DIE ERDE	129	1998	S. 301 - 315	Regionaler Beitrag

• *Weidemanagement - Degradation - Namibia*

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Himba Paradise Lost
Stability, Degradation, and Pastoralist Management of the Omuhonga Basin (Namibia)

Das verlorene Paradies der Himba.
Stabilität, Degradation und Weidemanagement des Omuhonga-Beckens (Namibia)

Mit 2 Figuren, 1 Tabelle und 1 Bild

Research on degradation has been a field of interest for geoscientists working in Namibia since the days of *Walter* and *Volk* (1954) and *Ganssen* (1963). Yet up to now an interdisciplinary (geography, botany, ethnology) and historically embedded approach to changes in the spatial patterns of environmental resources, degradation, land use and settlements has been lacking. The reconstruction of such changes might be used to generate a generalized model of degradation, which can be linked with analyses of the establishment and failure of pastoralists´ strategies of land management and land use

1. Introduction

'Under high acacias in thick green grass grazed hundreds of cattle and thousands of sheep; evidently I had got to the hitherto legendary Ovatschimba[1] paradise ... For several hours I rode up the river, finding village on village and water everywhere in the riverbed.' 12/10/1910 *Kuntz*'s Report to the Kaoko Land und Minengesellschaft, 1910.

The German traveller and mining prospector *Kuntz* is not alone in his emphatic description of the Omuhonga basin of northwestern Namibia. Its lush riparian vegetation and exceptionally good pastures are also mentioned in Himba oral traditions on 'the river without banks' (*Kaputu* in *Heywood* et al. 1992). The central figure of Himba pre-colonial traditions, Mureti, was born in this affluent environment early last century (*Bollig* 1997a). Today Mureti would find little grass in Omuhonga to feed his father's cattle on. His cattle's milk would turn bitter from the consumption of *Pechuel-Loeschea leubnitziae*, a hardly palatable shrub. While the huge *Faidherbia albida* trees are still giving shade to the gardens adjacent to the river, the land on both sides of the river is highly degraded. *Kuntz*'s Ovatschimba paradise has turned into a barren land.

The conventional approach of range ecologists to degradation was based on the concept of linear succession (*Stoddart* et al. 1975, *Le Houérou* 1989). Grazing pressure was seen as the most important driving force of the system. In contrast to this, a disequilibrium concept was recently proposed for savannas with an annual rainfall averaging lower than 300 mm or a rainfall variability above 30% (*Scoones* et al. 1993), stressing the importance of irregular rainfall against stocking density. Whereas the disequilibrium concept is valid in explaining the dynamics of rangeland development on most pastures of Kaokoland (*Bollig* et al. in prep.), the hypothesis needs to be qualified on two points: (a) Certain areas are indeed massively degraded due to over-exploitation; generally, these areas have been described as prime settlement and grazing areas in the past. (b) Savanna systems do change rapidly after herders start to exploit natural resources, but after some time a stable secondary state is reached where the system's dynamics are in fact mainly determined by rainfall variability.

Research on degradation has been a field of interest for geoscientists working in Namibia since the days of *Walter* and *Volk* (1954), and *Ganssen* (1963) (summarized in *Kempf* 1996). Yet the integration of geomorphological, pedological, botanical, ethnological and historical methods as applied in the research project ACACIA[2] allows a new quality of insights into the historical phases of degradation as well as into the establishment and failure of pastoralists' strategies of land use. A combination of these approaches has not been in the focus of geographical research in Namibia up to now.

2. Material and methods

Botanical methods

Field work was carried out between 1995 and 1997 in an area of about one square kilometre. Five plots were placed in homogeneous stands with different geological and edaphic features. Species cover was estimated each year in 10 x 10 m plots for herbaceous and in 20 x 50 m plots for woody species. For all individual trees, the basal stem circumference was recorded as well as the extent of being damaged by woodcutting (estimated as the loss of above-ground biomass at the time of cutting), and the exposition of roots due to soil erosion. The trees' age was estimated using an age class system (see *Urbanska* 1992). As death due to severe damage could occur in every age class, it was recorded as a separate category.

Geomorphological methods

Geomorphological methods were applied by mapping the distribution of micro-relief units and substratum on the plots, surveying the relations between relief and substratum in the surrounding of the plots and sampling of soils, sediments and rocks. Additional information about the relief and the distribution of settlements was supplied by interpretation of aerial photographs. Laboratory methods - as applied in the geomorphological laboratory of the University of Cologne - have been described in *Bremer* (1995).

Ethnological methods

Data on the pastoral economy were gathered from 1994 to 1996. Research focused on hazards arising from climate, environment and political economy and on herders' risk minimizing strategies. Various interview techniques were used to trace the history of resource management and to describe present grazing strategies in a highly variable environment. Methods from cognitive anthropology were used to elicit indigenous knowledge on fodder plants. By means of a detailed household survey, data on household organisation, spatial mobility and patterns of consumption were gained.

