Land and water usage by traditional pastoralists

A lecture given at Neudamm Agricultural College on March 31, 1998.

Introduction

Information given by the following lecture is based on the experience made with traditional pastoralists during a three year PhD study on range ecology in Northern Namibia supported by TÖB, GTZ (Tropical Ecology Support Program of GTZ - German Technical Cooperation). As one example of grazing management and for the general traditional patterns three pilot areas of NOLIDEP (Northern Regions Livestock Development Project) are introduced. The specific study on the three pilot areas was supported by NOLIDEP.

There will not be any quantitative data provided by this lecture. The grazing practise of traditional pastoralists will be **described** and reference will also be made to activities closely linked to

-the **management** of pasture
like:
- the management of **water resources**
- **cattle movements**
- the usage and management of **fodder supplies**

The usage of land and water in communal areas is subject to a range of **traditional and legal framework** conditions, like:

-the usage of boundaries
- the application of customary rights
- the impact of institutional linkages
- the status of land tenure rights

the clarification on which plays an important role for a development approach.

For future improvement and development of communal pasture ground **social implications** as the background of the prevailing system are also important specifically for the identification of decision makers. Therefore special reference is made to the traditional "gifting and loaning system of livestock" and the performance of resource poor and/or female headed households.

The detailed description of communal land use aims at a further clarification of the prevailing system in order to assist project planners to take **practical steps** for the enhancement of:

- community based resource management
- economic and social welfare
- livestock production and marketing

Methodology
In order to gain the following information, methods in the field of Participatory Rural Appraisal were applied, specifically **mapping** by small groups of participants and **informal interviews**.

Brief Characterisation of three Owambo communities

Oshambelo
- a Kwhaluudhi community and a relatively new settlement - only known as a borehole in other communities of Uukwaluudhi - with direct access to a cattle post area, used by the whole Kingdom of Uukwaluudhi.
- since settled only over the last years, large omahangu fields with enlarged 'ekoves' (= extended homestead area used as a grazing reserve) have developed
- few permanent brick build or tin houses exist, homesteads can still be moved according to the traditional practise, few fences with modern wire
- no pipeline, water provision for home consumption and animals is labour intensive, i.e. 7 km walk to main well with drinking water quality
- cattle post area is equipped with boreholes (*embola*; with diesel pumps)
- traditional leader is the King of Uukwaludhi with about 20 headmen reporting to him

Onaanda
- a grown Uukwambi community with a structured society pattern
- large omahangu fields, large 'ekoves' sometimes split into camps, most of the homesteads have at least 1 or 2 brick built permanent buildings, modern wire is used for fencing
- some people sell the surplus of 'omahangu' (basic staple food pearl millet)
- water provision for home consumption by a pipeline
- no boreholes in the cattle post area, which is partly covered by the pipeline, hand dug wells in the remaining area
- still have grazing reserves available, where access is restricted due to lack of water

Omatunda
- small Kwanjama community, densely populated and run through by oshanas considered as the last grazing reserves within the settlements
- no direct access to a related cattle post area
- homesteads are close to each other, no permanent brick built houses, few modern wire fences, sometimes no fence at all
- special feature: some 'omahangu' fields are shared and cultivated in collaboration with neighbours
- no sale of omahangu surplus
-large variety of exploitable trees

Management of grazing and water resources
Grazing resources are utilised communally but not managed in a communal way, i.e. in a sense that a control body elected or empowered traditionally would regulate access to defined areas. Virtually anybody can bring his cattle and establish a cattle post in community areas where a cattle post area is at disposal, like in Onaanda and Oshambelo. The same applies for Omatunda settlement area. However, there are different preconditions according to the minimum factors of the prevailing production system.

- in Oshambelo you must ask the controller of the borehole whether you can water your animals there (*'if not you can still survive for some time on a hand dug well'*)
- in Onaanda you must have your own hand dug well
- in Omatunda (densely populated, no grazing area) you must have a house there

Certainly the preconditions mentioned can be replaced by family or friendship relations or by the gifting and loaning system, dealt with later on. However, it is not the headman who is approached for access to grazing, it this usually the neighbours.
People in general are aware of different qualities of grass species, their changing nutrition value in the course of a vegetation period and of different pasture patches. The level of know-how differs between the three communities. The utilisation of this resource, however, is not linked to this knowledge and rather subject to framework conditions like water availability, wealth situation - whether herders can be employed - and distant grazing areas can be reached.
The management of water resources is in general more ownership featured, specially in the case of boreholes (ebola) with a diesel pump and drilled by the government as it is the case in Oshambelo cattle post area.

Drilled boreholes with a diesel pump are maintained by the government. Each borehole (in most cases) is controlled by one nearby cattle post holder. He is registered in Ondangwa at the Department of Water Affairs and is responsible for ordering service and repairs through the government. He is also in charge for the collection of the yearly fee from all users of the borehole (N$ 2,-- per cattle/year) and organises the diesel for the pump, which can be obtained free of charge from the government as long as he can present a receipt for the yearly fee. Trespassers are not charged for water because of lack of control. The controller of the borehole has usually assumed rights over the borehole beyond his original duties. He will only admit a restricted number of herds to this borehole and therefore also controls the surrounding grazing area. To some extent the number of herds admitted to the borehole can vary due to emergency situations like drought and has also been increased lately because of higher animal pressure and controllers of those boreholes report that it had become increasingly difficult to control access.
For other water resources like hand dug wells (grazing area Onaanda) or the pipeline (where no contribution for water is asked) access is not restricted. In this case a water committee is responsible for to address service and maintenance to the Department of Water Affairs and is also responsible for the settling of conflicts. The headman will also refer to the water committee for conflicts.
Whether the people can control access to water points in the future and thereby assume a certain control over a defined grazing area, is doubtful. Water points for instance in Omatunda, where a limited group of people paid for the instalation, are today used free of charge by everybody who is in need of water, whether he had paid at the beginning or not.

