DINTERIA No. 26: 77-92 Windhoek, Namibia – November 2000

# Vegetation degradation trends in the northern Oshikoto Region: III. The *Terminalia prunioides* woodlands and Andoni grasslands

Ben J. Strohbach

Environment Evaluation Associates of Namibia, P.O. Box 20232, Windhoek, Namibia[1]

## Abstract

*A proposed rural water supply 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* Terminalia prunioides *woodlands, being a transition between the Broad-leafed savannas to the north and east and the Andoni plains of the Etosha basin to the south, are discussed. Degradation is typically associated with deforestation as well as overgrazing and trampling.*

*Although a classification is given on various species' reaction to degradation i.t.o. decreasers and increasers, this is to be seen preliminary and to be used with caution.*

**Keywords:** Andoni plains; degradation trends; deforestation; desertification; indicator species; Namibia; northern Kalahari; *Terminalia prunioides*;

## 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 commissioned in the planning phase of this project (Strohbach 1999). This paper is the third in a series, discussing degradation gradients found in the *Terminalia prunioides* woodlands, with some notes on the adjacent Andoni plains.

[1] Corresponding address: National Botanical Research Institute, P/Bag 13184, Windhoek, Namibia

## 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 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 2000a). To note: whilst the transition to the Andoni plains is abrupt, the transition to the Broad-leafed savanna is often gradual. The *Terminalia prunioides* woodlands do occur in patches also in the Mangetti area.

### Geology, soils and climate

This vegetation unit is found on the Kalahari deposits (Geological Survey 1980), being a transition (ecotone) between the deep sand plateau to the north (specifically the agro-ecological zone KAL 3-3) and the salt plains of Etosha (ETO) agro-ecological zone (de Pauw *et al*. 1998/99).

Strohbach (1999) described a mini soil profile pit at relevé 87148 as follows:

Top: 5-8 cm light grey sand
A-Horizon: 35 cm of dark grey sand, mottled.
B- Horizon: below 40 cm, light grey-yellow sand.

The soils seem more productive than the arenosols to their north, thus also explaining the denser settlement pattern in this area. However, a remark has been made that the people here are "glad to have animals from elsewhere to graze. This ensures that there is enough manure available to fertilise the fields." This statement indicates that the soils are not as productive as assumed. (Strohbach 1999).

The *Terminalia prunioides* woodlands are within growing period zone 3 (de Pauw *et al.* 1998/99).

In the south, south of Omuthyia and Okashana (actually bordering Okashana Research Station), stretches the ETO, or Ekuma plains and Etosha Pan. These are described as plains with very low relative relief, lying in growing period zone 4. The dominant soils are Solonchaks, or undifferentiated saline soils. Some sandy, calcic and sodic soils are included (haplic Arenosols, luvic and petric Calcisols, and gleyic Solonetz) (de Pauw *et al*. 1998/99). Le Roux (1980) reports a sodium content of between 5 000 and 10 000 ppm.

### Vegetation

This vegetation type is essentaily part of the "Forest Savanna and Woodland (northern Kalahari)" described by Giess (1971).

*Terminalia prunioides* and *Albizia anthelmintica* are characteristic trees occurring in this veld type, together with *Lonchocarpus nelsii*. Shrubs include *Acacia mellifera* subsp. *detinens*, *Acacia nilotica*, *Croton gratissimus, Dichrostachys cinerea*, *Commiphora glandulosa* and *C. africana,* as well as *Grewia flava, G. bicolor* and *G. flavescens*. Some common dwarfshrubs are *Hibiscus elliotiae, Rhus tenuinervis* and *Gossypium herbaceum*. Perennial grasses are *Stipagrostis uniplumis* var. *uniplumis* and *Eragrostis trichophora*. The annual grasses are far more prominent, including *Urochloa brachyura* and *Anthephora schinzii* (Strohbach 1999).

In their natural state the *Terminalia prunioides* woodlands form tall closed woodlands or thickets (i.e. with an understorey of shrubs). However, these woodlands occur in the more densely populated areas of the study area around Omuthyia and are thus subject to some severe wood harvesting. In this way the vegetation is reduced to an open to sparse woodland, sometimes even a shrubland (Strohbach 1999).

Further south, bordering the "Saline desert with dwarf shrub fringe" of the Etosha pan, extends a tongue of "Mopane savanna". 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).

The Andoni grass plains are the easterly extension of the Ekuma plains and form a flood plain around the Etosha pan to the south – thus part of the "Saline desert" as described by Giess (1971). As the soils are sodic to saline, only a short, open grassland is supported.