3. Environmental and cultural situation and patterns of degradation

The Omuhonga Basin is located in Kaokoland, Namibia's semiarid Northwest. It is crossed by the temporary watercourse of the Omuhonga River, sustaining a riverine gallery forest. The vegetation of the basin is a low Mopane savanna. Currently the area is populated by about 50 households which are attracted by the good conditions for gardening on the floodplain of the main river and the easy supply of consumer goods and maize from the nearby village of Okangwati.

3.1. Geomorphology

3.1.1. Geological and geomorphological setting

Macrorelief

The macrorelief of the region shows three distinct units: (1) the Omuhonga range in the Northeast (1700 m a.s.l.), (2) a pediment which leads down to (3) the Omuhonga plain (1150 m a.s.l.). All plots are situated on this plain. As it is dissected by a SE flowing tributary of the Omuhonga River, neither recent sedimentation of material from the mountain range is possible at the sites of the plots nor does water running off the mountain range reach the plain. Thus soil erosion is caused by the run-off on the plain itself without excess water from the Omuhonga Range.

Geological units

Three geological formations are of importance (Geological Survey 1990, Bethlehem Steel Co. 1954/5): (1) the Epupa Metamorphic Basement Complex (> 2000 m.y. mainly gneiss) on the plain and the pediment, (2) quartzite, conglomerate, slate and limestone belonging to the Damara Group (> 570 m. y.) in the mountain range and (3) a fragmentary young (< 2 m. y.) sedimentary cover of varying thickness (in most cases < 2 m) on the plain. The latter is highly vulnerable to soil erosion.

Meso- and Microrelief

The plots are situated in a plain slightly (0-2.5°) tilting towards the southeast. It forms the watershed between the Omuhonga River and its northern tributary. The microrelief consists of three morphographic units: 0.5 to 2 m high 'ridges' of convex profile, saucer-shaped drainageways between them and flat surfaces (plains). These units can further be characterised by their substratum (see below).

In most cases the tree roots show signs of removal of at least 10 cm of the sedimentary cover, removal of more than 30 cm is not seldom, but even more than 50 cm during the lifetime of a tree have been recognised. As the stripping of roots is seen with trees of every age class (even young trees often having exposed roots), it is apparently a recent process. Stones, which still rest on pedestals of soil, are further evidence for the recent onset of soil erosion. In comparison to the thick, loesslike deposits around Opuwo (*Brunotte* and *Sander* in prep.), soil erosion in the sandy substratum of Omuhonga is not characterised by forms created by excessive gullying. Instead the flat and partly saucer shaped forms prove the occurrence of sheet flooding. As a consequence erosion is not restricted to the vicinity of small watercourses which are flooded after rain but occurs on most parts of the plain. Whereas nearly all kinds of substratum show signs of soil erosion they are most impressively

Photo 1 Characteristic features of the degraded landscape of Omuhonga are 1. a sparse herbaceous layer, 2. a high proportion of old trees and 3. roots stripped from soil / *Charakteristische Merkmale der degradierten Landschaft in Omuhonga sind 1. ein geringer Deckungsgrad der Krautschicht, 2. das Vorherrschen alter Bäume und 3. die Freilegung von Wurzeln durch Abspülung des Bodens*

developed in stone-free covers of red sands which lack a cementation by calcite *(photo 1)*.

Substratum on the plots

Besides small amounts of pediment debris and strips of fluvial sediments on discontinuous river terraces, four different kinds of substratum are found:

a. Red and reddish-brown sands and loamy sands of sedimentary origin which can in some places be slightly cemented by calcite.

b. Where the sediment cover is missing or has been eroded, angular debris of the bedrock occurs. The most obvious kind of debris are angular quartz pebbles. They have been released by decay of veins in the gneiss and have faced little or no transport, as some perfectly angular crystals reveal.

c. Gravel covers of different ages are identifiable. Quartzitic boulders with diameters of more than 10 cm are well rounded and show weathering rinds which prove that transport and sedimentation of the gravel is no recent process. Its most probable sources are quartzitic and conglomeratic layers of the Damara Group. As gravel which has been released from the sediment cover by erosion shows no signs of disintegration, mechanical weathering is of little effectiveness.

d. Carbonate nodules with diameters of about 3 cm are of pedogenetic origin. When soil is eroded, these nodules may form a residual layer on the surface.

Laboratory research
The substratum is characterised as sandy loam or loamy sand. Mineralogical analyses of the fraction < 63 µm revealed a high content of quartz, some feldspar and small amounts of mica/illite. Differences in the content of calcite and dolomite are remarkable. In some cases small amounts of smectitic clay minerals have been detected. Thus chemical weathering processes can be characterised as slow working ineffective processes.

Soil fertility
The poorly consolidated sandy/gravelly sediment-cover leaves more space for roots than the comparatively shallow stony substratum of pediments and slopes. The thickness of the sediment-cover guarantees a high water storage after rainfalls. High pH-values and traces of calcite, dolomite and feldspar lead to the conclusion that the occurrence of alkaline and earth alkaline cations as nutrients is abundant. Furthermore nutrient supply by dust seems plausible. Clay minerals of the smectite type preserve these nutrients from being leached. Edaphic restrictions to plant growth were few and soils in Omuhonga apparently were comparatively fertile.