Cattle movement

Whether cattle is moved or not is dependant on the individual production factors of the cattle owner:

- size of the herd
- labour capacity
- condition of the pasture
- access to water points
- family and friendship links (as such that a herd can go on the trek with a herd of a relative or friend)

as to mention a few.

Usually the movement is related to a specific season:

Okwenye (dry season, August to December) - throughout these month cattle is moved to the cattle posts
Othinge (Jan. to March, rainy season) - cattle is moved back to the settlement area
Oshikufuthinge (April to May) - transition period, cattle feed on harvest stover
Okufu (June to August) transition period

Valid for this general pattern is also that the movement is either towards the cattle posts or back home. Once arrived at the cattle post no further movement was stated within a specific season and the vegetation is obviously not utilised according to the know-how of the differing pasture quality and vegetation stages. However, in areas where the pressure on pasture is not extremely high, like in the Onaanda cattle post areas, herders may assume a certain right for the exclusive utilisation of the pasture circle in walking distance around their own hand-dug water point. The procedure - as mentioned earlier - on how to obtain such a water point (through approaching the neighbours) gives evidence that the herder can utilise the surrounding grazing area almost undisturbed. He may then apply certain management tools according to his know-how, i.e. to graze first the fresh pasture close to his water point in order to avoid loss of trampling, to reserve the most unpalatable species for later utilisation etc.

Fodder supplies

Cultivated and natural fodder supplies

In general little knowledge could be found on the cultivation of fodder. Lucerne production was mentioned by some farmers out of the experience gathered during earlier work on commercial farms. Other farmers required more acacias in order to feed the pods. Supplementary feed is only considered for the time of ploughing, when draught animals are fed with sorghum or omahangu straw and for drought times as means of survival. Emergency feed in drought times can consist of palm leaves, branches of the marula tree, and grass originally reserved for roof thatching. In Omatunda for instance the grass used for thatching is restricted from grazing (enforced by the headman), since it is a valuable building material, but can, if need occurs, be used for emergency feed. However, the motivation to cultivate fodder - either community based or in the individual 'ekoves' - is high, although, fodder cultivation is not yet perceived as means to increase livestock-production and is rather perceived as a strategy to survive.

Closely managed fodder supplies

The understanding of closely managed fodder supplies is in general related to the most equal distribution of livestock and emphasised by the request for more water points in order to realise this measure. Fodder is, however, reserved in the 'ekoves', and will only be utilised there once the communal pasture is depleted.

Whether the take-off of animals can be used as regulative factor to improve pasture depends on the commercialisation potential of the specific community, which differs enormously between the three communities introduced earlier. For instance in Omatunda, because of the scarce pasture, people cannot imagine a more productive scenario and also big herd owner would never sell their animals for cash, while in Onaanda, with a prevailing semi-commercial production scheme (remember: surplus of omahangu is sold), take off is discussed in order to avoid monetary loss during anticipated drought periods. The improvement of appropriate facilities for take-off are already tackled by this community as well as initial negotiations with MEATCO.

Handling and acceptance of boundaries

People are usually aware and can precisely state boundaries between settlement and cattle post areas and boundaries to neighbouring communities and it is assured from the side of the headmen and the villagers, that any further settlement behind the given boundary will be restricted. In reality the boundaries are usually boundary zones where cattle posts change with settlements. An exception is given in Oshambelo where a newly set up regulation (originally for environmental reason) fixes the boundary, because traditional authorities who claim to be the initiators of this regulation, have assumed the law-enforcement.

Land tenure rights and usage

When asked about enclosures people insist on the statement "there is no private grazing". This is rather contradictory, considering eye-catching largely fenced plots in settlement and grazing areas. However, enclosures - no matter how large they are - are not considered as private grazing reserves as long as a house is built or in the process of being erected. Whether in the settlement area or in the grazing area the extent of enlargement depends on the tolerance level of the neighbours. The enlarged area next to the 'omahangu' field is called 'ekove'. It is in the nature of it that an 'ekove' can be extended in low populated areas, where

the neighbour is far. In densely populated Omatunda for instance the largest 'ekoves' are held by the first who came to settle.

The biased performance of the headmen in this context, must be seen in connection with his income situation and the current loss of authority. An increasing number of new tasks (projects, community development etc.) do certainly not provide additional income but are time consuming. Land allocation is one of the last profitable privileges he has and under favourable circumstances he resides in the transition zone of a settlement/cattle post area and still has land to allocate at his disposal.

In the rare cases where an enclosure is considered as a private grazing reserve it is consequently termed differently - "eekamba". The case can then be brought to the High Court in Windhoek through the initiative of the community. Questioned on these very rare issues - community members state, that the prospect of success is very limited because of lacking legal framework.

Usage of customary rights and institutional linkages

Usually the headman is still the first institution to address problems and to accept judgements. However, the level of acceptance and respect up to obedience towards the headman institution differs between the communities.

Conflict issues of all kinds are brought to the attention of the headman or to the tribal court. However, it was stated that matters would take a long time to get settled. It may be for this reason that complaints of overgrazing through intruders or trespassers at a certain cattle post area are not transferred to the headmen, since only little support is expected in this regard. In cases of cattle theft however, clear legal customary procedures are followed. The difference is made between intended and unintended theft, i.e. when a herd is driven through the area and other cattle would join.