## Methods

A detailed description of the survey and data processing methods is given in Strohbach (2000a). Twenty-six relevés were sampled in this vegetation type, with an additional 4 relevés sampled in the Andoni plains south of Okashana Research Station.

## Results

### Degradation gradient

Due to the dense population in the area, few proper degradation gradients were found. However, a number of different stadia of degradation, however disjunct they may be, were found. For example: various stands of well-preserved *Terminalia prunioides* woodlands were found in the Mangetti and the cattle post area north of King Kauluma school (Photo 1). Within Okashana Research Station, a small patch of

protected, ungrazed vegetation was found. This can be compared to situations just outside Okashana (Photo 2) and north of Omuthyia (Photo 3). With these plots the degradation gradient was identified on the scatter plot (Figure 1) as being represented by Axis 1, with an Eigenvalue of 0.575 (representing roughly 45 % of the variation). Grass cover is strongly influencing Axis 2, with an Eigenvalue of 0.434 (representing roughly 34 % of the variation), as depicted in the biplot in Figure 2. According to this biplot, various disturbances, of which selective clearing, wood harvesting and deforestation are the most important, have the strongest effect on the variation along Axis 1. Directly opposed to these are the height and cover of the tree and shrub strata. Along the second axis the grass cover, and linked to it the herbaceous cover, is the strongest influencing factor. This can be mistaken as being a grazing gradient; on closer inspection, however, it was found that *Anthephora schinzii* is providing the bulk of this grass cover, whilst especially the perennial grass species show their reaction along Axis 1 (Figure 5). Axis 2 thus represents a gradient from the Broad-leafed savannas to the east to the *Colophospermum mopane* shrublands to the west. The specific habitat gradient is not clear, it could have to do with water logging and/or loaminess of the soil.

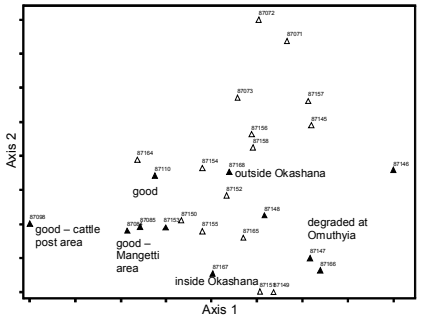


Figure 1: DCA ordination scatter diagram, with a the estimated conditions of some plots indicated (compare to Photos 1, 2 and 3).

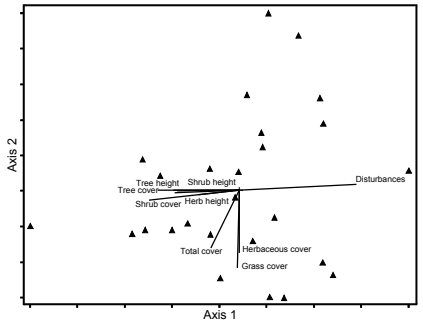


Figure 2: Biplot of the DCA ordination, indicating the influence of some vegetation characteristics, as well as disturbances, on the diversity.

## Species reaction to degradation

Figure 3a depicts the change of tree and shrub cover over the degradation gradient, whilst the change in vegetation height is given in Figure 3b. As was the case with the previous veld types, the vegetation height, tree cover and shrub cover reduces drastically as degradation progresses. The average height of the vegetation, being about 12 m (up to 15 m) under good conditions, drops to about 2 m, whilst the tree cover drops to zero. The shrub cover drops from well over 40 % to less than 10 %. This is typical for deforestation, as is happening in this vegetation type.