3.1.2. Climatological setting

As the nearest meteorological stations are Opuwo (about 100 km to the southeast) and Chitado (about 70 km to the east), no data are directly available for Omuhonga. Roughly 300 mm precipitation (usually summer rains) can be deduced for Omuhonga from Fig. 7 in *Page* (1976). Due to a rainfall variability of about 30 % droughts occur frequently but in unpredictable sequences. According to the data available for Opuwo, heavy convectional rains with more than 50 mm/24 h have been reported for the months between October and April. In combination with the sparse vegetation cover the occurrence of heavy convectional rains must be considered as a trigger for soil erosion.

3.1.3. Patterns of soil degradation

In Kaokoland soil erosion is most obvious on plains and basins covered by Cainozoic sediments (*Brunotte* and *Sander* in prep.) with a negligible stone content and only little cementation by calcite and dolomite. Three patterns of soil erosion in Omuhonga are observable:

1. In places where sandy layers of sediment cover the gneiss, the bedrock gets stripped from the loose cover, leaving behind a shallow substratum composed of a mixture of angular debris and sand. So the pedological difference between the formerly thick, sandy to loamy substratum in the plain and the thin stony soil cover on the slopes in the vicinity ceases.

2. Where gravelly layers are intercalated with sandy layers, the sand is worn away until the gravel will provide some protection for the fines.

3. Where the sediment is cemented by calcite, sheet flooding is less effective. This will result in the development of a distinct microrelief (see below).

Three consequences of soil erosion were observed:

1. The loss of substratum leads to a lowered storage capacity for water and a loss of space for the development of roots.

2. The exposure of cemented horizons results in increasing run-off as well as in a loss of space for the development of roots.

3. The different resistance of substratum towards denudation leads to the development of a micro-relief of drainageways and flat ridges which divide a formerly flat landscape into small relief units which result in different microhabitats.

Geomorphological processes which may lead to a compensation of the effects of soil erosion are deposition of new sediment and weathering. In Omuhonga - besides minor dust depositions - a recent accumulation of sediments is impossible. Chemical and mechanical weathering are slow working, ineffective processes. As compensation for the loss of material is impossible under recent environmental conditions, Omuhonga is a case of 'intolerable soil erosion' (cf. *Semmel* 1995).

3.2 Vegetation Ecology

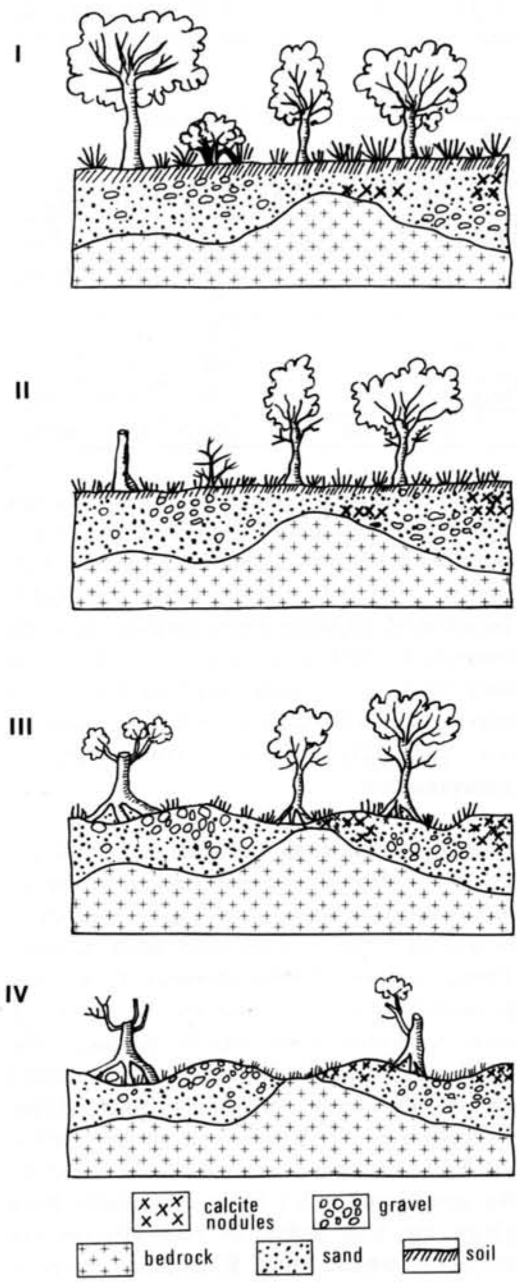
3.2.1. Flora and vegetation

The flora in Kaokoveld is estimated to number about 950 species (*Hilton-Taylor* 1994). According to *Sarmiento's* classification (1984), the vegetation in the Omuhonga Basin is a savanna woodland. The basin lies in the *Colophospermum mopane-Terminalia prunioides-Combretum apiculatum*-field type of Kaokoveld's dry northern area (*Viljoen* 1980).