Livestock gifting and loaning

Since cattle contributes to the status of the family who owns them, also non cattle owners are keen to at least pretend they own some heads of cattle. In this regard a loaning system has developed comparable to the system of depositing money at a bank. A rich cattle owner gives some heads of cattle to somebody who has less or none cattle. The lender remains the owner and can take off his cattle whenever he requires. To his benefit somebody takes care of his cattle. The off-spring, i.e. increase of value (like interests in a bank account), still belongs to the lender. The borrower has in return the benefit of increased status and reputation in his

community and all the products of the cattle like milk and manure. The splitting of herds in this regard can also be seen as an increased risk reduction for the lender. In Times of drought he may loose less heads of cattle. Moreover, the cattle is seen by the community as the belonging of the borrower. Such that the possession relations of the rich cattle owner are not exposed to his living environment. The gifting and loaning system is important for social implications but of minor relevance for cattle movement and off-take.

Problems of resource poor and/or female headed households

In a commercialisation process the non favourites always run the risk of being left out. If there is, however, a functioning social network by tradition through family and friendship linkages, the non favourites can profit the same way of innovations and intensified production, unless their social status and reputation within the community is not disturbed. Livestock donation by development projects to single households should be seen in this context and have reportedly led to competition and envy. In order to improve the living conditions of poor members of a community, they should rather be integrated in the development process through training - in a way, that they are enabled to offer payable service to their community, for instance basic veterinary services.

Practical steps for the enhancement of community based resource management should include the following points:

- consider the needs pointed out by the community and their own approach for solution
- work on a legal framework for land allocation
- strengthen the community requirements for the control of access to the cattle post area through community brand marks
- capacity building
- training in grazing management, external influence and examples (make aware of the effect of overlapping circles around water points, and constant gazing and equal distribution of the animals)
- create attraction for the participation of headman and extension
- concentrate on the improvement of framework conditions (water availability, vet. service) and do not interfere at the micro-economical level
- improve framework conditions for intensified production according to the development level of each community

A critical evaluation of the criteria laid down to evaluate range condition in Namibia

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Abstract of M.Sc. thesis presented in the Faculty of Environmental Resources, Arizona State University, Arizona, USA, October 1997.
Paper presented at the 2nd Namibian Rangelands Forum meeting, 31/03/1998, Neudamm Agricultural College, Windhoek, Namibia.

Abstract

The most important agricultural activity in Namibia centres around large and small stock farming which is highly dependent on the condition of the rangeland in the country. Range scientists and other field workers currently follow an ecological approach to assess condition, which uses a score sheet (attached) to focus on critical range condition features. The score sheet relies on a vegetation dynamics theory which is currently undergoing considerable worldwide debate.

Landowners, on the other hand, follow a production-oriented approach to range condition assessment, where emphasis is placed on above-ground biomass (forage) and perennial grass species. These vegetation attributes are considered crucial for sustaining their domestic herds and flocks.

The objective of the study is twofold: to investigate the relationship between range condition (as determined by score sheet), above-ground biomass and number of perennial grass species and to critically evaluate the criteria used in the score sheet relative to current ecological theory and approaches to range condition assessment in the United States.

Twenty fenced pastures were selected in the study area located on Neudamm Agricultural College, in the central Khomas Hochland savanna of Namibia. Above-ground biomass and number of perennial grass species data was collected in a systematic manner along transects located in each pasture. Each pasture was also evaluated by means of a score sheet. Statistical analysis to determine relationships utilized a multiple regression procedure. The score sheet criteria to determine range condition were compared to the rangeland health recommendations of the National Research Council, as well as the procedure of the Natural Resource Conservation Service in the United States.

The association between actual range condition score and above-ground biomass ($r = 0.7296$) was significant ($P = 0.0149$) as was the association between range condition score and number of perennial grass species ($r = 0.7821$) ($P = 0.0030$). The correlation coefficient for the independent variables above-ground biomass and number of perennial grass species ($r = 0.5778$) ($P < 0.05$) indicates that some degree of dependence exists between these variables. The model developed to describe the relationship between range condition (Y), above-ground biomass (X_1) and number of perennial grasses (X_2) is as follows:

$$Y = 2.0769 + 0.0110X_1 + 5.2628X_2 \quad (R^2 = 0.7275;\ SE = 12.4226)$$

Biomass and number of perennial species explained a significant proportion of variation in range condition score ($P = 0.0001$).

However, as the score sheet was found to be subjective, it is suggested that this finding be treated with caution. Subjectivity can be eliminated to a large extent from all proposed and used range condition indicators, but only if time, sophistication of equipment and expenses are not considerations. It was found that soil surface characteristics (determined subjectively) and above-ground biomass (determined either by clipping or estimating) encompass most rangeland condition indicators discussed in the thesis. It is suggested that these criteria could provide adequate and rapid information on range condition assessment in Namibia, as well as capture variation over landscape and time.

SCORESHEET. (Fourie, 1976)

Farm: ..... District: .....
Camp no: ..... Examiner: .....
Site no.: ..... Date: .....

Scale: Very Poor = 0; Poor = 1; Fair = 2; Good = 3; Excellent = 4.

	Mark x Weight = Total	
1. DENSITY OF PLANT COVERAGE:	x 1 =	
(a) Are there barren patches ?	+ No	- Yes
(b) Are the distance between the tufts small enough ? (% coverage of the soil high enough)	+ Yes	- No
(c) Is the coverage stable, in other words, perennial ?	+ Yes	- No
2. BOTANICAL COMPOSITION:	x 1 =	
(a) Are there ample perennial palatable productive species ? (Highly desired species)	+ Yes	- No
(b) Are there enough fairly palatable grass and small shrub species with regards to palatability, productiveness and perennial ?	+ Yes	- No
(c) Are there too many undesired species ?		
(i) Too many pioneer species and herbs	+ No	- Yes
(ii) Too many unpalatable species	+ No	- Yes
(iii) Too many woody plants (encroachers)	+ No	- Yes
(iv) Too many poisonous plants	+ No	- Yes
Criterion 1 x Criterion 2 = ... x ..... = ...	x 4 =	
3. VIGOR	x 2 =	
(a) Are there dead tufts or parts of tufts of the following:		
(i) The perennial palatable productive species	+ No	- Yes
(ii) The undesired species	+ Yes	- No
(b) Are there enough young plants and seedlings of the perennial palatable spp.	+ Yes	- No
(c) Are there little young plants and seedlings of the undesired species ?	+ Yes	- No
(d) Are there enough growth on the palatable productive perennial spp. ?	+ Yes	- No
(e) Are there little new growth on the undesired spp. ?	+ Yes	- No
4 SOIL CONDITION.	x 3 =	
(a) Are there any signs of loss of soil ? (Water erosion, wind erosion, plants on pedestals)	+ No	- Yes
(b) Are there any signs of soil surface sheet formation or driftsand ?	+ No	- Yes
(c) Are there enough litter (organic material) on the soil surface ?	+ Yes	- No
5. DAMAGE BY RODENTS OR INSECTS.	x 2 =	
(a) Are there any damage as result of rodent or insect activity ?	+ No	-Yes
TOTAL OF MARKS ALLOCATED:		

