THE AREA-TRANSECT: ONE METHOD FOR THE ASSESSMENT OF ARID AND SEMI-ARID PASTURE GROUNDS

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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 were 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 frequency-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 species 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 amount of soil without vegetation and the composition of the upper soil layer are 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 was 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 suggestion to objectify is to have the records of a plant society taken by several people (Opitz von Boberfeld, 1994); if training conditions are favourable, the time period for record taking can be shortened and a better comparison can be achieved. The comparison between two locations will serve as an example to demonstrate and discuss the method of the area transect.

METHODS AND MATERIALS

1. Choice of location

In order to give an example for the area transect, two locations with differing vegetation cover and different 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 between 90 and 100 ha. The camps were managed differently during the investigation period. Camp A3 at Sonnleiten was under high grazing pressure, while camp H17 at Neudamm was not grazed at all and 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 during 1994.

2. Experimental plant

A transect line of 30m is initially fixed by Global Positioning System (GPS) and marked with two sticks. A tapemeasure is placed along the transect line in order to visualise the distance. At each side along the tape measure 3 isosceles triangles of 50 m_ each are determined. The observing person stands at the apex of the triangle and estimates the different coverage rates within the triangle in percentages. Figure 1 illustrates the six estimation plots. 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 angle of vision. In order to record the different coverage rates a form has to be completed. Coverage rates are estimated in full percentages. Two coverage rates are estimated at any one time and the sum of the two rates must equal 100 %. In our study the first two rates that were estimated in the first plot were the percentage of ground vegetation with cover and the percentage without vegetation cover. Further pairs of estimation rates are for instance the percentage coverage made up of grasses/ Forbes and the percentage coverage made up of bushes/

trees. All 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 completed with further details beyond our example and required specifically. In the prevailing case a list of species, which is not further dealt with in this study, was recorded in addition to the transect. The recording of six triangles will generally take one hour but is dependent on the experience of the observer. If the location and the vegetation are well known, the time of recording is decreased. The number of transects is oriented to the homogeneity of the location and will be increased according to increasing inhomogeneity of the location.