The tree layer at Omuhonga is dominated by *C. mopane,* associated with *Terminalia prunioides, Ptaeroxylon obliquum,* and *Boscia foetida.* Shrub species are e.g. *Rhigozum brevispinosum, Catophractes alexandri* and *Pechuel-Loeschea leubnitziae.* The total cover of the woody layer is at maximum 10%. The herbaceous vegetation consists mainly of annual species like the grasses *Stipagrostis hirtigluma, Eragrostis porosa and Aristida adscensionis*, subdominant species include *Eragrostis annulata* and *Melinis repens*. Herbs like *Geigeria acaulis* and *Dicoma tomentosa* have normally low ground cover values (less than 0.5 %). Vegetation shows small-scale variation in congruence to the different microhabitats. Generally, the total ground cover of a savanna's herbaceous layer is highly dependent on the temporal distribution and the total amount of rainfall in a particular year (*Le Houérou* 1989). In contrast to this, the ground cover of the herbaceous layer in Omuhonga is always very low. Even in 1995 and 1997, when rainfall was above average, herbaceous ground cover was not significantly higher than in the dry year of 1996; it ranged between 5% and 10 %. Annual biomass production in the years 1995-97 did not exceed 20 g dry matter/m².

3.2.2. Patterns of degradation

Degradation of the tree layer
The vegetation at Omuhonga shows many features of pronounced degradation due to excessive woodcutting and browsing. The total tree cover does not exceed 10 %, which is, under the given climatic and edaphic conditions, very sparse. More than 95 % of adult *Colophospermum mopane* individuals show marks of woodcutting, about 70 % were cut several times during their life time. Normally at least 30 % of a tree crown is lost every time it is cut; the mean loss is 58%. Loss of above-ground biomass varies with age class (*fig. 1*). In *C. mopane*, loss is with



more than 70 % highest in age class 3, the class of the young generative trees. Older individuals lose on average 59 % (age class 4), and the crowns of very old plants are even less damaged. In *Terminalia prunioides,* most adult individuals have been cut at least once in their life, and crown loss averages 39 %. Old individuals are more affected by cutting than younger ones.

The variation can be explained with different stem circumference values (and related branch circumference) in the different age classes (*tab. 1*). Cutting is for practical reasons mainly restricted to branches and stems with a circumference of less than about 30 cm. The age class 3 of *C. mopane*, having a mean basal stem circumference of 26 cm is the class most affected by woodcutting, as these young trees are often cut down very close to the ground. These are the stems

Fig. 1 Relationship between the extent of woodcutting and the tree's age. Age classes: 0 = seedlings, 1 = subjuveniles ca. 1-5 years old, 2 = juveniles, 3 = young generative individuals, 4 = old generative individuals, 5 = seniles. Young individuals (age classes 2 and 3) are severely damaged by woodcutting, while very old trees are affected to a lesser degree: Their stems are often too thick for cutting, and only some branches are cut off. Very old trees may not be cut at all, because their lowest branches were already too thick for cutting at the time of intense settement / *Beziehung zwischen dem Ausmaß des Holzeinschlags und dem Baumalter. Altersklasse: 0 = Keimlinge, 1 = Subjuvenile, ca 1-5 Jahre alt, 2 = Juvenile, 3 = junge generative Individuen, 4 = alte generative Individuen, 5 = Senile. Junge Individuen (Altersklassen 2 und 3) sind durch Einschlag stark geschädigt. Alte Bäume sind weniger stark beeinträchtigt: Ihre Stämme sind häufig zu dick, so daß nur einige Äste abgeschlagen werden. Sehr alte Bäume sind häufig nicht eingeschlagen, da die zugänglichen Äste zu Beginn der intensiven Besiedlung bereits zu stark waren*

Tab. 1. Demography, mortality and mean basal stem circumference values in the different age classes of two tree populations (*Colophospermum mopane* and *Terminalia prunioides*) at Omuhonga. For definition of age classes see *fig. 1*

Colophospermum mopane*, Family *Caesalpiniaceae						
Age class	0	1	2	3	4	5
Individuals/ha (n = 276 on 5,000 m²)	18	30	126	144	138	96
Mortality [% of dead indiv.], not recorded for seedlings	-	33,3	50,8	45,8	14,5	10,4
Mean basal stem circumference [cm]	1,0	3,1	14,2	26,4	49,7	81,0
Terminalia prunioides*, Family *Combretaceae						
Age class	0	1	2	3	4	5
Individuals/ha (n = 44 on 5,000 m²)	0	4	14	48	20	2
Mortality [% of dead indiv.], not recorded for seedlings	-	0,0	42,9	25,0	50,0	100,0
Mean basal stem circumference [cm]	-	3,0	8,3	26,0	36,1	60,0

preferably used for fences and hut construction. The mean basal stem circumference of 50 cm in age class 4 has prevented many of these old generative individuals from beeing cut down completely. For *Terminalia prunioides*, the comparatively little damage might result from a Himba rule of tree protection: this species is, at least under traditional land use, excluded from cutting. Although this rule has clearly not been fully maintained, local people are still reluctant to cut a tree of this species close to the ground. Normally only some branches of old individuals are taken, leading to a mean biomass loss increasing with age class (see *fig. 2*).