CONDITION CLASSES	VERY POOR	POOR	FAIR	GOOD	EXCELLENT
SCORE	0 - 20	21 - 40	41 - 60	61 - 80	81 - 100

TREND (In comparison to previous assessment)	DETERIORATED	IMPROVED	STABLE

CRITERIA USED MUTUALLY, AS WELL AS SEPARATELY BY FOURIE, THE NRC, THE NRCS AND LANDOWNERS IN NAMIBIA.

	Fourie and the NRC	Both Fourie and the NRCS	Only NRC	Only Fourie	Only Land-owners
Indicator/criterion					
Distrib.(density) of plants	✓				
Age class distribution and vigor	✓				
Soil Condition					
- pedestaling	✓				
- rills and gullies	✓				
- scouring and sheet erosion	✓				
- sedimentation and dunes	✓				
Litter distribution and incorporation	✓				
Botanical composition		✓			
A-horizon			✓		
Root Distribution			✓		
Distribution of photo-synthesis			✓		
Germination microsites			✓		
Damage by rodents and/or insects				✓	
Abovegroùnd biomass					✓

Discussion and afternoon practical programme

Various methods of estimating and measuring veld condition and forage yield were discussed and demonstrated. An estimation method developed by Ingrid Christian (article included) was contrasted with the conventional mensuration methods of clipping quadrats (determining yield) and determining botanical composition with the step-point method. The subjectivity of all these methods was discussed, as well as how to reduce the level of subjectivity. However, it was concluded that (a) a completely objective method of determining veld yield and condition probably does not exist and (b) that the existing methods represent a compromise between objectivity, accuracy and practicality. By the same measure, it is possible to alter the basic methods slightly to adjust them to particular practical situations.

The afternoon was concluded by visiting an on-going trial comparing high-pressure and low-pressure grazing under similar environmental conditions at Neudamm. Although visual material containing preliminary findings were handed out to participants, this material is not included in the proceedings as it is still preliminary and will be published at a later stage.

It was also decided that the Namibian Rangelands Forum should meet annually and that all participants of the first two meetings (list of addresses attached) should be invited. The Polytechnic of Namibia (Ibo Zimmermann, Dave Joubert) will be responsible for the 1999 meeting.

Translation:

Die Flächentransekte: eine Methode zur Beurteilung arider und semi-arider Weiden

I. Christian, B. Wohlleber, W. Opitz von Boberfeld

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The Area-Transect: one Method for the Assessment of Arid and Semi-Arid Pasture Grounds

Summary

In the course of a research study in Namibia it was found that conventional methods for the assessment of semi-arid and arid pasture grounds were not adequate. Thereupon the need arose to develop a method which - appropriated to the demands of a running research program - could be considered as transferable combined with general validity and facilitated application. Above that, environmental variations and a progressive approach to achieve causal research patterns was taken into account. The development of the area-transect enables us to meet these conditions.

Introduction

In the course of a research study dealing with the assessment of arid and semi-arid pasture grounds in Namibia, it was found that common methods for pasture assessment are not detailed enough for the required long-term monitoring; observations according to conventional methods represent the inhomogeneous coverage of arid pasture grounds insufficiently and are very time-consuming. Moreover, common assessment methods like abundance-, dominance or frequence-procedures (BRAUN-BLANQUET 1928, 1964) have their origin in the moderate climate zones and are hardly appropriate to arid conditions. The existing tansect method (STODDART ET AL., 1975, GLATZLE, 1990) also turns out to be disadvantageous in the above mentioned context. In order to take the requirements of a long-term monitoring into account the area transect method was developed. The area-transect is an

estimation procedure, which makes use of the advantages of the dominance-procedure for arid pastures and moreover includes further edaphic factors. Similar to the dominance-procedure of BRAUN-BLANQUET (1964) all shoot parts of all individuals of one specie are projected to the ground and the coverage rate is estimated. Since the coverage of arid pastures is often inhomogeneous, the different vegetation floors, which are difficult to distinguish in the moderate climate zones, do not exist in general. Therefore the estimation of the coverage rate is evidently more user friendly in arid to semi-arid regions than the estimation of the yield portion for instance. Due to the long dry seasons of arid and semi-arid zones the extend of soil without vegetation and the composition of the upper soil layer are as well important components, which can be recorded by the area-transect by quantitative estimation. In the course of the development of the area transect special attention is paid to the condition that the method is transferable and comparable when applied to different locations. Since we are dealing with an estimation procedure a further possibility to objectify is to have the records of a plant society taken by several people (OPITZ VON BOBERFELD, 1994); providing good training conditions, the time period for record taking can be shortened and a better comparability can be achieved. As detailed below the comparison between two locations will serve as an example to demonstrate and discuss the method of the area transect.

