An ecological-economic analysis of the pastoral systems of the Nama Karoo in southern Namibia

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Farm settlement in the Nama Karoo. Photo: N. Dreber.

Part IV

IV.3 An ecological-economic analysis of the pastoral systems of the Nama Karoo in southern Namibia

Nama Karoo

An ecological-economic analysis of the pastoral systems of the Nama Karoo in southern Namibia

Stephanie Eileen Domptail*, Niels Dreber, Thomas Falk, Tarig Gibreel, Michael Kirk, Cornelia Limpricht, Christiane Naumann, Sebastian Prediger, Björn Vollan & Dirk Wesuls

Summary: The chapter presents an ecological-economic analysis of pastoral systems in the form of an interdisciplinary study on livelihoods, landuse practices, and related environmental impacts. The study focuses on three different pastoral systems of the Namibian Nama Karoo that differ in terms of climate, and cultural and socio-economic backgrounds: (i) the northern and more humid farmlands of the Rehoboth area about 80 km south of the capital Windhoek, characterised by small farm sizes and private and multiple-ownership land tenure; (ii) the large private meat- and pelt-producing ranches in the arid southern Namibia in the vicinity of the city of Keetmanshoop; and (iii) the semi-commercial goat production system in the communal areas of the neighbouring Namaland. Research results from nine case studies constitute the basis for the analysis. After a brief description of the landuse and management history of each pastoral system, three subchapters summarise the investigation of important drivers of the landuse strategies and of the dynamics of each system in general. Related impacts on biodiversity are also reported, with a special focus on land degradation.

The multi-faceted diversity, which characterises the Namibian Nama Karoo, was one of the most striking results. A major aspect is the diversity of tenure systems: the analysis reveals that no tenure system is a panacea and solutions for sustainable management should be sought within each social-ecological system as they consist of tightly coupled dynamics between the natural rangelands and the local social and economic systems. However, some general insights into the functioning of these systems were gained and are presented in an overall summary at the end of the chapter, which points out some implications for research with regard to the different pastoral systems in the Nama Karoo.

3.1 Introduction

[N. Dreber]

The Nama Karoo is the second largest biome and one of the driest of the southern African subcontinent. It covers a third of South Africa and most of southern Namibia and extends northwards into the more humid Thornbush Savanna. The climate is semi-arid to arid with a high spatio-temporal rainfall variability. The dominant vegetation type is dwarf shrub savanna (Palmer & Hoffman 1997). Due to the harsh climatic constraints and the subsequent limited and variable annual biomass production, farming with small stock, i.e. sheep and goats, is the most widespread pastoral activity on freehold tenure land and in communal areas (Mendelsohn 2006). However, with an increase in rainfall towards the semi-arid savannas of central Namibia, farming with cattle becomes profitable. Land degradation is commonly observed in the rangelands of the Nama Karoo, and is mainly driven by the variable climatic conditions and unsustainable management practices (Klintenberg & Seely 2004), which may occur both on commercial ranches and on communal lands (Byers 1997). An ecological-economic analysis of the pastoral systems consisting of an interdisciplinary study on livelihoods, landuse practices, and related environmental impacts was conducted within the BIOTA Southern Africa project. For this purpose, two focus regions differing in terms of climate and cultural and socio-economic background were chosen within the Namibian Nama Karoo.

One focus was on the farmlands of the Rehoboth area about 80 km south of the capital Windhoek. This area is situated in the transition zone between the Nama Karoo and the central Namibia savannas (Giess 1971), and thus in a more humid part of the Nama Karoo. Characteristic for the region are small average farm sizes often with multiple ownership and a relatively low proportion of full-time farmers. The second study area was located in the drier area of Keetmanshoop about 400 km south of Rehoboth. Here, two contrasting pastoral systems were investigated. On the one hand commercial ranching systems, i.e. privately owned large farms specialising in large scale production of meat and pelts, and on the other hand a semi-commercial goat production system in the communal areas of the Namaland.

In the following analysis, the social-ecological systems within the rangelands of the Rehoboth and Keetmanshoop areas are first introduced by describing the landuse and management history of the region. Together with the region's natural resource heterogeneity these components form an important determinant of farming opportunities and strategies. Second, drivers of landuse and of the social-ecological systems are explored. Related impacts on biodiversity highlighting the problem of land degradation are reported upon in a third section. We conclude with an overall summary of the main issues and point out the implications of the research for distinct pastoral systems in the Nama Karoo.

3.2 Rehoboth area: dynamics of small-scale commercial pastoral systems

The region and the town of Rehoboth

[C. Limpricht]

The core area of Rehoboth is inhabited by the Rehoboth Basters and is comprised of parts of the **Hardap and the Khomas Region.** It can be divided geologically into three adjacent zones: the Khomas Hochland Plateau, the Rehoboth Plateau, and the Kalahari Sandveld. In addition, three vegetation zones are to be found: the Highland savanna, the dwarf shrub savanna and the mixed tree and shrub savanna of the southern Kalahari (Giess 1971). The climate of this area is semi-arid with a long-term mean annual rainfall of about 250 mm. Apart from a few exceptions there is no year-round open water in the region. The land has been, and still is only used for animal husbandry, the prime herd animals being cattle, sheep, and goats.

The town of Rehoboth is situated close to the boundary of the Hardap and the Khomas Region. This is a recently drawn boundary dissecting the area of farms, the former Rehoboth Gebiet, which had been reserved exclusively for Baster owners until the Independence of Namibia in 1990. **Rehoboth** is the seventh largest town of Namibia, having approximately 30,000 inhabitants (21,300 according to the national census of 2001). Today Rehoboth is a regional centre with members of nearly all Namibian groups living in the town. The Oanob Dam, a smaller counterpart of the Hardap Dam, is situated on the outskirts of the town of Rehoboth offering an important resource for tourism.

Photo 1: Landscape to the north west of the town Rehoboth. Photo: Dirk Wesuls.

The Rehoboth Baster Community

[C. Limpricht]

The Rehoboth Basters, representing little more than 2% of the Namibian population (2 million in 2007), identify themselves as distinct from other groups of mixed descent on account of their right to **land ownership** as well as their peculiar history which reaches back into the middle of the nineteenth century. In 1868 they embarked on an exodus from the oppressive colonial rule at the Cape in search of land on which they could make a living by farming with large and small stock. They were pious Christians led by their Kaptein and a German missionary.

After settling peacefully in Rehoboth in 1870 the Rehoboth Basters began to distribute farms to members of the community in about 1895 and thus started a **transition from communal to private ownership of land** (Lang 1999). Population increase, inheritance pattern and political constraints during the better part of the 20th century led to the **splitting up of farms** (Fig. 1) into units which were no longer economically viable but which were of great social significance. Survey data gained in 2000 show that the process of subdividing farms must have at least slowed down considerably in recent years (Lang 2005). It can be inferred from the survey data (Lang 2005) that the **continuation of the fragmentation trend** is the result of a change in the value orientation of the farm owners. While Basters are found in jobs all over the country, the farm or home in Rehoboth remains the ultimate refuge or retreat. A rural ambience and the freedom which comes with owning a farm remain an ideal.

The Rehoboth farm system and its typology today

[C. Limpricht]

On the farm map of Namibia (Fig. 1), the Rehoboth Gebiet is easily identified due to the fact that the farms are heavily fragmented and subdivided. What caused this density? By the end of the 19th century, the Basters had enough space to grant every Baster applicant a farm of 7,000 ha. Twenty-five years later, with a population growth rate of about 3%, the limits were reached and all farmland had been distributed (Lang 1998). Combined with rules of inheritance giving each child an equal share of the farm, the farms became heavily subdivided within a few generations. During the Apartheid years even wealthier Basters were not allowed to buy land outside the Gebiet and thus political constraints added to land scarcity. These driving forces, population growth rate, inheritance rules and political constraints brought about two types

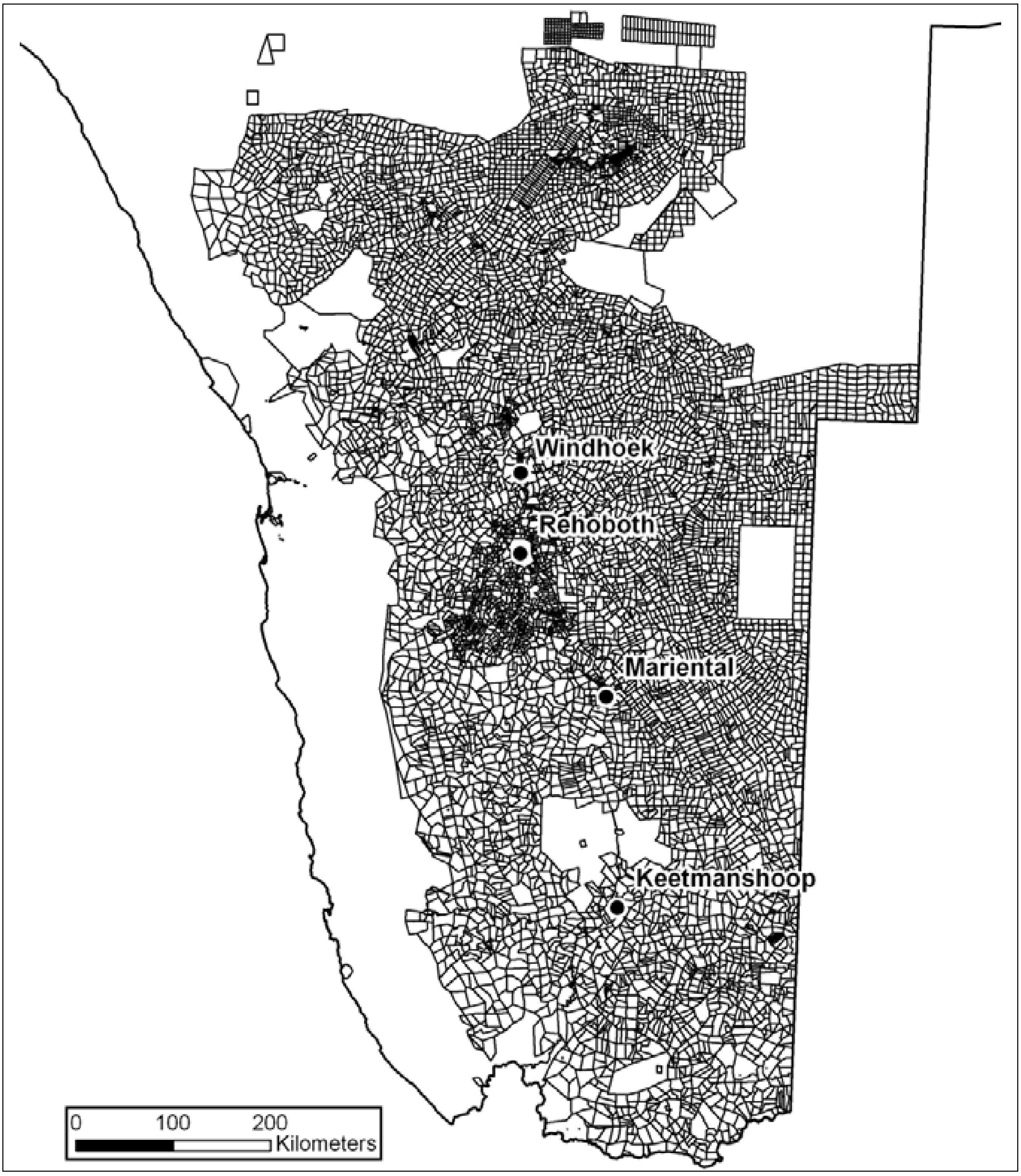


Fig. 1: Farm map of Namibia showing a concentration of comparatively small farms around Rehoboth (former Rehoboth Gebiet).

of farms, which in turn has led to a third type (Lang et al. 2004, Lang 2005):

1. Estate farms under multiple ownership
2. Small farms under single ownership
3. A few fairly large consolidated farms under single ownership

Type 1. So-called estate farms under multiple ownership are inherited farms, where all owners are related by blood or marriage. If several owners share a farm, their individually-inherited hectares are valuated and registered even today as undivided shares, which seems to be a peculiarity of land holdings in Rehoboth. Consequently the individual has no right to a specific piece of land. For example, ten owners with undivided shares of an 800-hectare farm would not be able to identify their own 80 hectares, and there are farms with more than 50 owners. This type of arrangement contains a potential for conflicts as well as negative effects on pastures.

Type 2. Small farms—smaller than 4,000 ha under single ownership, managed usually on a part-time basis: These farms usually had been fragmented in the past by inheritance but one single owner has managed to buy out co-owners and register the farm. These farms face ecological and economical problems.

Type 3. The rather large consolidated farms, run by a single owner, sometimes full-time, with a size of more than 4,000 ha have been developed only rarely. These farms mostly started as estate farms but one heir managed to buy out the other relatives and even succeeded in purchasing or exchanging neighbouring parcels of land in order to consolidate all the parcels into a bigger registered farm.

These three types of farms have not only different impacts on biodiversity but also on the quality and quantity of economic output.

How are these three types of farms being spread over the Rehoboth area and how representative is this grouping? Data gained from our survey (Fig. 2) conducted in 2000 provided a clear indication of these three main types of farms (Lang 2005). The survey showed that farm size and ownership structure—single versus multiple ownership—are independent factors. Thus one finds farms larger than 4,000 ha with multiple owners as well as smaller ones. In our survey sample, single ownership dominates the farm system while multiple ownership is found on a quarter of farms.

In the Rehoboth area 4,000 ha can be seen as a threshold for starting as a full time farmer. This threshold depends, of course, on individual aspirations with regard to the standard of living. There are full-time farmers on farms of 2,500 ha and the biggest farm of 11,000 ha was run part-time by a shop owner. Although fragmentation has been largely halted, it is still part of the system since roughly 80% of the Rehoboth Gebiet comprises farms smaller than 4,000 ha (Lang 2005: 233). Only 20% of the Gebiet consists of farms of more than 4,000 ha. But the data also indicate that the process of fragmentation has discontinued and a reverse process has started (Fig. 3).

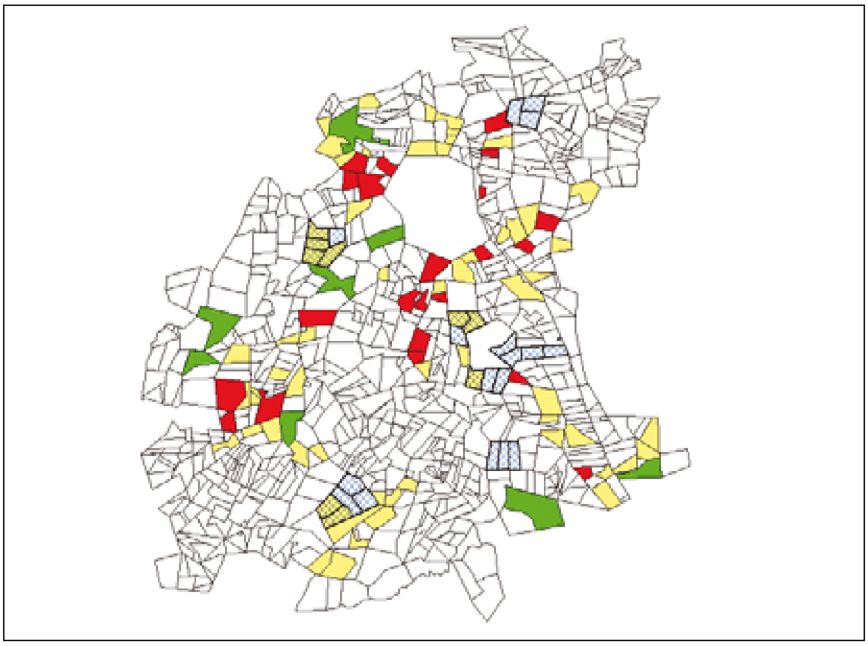


Fig. 2: The former Rehoboth Gebiet. Survey of farms and Odendaal-farms (Limpricht & Lang 2008). Red: estate farm with many owners. Yellow: Farm, run part-time by a single owner (< 4,000 ha). Green: large (consolidated) farm, run full-time by a single owner (> 4,000 ha). Blue cross-hatching: Odendaal farms (mean size 2,400 ha).

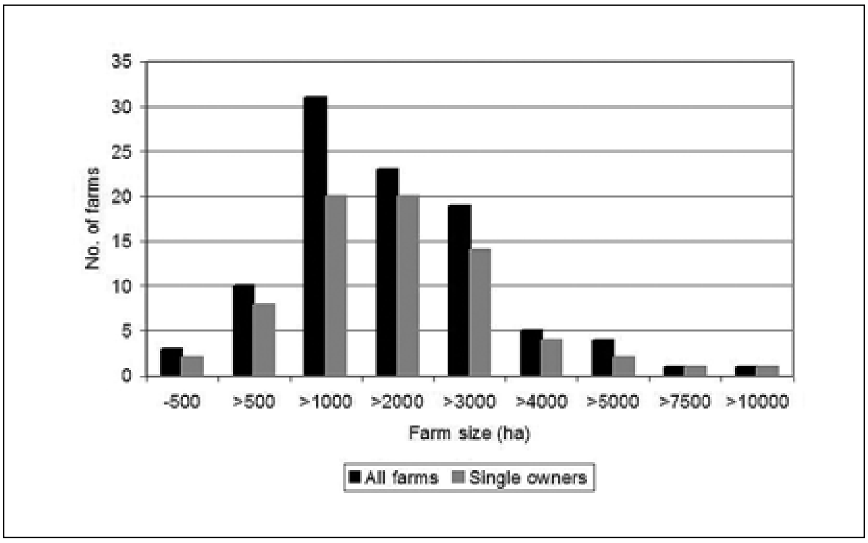


Fig. 3: Farm size distribution of all farms (including multiple owner farms) and single owner farms in 1999/2000 (Lang 2005).

The Rehoboth Odendaal-farms—a good example in land re-distribution?

[C. Limpricht]

During the late 1960s, the South African government purchased six white owned farms—the so-called **white islands** of the Baster Gebiet—comprising more than seventy thousand hectares. They were subdivided into twenty-six units, which were leased and later sold to Baster farmers. The idea to incorporate these farms into the Baster homeland came from the South African official F.H. Odendaal in 1964. Within the framework of South African Apartheid ideology and its racist goal of separate development, the Baster homeland was consolidated with the removal of white farmers from the region (Britz et al. 1999, Limpricht & Lang 2008).

