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Vegetation degradation trends in the northern Oshikoto Region:
II. The *Colophospermum mopane* shrublands

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Abstract

A proposed rural water supply scheme in the northern Oshikoto Region will impact on the settlement patterns of the rural population. For this reason, an environmental impact assessment was commissioned.

In this paper the degradation gradients found in the shrublands on the eastern fringe of the oshana system, dominated by Colophospermum mopane*, are discussed. Degradation is mainly due to deforestation by the over-utilisation of wood.*

Although a classification is given on various species' reaction to degradation in terms of decreasers and increasers, this is to be seen as preliminary and to be used with caution.

Keywords: *Colophospermum mopane*; coppice; degradation trends; deforestation; desertification; indicator species; Namibia; silviculture

Introduction

The Oshivelo - Omutsegwonime - Okankolo area in northern Oshikoto Region has been identified for a rural water supply scheme (Lund Consulting Engineers 1998). An environmental impact assessment was commisioned in the planning phase of this project (Strohbach 1999). This paper is the second in a series, discussing degradation gradients found in the *Colophospermum mopane* shrublands.

Study Area

The study area consists of a strip 30 km wide north of the tarred road between Tsumeb and Ondangwa (B1) from 17° East to Okatope, as well as a 5 km south of

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the road. This paper deals with the transition between the oshana system to the west and the broad-leafed savannas to the east and north (see Figure 1 in Strohbach 2000).

Geology and Soils

The *Colophospermum mopane* shrublands are found on the Kalahari deposits (Geological Survey 1980). Being a transition between the oshana system and the deep sand-plateau of the Kalahari, the sands show signs of water-logging in the deeper soil horizons. Strohbach (1999) summarises a profile as follows:

Top 5 cm: Bleached grey-white sand.
Next 45 cm: Dark loamy sand, seems very humic.
Below 50 cm: Yellow grey sand, mottled.

The mottling observed in the lower (B) horizon could indicate some water stagnation in the lower soils profile. However, the dark loamy sand of the A horizon seems to be rather fertile, with a fair potential for cropping.

Vegetation

This is a typical example of the "Mopane Savanna" as described by Giess (1971). Giess describes this vegetation type as dominated by *Colophospermum mopane*, which occurs both as a shrubland or woodland. Giess mentions frost damage and soil differences as causing factors for different structure forms.

From Okatope east- and northwards the *Hyphaene petersiana* plains are replaced by *Colophospermum mopane* shrublands. These are characterised by a fairly dense stand of *Colophospermum mopane*, or the Mopane, as tree (seldom) or shrub. These shrublands are basically the outer fringe of the Oshana system, the KAL9-4 agro-ecological zone (de Pauw *et al*. 1998/99). They occur in the far western parts of the study area, with patches occurring along the main road in the *Terminalia pruinoides* woodlands. To the north and north-east (towards Okankolo), this shrubveld is gradually replaced by broad-leafed savannas, whilst to the south-west, the vegetation is replaced by the *Terminalia pruinoides* woodlands. This transition is very patchy in nature.

Occurring typically in these shrublands are the shrubs *Croton gratissimus*, *Mundulea sericea*, *Grewia flavescens* and *G. bicolor*, and the grasses *Stipagrostis uniplumis* var. *uniplumis*, *Aristida stipoides* and *Eragrostis trichophora*. To the south, some *Odyssea paucinervis* occurs, whilst to the east *Terminalia pruinoides* and *Albizia anthelmintica* become prominent. To the north, *Terminalia sericea* becomes prominent, and gradually the mopane is then replaced by *Combretum collinum*. The structure is typically a high closed shrubland.

Methods

A detailed description of the survey and data processing methods is given in Strohbach (2000). Twenty relevés were sampled in this vegetation type.

Results

Degradation gradient

The scatter diagram of the DCA axis 1 and 2 is presented in Figure 1. A known degradation gradient has been plotted on this scatter diagram, and Axis 1 has thus been identified as the degradation gradient (Compare also with Photos 1, 2 and 3). This axis has an Eigenvalue of 0.708, which means that the axis represents approximately 48 % of the variation in the data set (compared to Axis 2 with an Eigenvalue of 0.528, which represents approximately 36 % of the variation). This is further proven by the biplot in Figure 2, which indicates typical degradation indicators like disturbances and compaction of the soil opposing vegetation height along the 1st Axis. Axis 2 represents a strong habitat gradient, most likely a gradient from more sodic / saline soils in the south-west to more sandy soils in the north-east.