Methods and Materials

Choice of location

In order to give an example for the area transect, two locations with differing vegetationcover and different use in terms of stocking rates were chosen in Central Namibia. Both locations are in Khomashochland east of Windhoek, one at the Agricultural College Neudamm, Camp H17, and the other one at the neighbouring Farm Sonnleiten, Camp A3. Both camps are of approx. the same size between 90 and 100 ha. They were managed in a different way during the investigation period. Camp A3 at Sonnleiten was under high grazing pressure, while H17 at Neudamm was not grazed at all, the amount of grass was only diminished casually by wild animals and

wind. Two area transects for each camp were carried out at two different dates for the year 1994.

Experimental plant

A transect line of 30 m is first of all fixed by GPS, Global Positioning System, and marked with two sticks. A tapemeasure will be placed in order to visualise the distance. At each side along the tape measure 3 isosceles triangles are determined of a size of 50 m^2: The observing person is standing at the narrow end of the triangle and determines the scale of the coverage rates by estimating in percentages. Figure 1 illustrates the estimation plots from one to six à 50 m^2. In the first plot the position of the observer is marked with a star. Triangles were chosen for the estimation procedure, since they correspond to the natural viewpoint (angle of vision), while the size of the triangle of 50 m^2 is known and feasible. In order to record the different coverage rates a form is to be completed. Coverage rates are estimated in full percentages. Two coverage rates are estimated at any one time; they must amount up to 100 %. In our example the first two rates to be estimated in the first plot are the share of vegetation cover against the share without vegetation (together they must make 100 %). Further estimation rates to form a pair, are for instance the coverage of grass/forb against the coverage of bush/trees. The estimation pairs in the form are chosen according to bio-indicative criteria. Quantitative vegetation and soil characteristics are estimated in the same way. The form can be extended with further details according to the requirements of the research study. In the prevailing case a list of species, which is not further dealt with in this example, was recorded in addition to the transect. The recording of six triangles will in general consume one hours time and is dependant on the experience of the observer. If the location and the vegetation is well known, the time of recording can decreased. The number of transects is oriented to the homogeneity of the location and will be increased according to increasing inhomogeneity of the location.

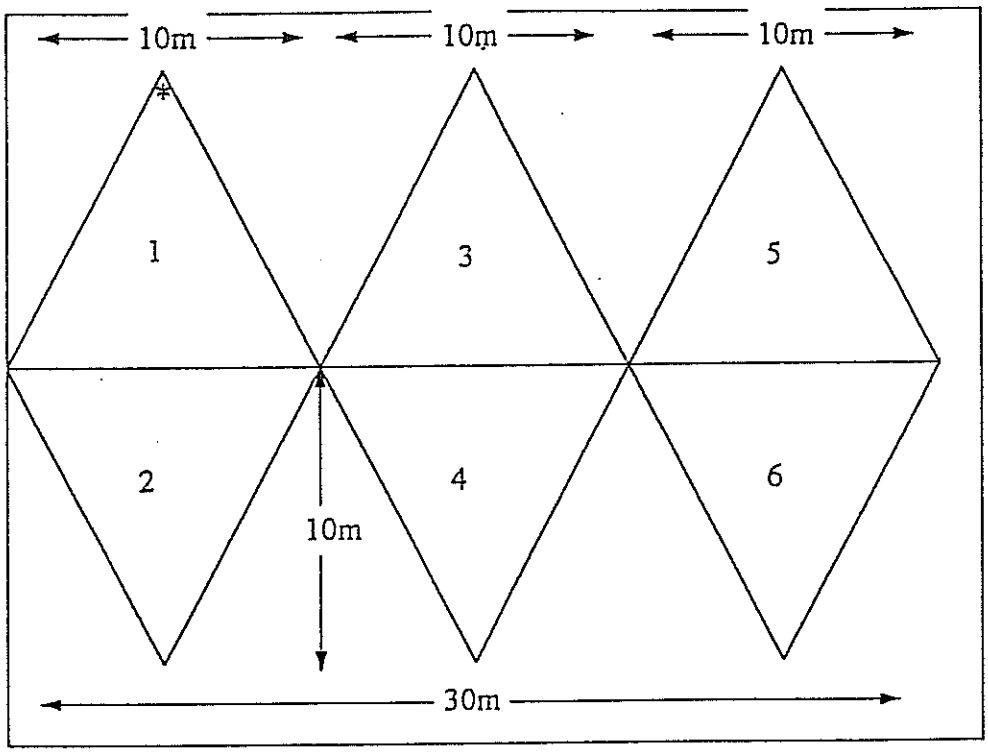


Figure 1: Outline of the area transect

Electronic Data Processing

The estimated figures recorded in the field are balanced against each other by means of the computerprogramme LOTUS 1-2-3 version 4 and the real coverage shares in percentages are calculated. Figure 2 shows the flow-diagram in LOTUS 1-2-3 version 4. It is shown that each estimation pair, which amounts up to 100 % in the field is subdivided and assigned to the initial estimation figures, either to vegetation cover or to the area without vegetation (no vegetation) respectively, in order to determine the real coverage shares or composition rates. Further the flow-diagram illustrates the estimation procedure for vegetation cover, which consists of the different species, and the estimation procedure for the composition of soil without vegetation, all edaphic characteristics. For the assessment of the size relations of litter and rocks/gravel the corn fraction of 6,3 cm, according to SCHROEDER (1983) the upper limit of gravel, was chosen. The assessment of the extent of bare soil spots </> 30x30 cm gives a hint to the homogeneity of the plant coverage. The flow-diagram further shows two

ramifications, which enable the user to retrieve different series of data. According to current requirements he/she can choose between details of the grass coverage or of the soil composition respectively. All different levels of the programme can be presented graphically.