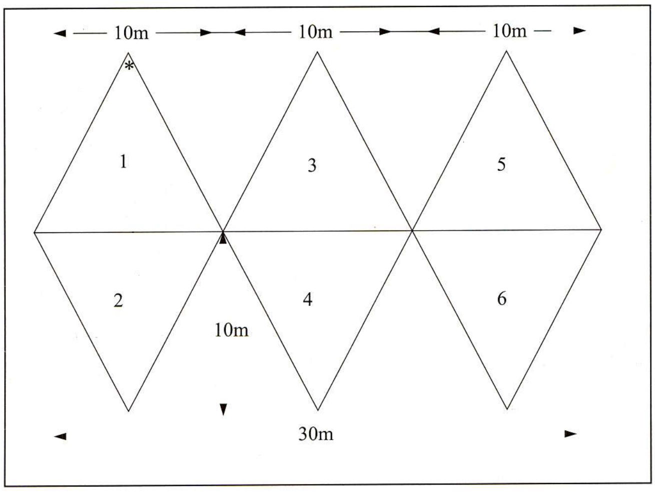


Figure 1. Outline of the area transect

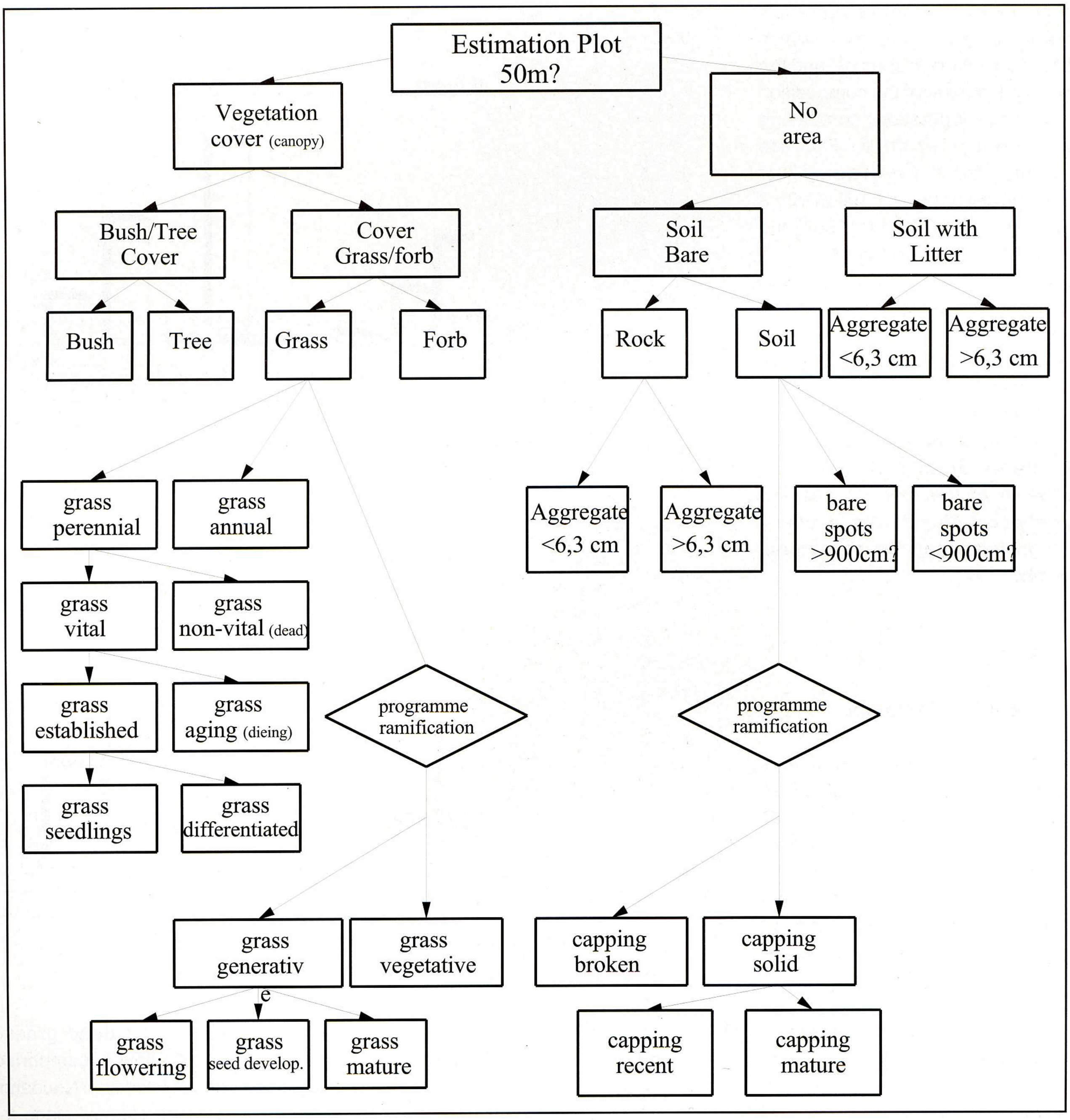
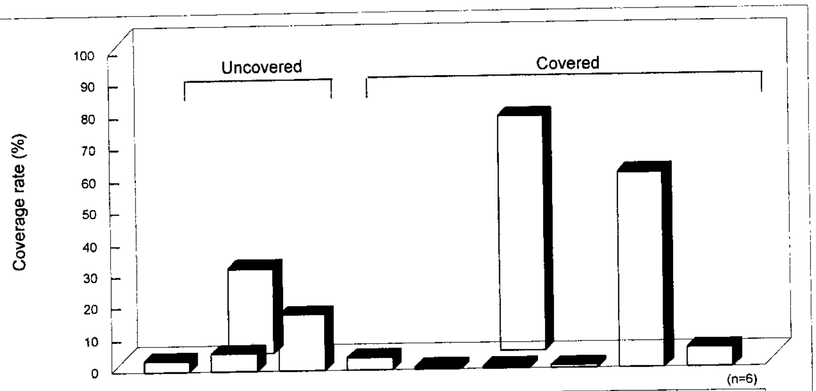


Figure 2. Flow-diagram of the electronic data processing

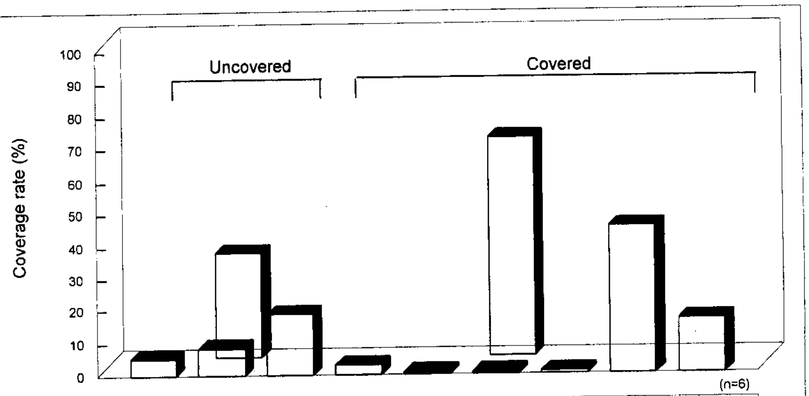
3. Electronic Data Processing

The estimated figures recorded in the field are balanced against each other by means of the computer programme 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 to 100 % in the field is subdivided and assigned to the initial estimation figures, either to the area with vegetation cover or to the area without 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, comprising 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 smaller than or greater than 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 details of the grass coverage or of the soil composition can be chosen. All different levels of the programme can be presented graphically.