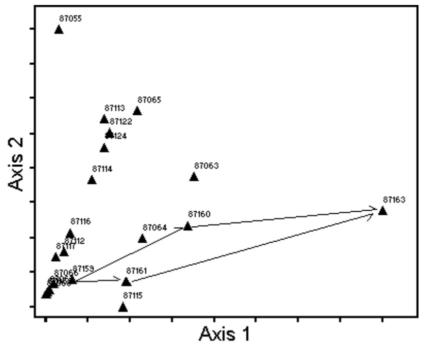


Figure 1: DCA ordination scatter diagram, with a known degradation gradient indicated (compare to Photos 1, 2 and 3).

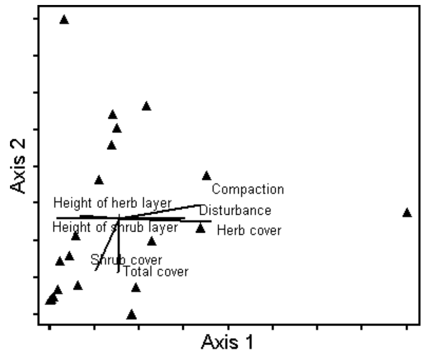


Figure 2: Biplot of the DCA ordination, indicating the influence of environmental factors on diversity.

With the degradation gradient identified, the reaction of various components of the vegetation to degradation could be tested. For this purpose, the measurements of these components were put as dependants against the degradation gradient, and a trendline (either calculated by way of an exponential regression or a 2nd or 3rd order polynomial regression - whichever gave the best fit) was fitted.

Photo 1: *Colophospermum mopane* shrubland in fairly good condition at relevé 87159 south of Onankali.

Photo 2: *Colophospermum mopane* shrubland in poor condition at relevé 87160. This relevé is ca. 600 m north of the previous.

Photo 3: Extreme degradation in *Colophospermum mopane* shrubland at relevé 87163, ca. 0.9 km south of Onankali. The remaining shrub is *Pechuel-Loeschea leubnitziae.*

Species reaction to degradation

Figure 3a depicts the change in tree and shrub cover over the degradation gradient, whilst the change in height of the vegetation (expressed as the height of the tree/shrub layer) with progressing degradation is shown in Figure 3b.

Colophospermum mopane is dominant this vegetation type, covering up to 80 % of the ground with its crown canopy under good conditions (Figure 4a). The cover of trees in this vegetation type is generally low, and seldom reaches 10 %. This can be attributed to the fact that most of the trees have been cut down for poles and timber, which means that the remaining vegetation consists of coppicing shrubs only. Harvesting also leads to a fast reduction of this wood resource.

The fact that the shrub cover picks up again towards the extreme end of the gradient can be attributed to the fact that *Pechuel-Loeschea leubnitziae* invades the cleared, trampled areas (Photo 3; Figure 4b). Although this shrublet is perennial, it is to be seen as a weed, and produces no usable wood at all. It is also not palatable as browse and has been reported to taint the taste of milk and meat (Wells *et al*. 1986).

Although a fair number of other woody species are present in this vegetation type, none attain a high abundance, mostly well below 5 % cover. *Boscia albitrunca* reacts as a typical Decreaser (*sensu* Voster 1982) (Figure 4c), whilst *Acacia nilotica* and

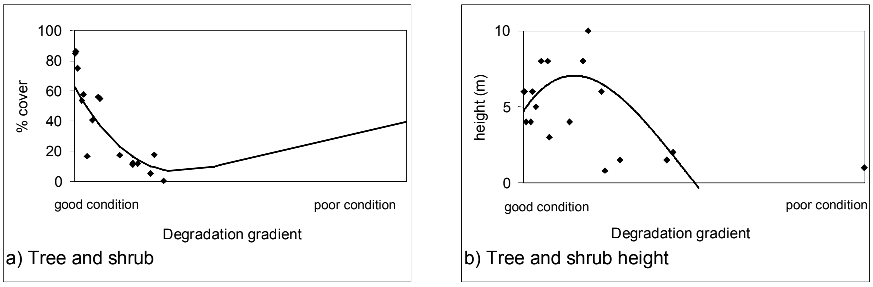


Figure 3: General reaction of the woody vegetation to the degradation trend.