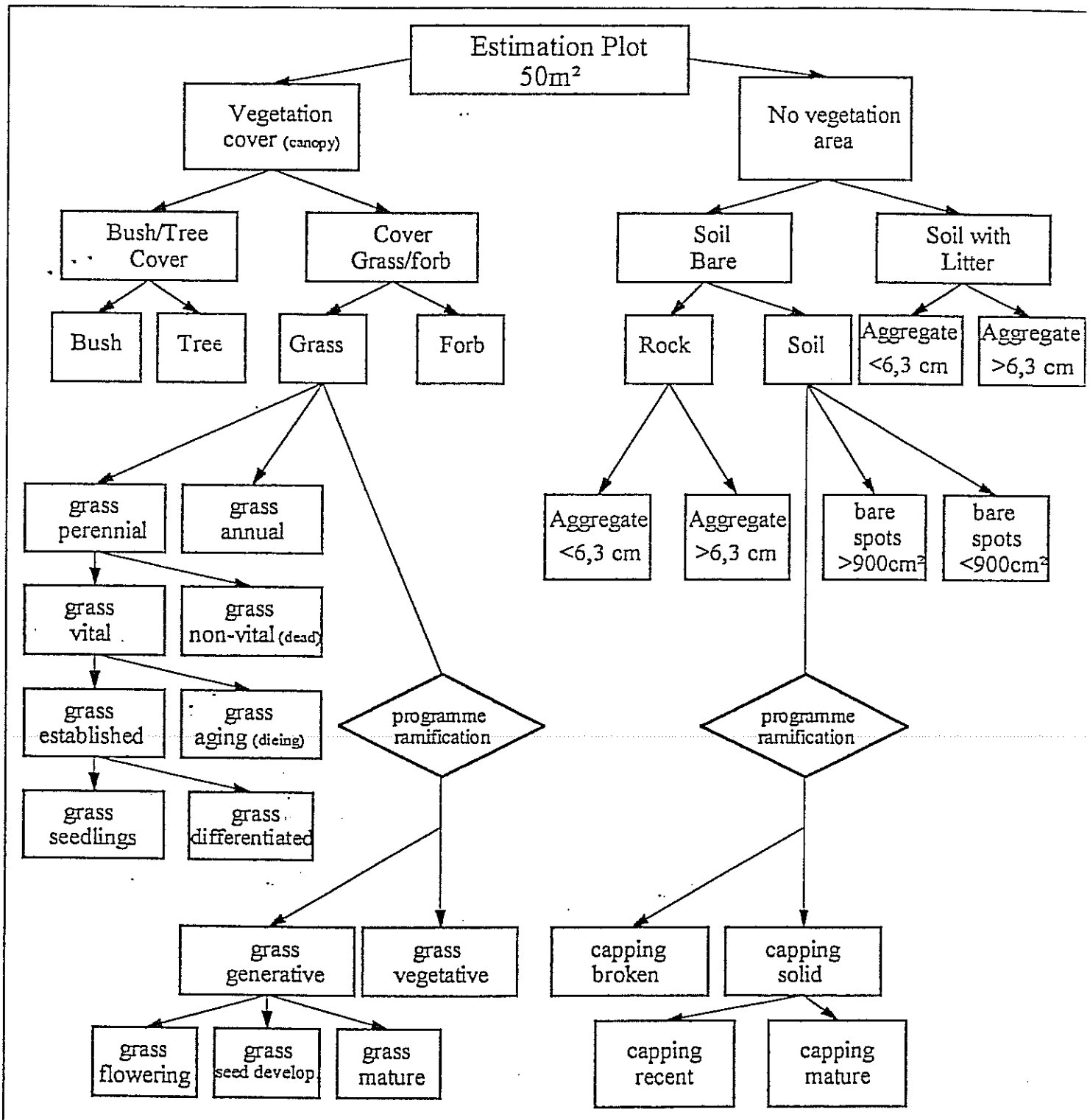
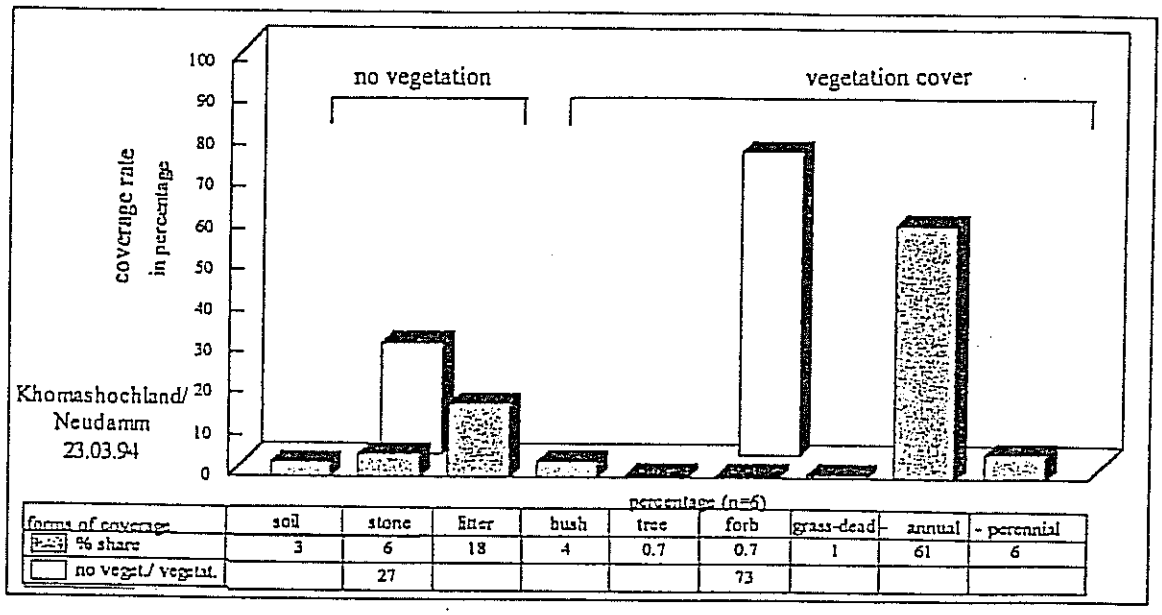