The Realisation of the Odendaal Plan: The first step was the subdivision

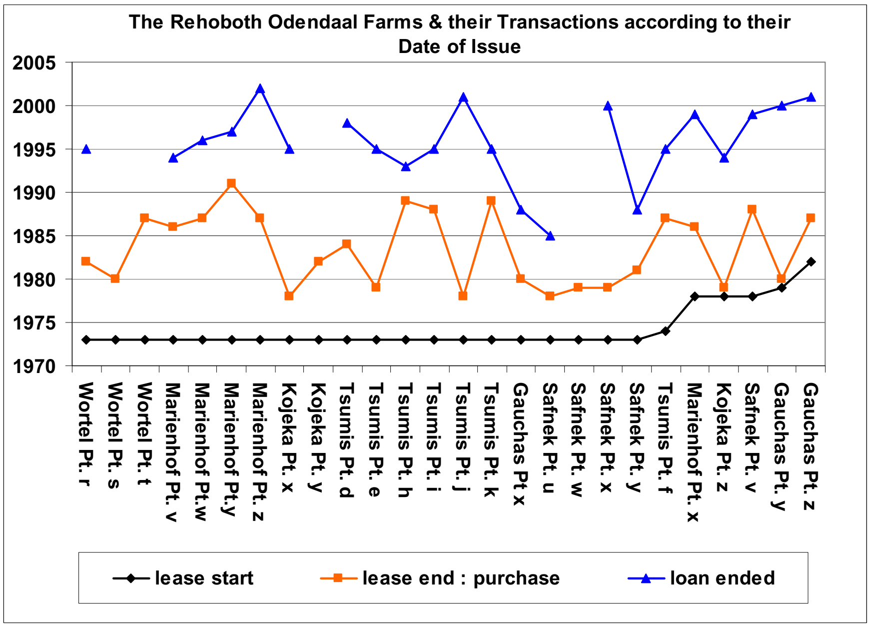


Fig. 4: Rehoboth Odendaal Farms: six farms were subdivided into twenty-six units.

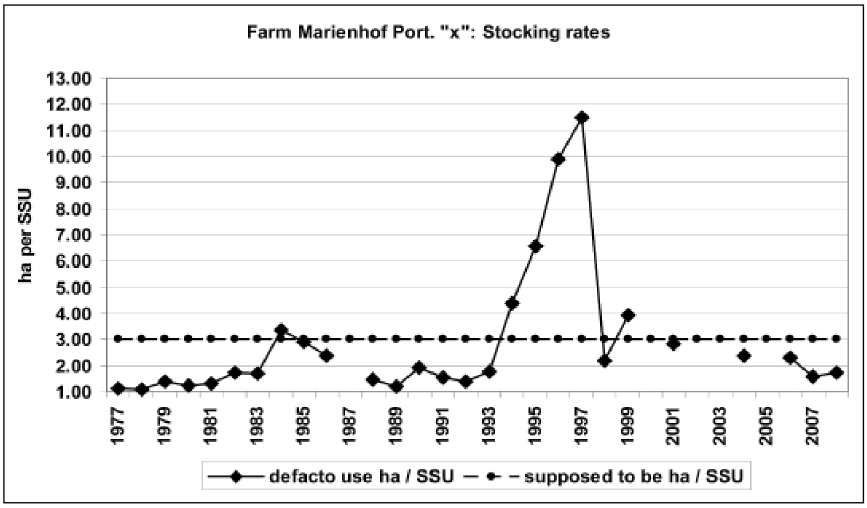


Fig. 5: The graph gives a rough idea about sticking to prescribed stocking rates. We used only the numbers of adult animals as the numbers of lambs and calves were incomplete.

of these rather large and mainly well-developed farms into smaller surveyed parcels, which ranged from little more than 2,000 ha to nearly 2,800 ha. The distribution of fences—camps and borders—had to be reorganised. Each unit had to get access to a water point. On paper, a detailed planned infrastructure with camps and water points was made available for each unit by the end of the 1970s. The single units were advertised. Within nine years the South African administration managed to purchase and to subdivide the **white islands**. Nearly all farms were allotted in 1973 with a five-year lease and an option-to-buy-contract to Baster farmers, after they had successfully completed a one year period of a lease-on-probation (Fig. 4). Five farms were given up by the first lessee for different reasons and the farms were distributed again: 3 in 1978, 1 in 1979, 1 in 1982. What becomes clear is that during the process of allotment the Basters were not lumped together but treated with individual solutions; otherwise we might have found a correlation between the different transactions of leasehold, purchase and pay off (Fig. 4).

Farm Marienhof: We focus here on some preliminary results of aspects like farm planning, subsidies and survival strategies of the Odendaal-owners, using mainly the case of the farm Marienhof. Originally 11,099 ha, Marienhof was divided up into five pieces (portions) in 1971. Today three of the original Odendaal-owners are more or less active, but rather old. One unit was sold to a third party, while one unit was passed as gift to the son.

Regarding farm planning, the Odendaal rules are stricter on paper than in reality: Some owners followed the envisaged detailed farm-plans made by the local agricultural department, which made provision for the location of camps, boreholes, water distribution, and rotational pasture management, while others did so only partly or did next to nothing. There is at the moment no case to be found where farm planning was enforced, but out of the archival material it has become clear that whenever subsidies were claimed, e.g. for farm investments like camp fences, owners had to stick to the plans and also to certain stocking rates. Nevertheless, overstocking the farm developed into a survival strategy due to the size of the farms.

Only one of the Marienhof farms still has the full records of stock numbers for the last 30 years. During this period the owner met the prescribed stocking rate of 3 ha per small stock unit (SSU) only six times, although this stocking rate was not high (Fig. 5). The farm does show signs of degradation in an increased number of annual grasses, and certain camps are dominated by the invasive *Acacia mellifera* (Swarthaak). But interestingly, despite this long period of heavy overstocking and corresponding degradation, the farm is still able to support a viable livestock production.

Most of the farmers of the southern Odendaal-farms indicated that they had to rent additional farms in order to survive. All interviewed farmers confirmed that the Odendaal allotment was the only chance for landless Basters, although it became clear quite early that the farms were rather small. In these days they could make a modest living, raise between three to ten children, and send them to school and sometimes university.

Conclusion: The whole process of re-distribution was inspired by an objectionable political system (Apartheid), but nevertheless it can be seen as an intervention experiment by a state to change property rights. This historical case of the re-distribution of private land in the Rehoboth Gebiet sheds light on aspects of the economical and ecological feasibility of such a process. The reconstruction of farm histories and landuse patterns indicates that the Odendaal farms can serve as a politically necessary, but not always ecologically positive, exemplary basis for redistributing land today (Hunter 2004, Odendaal 2006). The Odendaal farmers who were especially successful economically were those who accepted guidance and assistance from the local agricultural extension service if they could manage the risk of additional loans and if they joined the agricultural unions. The support of sometimes large subsidies helped a great deal.

Ethnobotanical knowledge

[C. Naumann]
Landusers perceive the flora of the area from a pastoral point of view and evaluate plants according to their relevance for their herds. Their knowledge focuses on plants which are well utilised by grazing or browsing animals, or which are known to be toxic for livestock. The use of plants for veterinary purposes can be observed in the region; in particular the application of *Aloe* spp. (Alwyn) for tick control is widespread among local landusers. However, the prevention and treatment of human ailments with medical plants is only reported by a few farmers (Naumann 2009).

Nutrition value, palatability, and biomass production are important local criteria for plant valuation. Species which are annual or occur in predominantly disturbed habitats are not necessarily seen as inferior, as long as they are well utilised by livestock and improve the animals' physical condition. Furthermore, the time of germination is an important local valuation criterion. Species germinating and establishing quickly after rainfall events, such as the annual grass *Enneapogon desvauxii* (Agdaegras), are admired, since they offer the first green grazing after a dry season.

Consensus analysis was used to investigate the distribution of cultural botanical knowledge within the farmer community in Rehoboth (Naumann 2009). Results showed that knowledge is unequally distributed among the farmers. Landusers that have a good knowledge of the local flora are generally senior full time farmers, who have many years of experience and are actively involved in farmer unions. Surprisingly, a comparison of botanical data concerning the perennial grass biomass on landusers' farms with results of consensus analyses suggests that local botanical experts are not necessarily the better pasture managers.

Local perceptions of degradation

[C. Naumann]
Degradation of vegetation and soils can be observed in many places in the former Rehoboth Gebiet. Numerous farms are covered predominantly with annual grass species and show signs of soil erosion. The degradation of pastures is also perceived by local farmers, in particular the decrease of perennial grass species, sheet erosion processes and the die off of *Acacia erioloba* (Kameeldoring) individuals. Landusers have varying explanations for the causes of this trend. Some farmers assume that change of vegetation is a result of decreasing precipitation. However, available rain data dating back to the 1980s do not indicate at least a short-term decline in annual rainfall. Besides precipitation, failure in farm management is seen by many local farmers as an important reason for degradation processes in the area. Especially high stocking densities are perceived as a problem for the local environment.

Change of vegetation, e.g. the decrease of perennial grasses and increase of annual species, is not regarded as alarming as long as pastures remain highly productive (see above). If land is strongly degraded and offers insufficient animal nutrition the long-term rest of rangeland is seen as the best means to increase pasture condition (Naumann 2009).

Environmental heterogeneity and productivity of the Rehoboth rangelands

[D. Wesuls]
The common features regarding the cultural and historical background of the Rehoboth area are contrasted by a high environmental heterogeneity and by a steep rainfall gradient. Coming from the foothills of the Khomas Highland in the north with an average annual rainfall of 350 mm, the rainfall is nearly halved within the next 100 km down southwards to 200 mm or even less in the southern parts near Kalkrand. As already mentioned in the introductory part, three geologically distinct units and three vegetation zones are to be found in the Rehoboth area.

In a botanical survey of ten different farms in the area conducted in the good rainy season of 2006 the plant species composition and cover were recorded on 10 m x 10 m samples on typical parts of these farms. Additionally a sample of the grass biomass was taken on a 1 m x 1 m sample within each of the larger vegetation sampling plots. The vegetation samples were classified by means of cluster analysis and detrended correspondence analysis (DCA).

Fig. 6 shows the three different vegetation classes that could be identified. The classes are mainly related to the different soil types which also reflect the different geological units. Class 1 was found on shallow calcareous (Calcisols) and rocky soils (Leptosols). The typical vegetation found here was a mix of grasses and dwarf shrubs. Class 2 could be related to sandy soils of medium depth. This class represented an open shrub savanna with taller shrubs compared to class 1. The vegetation of classes 1 and 2 are typical for large parts of the Nama Karoo. Class 2 comprised most of the samples and it is quite characteristic for the Rehoboth area. Class 3 was found on deep sandy soils (Arenosols). These soils are advantageous in terms of water infiltration and water storage allowing for taller trees and shrubs to grow. Consequently, the vegetation found here was characterised by a higher density of large trees and shrubs within a continuous grass layer. This vegetation represents a part of the southern Kalahari found in Namibia.

Grasses are the basis for farming in the savannas of the Rehoboth area as they contribute most to the annual biomass production and they represent the main fodder for livestock. Different species

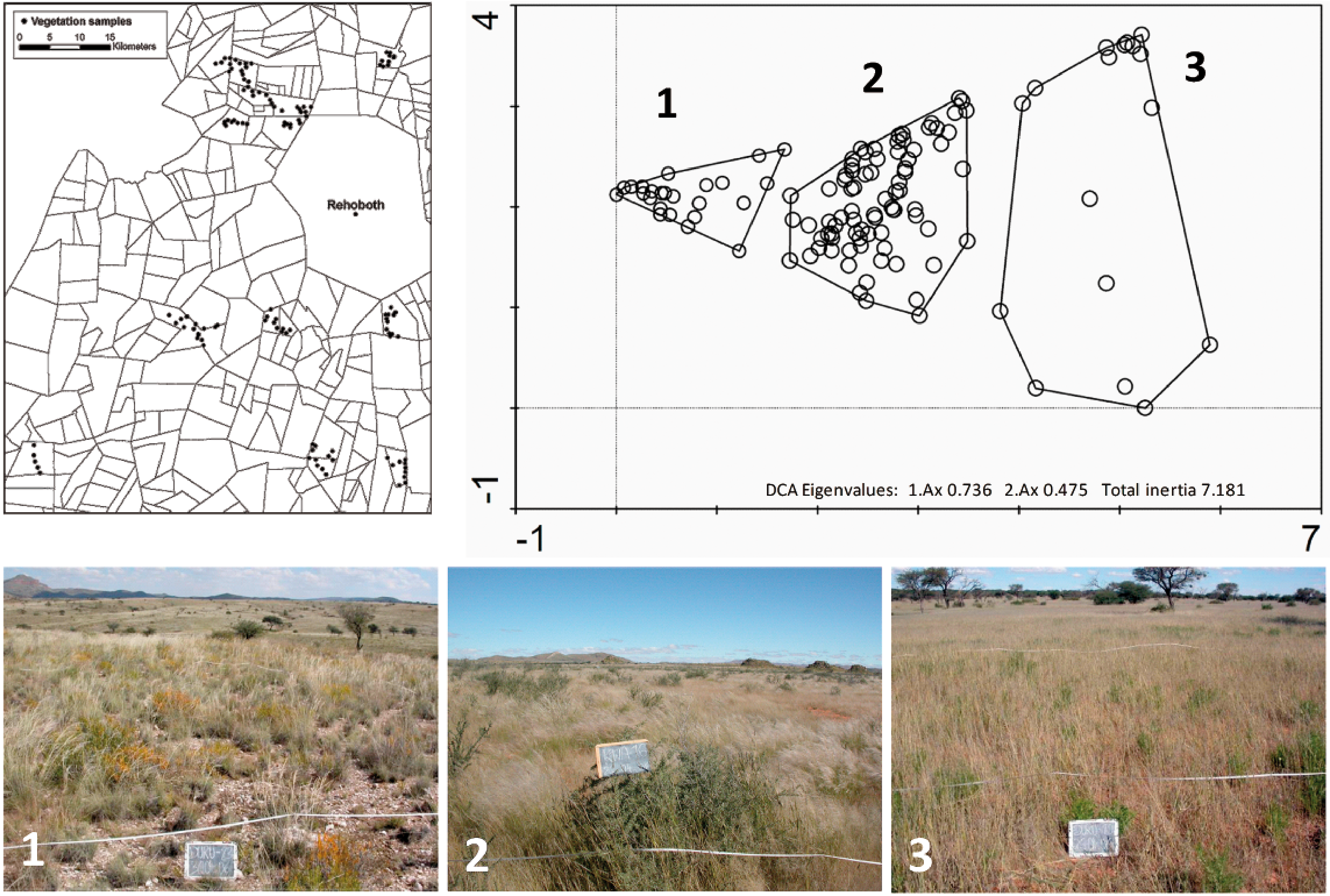


Fig. 6: Farm sampling conducted in 2006 in the Rehoboth area. Top left: Map of the ten sampled farms. Top right: DCA ordination of vegetation samples. Three distinct classes (top right and photographs below) which are mainly related to different soil properties could be identified. Class 1: Dwarf shrub savanna on rocky and calcareous soil. Class 2: Shrub savanna on sandy soil. Class 3: Tree and shrub savanna on deep sandy soil.

differ in their nutritive value and their ecological significance. Annual grasses are seen as valuable fodder since their protein content is often very high (see Wesuls et al. 2009). Nevertheless, vegetation with a high proportion of annual grasses is also a signal of ecologically impoverished pastures in an unfavourable state or an early state of plant succession. Compared to perennial grasses they are less reliable in terms of biomass production in poor rainy seasons and because of their shallow rooting depth they do not prevent soil erosion. The differences between the ten sampled farms in terms of biomass of annual grasses (Fig. 7a) mainly reflected patterns of rainfall. The highest amount of annual grasses was found on the smallest farm, belonging to vegetation class 3. This high biomass was mainly due to an extraordinary high rainfall (> 500 mm) on that farm in the sampling season. The grass biomass of this farm was mainly determined by *Schmidtia kalahariensis*, a very productive annual grass, typically growing on deep sandy soils. There was no significant correlation between the biomass of annual grasses and farm size (shown as grey boxes in Fig. 7).

Other farm management parameters like the current and past stocking rate and the number of camps per farm showed no significant correlation with the biomass of annual grasses. The same applied to the biomass of perennial grasses. Nevertheless, perennial grasses tended to be more abundant on larger farms although this correlation was very close to the significance threshold (Pearson $r = 0.62$, $p = 0.055$). On average, the highest amount of perennial grass was found on the two largest farms (Fig. 7b). Despite the fact, that the highest values for the overall biomass were again found on the two largest farms (Fig. 7c) there was no general significant trend of the total grass biomass (i.e. annuals and perennials) regarding farm sizes, stocking rates or number of camps.

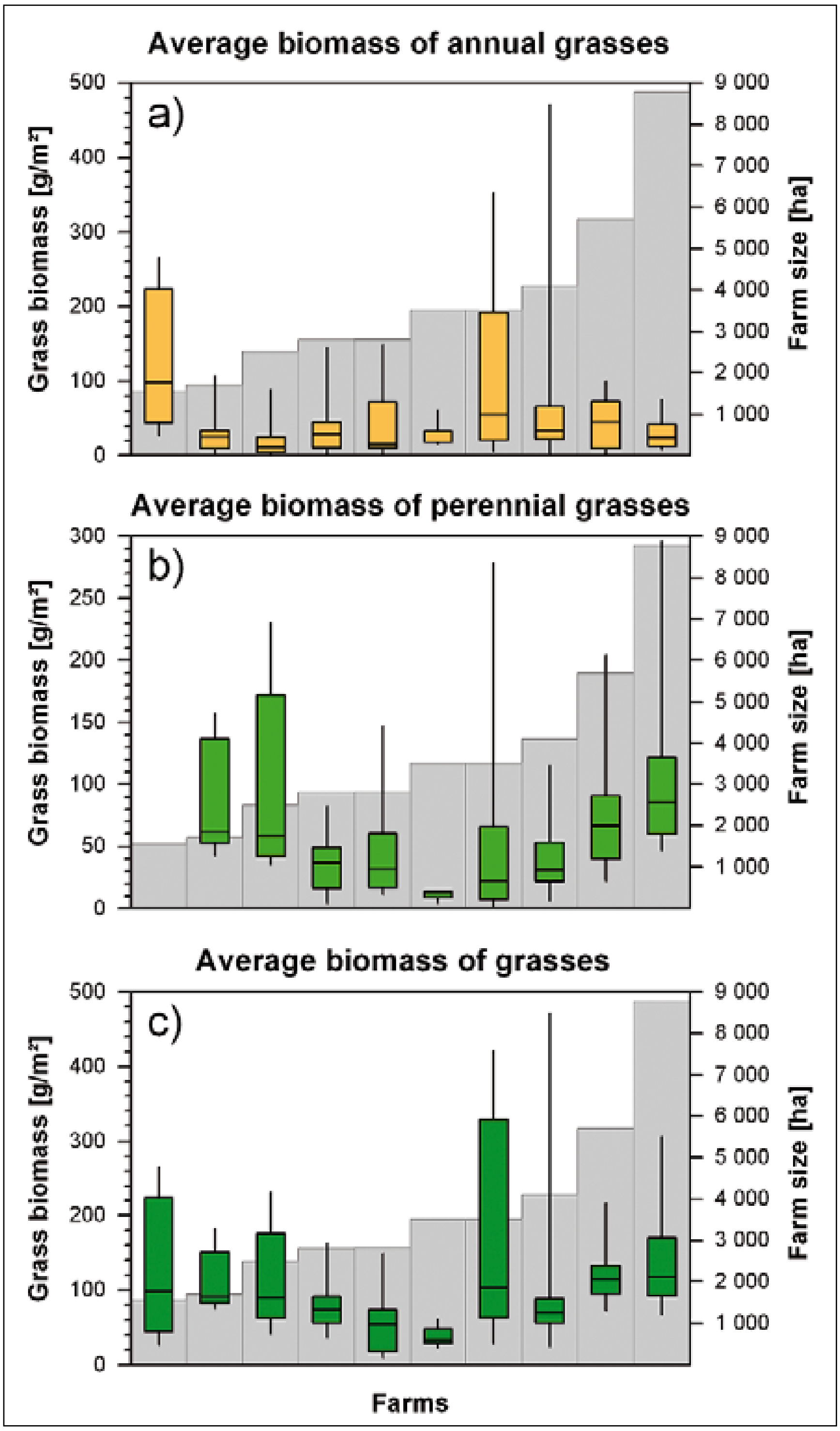


Fig. 7: Average biomass of annual (a), perennial (b) and the sum of all grasses (c) on ten farms in the Rehoboth area. The horizontal line in the boxes is the median value (*N* = 5–22). The boxes represent the interquartile range (25–75%) and the whiskers the total range. Light grey boxes in the background show the farm sizes.