Dichrostachys cinerea, both known as encroachers, react as Increaser III's (Figure 4d & e). Both species however do not become very abundant. Interestingly enough *Acacia mellifera* subsp. *detinens*, which is a strong encroacher elsewhere, is very scarce in this vegetation type. *Mundulea sericea* reacts as a typical Increaser II, being out-competed in these shrublands in good condition by *Colophospermum mopane*, but also not able to withstand the degrading forces (Figure 4f).

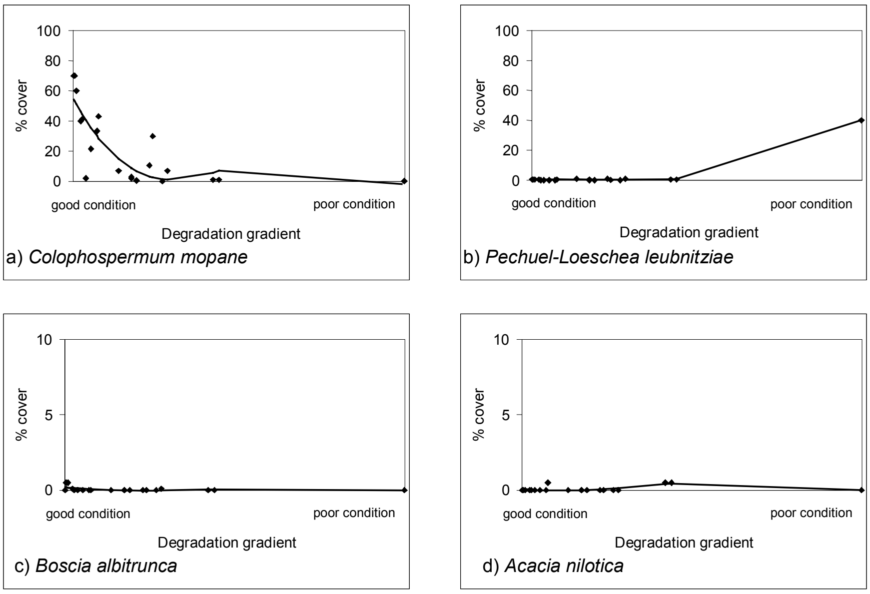
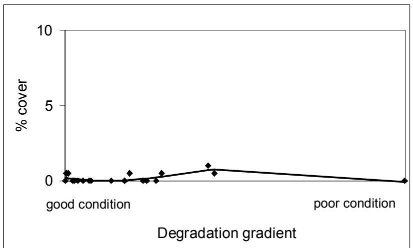
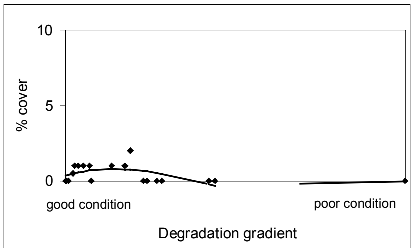


Figure 4: Reaction of various tree and shrub species to the degradation gradient.

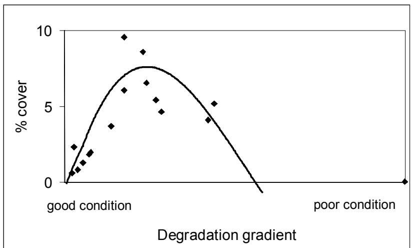


e) *Dichrostachys cinerea*

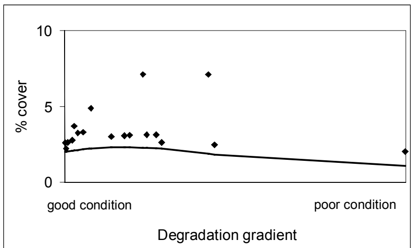


f) *Mundulea sericea*

Figure 4 (continued): Reaction of various tree and shrub species to the degradation gradient.