How much a plant's viability is affected by cutting depends to a large extent on its age. Young *Mopane* trees die more easily than older ones because of their comparatively higher loss of above-ground biomass (*fig. 1*) and because of their weaker ability to resprout. This effect is increased by the intense browsing at Omuhonga, where seedlings and young tree individuals are bitten frequently. If a high proportion of above-ground biomass is taken away several times during one vegetation period, the individual's ability of recovery can be exhausted (*Le Houérou* 1989). Frequent woodcutting and browsing has therefore resulted in a *Mopane* population containing a disproportionately high number of old individuals. Whether populations of other trees species show the same demographic structure is, on the current data basis, not clearly determinable, as the number of individuals recorded on 5,000 m² was generally too small for a detailed interpretation.

Field observations proved that species' ability to resprout are markedly different. *C. mopane* individuals are hardy and show powerful regeneration (see also *Scholes* 1990, *Trippner* 1996), whereas *Terminalia prunioides* and other tree species are much more sensitive to the loss of biomass. The weak regeneration abilities of the latter species are clearly reflected in rules of tree protection of the Himba (see above). Below the dense settlement in Omuhonga, however, the traditional rules have apparently been given up, and today all tree species are subject to woodcutting. Even the *C. mopane* population shows a mortality rate higher than the birth rate, resulting in a low population density. Only about 550 individuals can be found per 10,000 m², compared with a population density of 1,260 individuals/ha in

Omuramba, a lesser affected area north of Omuhonga.

Degradation of the herbaceous layer
The main effects of overgrazing on the herbaceous layer are shifts in species composition and a loss of productivity. Here, the absence of perennial grasses and herbs is most striking. *Stipagrostis uniplumis var. uniplumis*, a perennial grass which has a high frequency on sandy pastures in Kaokoveld, was not recorded in Omuhonga. The proportion of herbaceous perennials in Omuhonga's flora as well as their relative ground cover is negligible (less than 2 % in both cases). Species with protective adaptations and low nutritive value are less affected by grazing than other species. Therefore, species with short life cycles and low grazing values ('weeds') have been favoured.

This general pattern of degradation can be specified for the species inventories of the different microhabitats. Today's most common microhabitat (making up more than 70 % of the area investigated) was created mainly by severe soil erosion in the last 15 to 20 years. It is characterised by debris or gravel covers and very shallow soils. The herbaceous layer here is extremely sparse (cover values lower than 5 %) and dominated by *Aristida adscensionis*, a low-productive and weakly competitive pioneer grass only palatable when young (*Schulze* et al. 1996). *Eragrostis porosa* is a further low-productive annual grass species of this microhabitat. In contrast, the vegetation of the deeper, sandy soils of the rills and rill banks has cover values higher than 10 %: It is characterised by highly productive grasses such as *Schmidtia kalahariensis* and by different herbs. The species now restricted to this microhabitat can be regarded as the main component of Omuhonga's herbaceous vegetation prior to the severe degradation.

3.3. Pastoralist Strategies

Traditions suggest that the basin has always been a favourite place for combining agriculture and pastoralism, and we may assume an almost continuous settlement from at least the 1750s onwards. *Kuntz*'s written account (*Kuntz* 1913) shows how intensively the basin was used around 1910. From the turn of the century, the basin has been constantly settled by some ten to twenty households. In the late 1960s Okangwati was founded, first as a small trading centre and then in the 1970s as a basis for the South African Army leading to a concentration of population in the basin.

Most homesteads in Omuhonga are situated about 100 to 500 metres away from the rivercourse. These homesteads are the home bases of pastoral nomadic households. All households show a strong seasonal fluctuation of members. During the rainy season many household members congregate at the home base in order to cultivate, whereas during the dry season most people set off to various livestock camps. Homesteads are permanent and of a sturdy build. Households are relocated a few hundred metres away after about ten years when the dung accumulation makes work difficult inside the old homestead. No wood from the old homestead is used for the construction of the new one. The sturdiness of fences and huts and the periodic reconstruction of entire homesteads implies a heavy demand on wood. Gardens which are located directly on the banks of the river are surrounded by high fences too. Estimates for wood consumption for the construction of fences on the basis of aerial photographs from 1975 (measurements of kraal and garden circumferences) lead to the assumption that an estimated 6,000 trees were used (approximately 350 trees per household; the figure includes fences for livestock enclosures and gardens but excludes wood used for the construction of huts and maize stores). In the 1980s the households in the basin more than doubled due to the resettlement of households from the Kunene basin to Omuhonga. Between 1965 and 1985 an estimated 12,000 to 15,000 trees had to be cut to provide wood for fences and construction. Per homestead, which has an average size of 3,900 m² (n = 22), approximately some 23,000 square metres of land were denuded. In other words: Each homestead consumes about six times the space which is covered by huts and fences to cut wood for construction. It is easy to figure out that an increase in homesteads destroyed most of the vegetation in a belt of at least two kilometres on both sides of the Omuhonga river. Of course, the increase in homesteads did not only have an effect on the woody vegetation. Smallstock herds increased dramatically. With a conservative estimate of some 150 heads of smallstock per household, the resident herd increased from some 3,000 animals to about 6,000 within a period of a few years.