Conclusions: It becomes apparent, that a comparison of farms which is feasible in terms of socioeconomic factors could be difficult when the factors to be compared are based on environmental and ecological criteria. The environmental heterogeneity described for the Rehoboth area also showed up in the sampling of vegetation and grass biomass on ten different farms. The productivity of the Rehoboth rangelands is driven by this heterogeneity and by local patterns of rainfall. Nevertheless, the tendency of higher perennial grass biomass on larger farms shows that there are important background variables that affect whether management is sustainable or not. Some of these additional factors have been already mentioned in the preceding sections, e.g. ownership structure, ethnobotanical knowledge or perceptional concerns (see also Wesuls &

Lang 2010). For future research it would be desirable if environmental heterogeneity is kept at a minimum when comparing the effects of farm management on productivity. Furthermore a detailed analysis and integration of all factors that may influence farm management will be necessary in such comparisons.

Recommendations—targeting the regions—the former Rehoboth Gebiet

[C. Limpricht]
The size of the farms and the ownership structure influences the ecological and economic viability of farming since multiple ownership is found on a quarter of farms in the Rehoboth area (Limpricht & Lang 2008). Roughly 40% of the former Rehoboth Gebiet is used by farms smaller than 2,000 ha (Lang 2005).
Small farms and multiple-owner farms often suffer from incoherent and inconsistent pasture and stock management. Before Independence in 1990, **farm planning** was one of the major tasks of the Rehoboth extension service, which formed part of the agricultural department. Today it happens very rarely. Farms of multiple owners and small farms receive hardly any attention. A change of this attitude would be an improvement. Since farm consolidation is a time-consuming effort and not always successful, farmers and stakeholders could consider developing mechanisms for **farming jointly**, either within family structures or by including neighbouring small farms. This could stimulate thinking about new cooperative structures, smaller types of conservancies or forms of informal consolidation.

Due to individualistic attitudes and almost isolated work routines on their farms, the Rehoboth farmer community nowadays faces the problem of not knowing weather neighbours or farmers in the vicinity are going to sell or lease a piece of land. A **board or commission**, established under the auspices of the Rehoboth Extension Office of the Ministry of Agriculture, Water and Forestry and the Agricultural Unions of Rehoboth, could serve as an information collecting point, through which everyone who wants to sell or to purchase a farm, a portion, or shares of a farm has to operate. Neighbouring farmers and established farmers of the area should have first choice to buy such properties in order to get a chance to enlarge their farming activities so that they can become more ecologically and economically viable.

3.3 Keetmanshoop region: socio-economic analysis of large commercial ranching systems of south-central Namibia

Introduction to commercial farming systems

[S. Domptail & N. Dreber]
Research on commercial farming systems of the arid Nama Karoo and their impact on rangeland ecological condition started in 2004 in a study area of about 750,000 ha in the surroundings of the main town of the Karas region, Keetmanshoop. The Gellap Ost research station, hosting a BIOTA Observatory Gellap Ost, is located within this area. In total from 2004 to 2007, about 40 commercial farmers were interviewed.

Ecological context. Most of the study area consists of extended plains covered by grasses and dwarf shrubs, which are dissected by washes ending in larger river beds. Locally, prominent dolerite hills, shale 'inselbergs' and plateaus occur, which are sparsely vegetated. The climate is arid, characterised by erratic and low summer rains from December to April (150 mm on average). Rainfall follows an incomplete gamma distribution so that there are more below average than above average rainfall years, and frequent droughts. In this harsh environment perennial grasses, dwarf shrubs, and higher shrubs compete for scarce water resources. Most shrubs and grasses are of value as fodder with some species being more palatable than others are. Trees, mostly *Acacia* spp., are found in moist habitats such as river beds and along the beds of underground rivers. Characteristic species in the region are *Stipagrostis uniplumis* (Blinkhaarboesmangras), *S. ciliata* (Langbeenboesmangras), *S. obtusa* (Kortbeenboesmangrass) for the grasses, *Monechma genistifolium* (Perdebos) and *Petalidium linifolium* (Lusernbos) for the dwarf shrubs, *Rhigozum trichotomum* (Driedoring), *Boscia foetida* (Stinkbos), *Catophractes alexandri* (Gabbabos) and *Tetragonia schenckii* (Kooibos) for the taller shrubs, and *A. erioloba* (Kameeldoring), *A. mellifera* (Swarthaak), *A. nebrownii* (Soetdoring) for the trees. Degradation implies a change in the vegetation composition of the rangeland and consists primarily of the replacement of perennial grasses by annual ones and an increase of bare ground. Degraded areas can be also subject to bush encroachment by less desirable shrubs such as *Zygophyllum tenue* (Skilpadbos) on lime soils or by *Rhigozum trichotomum*. Biomass growth varies inter-annually quite strongly in the Karas region—with a coefficient of variation from 20% to 40%—which constitutes the major challenge for pastoral activities. Yet, at the location of the study site, biomass is even more variable with a coefficient of variation above 90% (MAWF 2004).

Farmers and farming systems. Commercial ranches occupy a majority of the rangeland suitable for pastoralism in this region. The commercial farms are family enterprises but employ a small number of workers. The majority of owners and managers belong to the Afrikaners ethnic group while the workers belong to the Nama, Ovambo, San or Kavango people. Most of the farmers belonging to the Afrikaans ethnic group and their households consist of the nuclear families, with seldom more than three children. Living standards (large house, tertiary education of the children, and ownership of a car) are rather high compared to the Namibian average. Until now, this was possible thanks to low costs of inputs and large farm sizes. The average farm size in the sample is 10,000 ha (S. Domptail, unpublished data) with average net margins oscillating around N$35 (about €3) per ha (Schuh et al. 2006). Workers enjoy many benefits in kind, including housing, but are often paid the minimum legal salaries. There is now pressure to increase their salary and thus the labour costs on farms (Karamata 2006). Commercial farmers mostly belong to farming families and have grown up on communal or commercial farms. This trend is changing with a high turnover of land ownership and management, resulting from the land redistribution effort conducted in the context of the land reform (Kahuika 2006). At the moment, many people enter the commercial farming profession without specialised knowledge about farming systems nor market oriented production.

Economic background. The commercial farms are specialised in the production of meat and sheep skins for sale, rather than self-consumption. The breeding of small stock, characterised by a short life cycle and fast herd dynamics, is the most suitable pastoral activity considering the climatic constraints. Skin production with Karakul sheep (i.e. fur from newborn sheep, also known as Astrakhan or Swakara) was the main pastoral activity in the region until the 1980's. Skins, referred to as 'Black Gold', were exported centrally by the national cooperative AGRA to Copenhagen. Yet, the market is characterised by a high volatility in prices. Following the price crash in 1979 (AGRA 2005, unpublished data), the region largely converted to meat production activities based on the breeding of Dorper sheep (a cross-breed of the English Dorset meat sheep with the indigenous Persian sheep). Other indigenous sheep breeds may occasionally be found

Table 1: Lamb product prices and variability over the period 2000–2006

	Goats	Dorper	Karakul	Damara
Price lamb (30 kg)	250	311	299	299
Standard deviation	*77.7*	*40.9*	*24.4*	*24.4*
Price lamb (40 kg)	334	394	349	349
Standard deviation	*77.7*	*48.9*	*34.8*	*34.8*
Price pelt			329	
Standard deviation			*81*	

Prices are given in Namibian Dollars
Sources: Pelts - AGRA Namibia 2005 (time series of the last 15 years); lambs - Meat board data, MAWF 2000 to 2006

on farms as well. Prices for meat products are less volatile, while still variable. They are affected by the Small Stock Marketing Scheme implemented in 2006 with the aim of adding value to the livestock industry in Namibia by strongly limiting the export of live sheep to neighbouring South Africa (Schutz 2009). National abattoirs, such as that of Keetmanshoop, create incentives through their pricing policy for the production of lean meat with Dorper sheep rather than of fattier meat from indigenous sheep. Finally, goat farming belongs, especially among the Nama ethnic group, to the traditional small stock breeds and is conducted largely as a side production on most farms. At the moment, goats are still exported live, mostly to the large market, which exist in South Africa. Table 1 shows the different prices and price variability for different livestock types and Fig. 8 shows the herd composition in the study area.

Veld types as units for management and transdisciplinary science

[S. Domptail & N. Dreber]
The environmentally heterogeneous Keetmanshoop region comprises a variety of distinct vegetation types and plant communities, each of them characteristic of a

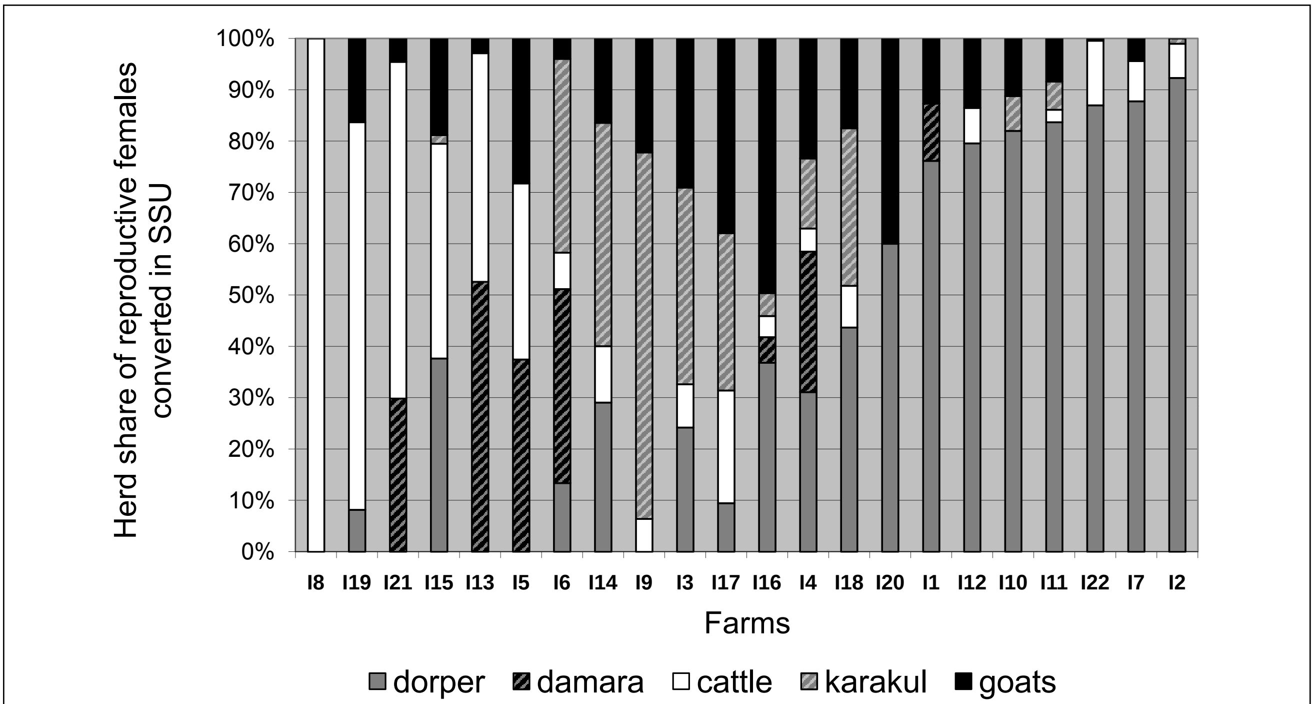


Fig. 8: Share of the different types of livestock in the herds of the 20 farms interviewed in 2005 in the study area (only reproductive females, converted in small stock units [SSU]). Graph: S. Domptail.

certain habitat defined by a set of geological, pedological, and topographical properties. A cultural domain analysis conducted within BIOTA among commercial farmers has shown that farmers in southern Namibia perceive this diversity and make use of it in their management strategies.

Results showed that farmers classify their land resources into distinct veld types using simple qualitative indicators of the abiotic and biotic environment (S. Domptail, unpublished data). They perceive veld types as entities with particular environmental characteristics such as topographical position, soil type, vegetation composition and structure (Table 2). In addition, distinctions between veld types are also made in terms of grazing value (i.e. the timing, the quality and quantity of fodder provided), carrying capacity and sensitivity to environmental impacts such as droughts and grazing. Within the whole interviewed sample, a total of seven veld types were identified by farmers (Table 2). Veld types often are delimited even on the small scale so that several veld types may occur on a single farm. Therefore, possessing a diversity of resources is perceived as highly valuable, as it supports a diverse fodder reserve in time and space. In this regard, veld types make specific contributions to the farming system and drive the spatial and temporal use of rangelands.

A main implication of this finding is that the concept of veld type may be very useful as a basis of communication between farmers and rangeland scientists as well as ecologists and conservationists to improve management, production, and conservation. Motivated by farmers' perception, we propose the hypothesis that ranching in the study area, where biomass variability is comparable only to that of the Namib Desert (MAWF 2004), is only viable because of this diversity. Access to key resources such as bossie veld and river beds (Table 2) is especially important since it enables farmers to better withstand the dry seasons in general and droughts in particular.

An attempt was made to establish a correspondence between a scientific concept of veld type classification and the farmers' perceived veld types in order to increase the knowledge on resource diversity in space for an improved management of rangelands (S. Domptail and N. Dreber, unpublished data). Therefore, a record and description of the resource heterogeneity in the Keetmanshoop area has been initiated in 2008 based on pedological and botanical mapping approaches.

The farms covered by the socio-economic study were also investigated in terms of the edaphic geodiversity (pedodiversity) existing in the study area. Grotehusmann (2006, Grotehusmann et al. 2006) conducted a soil survey in 2005 covering the most important geological and morphological structures in the area. A total of 61 soil profiles were examined and classified with the World Reference Base for Soil Resources (FAO 1998). Typical soils of the region included Arenosols, Calcisols, Cambisols, Fluvisols, Leptosols, and Regosols, most attributed as 'yermic' or 'aridic' in concordance with the dry climatic conditions (Grotehusmann 2006). Differences in e.g. soil texture, depth, and infiltrability are determining ecological factors for plant growth, and thus certain plant communities can be expected to be correlated with certain soil types. Consequently, in 2008, a pilot study was conducted recording the vegetation at the location of each soil profile examined by Grotehusmann (2006). Plant species composition and plant cover was recorded within 100 m^2 and 1,000 m^2 relevés according to the sampling design applied on BIOTA Observatories. Relevé-based environmental data was collected including aspect and inclination, and surface cover in percent of litter, stones, and bare ground on 100 m^2. In addition, soil was sampled to a depth of 10 cm for chemical and physical analyses (N. Dreber, unpublished data). A preliminary classification of veld types based on the pedological and botanical data revealed eight broad units frequently found in the study area (Table 2). The qualitative perception and assessment of veld types by farmers in the study area showed parallels to the preliminary veld types defined, but often lacked the understanding of the underlying causalities. Besides, the classification approach on the basis of ecological data provided a finer resolution in distinct entities, than the system perceived or used by farmers (Table 2). Though only a limited set of indicator species for each veld type is presented here, it is worth mentioning that farmers make use of a variety of taxa to differentiate between veld types and rangeland condition. However, in general farmers' knowledge of plant species was weak and frequently several names were used for identical plant species. This might also be due to the fact that guided botanical field trips are no longer organised by local farmer unions as in former years (Giel Steenkamp, pers. communication). This highlights the need for accessible and standardised information of the flora to improve communication among farmers and between farmers and researchers.

The ecological research on veld types is currently pursued with a refined classification of vegetation in the study area in order to define distinct phytosociological units and identify the main driving environmental factors for vegetation patterns. For this purpose, an area of about 1,800 km^2 was stratified into classes based on geological formation and topography using maps and satellite images. More than 200 vegetation-relevés (100 m^2 and 1,000 m^2) were assigned to these classes, and the same data set as in 2008 was recorded. First results revealed a total of 243 plant species from 54 families, and 12 vegetation units in the Keetmanshoop area, which are mainly separated by differences in soil depth, soil texture, lime content and inclination (J. Dorendorf, University of Hamburg, unpublished data). The work will provide a first phytosociological classification of plant communities in rangelands of the Keetmanshoop area, as well as environmental indicators and plant lists allowing stakeholders to identify standardised vegetation types and veld types, respectively.

