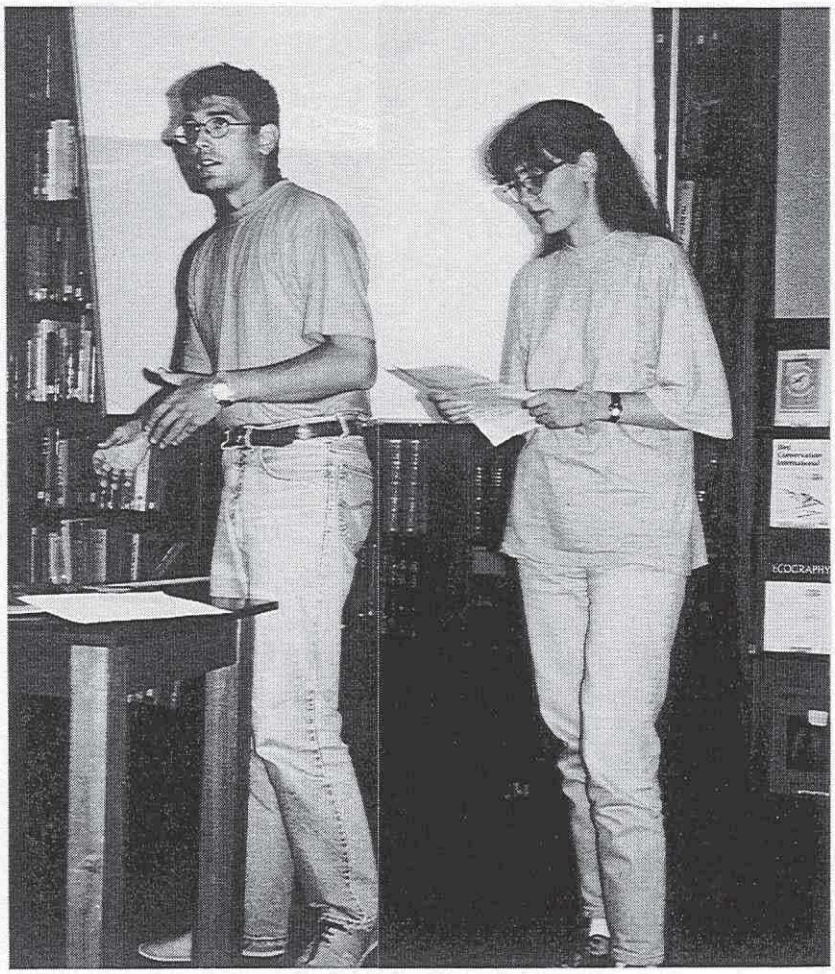

Picture 11: Presentations at UCT (University of Capetown) in early April 1998

Picture 12: Typical representative of domestic livestock in the Southern Karoo

UFZ-Bericht Nr. 23/1999

Rangeland Management in the Southern Karoo (South Africa):

Conflicts of Landuse and Environmental Conservation

(report of a scientific students' excursion)

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