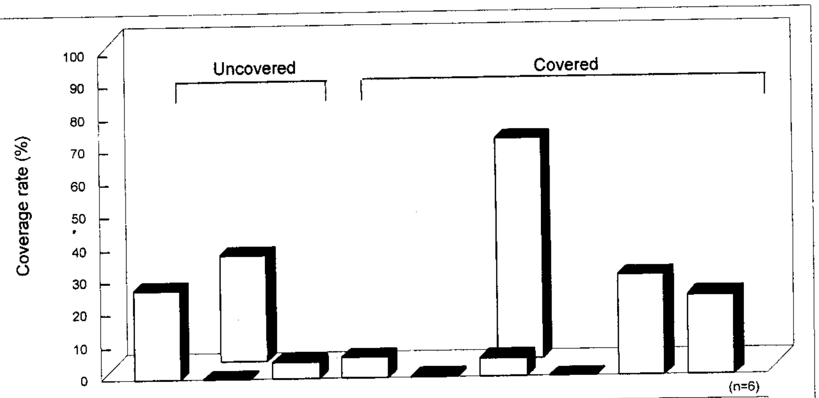
Forms of coverage	Soil	Stones	Litter	Bushes	Trees	Forbes	Grass-dead	Grass-annual	Grass-perennial
% share	3	6	18	4	1	1	1	60	6
No veget./vegetation		27				73			

Figure 3. Area transect Khomashochland, Farm Neudamm, H17, 23.03.1994.



Forms of coverage	Soil	Stones	Litter	Bushes	Trees	Forbes	Grass-dead	Grass-annual	Grass-perennial
% share	5	8	19	3	1	1	1	45	17
No veget./vegetation		33				68			

Figure 4. Area transect Khomashochland, Farm Neudamm, H17, 01.12.1994.



Forms of coverage	Soil	Stones	Litter	Bushes	Trees	Forbes	Grass-dead	Grass-annual	Grass-perennial
% share	27	0	6	6	0	6	0	30	25
No veget./vegetation		33				67			

Figure 5. Area transect Khomashochland, Farm Sonnleiten, A3, 27.03.1994.

RESULTS

1. Graphic Presentation

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

Figures 3 and 4 show the specific coverage (x-axis) and the percentage coverage rates (y-axis). The second level shows the extent of 'soil without vegetation' and the share of 'vegetation cover'. These factors are split in the first level into composition of litter, rock and soil (no vegetation) and of bush, trees, herbs and annual, perennial and dead grasses (vegetation cover). Figures 3 and 4 allow a comparison between different seasons of the research location Neudamm. The coverage rate was only decreased slightly, since it is known that the location was not grazed and the loss of fodder

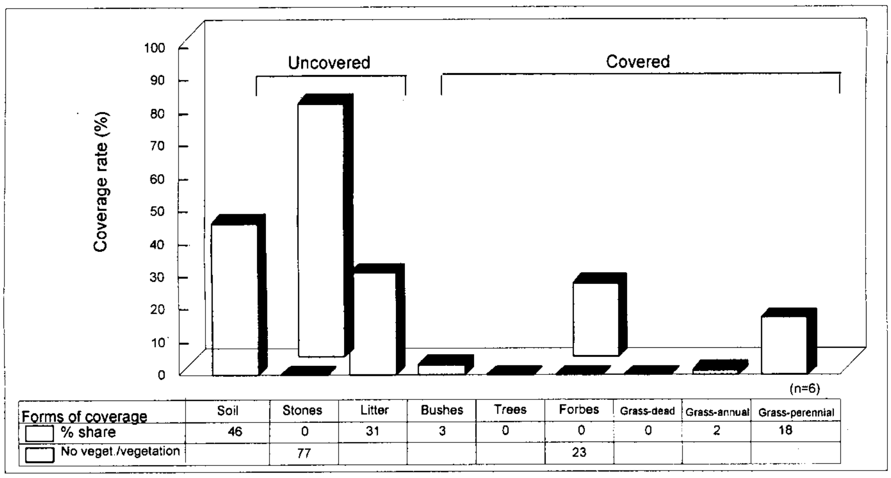


Figure 6. Area transect Khomashochland, Farm Sonnleiten, A3, 30.11.1994.

only caused by wild animals and wind. The share of annual grass was decreased substantially, as it is more sensitive to windbreak. The perennial grasses increased during the same time and thus vegetation coverage remained more or less the same.