Temporal and spatial landuse strategies of commercial farmers

[S. Domptail]

Short overview of current landuse strategies

The aim of management is to adjust herd size to the available biomass (Byers 1997), which in turn depends directly on

Table 2: Veld types and their characteristics as denoted by farmers in the Keetmanshoop region, and a broad classification based on ecological data

Veld type		Soil type		Habitat & vegetation		Indicator species	
Farmer	BIOTA	Farmer	BIOTA	Farmer	BIOTA	Farmer	BIOTA
Hard-veld (Torra, Vlakter)	Hard-veld (a) on dolerite	Hard & stony	Leptosols	Little vegetation, few bushes	Outcrops & rocky slopes; mix of trees, shrubs & grasses	*Stipagrostis anomala*	*Aloe dichotoma*, *Hermannia minutiflora*, *Triraphis ramosissima*
Mountain-veld	Hard-veld (b) on shale	Sandy-stony	Regosols & Leptosols	Plateaus & mountain sides; grasses & shrubs	Slopes, pediments & outcrops; diverse in dwarf shrubs & perennial grasses	*Petalidium linifolium*, *Monechma genistifolium*	*Hibiscus elliottiae*, *Setaria appendiculata*, *Indigofera pechuelii*
Bossie-veld	Bossie-veld on shale	Clayey & sandy, crusts	Leptosols	High bush cover, low-medium grass cover	Plains densely covered by gravel, often calcareous; dwarf shrub dominated	*Petalidium linifolium*	*Aizoon schellenbergii*, *Leucosphaera bainesii*, *Pteronia mucronata*
Soft-veld	Soft-veld (a) on dolerite		Regosols & Leptosols	Plains & small hills; grass dominated	Plains locally in contact to saprolite, often calcareous; species poor, much bare ground	*Parkinsonia africana*, *Rhigozum trichotomum*, *Tetragonia schenckii*	*Parkinsonia africana*, *Stipagrostis anomala*, *Zygophyllum rigidum*
	Soft veld (b) on shale		Regosols & Cambisols		Plains & moderate slopes dissected by washes; rich in shrubs, grasses & annuals		*Boscia foetida*, *Phaeoptilum spinosum*, *Lycium* spp.
	Grasslands on dolerite		Regosols (calcaric)		Plains, rich in silt & lime; species poor, mono-dominated by grasses		*Stipagrostis ciliata*
Lime-veld	Limeveld on dolerite	Stony & limy	Calcaric Regosols	Bushes & grasses	Plains, often underlying calcretes or lime nodules; species poor, much bare ground	*Zygophyllum* sp.	*Zygophyllum decumbens*
River beds	Riverbeds		Fluvisols	Bushes, trees & high grasses	Ephemeral river beds; dense, species rich vegetation	*Acacia erioloba*, *Stipagrostis namaquensis*	*Acacia erioloba*, *Stipagrostis namaquensis*, *Ziziphus mucronata*
Brak-veld		Salty		Flat		*Salsola* sp.	

rainfall and on the rangeland condition (ecological state). It is a dynamic problem, because herd and landuse decisions in a given year affect the herd and landuse options available in the next year. Thus, the high variability in rainfall and the related risks constitute the main challenge for farm management. Adjustment options include (1) the sale and purchase of ewes, (2) the purchase or production of supplemental fodder in the form of alfalfa pallets or corn, (3) increasing the output per lamb by retarding sale or slaughter, (4) and renting one's herd to another farmer. Another handling option is (5) to rest the rangeland (not use it), which improves the state of rangelands when rainfall conditions are favourable.

The recommended stocking rate for the area is about 1 Small Stock Unit (SSU; animal of 50 kg live mass) on 5 ha (MAWF 2005), but practices vary from 1 SSU on 10 ha to 1 on 3 (Domptail et al. 2009). Spatial farm management is based on rotational grazing. Indeed, fixed fences divide farms into landuse units called camps. Rotational grazing is the practice of moving animals from camp to camp following a grazing management scheme or biomass availability. The spatial and temporal allocation of animals to particular camps is the result of a complex decision process and aims not only at facilitating rangeland management. The allocation of livestock to camps is subject to constraints such practicability, location, and rangeland resources, as well as dependent on the breed or on special needs of livestock types (e.g. pregnant ewes). There are always trade-offs among the fulfilling of constraints so that the strongest one on a specific farm will have a major impact on the grazing management.

Farmers resort to seasonal or whole-year resting and rotate the camps rested. Resting during the rainy season or in rainy years is critical for the regeneration and therefore the conservation of rangeland. Strategies for herd management in time

Table 3: Classification of behaviour according to farmer's actions in case of drought and extreme rainfall events (source: Domptail et al. 2009)

Behavioural category	Keyword	Behaviour description
Category 1	Threat avoider	Operating with land of high carrying capacity, but lower stocking rates; are very reactive to droughts (immediate herd reduction, eventually all animals can be sold or sent to another farm) and rather static in case of high rainfalls
Category 2	Opportunity seizer	Operating with land having a good carrying capacity, rather static in cases of drought (partial reduction in herd size, fodder purchase) and reactive to high rainfalls; indicators for rangeland management are based on vegetation
Category 3	Less flexible strategy	Rather static group, following a moderately tracking strategy (occasional purchase of fodder, low variability in animal numbers), with stocking rates sticking to recommended carrying capacity.
Category 4	Static strategy	Conservative and static strategy with maintenance of animal numbers, operating at rather low stocking rates (19 has a low stocking rate in absolute terms)
Category 5	Highly reactive strategy	Immediate adjustment in herd size by drought (all animal can be sold or sent to another farm) and high rainfall events (increase number of female lambs kept and purchase of ewes).

range from conservative schemes with low and constant animal numbers to dynamic 'opportunistic' schemes, where all control options are used to exactly match biomass and livestock in droughts as well as in times of abundance (Table 3). Importantly, landuse also affects the condition of rangeland, as is shown later in this chapter, and thereby its biomass production. This feedback is of key importance in the development of dynamic landuse strategies. Degradation risks associated with landuse options are known to farmers, although the amount of local knowledge varies with individuals.

Drivers and impact of landuse strategies

A series of hypotheses concerning the drivers of landuse strategies of commercial farmers in the study area were investigated. Potential drivers are (1) farm characteristics such as the average carrying capacity of the farm and the farm size, (2) farmer-related characteristics—the age of the manager/farmer, whether he is full time or part time farmer, his preference for rangeland conservation, and the indicators used to decide on the rotational grazing patterns on the different camps of the farm—as well as (3) economic factors such as product prices and fixed costs. Most factors were looked at on the basis of a correspondence table between the observed landuse strategies and farm/farmer characteristics. The impact of economic factors and farmer preferences for conservation on the economic and ecological outputs of farming activities was explored on the long term with the use of a bio-economic model parameterised for the study area.

Farmer related factors. Farmers use indicators as a basis for daily decision making in the allocation of animals and stocking rates to each camp. Vegetation indicators account there for 68% of the indicators cited and animal-related ones for 20%. Remaining indicators were related to other elements of the ecosystem such as soils and the presence of wild animals. Indicators range from the level of grass biomass to the observation of indicator plants (e.g. *Leucosphaera bainesii*, the 'Wolbos') (S. Domptail, unpublished data). Our results show a contra-intuitive trend with farmers practicing high stocking rates also using more vegetation indicators. Yet, one should recall that grass-dominated vegetation has a high productivity in comparison to other types of veld and thus farms dominated by grass veld have higher carrying capacities. No correspondence was found with the management types defined in the previous section. Thus, indicators used for the spatial allocation of stock by farmers would depend on the characteristics of the ecosystem rather than strategies chosen to cope with rainfall variations.

Farmers' occupation—whether part time or full time—may have an important implication for management since a parallel occupation generates income, which may be injected in farm management at times of need. Especially, we hypothesise that off-farm income reduces the yearly pressure to cover the fixed costs of the farm and households consumption. Results indicate that farmers benefiting from an additional income source adopt the most reactive (or 'opportunistic') strategies, strongly reacting to rainfall signals by selling a large share of their herd and purchasing livestock back again when conditions have improved. This can have either a positive or a negative impact on the rangeland, depending on whether livestock numbers remain coupled to the ecosystem or whether the access to markets (auctions) leads to a decoupling of the system and increase risks for degradation (Domptail et al. 2009, Müller et al. 2007). On the other hand, no pattern could be identified among strategies practiced by full-time farmers (S. Domptail, unpublished data). The role of farmers' preferences was not investigated empirically but rather via the analysis of landuse strategies simulated for the two objectives of rangeland conservation and income generation. The strategy aiming solely at income generation led to a much higher degree of degradation than strategies aiming at conservation (1/3rd of the farmland versus 1/10th; note that 100% conservation cannot be achieved due to the landuse-independent impact of rainfall). The trade-off between the two objectives increases with the achieved conservation level. Thus, when high stocking rates are practiced, small differences in stocking rates, which create only a small reduction in income, can have a large impact on rangeland ecology and biodiversity. This indicates that a potential exists to achieve a 'cheap' improvement in rangeland condition among some farmers providing appropriate incentives are used. At higher levels of conservation, differences in stocking rates become much more important in order to make a difference in rangeland condition (Domptail et al. 2009).

Farm related factors. Low carrying capacities affect the net margin per ha, since per ha costs—particularly high in rotational commercial systems—are independent of the land's productivity. Similarly, due to the importance of fixed costs, farm size may affect the economic viability of the farm. Critical fixed costs are the income desired by commercial farmers as well as annuities from the concentration of loans for a land purchase when it applies. Thus, these two factors may affect landuse strategies by increasing the risk perceived in the occurrence of drought events, which may in turn favor conservative (low and constant stocking rates) or threat-avoiding strategies. Results show that strategies used on land with a high carrying capacity (as announced by the interviewed farmers) tend to be dynamic. Both strategies which react strongly to drought as well as those which react primarily to high rainfall events are observed. A possible explanation to this rather contra-intuitive finding is that high carrying capacities are found on veld types dominated by a healthy perennial grass layer. Grass-dominated veld types on soft soils were found to be particularly sensitive to overgrazing and to drought (S. Domptail, and A. Popp, University of Potsdam, unpublished data), and therefore their management would require a strong reaction to either drought or high rainfall events, depending on the initial stocking rate practiced. The heterogeneity in rangeland resources is thus also a key criterion to understanding the diversity of farmers' strategies. Farm size appeared as an even more discriminating factor. As expected, a small farm size was found to correspond strongly to threat-avoiding strategies and may have important costs in the long term due to the 'forced' sale of animals during dry spells. On the contrary, farmers with large farms are able to keep low and constant stocking rates, thus minimising the costs of adaptation to rainfall variability, while still covering fixed costs (S. Domptail, unpublished data).

Economic factors. Economic drivers and stimuli to which the farming systems respond include household consumption levels and prices (of livestock, of inputs and of products). The yearly net income farmers need to generate for personal needs, education and debt reimbursement for the land, despite the impact of drought, can play an important role in stocking decisions. High costs may reduce the flexibility of strategies, as they constitute a disincentive to the reduction of herd size. Input prices, particularly of infrastructure, may play a similar role, when considering a farm of a given size. Further, high prices for livestock (productive ewes and rams), and especially a large difference between the income from livestock sales (usually in times of drought) and the costs of livestock purchase (after the drought) similarly constitutes a disincentive to adopt flexible and reactive stocking strategies with low levels of breeding. The ecological and economic impact of the level of household needs and of input prices was assessed by comparing long term computer simulated strategies. We found that when costs increase, the diversity in the possible strategies, expressed in the average stocking rates, is reduced. Stocking rates of income-oriented strategies decrease with increasing costs because the resource base (rangeland condition) must be maintained at higher levels to cover the costs on the long term, whereas stocking rates of the conservation strategy increase with increasing household needs, as can be expected intuitively (S. Domptail, unpublished data; Fig. 9). Thus, higher input, infrastructure, and household consumption reduce the flexibility of the farming strategies to adapt and react to different environmental conditions.

Prices of products on the other hand tend to affect herd composition, which in turn alters rangeland condition. Optimal herd composition, which satisfied the objective of maximal conservation, while maintaining minimum household consumption, was found to be composed of Karakul, Dorper, and Damara sheep as well as of Boergoats. Thus, the diversity of products (meat and pelts) as well as of grazing pressures (browsers vs. grazers) is important for the farming system. The optimal herd composition for conservation gives the Karakul sheep as the main breed of the herd. However, if prices for Karakul pelts drop below the threshold of N$250 (€22) per pelt, the proportion of the Dorper in the optimal composition overcomes that of the Karakul (S. Domptail, unpublished data; Fig. 10). In practice, when pelt prices are low, another more lucrative grazer breed should be brought into the herd. If not, there will be consequences either on the financial or on the ecological outcomes of the farming activity. These results are especially valid when uncertainty about rainfall is low. In a context of high rainfall uncertainty, Karakul skin production remains important, but the role of Damara sheep increases. Damara flocks are used as a buffer against the variability in biomass availability because of their low cost at purchase (S. Domptail, unpublished data).

Implications. Income sources and farm size both affect the dynamism of the stocking strategies. An increase in farm size reduces the strategy's dynamism while a diversification income sources increases it. The impact of these factors is also affected by a major constraint in a farming system, namely the fixed costs and household consumption which must be covered by every period of activity. Indeed, we found that for a given farm size, an increase in costs reduces the portfolio of possible different stocking strategies and makes it difficult to adopt veld friendly practices. This result is all the more relevant in the context of the land reform programme, as emergent commercial farmers contract important loans for the purchase of the land and also incur increasing input prices with regard to product prices. The means to alleviate this pressure were sought within the Affirmative Action Scheme (AAS), where loans are subsidised and the repayment of interests is deferred (Werner & Kruger 2007).

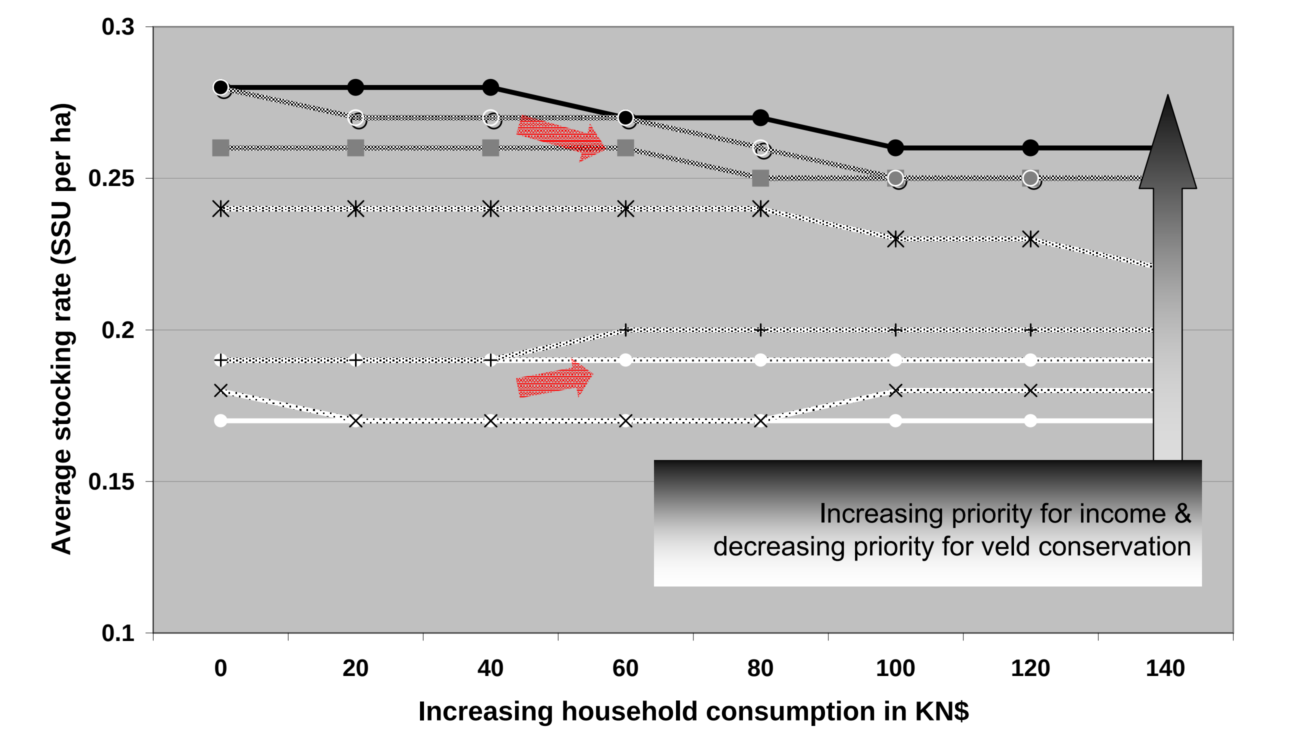


Fig. 9: Average stocking rates for eight different strategies with increasing preference for income generation over rangeland conservation objectives. Graph: S. Domptail.

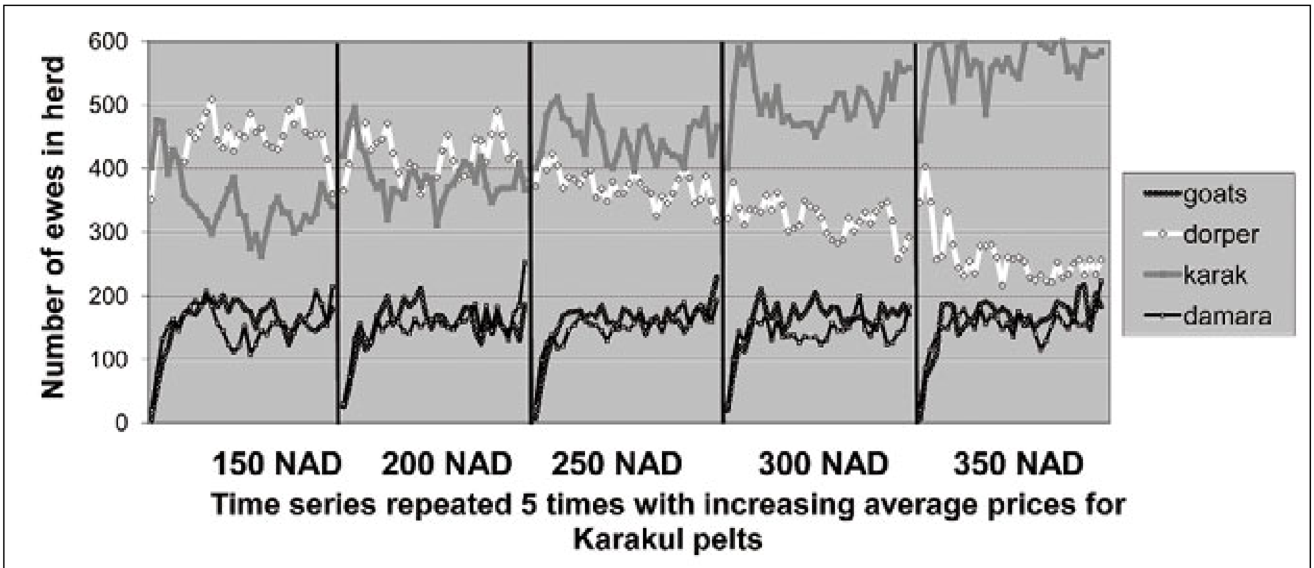


Fig. 10: Optimal herd composition for rangeland conservation under low uncertainty of rainfall and effect of Karakul pelt prices. Graph: S. Domptail.