3.3.1. Land use patterns in the basin

The traditional mobility pattern of herds affiliated to households in the Omuhonga basin constituted a regular cycle. After the first good rains resulted in some grass growth and the greening of bushes in the basin, herds congregated at their home base. Non-milking stock moved fairly early to dry-season pastures. At the height of the dry season, most households did not keep any cattle in the Omuhonga basin while large herds of smallstock stayed on in order to supply the remaining residents with milk and meat. Nowadays many households decide to leave substantial numbers of livestock at their various camps throughout the year. They only return those animals to Omuhonga which are necessary to supply the people who stay at the gardens with food. Some households even maintain two home bases nowadays: one within the basin mainly for gardening purposes and one outside the basin for pastoral purposes. Due to the degradation of Omuhonga's pastures the two productive strategies, livestock husbandry and agriculture, become progressively disintegrated.

Riverine gardens, in which the Himba mainly cultivate maize, millet, pumpkins and melons, are used by one household for several decades. Soil fertility is replenished by annual inundation. Gardens are directly located at the river or sometimes even on islands within the river. Eleven gardens were measured on aerial photographs; they had an average size of 9,000 m ² (range: 14,326 to 3,139).

3.3.2. Land tenure and institutions of sustainable pasture management

Informants were unanimous in that the basin had deteriorated significantly only within the last two decades. While the continued settlement of households in the basin has to be seen as a major reason for rapid degradation, the question remains open as to how pastoralists succeeded in maintaining the basin as a viable habitat for more than two centuries. Evidence from comparable places in northern Kaokoland shows that large scale degradation has taken place only in the immediate vicinity of the settlements. The Himba follow a complex set of grazing regulations that are meant to fulfil two goals: to give all herders equal access to good pastures and to protect pastures in order to ensure their sustainable usage. Several rules ensure the protection of pastures: (1) Nobody is allowed to herd cattle or other livestock in the dry season grazing areas after the onset of grass growth there. There are some few central areas where herds congregate during the rainy season, and Omuhonga has been one of them ever since. The concentration of cattle herds in a few areas ensures that grasses in the major grazing areas are not damaged during this critical part of their lifetime and are allowed to develop seeds. (2) Livestock camps have to move some kilometres away from the settlement in order to ensure that the grazing orbits of the household herd and cattle-camp herd do not overlap. This lowers grazing pressure in the settlement zone and guarantees that the lactating stock of the home base have sufficient fodder for another few months. (3) Livestock camps should move in one direction. The ideal is that a group of camps moves forward together. Widely scattered livestock camps would necessitate more moves and would create a state of unequal access to grazing resources. (4) Herders should not move their camps too frequently. Himba argue that due to frequent shifts a lot of grazing is lost to trampling. Only when the first rains fall and the vegetation period of *Commiphora ssp.*, *Terminalia prunioides* and *Rhigozum ssp.* starts, are these regulations given up in favour of free trekking.

These rules are sustained by an institutionalised way of decision making. Minor contraventions against grazing regulations are tried by the council of men using the area. Grazing regulations and rules of tree protection functioned in a similar way in the Omuhonga basin. Only when numerous households were forcefully resettled to the Omuhonga basin in the late 1970s did pressure reach a climax which could not be handled effectively within the range of existing institutions.

4. Processes of degradation

Pastoralists have been accused frequently of mismanagement of rangelands by development planners. However, anthropologists and geographers have recently shown that pastoralists have found a wide range of institutions to protect key resources. Obviously these two views are incompatible (for an introduction into this discussion see *Hardin* 1968, *Galaty* and *Johnson* 1990, and *Ensminger* 1992). What do herders exactly try to protect and under what circumstances do their institutions fail to guarantee sustainable management? The Himba example shows that herders at least in the Omuhonga case had no answer to curbing the effects of high settlement density. There was and still is no consensus how to handle a rapidly degrading resource, although there is a general agreement that the environment has deteriorated rapidly over the last two decades. Apparently institutions need some time to develop and have to relate to a resource with roughly predictable characteristics.