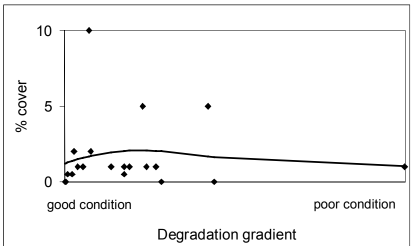


a) Annual grass cover

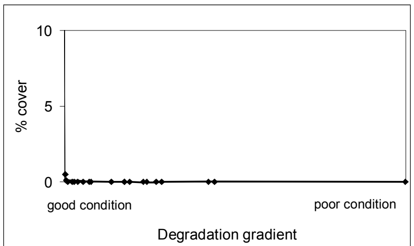


b) Perennial grass cover

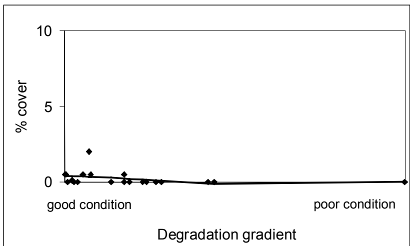
Figure 5: General reaction of the grasses to the degradation trend.



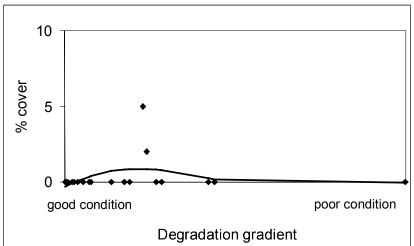
a) *Eragrostis trichophora*



b) *Sporobolus fimbriatus*



c) *Stipagrostis uniplumis* var. *uniplumis*



d) *Anthephora schinzii*

Figure 6: Reaction of various grass species to the degradation gradient.

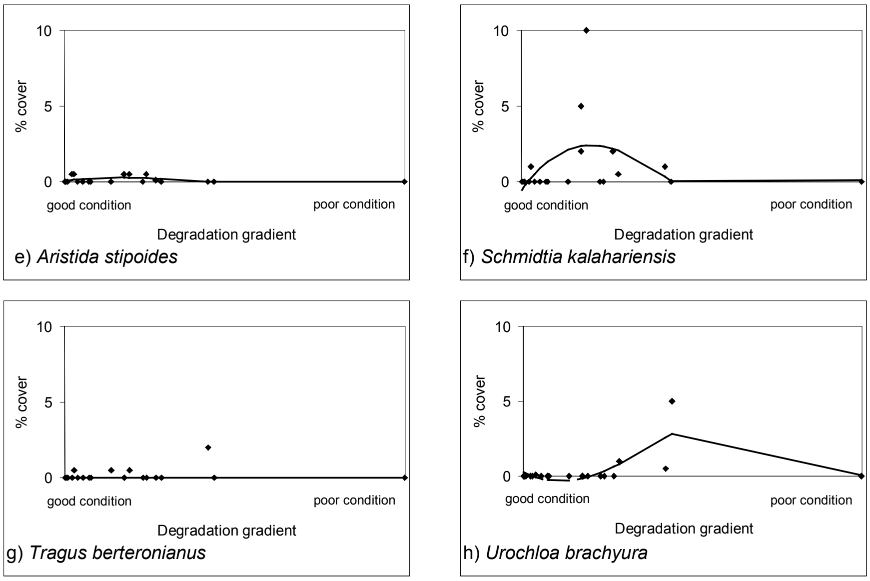


Figure 6 (continued): Reaction of various grass species to the degradation gradient.