Figures 5 and 6 show the specific the coverage (x-axis) and the percentage coverage rates (y-axis). The second level shows the extent of 'soil without vegetation' and the share of 'vegetation cover'. These factors are split in the first level into their corresponding components. It is clearly shown that the coverage rate at Sonnleiten decreased enormously from one observation date to the other. Annual grasses were 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, whereas at Sonnleiten the vegetation cover is reduced drastically due to intensive cattle grazing. Consequently, at Sonnleiten there is also a higher share of litter recorded. At Neudamm there was no increase of litter from the first observation date to the second.

2. Statistical Evaluation

The table 1 includes all estimated figures of the vegetation and the edaphon as they are presented in figures 3 to 6. The differences between the seasons of the year and between the two locations are indicated by capital letters. The recording

Table 1. Estimation figures of bio-indicators

	Region	Khomas-hochland	Neudamm	Khomas-hochland	Sonnleiten	Sig. Niveau
	Date:	23.03.1994	01.12.1994	27.03.1994	30.11.1994	F-value
Indicator	comparison groups	end of rainy season	end of dry season	end of rainy season	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 (stones)	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	
bushes	mean n=6	3.8	3.1	6.5	3.2	=0,06
	*between groups	*a*	*a*	*a*	*a*	
trees	mean n=6	0.7	0.6	0.2	0.1	=0,4
	*between groups	*a*	*a*	*a*	*a*	
forbes	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	

*Variance analysis including comparison of the means according to "LSR-test " (Grenzvariationsbreitentest)

ABC = means followed by the same capital letter do not differ significantly of data according to the flow-diagram of the area transect allows a statistical evaluation by means of one factorial variance analysis including comparison of the means between the groups according to the LSR-test ("Grenzvariations-breitentest").

The table illustrates that the differences between most of the bio-indicators found through estimation can be confirmed statistically. The coverage rate for litter, for instance, illustrates how detailed the changes of a location can be recorded and processed statistically. Between the observation dates at Neudamm there are no significant differences for litter.

At Sonnleiten there are significant differences for litter between the two observation dates, which indicate intensive grazing. All locations differ significantly in the amount of organic matter independent of the date of observation. The different grazing pressure between Sonnleiten and Neudamm is confirmed by the comparison of the coverage rates. At Neudamm there are no significant differences in the vegetation coverage rate. At Sonnleiten there is a significant change in the vegetation coverage.

DISCUSSION

1. Evaluation of the Flow-Diagram

The change of the vegetation, caused by climatic or anthropogene influences, can be recorded for several years by means of continuous estimation of coverage rates based on the flow-diagram. Also complex research requirements like dynamic interactions of soil and vegetation can be met through long-term recording and the inclusion of the characteristics of soil without vegetation and its composition. In this context Kempf (1994) ascertains that in Namibia enormous edaphic differences, apart from the climatic variability, strongly affect the succession of plant societies also in micro-spaces. Based on this, the area transect can be an important instrument of environmental assessment for the utilisation of arid and semi-arid pasture grounds. The flexibility of the flow-diagram enables us to build up a range of data, which represents the real system as a share of parameters of the prevailing conditions. This will enable us able to understand the dynamics of the system and thus to obtain detailed knowledge of the principal ways in which the system works (Benz, 1988).

2. Graphs

Graphs are essential for the visualisation of the collected data or parts thereof. They are a medium to illustrate the condition of system elements or parts of the system and provide immediate access to data collections and their tendencies. They facilitate a long-term pasture monitoring. Changes of bio-dynamic origin or of anthropogene nature as well as changes in pasture management are easy accessible.

3. Statistical Evaluation

The statistical evaluation confirms the graphs and the results in tables. As mentioned before, the significance is clearly seen. However, the transect should be placed in such a way that bio-indicators that are to be recorded are represented homogeneously in the different triangles. If an estimated figure mainly performs in zones or in certain spots, as is the case in Table 1 for the coverage rates of 'bush', 'tree', or 'grass perennial' and 'grass dead', the transect should be shifted or the number of transects increased. In order to meet the requirements of the inhomogeneous vegetation cover of arid or semi-arid areas the area transect should be repeated accordingly.

CONCLUSION

The development of the area-transect can be seen as an important contribution to facilitate the assessment of arid and semi-arid pastures. The method is less time consuming than conventional methods and is further comparable and transferable. The two presented studies in Namibia give a detailed reflection of the situation and condition of the two research locations and introduce numerous possibilities of interpretation confirmed by statistical processing of the data. Since criteria for the record procedure are flexible and can be appropriated to research requirements, it is possible to monitor dynamic biologic changes and edaphic interactions in their causal connection. The area transect is above all suitable for large areas and long-term monitoring, since the method can provide reliable data while reducing the field observation time.

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