We may well ask why no new institutions have been developed which could cope with the new situation. Institutional solutions can only be established in relation to resources with known dynamics. Ideas on transaction costs of institutions (*North* 1990) may explain this problem. Herders constantly gather information on the state of the environment and on the exploitation of ranges by potential competitors. The costs of gathering information and processing them in institutions are subsumed under the concept 'transaction costs'. With information on the environment and the knowledge of strategies of their neighbours (and potential competitors), pastoralists enter into agreements on sustainable management. As long as environmental factors are just oscillating and economic strat-

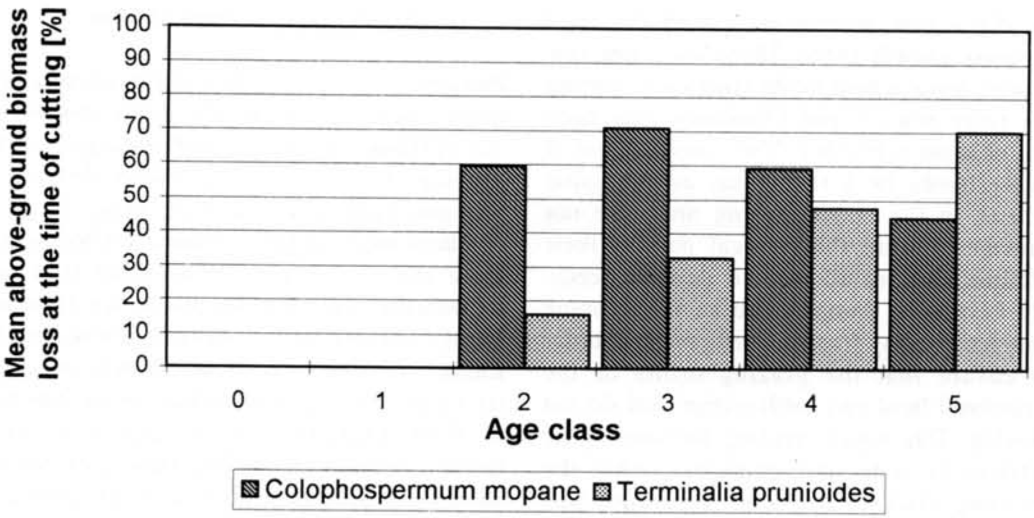


Fig. 2 Hypothetical four-staged model of degradation (see text) / *Hypothetisches vierstufiges Degradationsmodell (Beschreibung siehe Text)*

egies do not change massively, it is worthwhile clinging to these institutions of resource protection. If the resource itself changes rapidly and in an unpredictable way and if the group of users becomes also unpredictable, transaction costs will rise rapidly. Past agreements with other pastoralists become unreliable. An institutionalised resource management always relates to a past state of the environment as it is time-consuming and inefficient to constantly update information on environmental properties.

In the same way that herders are unable to curb rapid degradation they are also apparently uninterested in the maintenance of biodiversity. We must conclude that herders are primarily interested in fodder production, i.e. a Himba herder would value a pasture of *Schmidtia kalahariensis* as highly as a pasture constituted of different grasses as long as they produce roughly the same amount of grass. These observations have important implications. Herders conceptualise degradation as a sudden loss of biomass and not as a loss of diversity. Thus, their point of view sharply diverges from the concepts of ecologists and geographers who emphasise that degradation already starts at a very early stage of human impact.

On the basis of our data, a clear sequence of degradation can be hypothesised (*fig. 2*):

I) Under natural conditions (i.e. no human settlement), primary vegetation is a savanna optimally adapted to the environmental conditions; the main driving force of the system is rainfall variability (*Bollig* et al. in prep.). The original savanna had a relatively dense cover of perennial grass species, adapted to browsing by wild herbivores. In the rainy season the gaps were filled with a highly diverse annual vegetation. The woody layer consisted of a mixture of trees, *Colophospermum mopane* already being an abundant species. The sediment cover was 20 to 50 cm thicker (proven by the stripping of tree roots) and comparatively fertile.

II.) After the immigration of herders the vegetation changed rapidly. The palatable perennial grasses lost their dominance in the herbaceous layer, mainly because their reproduction was suppressed. They were replaced by species with lower grazing values, and/or with different life strategies. Annuals were the winners in this change in vegetation structure. They cope with the frequent and severe disturbances by having a very short life cycle (r-strategists; see *Oksanen* and *Ranta* 1992). In the woody layer, a similar shift in species composition and dominance took place, and 'tree weeds', i.e. species with effective protection against herbivores and good abilities for regrowth such as *C. mopane* gained dominance.

In this secondary savanna, the production of palatable biomass did not necessarily decline. However, as the new and important environmental factor 'grazing' determined species composition to a high degree, the system was automatically less adapted to other environmental factors. This means that the ecosystem became less resilient to changes in environmental conditions, e.g. long-term droughts having stronger effects than in the original system. The soils became more vulnerable to erosional processes, but soil erosion stayed at a tolerable rate. Obviously Kuntz´s observations were relating to this state.

III.) As anthropogenic pressure increased significantly, the stability of the secondary vegetation was destroyed. Soil erosion increased strongly due to temporal breakdowns of the herbaceous vegetation cover triggered by overgrazing. The stripping of roots and the depletion of the seed bank was the result of this phase. In contrast to phase II, the ability of the ecosystem to recover is fundamentally disturbed. As the soil is nearly bare of its grass cover even after years with much rain, it seems probable that erosion can be triggered by less intense rainfalls than in phase II.