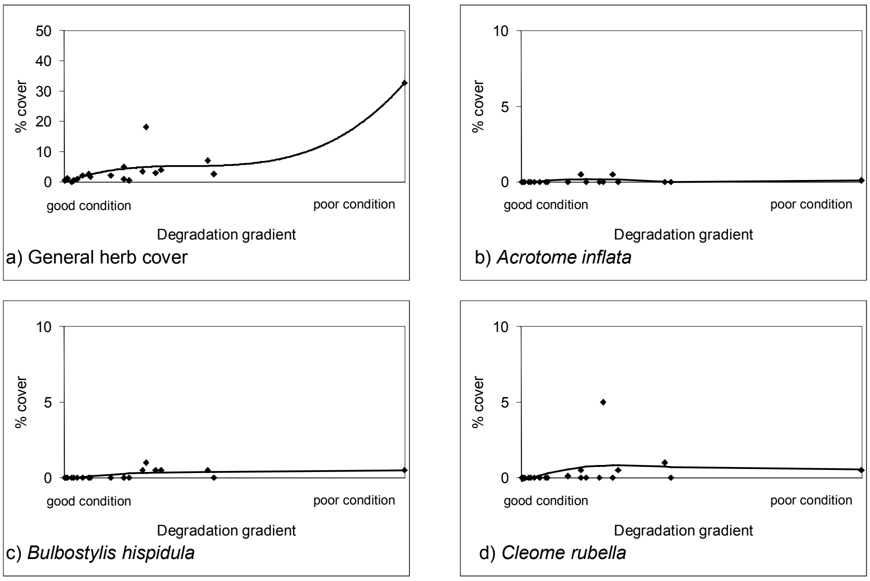


Figure 7: Reaction of various herb species to the degradation gradient.