Yet, our results suggest that the farming system based on high infrastructure costs may not remain viable. They call for innovative designs corresponding to the contemporary economic context and ecological insights. Concerning possible means to foster conservation, we found that a big difference in veld conservation can be achieved with slightly reduced stocking rates. This means that there is scope to encourage rangeland friendly practices, also at the political level through the use of well-targeted measures. An example is given in the next section on land tax design for rangeland conservation. Herd composition may also play a role in conservation, but results show that the suitability of the respective species depends much on prices.

Institutional solutions to foster conservation: the example of land taxes

[S. Domptail]

In the context of the land reform programme (Hunter 2004), land taxes have been designed and implemented in Namibia for all privately-owned agricultural land. Land valuation was carried

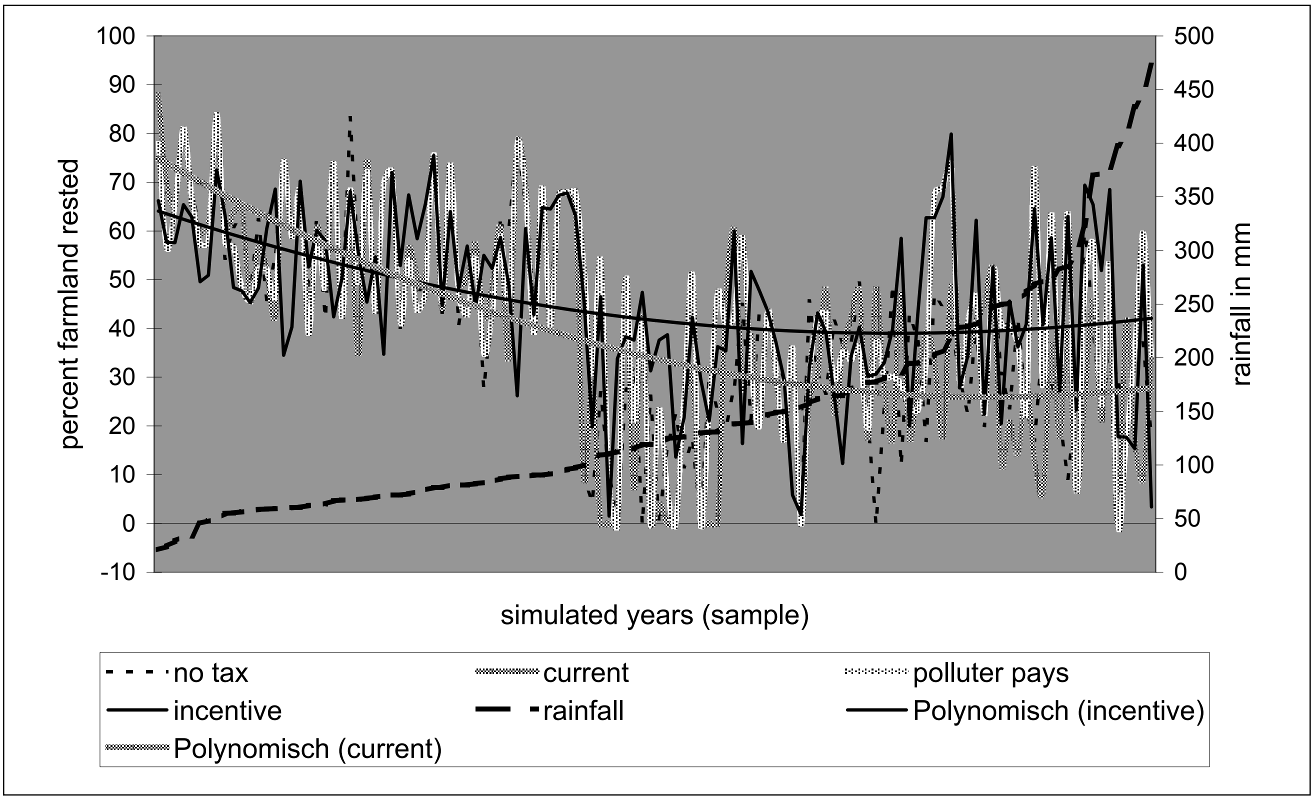


Fig. 11: Percentage of farmland rested (not grazed for a year) under each scenario and rainfall. Here we present only an illustrative sample of the 4,000 pairs of results obtained for the basic case where the rangeland is in initial good condition (from Domptail et al., in press).

out throughout the country to create a basis for the taxation. During the process of land tax design, concerns were raised about the financial burden that the tax represents. Will the tax lead farmers to change their farming strategies and would this change impact on veld management and veld condition? And especially, are there possibilities to use the land taxation system as tool to reward good veld maintenance or veld conservation? Answers to these questions were sought using a bio-economic model based on optimisation techniques and programmed in GAMS. Bio-economic models represent management decisions and the ecological dynamics of the veld. Rangeland ecology is incorporated in the model using the state-and-transition conceptual framework (Westoby et al. 1989).

First, our modelling results show that at the actual level, the fixed tax does not lead to a major change in farming strategies, nor does it have an impact on the veld condition. In a second iteration, an alternative design of the land tax was proposed. Based on the concept of payments for ecosystem services where environmental friendly practices are rewarded (Bulte et al. 2008), the design incorporated a tax waiver on farm areas in a healthy ecological condition. Practically, the scheme would function with regular on-farm assessments of the ecological condition of the farmland and its degradation status for each farm individually. This design may be proposed as a voluntary program: farmers who manage to reach high conservation levels get a bonus (the tax waiver), while others simply pay the due tax, as designed currently. In this way, farmers who suffer productivity losses due to degradation are not penalised (Buß 2006). This incentive design was compared to a design based on the polluter-pays approach, where all farmers pay the current tax, and farmers who degrade pay additionally for the damage costs. Results of simulation of the two taxation designs with the bio-economic model showed that both tax schemes create an incentive to increase conservation on the farm as compared to the scenario of the current land tax. This is especially the case in the incentive scheme, which achieves a reduction in the desertification of rangelands of 70%, while bringing in comparable income to the state as the actual tax scheme. Corresponding landuse strategies consisted of resting grass-dominated rangeland states, and adjusting herd size through purchases rather than by farm-breeding. Indeed, keeping a large proportion on ewe lambs is risky in a context of rainfall uncertainty because they stay on (and eat from) the farm for a whole year before they become productive. Adjusting herd size to the varying rainfall and biomass conditions by purchases and speculation appears more conducive to rangeland conservation. In addition, resting the land in time of high rainfall, which was found to have the most beneficial effect for rangeland regeneration (Müller et al. 2007) was also favored by the incentive scheme as compared to all other tax and to the no-tax scenario (Domptail et al., in press; Fig. 11).

To sum up, the land tax at its actual level would not lead to changes in the landuse strategies of farmers. The incentive tax design can bring the same amount of income to the state and foster on-farm conservation through its effect

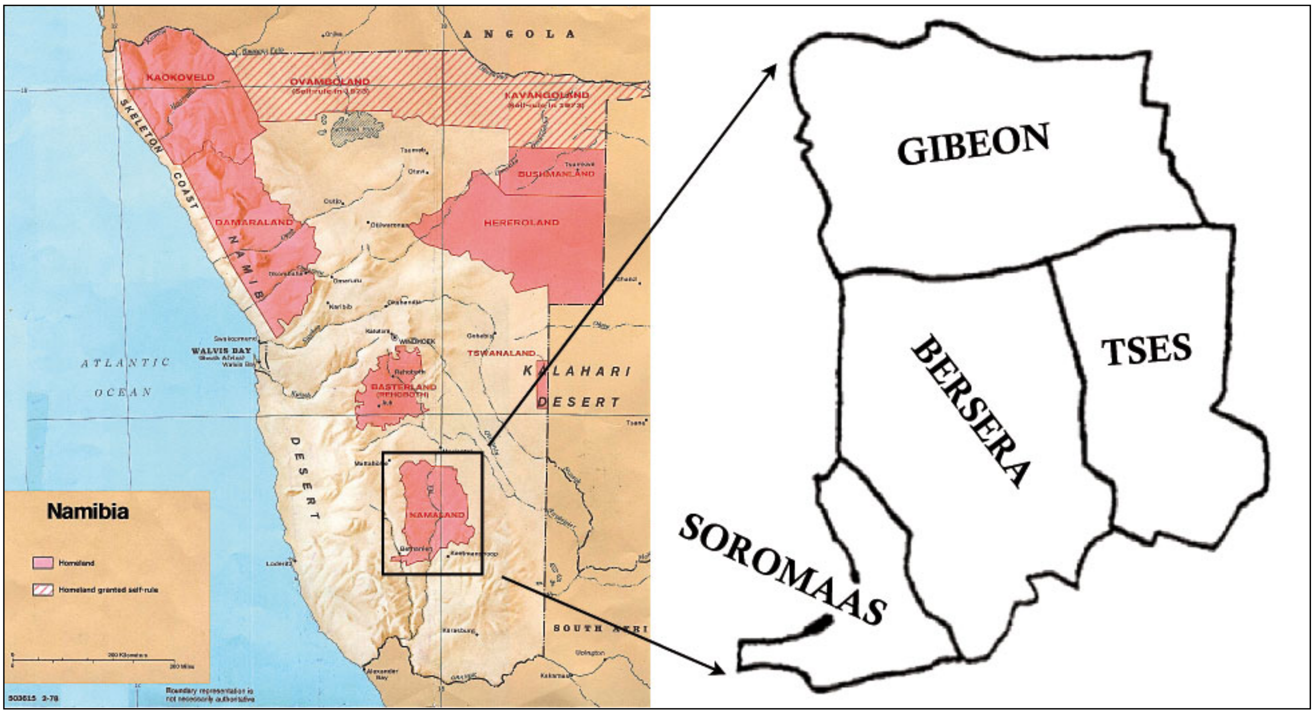


Fig. 12: Namaland in Namibia and their Administrative Districts. Adopted from Agricultural Office Keetmanshoop, cited by Klocke-Daffa (2001); map on the left side by courtesy of the University Libraries, The University of Texas at Austin.

on two key elements of the farming system: breeding versus speculation levels and resting practices.

3.4 Namaland: drivers of landuse in communal pastoralism

Livelihoods in the communal areas of Namaland

[T. Gibreel]

Background to the communal area

Namaland is a former homeland and occupies an area of 1,145,000 ha (Klocke-Daffa 2001). It is populated chiefly by the pastoral-agricultural Nama ethnic groups, who speak a Khoikhoi language. In 1963, the area was divided into five administrative districts, accommodating the major Nama clans (Fig. 12; Klocke-Daffa 2001). Communal areas occupy about 48 per cent of the total farming area of Namibia (Sweet 1999). This subchapter focuses on the Berseba district, home to the Goliath Nama-group in the south and to the Isaack Nama-group in the north (Klocke-Daffa 2001). The climate is arid, but well suited for sheep and goat production. Rainfall throughout the entire region is erratic and highly variable with a mean of 150 mm. It often occurs as isolated thunderstorms (Heyns et al. 1998). The main resource use activity in the communal area is small stock farming (Popp 2007).

The production systems in Namaland are based on pastoralism and agro-pastoralism, and the majority of households is subsistence-based and labour intensive, and make use of little inputs and technology. The outputs and objectives of livestock ownership are much more diverse than in commercial livestock production and include milk, meat, cash income and capital storage as well as socio-cultural factors (Sweet & Burke 2002, Falk 2008). Communal farmers let their livestock graze near the homesteads and make use of available water at water points (Kuiper & Meadows 2002). Land is non-title deed in communal area (LEAD Project 2005) and the government is obliged to administer the land in trust for the benefit of traditional communities residing on such land [Republic of Namibia 1998: 11, 2002: sec. 17(1), cf. Falk 2008]. Most of the people who live on this land are in dire poverty (LEAD Project 2005).

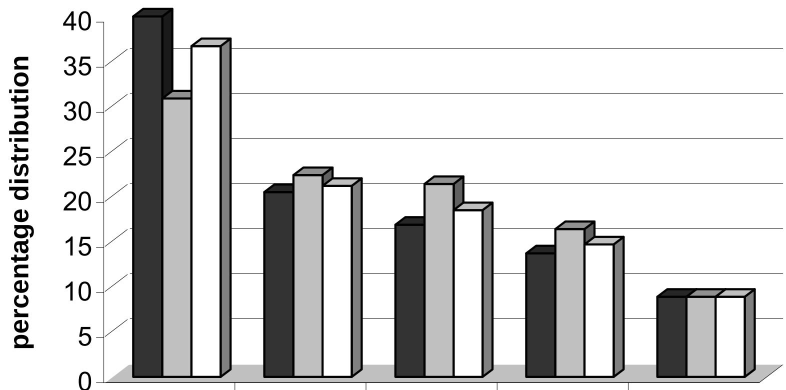
The communal farming land is managed under a communal land tenure system wherein livestock movement in the area is not controlled, although there are unwritten rules of access and use which exist between different users. The land is overstocked (0.2 SSU/ha) (Popp 2007) and the veld is continuously grazed (Falk 2008), which has a strong impact on the rangeland resource (Popp 2007). This is in stark contrast to the management practiced on the neighbouring governmental research farm Gellap Ost, which has 160 camps, some of them are purposely under-stocked (0.05 SSU/ha). There, animals graze the camps within a rotational grazing system (Popp 2007, Falk 2008), which allows for resting periods (Kuiper & Meadows 2002).

Households' preferences, income sources and labour time allocation in the communal area

The data used in this section was collected by different BIOTA researchers through household surveys conducted during the period from 2001 to 2009 in the south of the Berseba district of Namaland. The investigated settlements are located from 25 km to 60 km north-west of Keetmanshoop and include Nabaos, Nuwefontein, Beespos, Tiervlei Kamelrevier, Snyfontein, Middleputs, and Uibes.

Twenty-seven households were surveyed in 2003 and 25 households in 2009. The average household size was found to be three persons (U. Schneiderat, T. Falk & B. Bock, University of Giessen and University of Marburg, unpublished data; T. Gibreel, unpublished data). Household heads were 54 years old on average, while male household heads were younger than female ones (53 vs. 64). In general, household heads obtained an average of 4.3 years of formal education, although the level of education of female household heads was significantly lower with only 2.6 years of formal education (B. Bock, University of Marburg, unpublished data).

Farmer's preferences were analysed by Bausch et al. (2009). Fig. 13 shows the preferences results for each livelihood element for a total sample of forty-eight farmers based on gender. In general, it was found that 36.7% of the farmers prefer the strategy of animal production as their major livelihood activity. Despite the adverse conditions for cultivation, gardening comes in the second place with 20.5% before wage labour, which takes the third position with 16.9%. Using natural resources and family and leisure claimed 13.7% and 8.9%, respectively. Principally, the female headed households showed different strategies from the average results of the conjoint analysis. They set great store by gardening and using natural resources. Households with the greatest availability of financial capital showed the highest values for gardening and natural resources using. The same result was found among the group of male-headed households benefitting from a state pension but with a weakened trend. Financial capital appears to be a decisive factor, which makes gardening more important.



	animal production	gardening	wage labour	using natural ressources	family and leasure
men (n=31)	40	20.5	16.9	13.7	8.9
women (n=17)	30.9	22.4	21.4	16.4	8.9
over all (n=48)	36.7	21.2	18.5	14.7	8.9

Fig. 13: Results from the Conjoint Analysis divided into gender groups. Source: Bausch et. al. (2009).

Results from the 2001 and 2003 household surveys showed that a full-time job share in the average total income of the farmer was 61% followed by pension fund with the share of 25%, whereas results from the 2009 survey demonstrated that income from full-time job got the share of 29% in the average farmer's total income, but pensions transfers share was 8%. On average, the share of livestock sales in 2009 remained without change from the one of 2003 (5%). The small-enterprise and the remittances shares were found to be greater in 2009 (16% and 8%) than it was in 2003 (4% and 3%). The part-time employment share was larger in 2009 and accounted for 27%, while in 2003 it contributed only 1% (B. Bock, University of Marburg, unpublished data; T. Gibreel, unpublished data).

Concerning labour time allocation, we found that farmers allocated on average about 42% of their time on herding goats, 25% for off-farm work, 16% for grass collection, 8% for leisure and family, 6% for goats-kids rearing and 2% for home activities, while only 0.1% was assigned for firewood collection activity, although the estimated average collected firewood by a farm household for home consumption was found to be 2,400 kg per year (T. Gibreel, unpublished data).

Landuse driving factors

Goat keeping as a major source of sustenance characterises the economy of the whole Namaland communal area and particularly of the larger Tiervlei community. The concept of agricultural subsistence orientation (output-oriented) was adopted here to measure the extent to which farmers in the communal area consume from their goat produce in comparison to their marketed surplus, which may be represented by the agricultural subsistence (AS) ratio. The "*AS*" ratio, is the value of non-marketed agricultural produce over the total value of the agricultural production (Gibreel 2009). But, in this case study we calculated the '*AS*' ratio as the number of goats consumed divided by the total number of goats in the herd. As such, subsistence can be measured along a continuum from zero (total subsistence-oriented production) to unity (100% of production is sold).

The share of goat marketed surplus was found to be 26%, while home consumption of the own produced goats accounted for only 12% of the total average herd size (T. Gibreel, unpublished data). Goat off-take in 2003 was 17% only (Falk 2008). Thus, there is an increase tendency to sell more goats on the market. This results corresponds to national statistics of the Meat Board of Namibia (2010a, b) according to which the marketing of small stock increased by 4.73% from the end of 2006 to the end of 2007 due to increasing goat export. The goat export to South Africa, according to Agra Cooperative Manager for Small Livestock Pieter Hugo, has been overwhelming, thus the auction prices of a goat in the 30-45 kg range, fetched close to N$500 per animal (Fig. 14). Hugo pointed out that with the upswing in prices farmers, especially in the communal areas, had realised the potential in exporting goats (Ekongo 2005). Moreover, Namibian small-stock producers received on average a 25 per cent

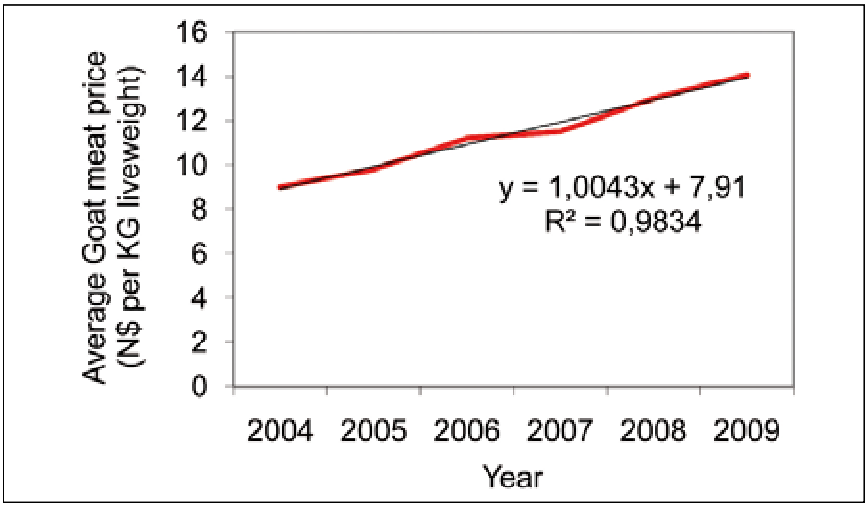


Fig. 14: Goat average auction price trend (2004–2009). Data source: Meat Board of Namibia (2010a).