Figure 2: flow-diagram of the electronic data processing

Results

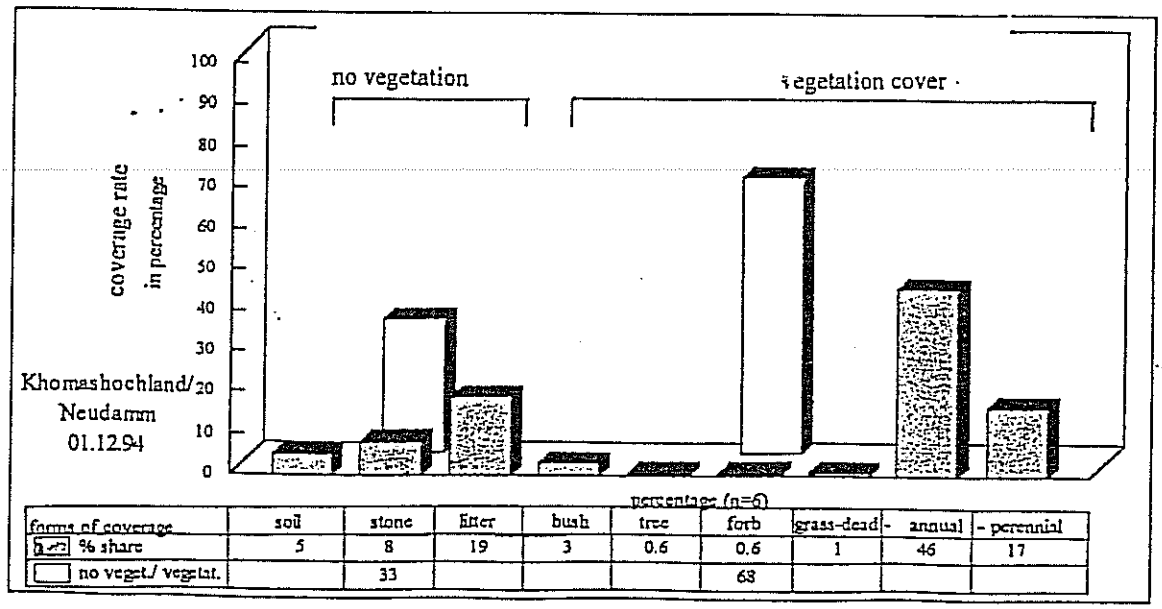
Graphic Presentation

All data recorded in the field and processed by LOTUS 1-2-3 version 4 can be presented graphically or in tabular form. As extension of the programme there is also a statistic evaluation included. Also extracts of the records of processed data can be presented graphically or in tabular form. A graphic presentation of important parts of the flow-diagram will be presented as an example below:



forms of coverage	soil	stone	litter	bush	tree	forb	grass-dead	- annual	- perennial
% share	3	6	18	4	0.7	0.7	1	61	6
no veget./ vegetat.		27				73			

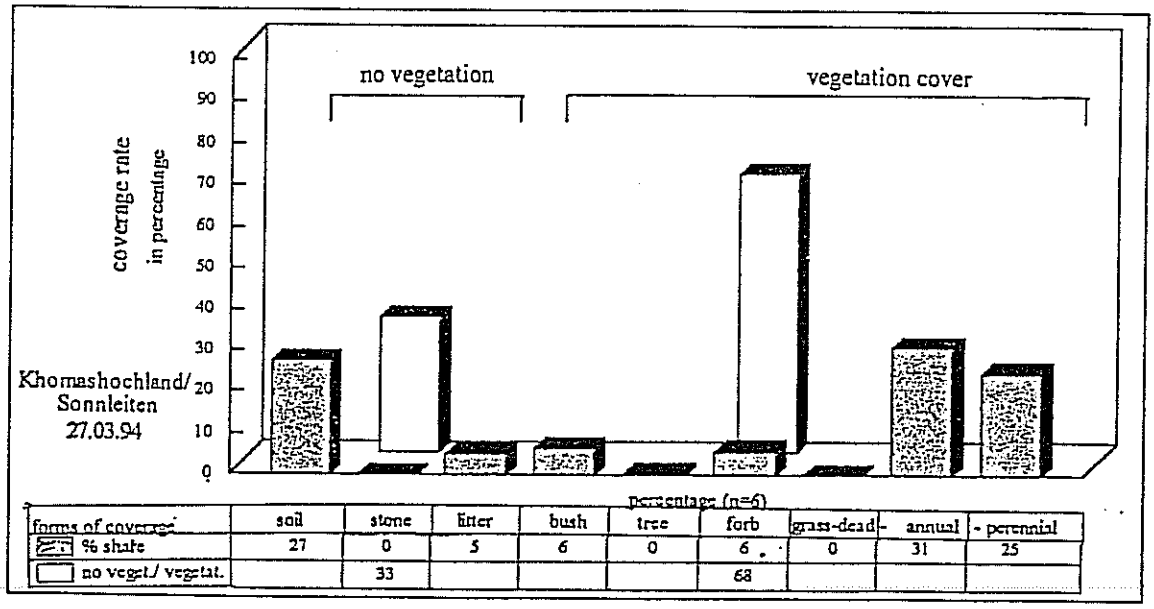
Figure 3: Area transect Neudamm, H17, 23.03.1994



forms of coverage	soil	stone	litter	bush	tree	forb	grass-dead	- annual	- perennial
% share	5	8	19	3	0.6	0.6	1	46	17
no veget./ vegetat.		33				68			