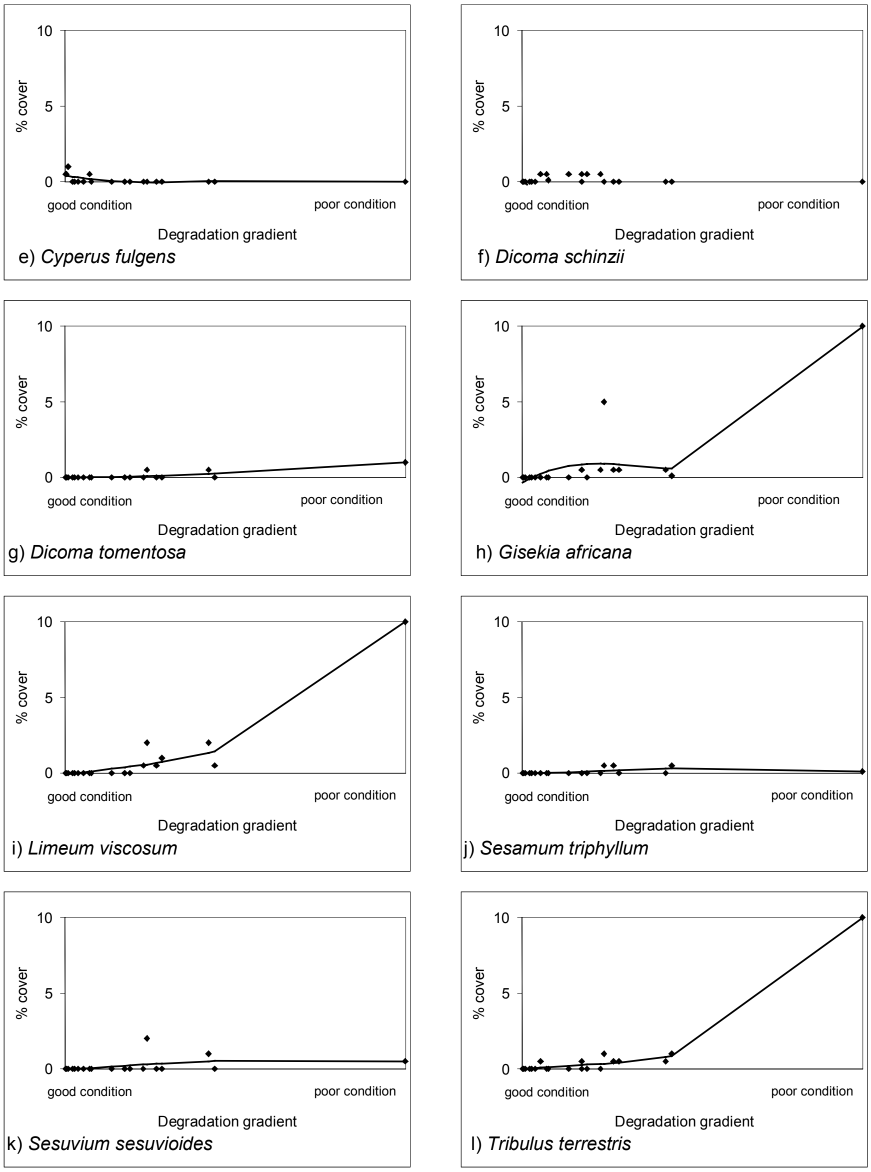


Figure 7 (continued): Reaction of various herb species to the degradation gradient.

The response of the annual and perennial grasses to degradation is shown in Figure 5 a and b. Due to the dense shrub growth, little grass biomass occurs in the shrublands in good condition. Many perennial grasses occurring in the *Colophospermum mopane* shrubland react as Increaser II's, whilst annual grasses typically react as Decreasers III's. A typical perennial grass, *Eragrostis trichophora*, reacts as Increaser II (Figure 6a), attaining a maximum of 10 % cover. Due to its low-growing, partially stoloniferous habit, it can, however, resist grazing pressure (and thus degradation) to a fair extent. *Sporobolus fimbriatus* is a typical Decreaser, occurring once only at a very low abundance in good veld (Figure 6b). This concurs with Müller (1985), who described the species as a "palatable climax grass". *Stipagrostis uniplumis* is also a Decreaser (Figure 6c), never occuring at a high abundance (mostly due to grazing), but more persistent than *Sporobolus fimbriatus*. *Schmidtia pappophoroides* occurs here as well, but is very scarse. Most annual grasses react as Increaser II's, including *Anthephora schinzii* (Figure 6d), *Aristida stipoides* (Figure 6e) and *Schmidtia kalahariensis* (Figure 6f). *Anthephora schinzii* and *Schmidtia kalahariensis* are most abundant, presenting the bulk of the available grazing biomass. *Tragus berteronianus* and *Urochloa brachyura* both react as Increaser III species (Figure 6g and h respectively). Whereas *Tragus berteronianus* (and *Tragus racemosus*) occur at a very low abundance, and thus also show only a very indistinct reaction to grazing, *Urochloa brachyura* forms a distinct peak under heavily overgrazed situations. It does not seem to establish on sites with extreme / continuous overgrazing like relevé 87163.

Herb cover is increasing as degradation progresses (Figure 7a). However, most herbaceous species have a very low abundance, showing indistinct reactions to degradation, varying between classical Decreaser to Increaser III species (Figure 7b – g, j and k). However, the species *Gisekia africana*, *Limeum viscosum* and *Tribulus terrestris* all react as Increaser IV species, dominating the herb layer in totally degraded veld (Figure 7h, i and l). Although *Tribulus terrestris* is browsed, it is also known to cause poisoning ("geeldikkop" – a photosensitivity disease) when wilted (Kellerman *et al.* 1988). It is not known whether *Gisekia africana* and *Limeum viscosum* contribute in any way to the diet of domesticated animals.

Discussion

The greatest threat to these shrublands is deforestation. These shrublands are believed not to be "natural" shrublands, but rather degraded woodlands. The occasional *Colophospermum mopane* tree (6 to 8 m high), and the numerous coppicing stumps, indicate this degradation. Although *Colophospermum mopane* is a strongly coppicing species (see Photo 4), continued harvesting will lead to the reduction of this species (as illustrated in Figure 4a). A common practice in this vegetation type seems to be the cultivation and re-harvesting of coppice. A striking example of this practice has been seen on relevé 87114 (Photo 5). The owner of this patch has removed about three-quarters of the coppice, with only one or two coppice stems remaining per plant. Yet the wood demand was not satisfied; wood harvesting went on outside the fenced plot at the time of surveying.

Photo 4: Coppicing of *Colophospermum mopane*.

Photo 5: Siliviculture: coppice of *Colophospermum mopane* has been harvested at relevé 87114.