Photos 2 and 3: Agra auction market in Keetmanshoop, southern Namibia. Photo: T. Gibreel.

increase in producer prices during 2006, according to Diana Mueseler, spokesperson of the Abattoir Association of Namibia (AAN) (Weidlich 2006). Because of increasing market price as shown in Fig. 14, farmers are encouraged to produce more goats to meet the export market demand. Consequently, increasing market-oriented goat production could be a double edge weapon in the sense that it may encourage intensive use of the rangelands to meet the export market demand, which can lead to rangeland degradation. On the other hand it may improve farmer's income by which he or she will be able to buy additional fodder for his or her livestock, which will have a positive impact on the range land by substituting the fodder from the veld with the additional supplementary food bought from the market.

On the demand side, farmers' consumption patterns explain their high dependency on markets. It was found that they allocate about 72% of their income to buy non-food and services goods from the market, whereas the rest of the budget is allocated for food goods. Furthermore, the total annual expenditure of farmers was significantly and positively correlated with the total number of goats which were marketed and although the number sold was small, the price they received was relatively high (T. Gibreel, unpublished data).

These results show that the farmers of the communal area are semi-commercialised rather than purely subsistent (Falk 2008) and that they decide simultaneously about their production and consumption patterns. Accordingly, farmers' consumption needs induce them to sell more livestock. Thus, farmers try to increase their herd size to gain enough income to fulfil their market goods and services needs. This hypothesis is supported by the existence of a positive and significant correlation between the numbers of does (female goats) owned per farmer and the time allocated to herding per farmer. This correlation suggests that farmers with large herds (encouraged by the market trends) allocate more time to grazing management, which means more control of the grazing pressure. In addition, it was found that weekend farmers allocated 206 hours per year while the part-time farmers and full time farmers allocated 585 and 1763 hours per year, respectively. This may have a positive impact for possible rangeland improvement as it shows that there is some knowledge and practice of grazing management among fulltime farmers especially (T. Gibreel, unpublished data).

In conclusion, farmers' consumption needs could be one of the drivers among others that provoke them to put more livestock in the market as well as to allocate more time for herding in relation to the number of animals marketed and the population of female goats.

Perceptions of communal farmers about past and future landuse

[B. Vollan & S. Domptail]

In the context of a full day participatory workshop in 2007, the main problems faced by the communal farmers and the solutions available to them, with a special focus on the role of the ecological state of the rangeland resources, were assessed among members of the Tiervlei community, in southern Namaland.

The careful choice of the method used for assessing problems of communal farmers is important since standardised questions are based on pre-existing knowledge of the researcher and thus might miss out certain aspects. Additionally, since the BIOTA project focuses on biodiversity, other important livelihood factors might be overlooked. Here we used a tool called "problem-cause-tree" aiming at identifying the main problems perceived by a person or a group, their causes and their visible consequences. Three groups were constituted among the participants, each producing a tree scheme. As a main problem the communal farmers identified poverty, which is evidently a multi-dimensional problem. The roots of this problem were perceived in the high unemployment rates, the lack of education, small herds, low rainfall, access to drinkable water, and the absence of savings or capital. The identified consequences included health problems, hunger, theft, little contribution to public or common goods such as the maintenance of water provisioning equipment, and finally degraded grazing lands resulting in low biomass and livestock production. An important insight in the discussion following the exercise was that effects of the problem will last until the causes of the problems are tackled. These findings may be understood in relation to the results of a survey conducted among the same farmers in 2004. According to those results, 81% of the farmers share the opinion that other issues are more important for farmers than resource protection and only 50% of them considered they knew how the environment could be better protected. Indeed, knowledge in ecology is rather limited: 95% of the interviewees believe that plants do not get extinct, but that they rather simply disappear temporarily and then reappear. Only 21% of the people know the carrying capacity of their grazing lands and 61% of the people share the opinion that the role of landuse on degradation is overestimated by scientists or politicians.

As the degradation of the rangeland is an important cause of the actual poverty problem of the farmer community of Tiervlei, the trend in degradation in time on their territory was further investigated. The farmers were asked to recall the ecological state of the communal rangeland during the last 40 years up to the 1970's (Fig. 15a). According to them, the grazing land in 1970 was in a very good state, flocks of Kudus (*Tragelaphus strepsiceros*) and other antelopes were seen every day up to 5 times a day. The ecological condition of the rangeland has since then, and particularly since the late 1980's, declined severely to the point that today one can hardly spot tracks of large game species. It seems to the farmers that if the trend continues, antelope will have vanished from the communal area in 20 years time. Farmers mentioned that one of the drivers of land degradation was the fodder subsidies, which were granted to communal farmers during the drought relief program, which was in place until independence in 1990 (pers. communication A.S. Kruger 2010). The program enabled farmers to maintain large herds during drought periods and especially after the drought, when the rangeland regenerates after the first good rains. The second driver mentioned was the in-migration of several families in the area, which generated a stronger grazing pressure on the land. Farmers associated this development with a 'weakening' of the traditional authorities of the Namaland, who regulate land access, or to an increasing pressure from poverty and the subsequent need for land to sustain livelihoods. It might also be due to the proximity of the Tiervlei community to the city of Keetmanshoop, thus attracting many so-called "weekend-farmers". The intensity of the pastoral activity also showed an important decline co-incident with an increase in rangeland degradation. Farmers stated that 20 years ago (ca. 1987) the largest farmer still had five times as much livestock as the largest farmer of the Tiervlei area today, who has only 200 animals today.

The fact that farmers with up to 500 animals were practicing transhumance in more remote and less degraded areas (B. Vollan, unpublished data) supports the hypothesis that proximity to Keetmanshoop and the absence of seasonal mobility affects the ecological status of Tiervlei's rangelands. In addition, scientists and local experts were consulted on their view of the high degree of degradation evident in the region. Their answers suggest that a combination of the drought relief program (pers. communication A.S. Kruger 2010) together with a severe drought from 1979–1986 might have led to both the severe degradation and the consequent reduction in livestock numbers (Schönherr 1989). Fig. 15 with illustrations evolved during the participatory workshop in 2007 shows the long dry spell mentioned by Schönherr (1989). Since 1992, the Namibian Government has promoted the marketing of livestock in drought periods but there has not been any positive significant change in the state of the rangelands. As mentioned below, it might take decades and an important rehabilitation effort to improve the ecological state of the rangelands to their initial state. Fig. 15a shows the perceived trend in 'veld' condition as well as the parallel trend in livestock numbers, which do not seem to be driven by an equally decreasing rainfall trend Fig. 15c. It was also mentioned by the farmers, that there high rainfall events have declined over the past 30 years. This observation is in line with the rainfall data from Gellap Ost that shows the absence of major rainfall events between 1979 and 2006. The absence of these major events combined with high stocking rates might have prevented the recovery of the grazing area.

Finally, the last discussion of the workshop revolved around the possible paths for improvements of the livelihoods in the community. During the initial brainstorming sessions, farmers named as a possible solution the establishment of a conservancy in the whole Berseba district of the Namaland. This idea has been in process for seven years but is blocked at the moment due to conflicts among Nama groups about the size and benefit-sharing of the planned conservancy. Second, the establishment of fenced camps was mentioned, with the aim of enabling the practice of rotational grazing, as well as to prevent others from entering the area. An increase in productivity through the use of livestock of higher quality for breeding was also mentioned. Lastly and most importantly, the community aimed at getting involved in tourism through the construction of a campsite and by proposing tourist activities such as for example hiking in designed botanical trails, horse, and donkey rides. The vision included game watching as an important activity, motivating the reestablishment of Kudu (*Tragelaphus strepsiceros*) in the area for the benefit and pleasure of both farmers and tourists. Notably, the reduction in stocking rates was not mentioned as an element of solution. This is congruent with results of a previous survey conducted in the same area according to which a reduction of the number of livestock is not an option for most farmers even in times of drought. Importantly 44% of the farmers stated, that they would or could do nothing to prevent the overuse of rangelands (Vollan 2009).

To sum up, the diversified and positive visions of the community for their

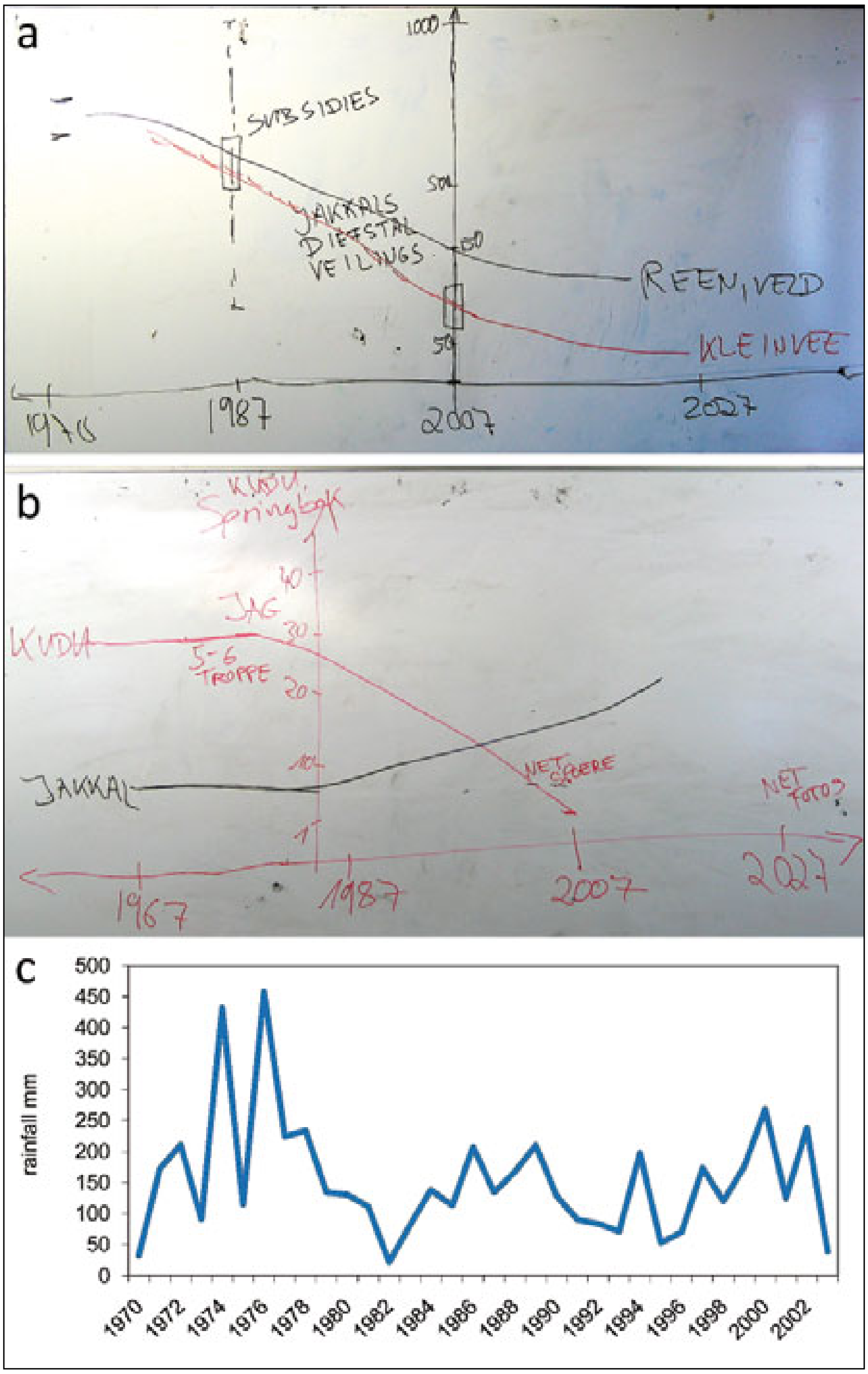


Fig. 15: Ecological condition. a) and b) reconstitution of the past rangeland ecological condition; c) rainfall at neighbouring farm Gellap Ost from 1970 to 2003 (data: Gellap Ost). Photos a & b: B. Vollan 2007.

livelihoods and lands show that the community is eager to implement any beneficial project which is both ecological sustainable and generates income. While degradation has been shown to be a main root of the poverty problem encountered in the communal area, a reduction in livestock densities seems unlikely to occur. This is highly problematic, as any restoration effort is likely to fail without reduced livestock numbers and/or a sustainable grazing management. As a result, the political focus should be put on the improvement of access to basic resources such as secure lands and drinkable water as well as on the development of alternative landuses or of additional incomes sources. A pre-requisite for the implementation of any solution in the communal area is good governance and cooperation. Drivers of cooperation are investigated in the next section.

Is lack of cooperation in the commons a driver for ecological processes and the missing key to sustainability?

[B. Vollan]

The environmental awareness among the interviewed farmers in the communal area of Berseba is extremely high and people know that they are affected by environmental degradation. The same is true for the intention of people to act to protect biodiversity or the environment (Vollan 2009). However, there is a discrepancy between what people would like to do and what is actually achieved through local institutions. Given that most people feel affected and intend to do something against the advancing degradation, why do people still fail to take action for the conservation of their environment?

We have argued above that a degraded area might take decades to recover and that rangeland in a healthy state would benefit from cooperative farming practices. Also, in drought periods it might be beneficial for farmers to collectively reduce their stock. A unilateral reduction of livestock by a single farmer would not be effective ecologically and would economically harm the individual concerned. Thus, it is important that a reduction in herd size is decided collectively, for the benefits of the whole community of farmers. This so-called social dilemma between individual and collective rationality is recognised by many practitioners, which is why appropriate veld management practices in communal areas need to be based on the coordination and cooperation among farmers. This view is also shared by communal area farmers themselves with more than 50% of the interviewed farmers believing it is possible to practice rotational grazing in communal areas. Almost 40% see the lack of co-operation between farmers as a main problem (pers. communication with A. Lourens, Dept. of Agriculture, Namibia, 2004). Similarly, 77% of all interviewed farmers would accept a limitation of stocking rates and 43% a prohibition to harvest firewood should such a decision be made collectively. Also, 65% of the farmers notice that co-operation increases their own personal benefits and agree that they would get more money from farming if they and everybody else would reduce the amount of animals that utilise the rangeland. However, the widespread poverty together with a lack of sound institutions in the communal areas makes 65% of the farmers, state that they are planning to increase their stock of animals. Given the perceived need for cooperation and the observed failures to reach cooperative solutions, one important question is how farmers change institutional rules and how does this relate to their own experience with the environment. This research questions was explored by using a method of economic field experiments that mimic such a social-dilemma situation (B. Vollan and S. Prediger, unpublished data).

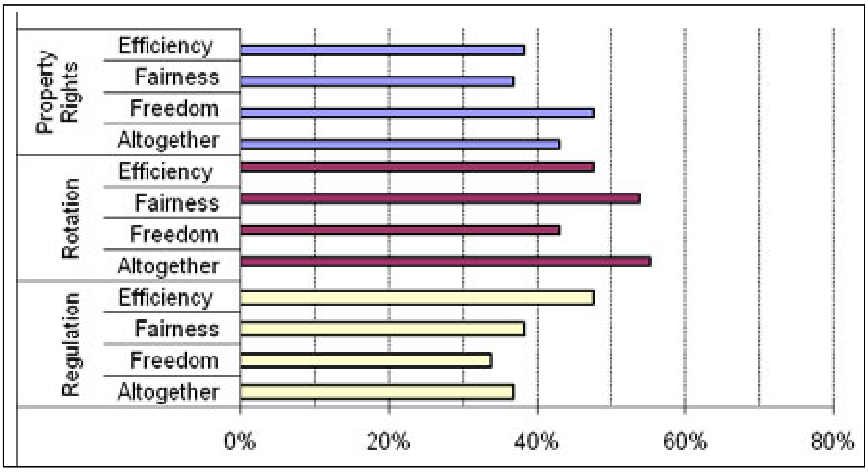


Fig. 16: Perception of different rules. The rotation rule is perceived to be the fairest rule. Graph: B. Vollan.

In the context of a workshop held in Keetmanshoop (2007) we let communal and commercial farmer as well as other stakeholders from government and non-governmental organisations and scientists from various disciplines participate in this experiment. All participants realised the difficulty of cooperation in the experiment and saw the similarities between the experiment and the communal farming system. Backed with that experience, almost 70% of participants chose the rotational rule to solve the dilemma among three possible rules (property rights, rotation, and regulation of stocking rates) that could all work equally well to establish cooperation. According to Fig. 16 the rotational rule was perceived to be the fairest rule. Participants also realised that their personal freedom was higher with the establishment of well-defined property rights and that regulation would have been more effective. However, these features seem to be less important than fairness (Fig. 16). In our experiments with communal farmers in Namibia and the Namaqualand we found similar results with 50% of the people voting for rotation rule and only 20% the regulation rule (which is already in place in Namaqualand) (Vollan et al., unpublished data). Since it is more likely that laws and regulation work well if they are supported by the community and the involved stakeholder one could try to build on this shared perception. From other co-management arrangements one could draw the lesson that the rotation rules would need to be enforced by an external agency while the monitoring of the rule would be the task of the community.

Potentials and limitations of communal conservancies in southern Namibia

[S. Prediger & M. Kirk]

Introduction

Since independence in 1990, the Namibian government has gradually begun to devolve authority over natural resources to local users. These so-called community-based natural resource management (CBNRM) approaches have received considerable policy and research attention in the last two decades and encompass forest, game, and water resources. The most popular CBNRM initiative in Namibia is doubtlessly the communal conservancy approach on which we focus in this article. The conservancy approach attempts to combine both wildlife conservation and economic development, aimed at the improvement of local livelihoods through the sustainable use of wildlife resources and an increase of environmental awareness among local resource users.