Figure 4: Area transect Neudamm H17, 1.12.1994

Figures 3 and 4 show forms of the coverage (= x-axis) and their coverage rates in % (= y-axis). The second level shows the extend of 'soil without vegetation' and the share of 'vegetation cover', which are split in the first level into their composition of litter, rock and soil (no vegetation) and of bush, tree, herbs, annual, perennial and dead grass (vegetation cover). Figures 3 and 4 allow the comparison between different seasons of the research location Neudamm. The coverage rate is only decreased slightly; since it is known that the location was not grazed, the loss of fodder can only be caused by wild animals and the wind. The share of annual grass has decreased at a higher proportion, since it is more sensitive to windbreak. This is the reason why the perennials reach some higher share while the vegetation coverage remains more or less the same.



forms of coverage	soil	stone	litter	bush	tree	forb	grass-dead	- annual	- perennial
% shate	27	0	5	6	0	6	0	31	25
no vegt./ vegtat.		33				68			

Figure 5: Area transect Sonnleiten, A3, 27.3.1994

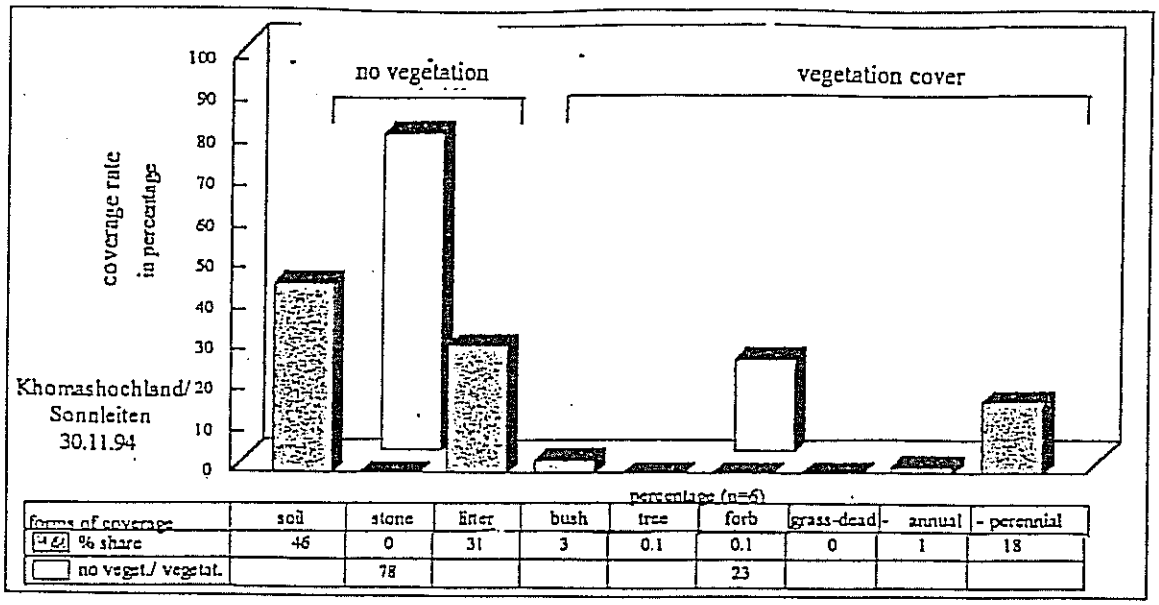


Figure 6: Area transect Sonnleiten A3, 30.11.1994

Figures 5 and 6 show forms of the coverage (= x-axis) and their coverage rates in % (= y-axis). The second level shows the extent of 'soil without vegetation' and the share of 'vegetation cover', which are split in the first level into their components. It is clearly shown that the coverage rate at Sonnleiten decreased enormously from one observation date to the other. Annual grass was utilised the most.

Figures 3 to 6 allow a direct visual comparison of quantitative vegetation changes between the different locations and between different seasons of the year. Already the comparison between the figures of coverage (2nd level of the graphs = vegetation cover) gives evidence that the utilisation of both research locations had differed a lot. The vegetation cover at Neudamm is only reduced by the decreased share of annuals due to windbreak and wild animals grazing. Thereupon at Sonnleiten the vegetation cover is reduced drastically due to intensive cattle grazing. Consequently at Sonnleiten there is a higher share of litter recorded. At Neudamm there was no increase of litter from the first observation date to the second.

Statistic Evaluation

Table 1: Estimation figures of bio-indicators

Region: / Date:		Khomas-hochland/ 23.03.94	Neudamm 01.12.94	Khomas-hochland/ 27.03.1994	Sonnleiten 30.11.1994	Sig. niveau F-Wert
Indicator	comparison groups.	end of rainyseason	end of dry season	end of rainyseason	end of dry season	n=6
Vegetation-cover	mean n=6	73	68	68	23	<0,05
	*between groups	B	B	B	A	
no vegetation	mean n=6	27	33	33	78	<0,05
	*between groups	A	A	A	B	
soil	mean n=6	3	5	27	46	<0,05
	*between groups	A	A	B	C	
rock	mean n=6	6	8	0	0	<0,05
	*between groups	B	C	A	A	
litter	mean n=6	18	19	5	31	<0,05
	*between groups	B	B	A	C	
bush	mean n=6	3.8	3.1	6.5	3.2	=0,06!
	*between groups	*a*	*a*	*a*	*a*	
tree	mean n=6	0.7	0.6	0.2	0.1	=0,4!
	*between groups	*a*	*a*	*a*	*a*	
forb	mean n=6	0.7	0.6	5.7	0.1	<0,05
	*between groups	A	A	B	A	
grass(perennial) dead	mean n=6	1	1	0	0	=0,13!
	*between groups	*a*	*a*	*a*	*a*	
grass annual	mean n=6	61	46	31	1	<0,05
	*between groups	D	C	B	A	
grass perennial	mean n=6	6	17	25	18	<0,05
	*between groups	A	B	B	B	

* = Varianzanalysis including comparison of the means according to "LSR-test " (Grenzvariationsbreitentest)

ABC = means followed by the same capital letter do not differ significantly