IV) If anthropogenic pressure continues, biological recovery of the already highly degraded and barely buffered herbaceous layer will be inhibited altogether due to an intolerable depletion of the remainders of the soil seed bank. Excessive woodcutting and browsing will inevitably lead to the local extinction of all tree populations due to high mortality rates and the lack of seedling establishment. The perspective of a total collapse of the ecosystem, characterised by large areas with permanently bare ground as they already exist around the town Opuwo and along the Hoarusib river, seems very likely.

Acknowlegdements:

The investigations are part of the SFB 389: 'Arid climate, adaption and cultural innovation in Africa (ACACIA)'. The authors are grateful to the German Research Foundation (DFG).

1 Himba and Tjimba (or Tschimba) are different terms for one population.
2 ACACIA (= Arid Climate, Adaptation and Cultural Innovation in Africa) is an interdisciplinary project at the University of Cologne.

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Zusammenfassung: Das verlorene Paradies der Himba. Stabilität, Degradation und Weidemanagement des Omuhonga-Beckens (Namibia)

Die Autoren nehmen ein räumlich eng begrenztes Gebiet mit bekannter Nutzungsgeschichte (das Omuhonga-Becken im Nordwesten Namibias, Kaokoland) als Modellraum für einen interdisziplinären Forschungsansatz. Aus geographischer und ökologischer Sicht werden Veränderungen der Umwelt wie z.B. das Auftreten von Bodenerosion beschrieben und analysiert. Das veränderte Ressourcenangebot wird in Beziehung zur agropastoralen Ökonomie der ortsansässigen Himba gesetzt. Darauf aufbauend werden mögliche Gründe für die schrittweise Zerstörung der Weideflächen diskutiert, deren Ergebnisse in ein generalisiertes Degradationsmodell umgesetzt werden. Bereits zu Beginn der Nutzung durch Beweidung treten ein Verlust an Biodiversität und Verschiebungen in der Vegetationszusammensetzung und -struktur auf. Solange die Produktion nutzbarer Biomasse jedoch nicht beeinträchtigt wird, ist dies für die Hirten offenbar von geringem Interesse. Das System wird in diesem Stadium durch elaborierte Nutzungsregeln in einem nachhaltig nutzbaren Zustand gehalten. Erst wenn der Druck auf das System stark zunimmt, wird eine rasche Degradation in Gang gesetzt. Da das lokale Wissen offensichtlich an ein sekundäres Ökosystem angepaßt ist, bietet es weder Lösungen für den natürlichen Ausgangszustand noch für eine rasche Degradation.

Summary: Himba Paradise Lost. Stability, Degradation and Pastoralist Management of the Omuhonga Basin (Namibia)

The authors choose an interdisciplinary and historically embedded approach to environmental degradation, taking one spatially limited area as an example (the Omuhonga Basin in northwestern Namibia, Kaokoland). Changes in the environment are described and analysed from the perspective of geography (e.g. soil erosion) and ecology. The agropastoral economy of local Himba is set in relation to changing environmental resources. Causes for different stages of environmental decline are elucidated, and a generalised model for degradation is presented. The exploitation of savannas by large herds of domesticated herbivores triggers a loss in biodiversity and a shift in vegetation structure. These changes seem to be of little concern to local herders as long as the production of palatable biomass does not decline profoundly. At this stage the system is stabilized by elaborate management rules which ensure a sustainable management. Only if further stress is put on the system will it degrade rapidly with the likely perspective of a total collapse. While local knowledge is adapted to a secondary ecosystem, it offers no solutions for a system in its natural stage nor for rapid environmental decline.

Resumée: Le Paradis Himba perdu. Stabilité, dégradation et économi pastorale du basin Omuhonga, Nambië.

Les auteurs choisissent une approache interdisciplinaire et historique concernant la dégradation de l'environnement, en se concentrant sur une région limitée (le basin Omuhonga du nord-ouest de Namibia). Les changements dans l'environnement sont décrits et analysés dans une perspective géographique et écologique. L'économie agro-pastorale des Himbas est mise en relation avec les resources changeantes de l'environnement. Les causes pour les différents stades de la dégradation de l'environnement sont expliquées et un model général de dégradation est proposé. L'exploitation de la savanne par d'amples troupeaux d'herbivores domestiqués cause une diminution de la biodiversité et un changement dans la structure de la végétation. Ces changements semblent être de peu d'importance pour les pastoralistes tant que la production de la biomasse mangeable ne diminue pas vraiment. À ce stade le système est stabilisé par les règles complexes de l'utilization des pâturages qui assurent une exploitation durable. C'est simplement s'il y a surexploitation du système qu'il se dégrade avec la perspective vraisemblable d'un collapse total. Tandis que les connaissances locales sont adaptées à un écosystème secondaire, elles n'offrent de solution ni pour le système dans son état naturel ni pour une rapide dégradation de l'environnement.

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Manuskripteingang: 24.01.1998
Annahme zum Druck: 11.03.1998