Since the establishment of the first conservancy in 1998, no less than 59 conservancies have been registered until October 2009, covering 133,092 km² of Namibia's surface area. A further 25 communities are currently in the registration process. Annual income generated by these conservancies has risen from less than N$1 million in 1998 to about N$32.45 million in 2008 (NACSO 2008). Moreover, wildlife populations in the communal land, including the populations of endangered species such as the Black Rhino (*Diceros bicornis*) or the Desert Dwelling Elephant (*Loxodonta africana africana*) have increased significantly over the last decade (NACSO 2008). These encouraging records suggest that conservancies can have a substantial positive impact on resource protection, biodiversity preservation, and local livelihoods. So far, however, most registered conservancies are situated in the relative wildlife-rich northern parts of Namibia, in particular in the Kunene (20 conservancies), Caprivi (11 conservancies) and Otjozondjupa (8 conservancies) region. Detailed case studies on the impact of conservancies on local livelihoods have almost exclusively been conducted in these regions (e.g. Bandyopadhyay et al. 2008, Barnes et al. 2002, GTZ 2006). An important unresolved question is thus, whether conservancies can also generate considerable income in areas where wildlife resources are rare and wildlife-based tourism potentials are relatively low, as in the Nama Karoo biome in the Karas region. In addition, it is also important to know whether conservancies provide an additional (or even alternative) landuse option to exclusive small-stock livestock farming, which, at present, constitutes the main livelihood strategy in the communal areas in the southern Nama Karoo. In the following, we will address these questions.

Fig. 17: The !Khob!Naub conservancy. Source: NACSO 2008.

Legal framework and aims of conservancies

Conservancies are legally gazetted areas within the state's communal lands which enable rural communities to gain consumptive (e.g. trophy hunting, live sell) and non-consumptive (e.g. safari-tourism) wildlife use rights, provided some obligatory requirements are fulfilled. According to the 'Nature Conservation Amendment Act' of 1996, the registration of communal conservancies requires the elaboration of a local constitution, clearly defined boundaries of the conservancy area, the election of a representative committee plus a plan for the equitable distribution of benefits to the conservancy members and sustainable wildlife resource management (for a detailed description of the legal framework of conservancies see Corbett & Jones 2000, Jones & Murphree 2001). The conservancy initiative mainly aims at the improvement of local livelihoods and the preservation of biodiversity. Through the establishment of a conservancy and the subsequent devolution of rights to use and benefit from wildlife, local communities get incentives to manage their game resources sustainably and therefore to conserve biodiversity. Another goal which is often expressed by representatives of NGOs and politicians is the promotion of gender equality and democratic structures at local level. Conservancies thus try to serve a wide range of partly contradicting objectives, entailing the danger of trade-offs and conflicts in implementation and management.

Communal conservancies in the Nama Karoo in southern Namibia

There are four communal conservancies in the Karas region, which is the southernmost administrative unit in Namibia. By the end of 2001, residents from settlements in the eastern part of the communal land of Berseba and the communal land around Karasburg had began to prepare the formation of the first communal conservancies in the Karas region, which eventually became registered in July 2003 under the names !Khob!Naub and //Gamaseb respectively. Another two communities (!Gawachab and !Han /awab) followed suit and established conservancies in 2005 and 2008. The //Gamaseb conservancy has had considerable problems in the last few years. The former committee consisted of members who were partly illiterate and who had no proper management experience. Information was not shared with ordinary conservancy members, the disposal of funds was not transparent and they were accused of being corrupt in their activities. We were thus recommended by U. Davids (Namibian Development Trust, NDT), the head of the local CBNRM-supporting NGO, to conduct research rather in the !Khob!Naub conservancy, which is according to him the most successful conservancy in the south. The !Khob!Naub conservancy (Fig. 17) is situated northwest of the Nabaos BIOTA Observatory and extends over an area of 2,747 km². The northern part is dominated by the plateau after which the conservancy is named, while the eastern and western parts are flat grasslands (NACSO 2006). The area is mainly populated by Nama people and is home to approximately 5,000 people.

Survey results

To investigate conservancy members' and non-members' personal perceptions of and experiences with the !Khob!Naub conservancy, we interviewed 54 residents, of which 35 were conservancy members, and two committee members in June 2008, 5 years after the conservancy was registered. All data reported here are taken from the survey and personal interviews (S. Prediger, unpublished data).

The conservancy establishment itself was expedited by traditional authorities and M. Cloete in collaboration with NDT, the main local support agency, and the Ministry of Environment and Tourism (MET) in Keetmanshoop. Cloete has been the chairperson of the conservancy ever since its inception, and was confirmed in office in recent elections held in 2009. The conservancy committee consists of seven men and four women and is elected by the registered conservancy members. The committee aims at representing different interests within the community and thus consists of farmers and non-farmers, representatives of the traditional authorities and of other CBNRM initiatives, such as the community Hoodia (ghaap) nursery and the water point association. Cloete defines the main functions of the committee as being the management of the conservancy, including budgeting, attraction of funds, the implementation of conservancy-related projects (e.g. the campsite project), and information-sharing with the conservancy members as well as the improvement of environmental awareness. The committee members do not receive a salary for their efforts although only an allowance of N$65 is paid to them when they attend committee meetings, which are held every second month. To compensate them for travel costs, members additionally receive a mileage allowance of N$2.5 per km.

Any person living or farming in the !Khob!Naub area can become an ordinary conservancy member and any registered conservancy member can run for committee membership. Initially, the registration was free of charge but since 2008 registered members have to pay an annual membership fee of N$20. In November 2009, 60 villagers were registered as conservancy members according to official records, compared to 56 at the time when we conducted our survey.

Information sharing is an essential precondition for participatory initiatives like conservancies. Once a year, a general meeting for all conservancy members and non-members takes place. At these meetings, the committee provides members with the latest information about game count results, the financial situation, proposed appropriation of financial revenues from game utilisation and the budget for the next year. About 80% (N = 50) of the interviewed members stated that they attend these meetings regularly. However, most interviewed members receive information mainly in the conservancy office in Blouwes or through personal discussions with committee members. When asked whether the interviewees felt that committee members provided them with sufficient information about conservancy progress, we found mixed results. While more than 50% answered "yes", about 40% felt that they were insufficiently informed. Because some respondents who lived far from Blouwes complained that meetings are held disproportionately often in Blouwes, we used multivariate regressions to investigate whether the location of residence or other covariates can explain the heterogeneous judgements. None of our results supported this hypothesis. The results show, however, that the provision of information could be improved. This is not a particular problem of the !Khob!Naub conservancy, but rather seems to be a general problem faced by many conservancies [U. Davids (NDT), R. Malone (Namibia Nature Foundation, NNF) and U. Hdjavera (Namibia Community Based Tourism Assistance Trust, NACOBTA), personal interviews]. Another frequently reported problem with respect to information sharing pertains to the refusal of former committee members to teach their successors in accounting and other management skills acquired during the training.

Expectations, judgements, and benefits

When we asked conservancy members what prior expectations they had on conservancies before they became members, most named job creation (46%) or meat distribution (33%) while about 20% awaited either better environmental knowledge or game protection. So far, however, only 50% of all respondents were the opinion that their expectations were fulfilled. Nevertheless 86% ($N = 50$) stated that they or their household benefited directly from the conservancy, and when only the responses of conservancy members were considered, the fraction was even higher (94%).

Tangible benefits include salaries and meat distribution. There are eight persons, who receive a permanent monthly income from conservancy activities. These include one coordinator, who is responsible for several administration tasks and who receives N$1,000 per month, and seven game guards who earn N$250 per month for monitoring wildlife. The expenses for salaries and the allowances granted to committee members cannot be covered by conservancy revenues yet and are subsidised by the integrated community-based ecosystem management (ICEMA) program. More jobs are expected to be created in 2010, when the recently constructed community campsite will be launched. The committee has applied for funds to employ three campsite caretakers and a tour guide, but to date they have been unsuccessful in their applications. Aside from wage labour, a substantial fraction (34%) of conservancy members has been working voluntarily for the conservancy. Typical examples for voluntary work are the assistance at game counts, monitoring and hunts, kitchen work to prepare meals at workshops, as well as the provision of private assets (e.g. car or fridge) for conservancy purposes.

Benefits enjoyed by all conservancy members are the annual meat packets distributed among them. Since 2005, the MET has granted hunting quotas to the conservancy. The size of the quota depends directly on the population size of key game species, which are estimated according to annual game counts. The MET, NDT and conservancy members conducted these counts jointly. So far, only Springbok (*Antidorcas marsupialis*) have been allowed to be hunted. The quotas for springbok have varied in the last 5 years and have ranged from 62 animals in 2006 to 250 in 2008 and 2009. Except in 2005, the quotas have been used solely for own consumption, that is for meat distribution among the conservancy members. Quotas have also not always been exhausted. When we visited the conservancy in November 2009, for instance, only 38 springbok had been shot, due to the lack of necessary equipment and assistance from MET. The vast majority of interviewees (67%) saw the annual meat distribution as the main benefit of conservancies at household level, while job creation was only named by one respondent. Six people did not see any benefit at all, although five of these respondents were not conservancy members.

Interestingly, about 18% of the respondents felt that improved knowledge about wildlife protection and community empowerment were the most beneficial aspects of the conservancies. This shows the importance of non-material benefits of conservancies, such as pride and empowerment, which has also reported in studies carried out in other conservancies (e.g. Ashley 1997). It became further apparent that the respondents attach high value to the growing number of wildlife, as roughly 95% said that the reintroduction of formerly extinct or rare species, such as Oryx (Gemsbok; *Oryx gazella gazella*) and Kudu (*Tragelaphus strepsiceros*), make them proud. The fact that about 40% of the respondents felt that they were willing to reduce livestock numbers if this was necessary for the reintroduction of game, further highlights the importance some people attach to the existence of wildlife in their area, although this question might be prone to hypothetical bias or surveyor effects.

Another important aspect of conservancies is the equitable sharing of benefits among members. In our study, 73% of the conservancy members were the opinion that benefits are shared equally.

Finally, we asked the respondents whether they see any disadvantages of the conservancy to either them or the community. While the vast majority felt that there were no disadvantages, about 18% of the respondents (15% if only conservancy members' answers are considered) saw disadvantages. Most of these respondents criticised the size of meat packets allocated to them, the frequency of meat distribution (only once a year) or the fact that they cannot keep the meat fresh because they do not have a fridge. One respondent (who was not a conservancy member) complained about the prohibition of hunting with dogs, which is now of course illegal. None of these complaints, however, could be considered to be disadvantageous in the strictest sense of the word.

Discussion and conclusions

Do conservancies contribute to habitat and biodiversity protection?
Perhaps the most important questions with respect to conservancies in southern Namibia are (1) whether they can serve as an additional or even alternative landuse option and (2) whether they can contribute to biodiversity preservation. We will first discuss the impact of conservancies on biodiversity protection and then focus on the potential of conservancies to serve as an alternative landuse option.

One main benefit which has resulted from the establishment of the conservancy is the increase in wildlife populations and the increased diversity of game in the area through the introduction of rare species and the reduction of poaching. However, the main anthropogenic drivers of biodiversity loss in communal areas are not poaching, but continuous overgrazing and the collection of firewood, which both cause degradation. While poaching is directly tackled in the conservancy approach, overgrazing is not! A first step for comprehensive biodiversity protection, at least on a small-scale, would be the declaration of zones exclusive to wildlife where livestock keeping is prohibited. The! Khob!Naub conservancy has been discussing the establishment of an exclusive game area since 2007, but has not reached an agreement, yet. Problems are the costs of fencing-off the area and the necessary compensation and allocation of alternative grazing areas, respectively, for farmers who graze livestock in the proposed wildlife area. However, as long as stocking rates are not reduced within the existing management system, it is unlikely that conservancies will be able to contribute substantially to biodiversity preservation.

Conservancies as an alternative landuse option
While some conservancies generate substantial revenues, which are high enough to cover running costs and to supplement their members' annual incomes, most still depend on external funds and might never become financially independent. Of the 53 conservancies that were registered in 2008, 38 earned cash income and 34 of them at least contributed to their own operational costs. However, among these 34 conservancies, only 14 were able to cover all their costs while 11 contributed more than half of their operational costs (NACSO 2008). Altogether, 257 people were employed by conservancies in 2008 and 154 of them were entirely funded by the conservancies themselves (NACSO 2008).

The main drivers of conservancy revenues and employment are joint venture lodges, which accounted for N$17 million or 56% of total revenues, followed by (joint venture) trophy hunting (25.4%) (NACSO 2008). However, the potential for trophy hunting is comparably low in the communal areas of southern Namibia, where only springbok have large enough populations, which can be hunted. Springbok, however, are not a highly-prized trophy species and do not compare favourably in this regard with animals such as Kudu, Oryx, and other large antelope species as well as premium trophy animals such as the Big Five, of which bigger populations only occur in the north (C. Weaver, WWF, pers. commuication). Moreover, most trophy hunters come from overseas and usually expect "luxury" accommodation, which is not available in any conservancy in the south. The MET has been looking for private hunting operators who are willing to obtain a hunting concession for the !Khob!Naub area, but to date has not been able to find any interested party. Similarly, joint venture lodges have been launched in either relative game-rich regions and/or in areas with spectacular landscapes, often close to tourism "hotspots" like Etosha, the Kaokoveld or the Brandberg. Unfortunately, the! Khob!Naub conservancy does not constitute such a place.

In our survey, 96% of the respondents expected more jobs and higher financial benefits generated by the conservancy in future. Most expect the recently established campsite, which was funded by the EU and cost N$ 350,000, to foster development. Though the campsite is close to the B1 highway and thus easily accessible for tourists, it is unlikely that it will generate high revenues. First, conservancy campsites accounted for only 2.7% of total conservancy revenues in 2008 (NACSO 2008). Many campsites also suffer from poor infrastructure (e.g. no electricity or accessible water) and, perhaps more importantly, a lack of marketing. This makes community campsites rather interesting for backpacker and/or low-budget tourism users only. Second, lessons drawn from the Brukkaros campsite, situated close to the !Khob!Naub conservancy, indicate that tourism potential is rather low in the communal areas in the south. The Brukkaros Mountain is a beautiful place offering its visitors a spectacular and scenic view. Despite its beauty and location, however, overnight visitors are rare, and entrance fees are not sufficient to cover the salary of the caretaker, which is still subsidised by NACOBTA (U. Hdjavera, pers. comm.). Third, many (overseas) tourists book package tours when travelling through Namibia. Package tour providers, however, do not offer trips to the southern communal areas but usually stop in Keetmanshoop before going further to the Fish River Canyon, Ai-Ais or other more popular tourist attractions. In addition, the use of wildlife will also not provide high enough revenues to constitute an alternative landuse option to farming, even though revenues from wildlife utilisation could be increased if the conservancy engaged in trophy hunting, live sales or meat sales instead of only own consumption options (see Ashley et al. 1997 for numerical examples).

Moreover, even the most successful conservancies, which cover their costs and earn relative high revenues, generate benefits at a household level, which are too low and not sufficient to constitute an alternative to livestock farming or agriculture (Ashley & LaFranchi 1997, Bandyopadhyay et al. 2004). This, at least, is the case for the vast majority of members who are not employed by the conservancy and thus do not receive a monthly income. Currently, the !Khob!Naub conservancy has an annual expenditure of at least N$36,200 (which includes only the salaries for game guards and the coordinator as well as the allowances for committee members, paid by ICEMA) and annual revenues of N$1,600 originating from member fees plus earnings from occasional livestock sales. To state the obvious, the gap between expenditures and revenues is huge and will require an enormous effort if it is to be closed, not to mention the challenges of generating net revenues.

Given all these facts, we do not believe that conservancies in the south will constitute an alternative landuse option to farming. Nevertheless, conservancies constitute an additional landuse option as they generate material and non-material benefits on local and community level, which reduce vulnerability and complement local livelihoods. Material benefits comprise jobs, game donations, and meat distribution. Increased local empowerment and pride due to the reintroduction of rare species are important non-material benefits. Another potential merit of a conservancy is the provision of an institutional platform, which may serve as a starting point for further collective action. In addition to the economic benefits, the conservancy establishment in the !Khob!Naub area has led to an increase in wildlife populations and diversity as well as an increase in environmental awareness among local resource users.

Ecological impacts of communal farming in southern Namibia: an interdisciplinary case study

[N. Dreber & T. Falk]

Land degradation is a widespread problem in Namibia, particularly in communal areas affected by high population and livestock densities, and non-adaptive land management (Klintenberg & Seely 2004). This issue has been investigated at the adjacent BIOTA Observatories of Gellap Ost and Nabaos in the Keetmanshoop region in the context of an interdisciplinary research effort. There is a marked fence-line contrast between the state research farm Gellap Ost and the communal area of Nabaos which forms part of Namaland (Photos 4 & 5). Fence-line contrasts create a visual impression of the differences in rangeland condition and allow for an analysis of long-term consequences of different landuse practices on the biotic and abiotic environment (Zimmermann 2009). This, in turn, provides important information about ecosystem dynamics, resistance, and resilience (Todd & Hoffman 2009).

Previous socio-economic studies have examined different resource use strategies of farmers in the study area, and have investigated which factors at different socio-political scales influence their landuse strategies (e.g. Falk 2008). Due to the absence of economic incentives for profit maximisation, rangelands of Gellap Ost are stocked at lower rates than those recommended by the Ministry of Agriculture, Water and Forestry. This fact together with a sophisticated management system of rotational grazing and rangeland monitoring has contributed to a situation where BIOTA researchers could not observe any signs of rangeland degradation in Gellap Ost. These rangelands can be regarded as a reference for intact ecosystems in terms of biodiversity and ecosystem functioning. In contrast, on the communal rangeland of the Nabaos unit, strong competition over resources and inappropriate governance structures has resulted in poor range management and high stocking rates (Falk 2008). The governance system of the area is weak as neither traditional nor statutory organisations are present at the local level. Newly established water point committees could potentially fill the institutional gap at the local level and could play an important role in overall natural resource management (Falk et al. 2009). To date they are, however, overburdened with this task as the community cohesion is very low. The poor resource management is particularly expressed in a reduced availability of natural resources and ecosystem functioning. At least since the late 1970s when land tenure changed from commercial to communal (Kuiper & Meadows 2002), severe grazing mainly by goats and free-roaming donkeys, combined with a high variability in rainfall, has contributed to the current degraded state of Nabaos' rangelands.

In this chapter we summarise the socio-economic, botanical, zoological, mycological, and pedological studies which together demonstrate a cause-and-effect chain. Various ecological studies have analysed the long-term impact of severe overgrazing on the formerly grassy shrublands, now degraded open shrublands, using the fence-line contrast approach. The interdisciplinary studies conducted at both BIOTA Observatories provide a broad insight on how long-term, unsustainable landuse is able to transform the physical environment, affect different groups of organisms, and limit the natural regeneration capacity of the rangeland towards healthy ecological states.