The availability of grazing in these shrublands is a problem. Due to the dense stand of shrubs, few grasses grow to produce biomass. The main producers are *Stipagrostis uniplumis*, having no greater abundance than 2 % crown cover, *Eragrostis trichophora,* a fairly small, low growing grass producing little biomass, and the annual grasses *Schmidtia kalahariensis, Urochloa brachyura* and *Anthephora pubescens*. Although especially *Schmidtia kalahariensis* and *Urochloa brachyura* are known as good producers elsewhere in the country, the common problem with all annual plants is the nature of their life-cycle: being an annual plant, little is invested in rooting and/or leaf material production other than necessary to produce flowers and subsequently seeds. After seed setting, the life cycle is completed and the plant dies. These dry remains are soon uprooted by grazing animals and, if not eaten, trampled or blown away. A plain covered by annual plants with little or no perennial (including woody) plant cover (e.g. relevé 87163, Photo 3) is soon uncovered and subjected to wind- and water erosion during the dry season and the onset of the next rainy season.

From the results presented in Figures 6 and 7, herbaceous species showing a distinct reaction to grazing pressure have been classified as Decreasers or Increasers (Table 1). As guide to the reliability of the classification the r^2 value, indicating the reliability of the polynomial regression, has been presented. The classification of plants as Decreasers and Increasers can be used in veld condition assessment techniques like the Ecological Index Method described by Vortser (1982).

Table 1: Key herbaceous species in the *Colophospermum mopane* shrublands

Species	Fitted polynomial regression formula	r^2 value
Decreasers		
Sporobolus fimbriatus	$y = 0.117 - (0.00353*x) + (0.0000254 *x^2) - (0.0000000443*x^3)$	0.214
Stipagrostis uniplumis var. *uniplumis*	$y = 0.398 - (0.00151*x) - (0.0000181*x^2) + (0.0000000504*x^3)$	0.128
Increaser II's		
Anthephora schinzii	$y = -0.322+(0.0309*x) - (0.000234*x^2) + (0.000000404*x^3)$	0.135
Eragrostis trichophora	$y = 1.213 + (0.0216*x) - (0.000159*x^2) + (0.000000264*x^3)$	0.119
Schmidtia kalahariensis	$y = -0.535 + (0.0829*x) - (0.000673*x^2) + (0.00000120*x^3)$	0.208
Increaser III's		
Tragus berteronianus	$y = 0.128 - (0.00674*x) + (0.000103*x^2) - (0.000000224*x^3)$	0.253
Urochloa brachyura	$y = 0.268 - (0.0304*x) + (0.000419*x^2) - (0.000000887*x^3)$	0.578
Increaser IV's		
Gisekia africana	$y = -0.344 + (0.0339*x) - (0.000286* x^2) + (0.000000694*x^3)$	0.821
Limeum viscosum	$y = -0.110 + (0.00797*x) - (0.0000242*x^2) + (0.000000186*x^3)$	0.958
Tribulus terrestris	$y = -0.0235 + (0.00645*x) - (0.0000521*x^2) + (0.000000267*x^3)$	0.988

The fairly strong habitat gradient dominating Axis 2 of the ordination, and the relative low number of samples from these shrublands necessitate a word of warning to use the above results cautiously. More samples are needed, especially in the transition from poor to extremely degraded veld, but also the better veld should be sampled more intensively to restrict the strong influence of the habitat. This variation due to the habitat influence is resulting in the low r^2 values of the Decreaser, Increaser II and Increaser III species. The low r^2-values indicate a poor fit of the regression lines, meaning that the above results are to be seen as preliminary and to be used with caution. It is also doubted whether the peak condition of this veld type has been found, as most of the area is already degraded due to the settling of people (see also Strohbach 2000).

As deforestation is the main threat to this vegetation type, the people are to be encouraged to establish community forestry reserves, in which some of the vegetation is protected against excessive wood harvesting and in this way protected for future generations. Of equal importance would be a general increase in living standards, with less dependence on the natural environment for commodities like building material, etc. As pointed out by Thomas (1997), desertification is more a societal and political issue than an environmental issue. Solutions for desertification will have to be found by the society and its leaders; environmental science can at best give support by providing an understanding of the processes involved and by monitoring the advance of the problem.

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