Kuiper & Meadows (2002) compared aerial photographs from 1970 and 1998 and detected a 5% increase in bare ground in the whole Nabaos communal area, while cover has remained relatively constant in the rangelands of Gellap Ost. An increase in bare ground was also observed at the scale of the BIOTA Observatory when contrasting Gellap Ost and Nabaos. The reduced vegetation cover on Nabaos is mainly due to the loss of perennial grasses such as *Stipagrostis uniplumis* (Blinkhaarboesmangras) and *S. hochstetteriana* (Gemsbokstertgras), which dominate the inter-shrub matrix on Gellap Ost and reach the highest cover values of all species present at this site (Wolkenhauer 2003). On the communal site, continuous high grazing pressure profoundly reduced the abundance of perennial grasses and favoured the abundance of generalists such as the annual prostrate forbs *Indigastrum argyroides* and *Trianthema parvifolia* (Rooi-rankvygie), and the annual grasses *Schmidtia kalahariensis* (Kalaharisuurgras) and *Aristida adscensionis* (Eenjarige Steekgras) in the herbaceous layer. Both grasses can be regarded as indicators of degradation if occurring in such dense stands (Müller 2007). A comparison of grass species occurring on the Gellap Ost and Nabaos Observatory in March 2006 revealed that Gellap Ost is more diverse (22 species versus 14 on Nabaos), and most of them are perennial species with high nutritional value (sensu Müller 2007). In contrast, climax grasses and even sub-climax grasses with some grazing value are seldom present on Nabaos (N. Dreber, unpublished data). In addition to the qualitative and quantitative differences in grass species composition, the presence of arbuscular mycorrhizae fungi (AM-fungi) in grass species was found to be significantly reduced on Nabaos compared to Gellap Ost, although spore communities and spore numbers were similar among the sites (Uhlmann et al. 2006). These symbionts supply the host with water and nutrients receiving organic carbon in return, thereby increasing plant growth. There is evidence for a reduction of mycorrhization of grasses by AM-fungi due to grazing in semiarid grasslands, which may not only affect plant nutrition, but also soil structure and soil stability (Bethlenfalvay et al. 1985). The shift in availability and quality of fodder highlight the relatively poor condition of the ecosystem and point to the limited possibility of farming with grazers such as sheep, whose diet largely consists of grasses and forbs. The woody vegetation on Nabaos provides, however, some available fodder for goats throughout the year with common shrubs such as *Acacia nebrownii* (Slapdoring), *Calicorema capitata*, *Monechma genistifolium* (Perdebos), *Rhigozum trichotomum* (Driedoring) and *Tetragonia schenckii* (Kooibos) being heavily browsed (N. Dreber, pers. observation). Nevertheless, the compositional shifts towards the dominance of annual species leads to higher inter-annual as well as seasonal variations in plant cover, but also in phytodiversity and biomass production. This makes Nabaos farmers more vulnerable to livestock losses even in times of moderate rainfall.

In the dry season and during drought periods only the woody vegetation remains on Nabaos, while on Gellap Ost the prominent perennial grasses still provide much standing biomass (Photos 4 & 5). These grasses are effective in stabilising the upper layer of soil in the inter-shrub matrix, thus preventing soil erosion by wind and water. Conversely, soils on Nabaos are prone to erosion due to the lower efficiency of its annual vegetation to stabilise the soil and an increased topsoil disturbance caused by livestock trampling (Petersen 2008). Moreover, loamy layers with small, vesicular inclusions in the topsoil, which reduce water infiltration and increase runoff, are more strongly developed on Nabaos than on Gellap Ost. Their development is likely to be favoured by higher topsoil temperatures and water evaporation rates resulting from reduced plant cover (Petersen 2008). Water is the limiting factor for plant growth and vegetation recovery, and therefore the inability of degraded rangeland soils to retain water limits its regeneration capacity. On Gellap Ost, a small scale mosaic of vegetated patches on sandier soils and bare patches on loamier soils maintains source-sink processes, such as the redistribution and entrapment of nutrients, organic material and water (Petersen 2008). Local resource concentrations favour plant establishment and biomass production, and increase water infiltrability at the vegetated patch, which in turn maintains the mosaic of vegetation patches and bare ground (Rietkerk et al. 2002). On Nabaos, however, respective ecosystem functioning at the patch scale is largely altered, and thus the rangeland is dysfunctional to some degree. There are strong ecohydrological interactions in arid environments, with vegetation patches obstructing runoff and storing significantly more water than bare patches (Ludwig et al. 2005). Popp et al. (2009) developed a vegetation model for ecohydrological feedback mechanisms parameterised for the Gellap Ost and Nabaos sites. It incorporates structural elements of the vegetation, spatio-temporal water availability through precipitation and redistribution processes, topography and disturbance (grazing) parameters. The simulation results revealed that overgrazing has a profound effect on hydrological processes and associated vegetation productivity. The loss in vegetation cover increases run-off and evaporation from the soil, and thus limits the landscape's ability to retain and conserve water, which leads to an additional reduction in forage production (Popp et al. 2009). The interrelated changes in plant species composition, vegetation cover, soil properties, and water balance of the ecosystem as a consequence of high livestock pressure render the degraded communal rangelands vulnerable to environmental threats such as droughts, but also heavy rainfall events.

The grazing regime on Nabaos has transformed the structure and composition of the vegetation. It has also transformed the physical environment with knock-on effects for the fauna of the region. As shown for small mammal communities, species richness, abundance, diversity and settlement of rodents is lower on the overgrazed Nabaos Observatory (Hoffmann & Zeller 2005). The most frequent species at Gellap Ost, *Gerbilliscus leucogaster* (Bushveld Gerbil), prefers a savanna-like environment, and did not occur on Nabaos. In contrast, *Gerbillurus vallinus* (Brush-tailed Gerbil), a desert inhabitant, was the dominant species on Nabaos, while it was only subdominant at Gellap Ost. Obviously, this xeric-adapted species has found a more suitable habitat in the transformed, more open rangeland of Nabaos than in the grassy shrubland of Gellap Ost (Hoffmann & Zeller 2005). The authors conclude that the changes in small mammal community were caused by the disrupted habitat structure, reduced shelter and higher predation risks resulting from the reduced vegetation cover, as well as by the reduction in food supply as a result of the smaller population of arthropods on Nabaos. Indeed, arthropod surveys conducted at the Observatories (e.g. Vohland et al. 2005) revealed for example a reduction of termite numbers on Nabaos, which might be related to the low grass biomass. As termites are also important in the diet of small mammals, their reduction might have an impact on these animals. Further, the abundance and diversity of beetles (Coleoptera) were also reduced on Nabaos. Overall, this leads to a reduction of ecosystem functions provided by arthropods such as infiltration and water holding capacity of the soil, pedoturbation, and turn-over in nutrients (Vohland et al. 2005).

This research demonstrates the ecological consequences of inappropriate land management. The interactions between continuous overstocking, reduced vegetation cover, soil deterioration, and shifts in biodiversity result in a loss of landscape functional integrity (sensu Ludwig et al. 2004). The path for the improvement of rangeland condition depends on the rehabilitation potential of the ecosystem and is specific to the given socio-economic context. An important aspect in rangeland rehabilitation is the regeneration capacity of vegetation towards a more desirable state. In the case of Nabaos, a recovery of target plants such as perennial grasses would result in a change in vegetation structure and

Photos 4 and 5: Fence-line contrast between Gellap Ost (left of fence) and Nabaos in the wet season (left; 15.04.2008) and dry season (right; 23.01.2008). Photos: N. Dreber.

improve ecosystem functioning by contributing to the prevention of erosion, enhancing the water balance, and providing fodder for insects, rodents, and livestock. However, the recovery of desirable vegetation depends largely on intact soil seed banks and establishment conditions. The analysis of soil seed banks is a constructive tool to assess the condition and restoration potential of a site (Jones & Esler 2004). It can yield information on the current seed reserves and allows one to predict the overall composition of post-disturbance vegetation (van der Valk & Pederson 1989). Further, if the aim is to improve site conditions or re-establish a target plant community, the examination of soil seed bank formation prior to the initiation of any management strategy is important, as the knowledge derived from such an analysis can be used to structure and accelerate the restoration process (Chambers & MacMahon 1994). A respective approach was initiated in 2006 with a pilot study assessing species richness and species composition of the seed bank, and seed densities on Nabaos and Gellap Ost (Dreber 2010). Based on this study, a detailed seed bank analysis was conducted in 2007 and 2008 (N. Dreber, University of Hamburg, unpublished data). Results revealed that the soil seed bank on Nabaos is altered and mirrors the species composition of the standing vegetation. Species common on Gellap Ost, which has been managed sustainably, are generally absent. In addition, a shift in the abundance of plant functional groups towards the dominance of grazing resistant prostrate annuals was also detected. In particular, seeds of perennial grasses were significantly reduced. While the seed bank on Gellap Ost consisted of 11% of perennial grasses (*Stipagrostis uniplumis* and *S. hochstetteriana*), these made up less than 0.2% of germinated seeds from the seed bank of Nabaos. This points to an inability of perennial grasses to establish and replenish the seed bank, which may indicate a low availability of safe sites for seed capture and/or high grazing pressure on seed-bearing plants (Kinloch & Friedel 2005). An analysis of similarity revealed that the species composition of the seed bank at Nabaos was significantly different from that of Gellap Ost. Even safe sites such as under shrubs, which are effective in trapping and accumulating dispersing seeds, provided no desirable seed material, although seed bank richness and seed densities were highest under shrub canopies (mean of 3460–5150 seeds m^{-2}). This also indicates that the seed input via seed rain from the adjacent Gellap Ost rangeland is limited. Accordingly, the potential of degraded vegetation to recover and to support species which are common to rangelands which have been managed sustainably is low, particularly if recovery is not supported by active intervention.

The contrast between Gellap Ost and Nabaos documents the impact of land degradation both above and below ground. The interdisciplinary studies have identified several indicators, which can be used to assess the degree of transformation in a Nama Karoo ecosystem. They also provide reference points for future assessments of rangeland condition and evaluations of restoration potentials. These indicators can be used to support the introduction of either restoration methods in degraded habitats or preventive methods for conserving biodiversity. In the case of Nabaos, results indicate a profound regime shift and loss of ecosystem functioning with the natural regeneration of habitats unlikely to occur even under an adaptive management approach. Recovery processes of degraded arid rangelands are slow, and the time-span for improvement might take 60 years or more (Wiegand & Milton 1996). As no desirable seed material is available at the degraded site, post-disturbance vegetation is likely to be no different from the present vegetation, at least in a time span relevant to present farmers. Therefore, in order to improve site conditions active restoration, implemented in a long-term management framework, is indispensable. In practice, effective ways to rehabilitate the rangeland may consist of the seeding of target species, creating refuges for vegetation regeneration and adopting appropriate grazing management systems including herding and resting periods. A rangeland rehabilitation program can only be developed together with all involved stakeholders. Landusers will accept alternative practices only if they recognise that new approaches affect their livelihoods in a positive way. One focus could therefore be to enhance the awareness of farmers, government officials, traditional authorities, and policy makers on the linkages between vegetation dynamics, soil condition, ecosystem water balance, biodiversity, natural resource productivity and livelihoods. It is of utmost importance to develop innovative approaches in order to improve existing management instruments and governance structures targeted at alleviating poverty through biodiversity conservation. Therefore, in order to avoid continuing resource degradation, institution-building at the local level is indispensable.

3.5 Rangeland—landuse interactions and suggestions for the management of pastoral systems in the Namibian Nama Karoo

[S. Domptail]

Background

A major insight delivered by the interdisciplinary research reported on here is the multi-faceted diversity, which characterises the Namibian Nama Karoo. The three sections of this chapter illustrate this diversity of ecological and institutional settings thanks to the presentation of different case studies. A major aspect is the diversity of tenure systems. The commercial and communal farming sectors comprise very different and somewhat opposed tenure systems, which occur side by side in the arid Nama Karoo. The Rehoboth farmlands, on the other hand, are characterised by a more diffuse system of small-scale private farms, where multiple-ownership introduces management problems typical for collectively-managed natural resources. While these differences do not make the comparison of case studies easy, they create a more complex and complete picture of the problems and drivers of landuse, and of the degradation patterns, which occur in all social-ecological systems of the Namibian Nama Karoo. Importantly, each tenure system appears to have its pitfalls and no system is a panacea for sustainable rangeland management. Solutions for sustainable management will be specific to each social-ecological system (Anderies et al. 2004, Ostrom 2007) because the farming systems considered are tightly coupled to the natural rangelands and local ecological and economic dynamics (Campbell et al. 2006). For instance, diversity of rangeland resources is a key asset specific to the commercial area around Keetmanshoop. In addition, the relatively close proximity to major urban centres (such as Keetmanshoop and Windhoek), which characterises all three study sites, distinguishes them from more remote zones with regard to the existence of alternative income sources. Nevertheless, some insights were gained into the functioning of the main socio-ecological systems associated with rangelands of the Namibian Nama Karoo and are presented in the following paragraphs.

Ecological drivers of rangeland dynamics

It is well-known that erratic and low rainfall drives vegetation dynamics. This in turn poses a major challenge for pastoral activity, which focuses on coping with the variation in biomass produced by natural rangelands. Research within the BIOTA project (Herpel 2008, Petersen 2008, Popp 2007, N. Dreber, unpublished data) has shown that hydrology, soils and soil seed banks are key elements of those dynamics at both small and larger levels of scale. An important property of the ecological dynamics of the system is its non-linearity. Thus when land deterioration has become established it may be very difficult to reverse. It is important therefore to avoid the risks associated with degradation by paying attention to how landuse impacts on key ecosystem processes.

Impact of landuse on rangelands

With regard to the conservation of healthy rangelands, we found that the use of Karakul sheep for the production of skins as the main (but not only) income-securing breed seemed compatible with rangeland conservation objectives. However, mixed herds appeared important in enabling the practice of both breeding and speculation side by side in non-mobile systems (i.e. when land resources are fixed and limited) and where rangeland resources allow it. Indeed, low breeding levels were found to be conducive to rangeland conservation because they enhance the farming system's flexibility with regard to drought. Resting is another key farming practice for conservation and was found to be most effective if practiced extensively in wet years. Although farmers' ecological and botanical knowledge may play an important role in their management strategies, botanical expertise was not found to correlate with a better ecological state of the rangeland on farms in the Rehoboth area. Other factors probably play a more important role. As for the main drivers of degradation, high past and present stocking rates summed to long term overgrazing and were found to have transformed ecosystems substantially at both the biotic and the abiotic levels. Impacts included increased rate of soil erosion, changes in habitat hydrology, shifts in plant species composition, both above ground and below ground, changes in small mammal and beetle communities. Finally, in the region of Rehoboth, small farm sizes and multiple farm ownership have both been found to reduce perennial grass cover and lead to degradation.

Drivers of landuse strategies

Managers of small commercial farms in the area of Keetmanshoop tend to emphasise the avoidance of overgrazing risks during drought by reducing herd size but have rather low variations in their herd size. While farm size is indeed a constraint, the real driver behind overgrazing is the understandable need that farmers have to generate an income from the land. In all systems, the combination of scarce land resources and of high income needs, often as a result of large household size, the purchase of land or the necessity to accommodate several families, was found to influence the specific strategy used on a farm. Ultimately, the limited access to resources affects rangeland condition, as well as the abundance of grasses and other resources such as fire wood-providing trees. Malfunctioning or absent formal and informal institutions for the regulation of access to resources, as well as designing, monitoring and enforcement of rules to govern these collectively have exacerbated the problem. In some communal areas, uncontrolled in-migration and the absence of spatial delimitation of resources or of exclusive property rights jeopardises efforts to implement grazing rules and to maintain infrastructure. Subsidies were granted to both communal and commercial farmers in the context of the drought relief policy and other programs until independence in 1992. However, these subsidies have maintained high numbers of livestock on communal areas during and immediately after droughts, thus potentially having a strong impact on rangeland health. In Rehoboth, they have also supported the development of farm infrastructure, thus artificially boosting the viability of small farms and favoured the establishment of multiple farm ownership. An important major driver for high stocking rates especially in the arid Nama Karoo communal lands, far from the economic dynamism generated by the capital Windhoek, is widespread poverty and unemployment leading people to search for opportunities to access to and generate income from the communal lands. Within the communal areas, livelihoods are so constrained that marginalised farmers are prevented from reducing their stock even in times of drought. Until recently, prices have also strongly affected landuse strategies, especially the herd composition of commercial ranches by favouring meat production. Yet, following the increase in the price of Karakul skins as well as the constraints linked to the implementation of the Small Stock Marketing Scheme, which virtually closed the South African market for live sheep, interest in Karakul is being revitalised. Finally, farmer-related drivers were also identified. These included farmers' interest in conservation per se and whether farmers are full-time or part-time farmers. While it may be argued that the pressure on the rangeland is higher when the household depends only on income from farming, we found that farmers with a several sources of income also increase the risk that their rangelands will become degraded. In commercial systems, part-time farmers benefiting from additional income adopted more opportunistic strategies and reacted to strong rainfall by purchasing much stock, thus creating the risk of de-coupling the herd and the ecology of their rangelands. In the communal systems, more time was spent on herding the flock and faster rotations were used to manage the grazing lands by full-time farmers. This suggests that due to the lack of an available labour force, part-time farmers are less likely to implement sound rotational grazing practices.

Towards solutions

Following from these insights, key elements of potential solutions to counteract the degenerative trend in the farming systems studied are highlighted. First, in the context of Namibia's land reform and land redistribution program, particular attention should be given simultaneously to (1) the access of individual farmers to key resources, (2) the size of the farm units in order to ensure the viability of farms in the long term and (3) the type of farm structure and ownership. With this last point, we highlight the potential role of joint farming at a scale, which is ecologically and economically sound. Furthermore, innovative structures with well-defined property rights must also be sought and new forms of cooperatives or conservancies are also needed. Second, many farming practices may be improved. For instance, manure in communal areas may be used as fertiliser and alternative energy sources such as solar ovens may alleviate the pressure on wood resources. The keeping of mixed herds and the combination of breeding high quality sheep and less high quality sheep for speculation purposes should be supported by the creation and maintenance of diversified markets for the diverse products rather than solely focussing on high quality products. Our analysis suggests that practices may be influenced by some well-targeted policy measures such as the provision of financial incentives for farms on which effective and measured rangeland conservation is achieved. Finally, the development of alternative or additional income sources is important in communal areas because recovery processes of degraded rangelands are slow and time-spans needed for improvement might last up to several decades. The rehabilitation of severely degraded rangelands will require the design and implementation of long term management frameworks together with a significant investment in active restoration efforts. Additional effort should also be allocated to the alleviation of poverty through the development of other economic activities and to the prevention of further degradation of the region's rangeland resources. Here local institutions and cooperation among farmers will play a key role and their development should be fostered. This will foster the development of rules perceived as fair and agreed upon by those concerned, rather than dictated in a top-down manner. Conservancies, while providing a context for the development of cooperative behaviour within the community do not seem likely to achieve an improvement in the ecological state of the communal lands as they do not include long term rangeland management plans. Conservancies nevertheless constitute a sound approach to reduce vulnerability and to provide additional income sources, even if the benefits generated and perceived by individual members of the community are rather low.

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