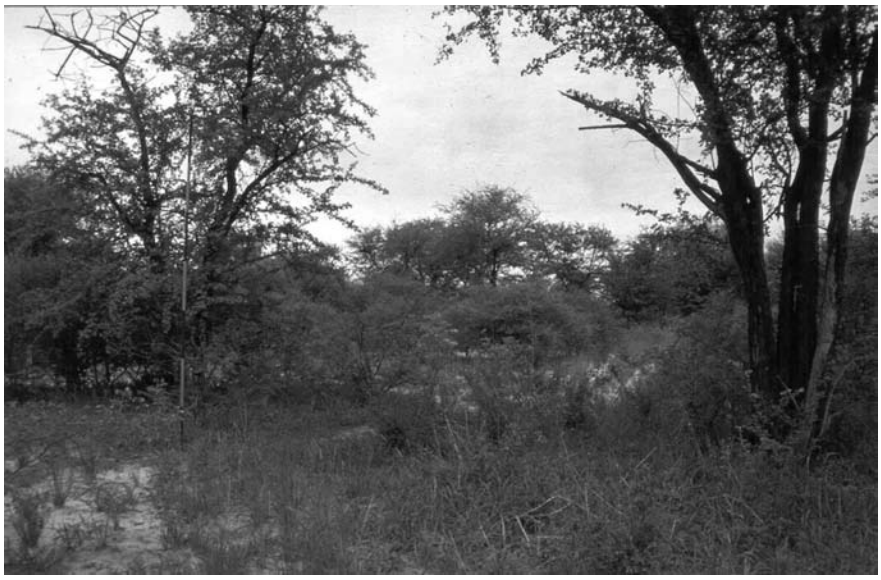

Photo 1: *Terminalia prunioides* woodlands in relative good condition. Note the relative dense undergrowth. Relevé 87098 in the cattle post area north of King Kauluma school.

Photo 2: *Terminalia prunioides* woodlands in mediocre condition. Note the little undergrowth and bare soil. Relevé 87168 just outside Okashana Research Station.

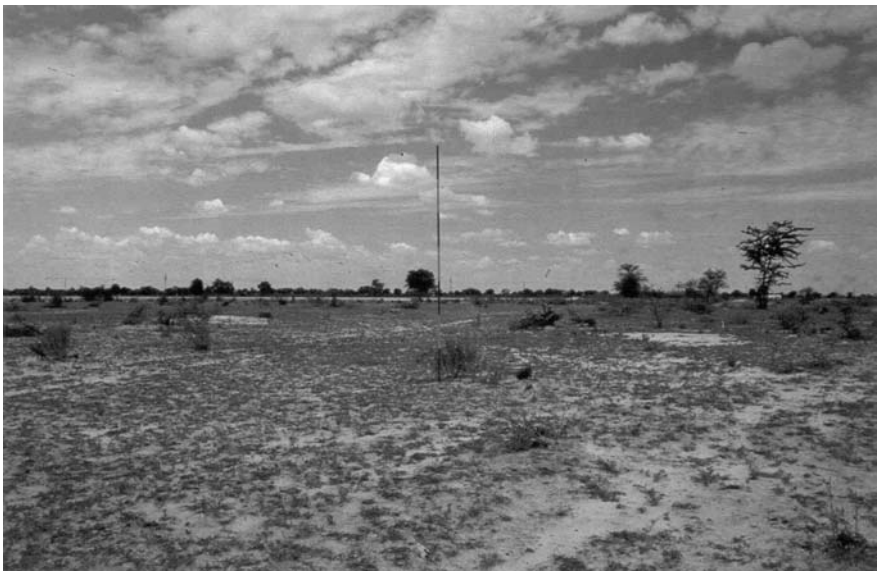

Photo 3: *Terminalia prunioides* woodlands in poor condition. Relevé 87166, at the turn-off to Okashana Research Station.

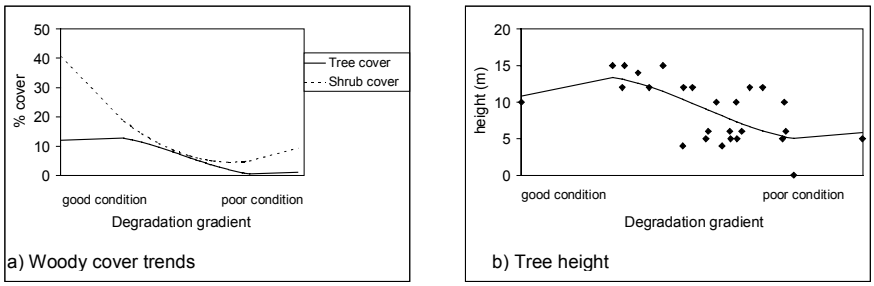


Figure 3: General reaction of the woody vegetation to the degradation gradient.

In Figure 4 the reaction of various tree and shrub species is depicted. *Terminalia prunioides*, as the dominant tree species, decreases from good condition veld (average abundance 20 % canopy cover) to less than 2 % canopy cover under poor condition (Figure 4p). This species has very poor coppicing ability: a stump which has been cut down at ca 1 m height will form some 10 cm long sprouts with a dense leaf-mass, but will never grow out long, strong branches (Photo 4). Such a stump will eventually die. *Terminalia prunioides* shrubs (young plants) were seldom seen, meaning that regeneration is low. These factors lead to a rapid degradation if the wood resource is overutilised.

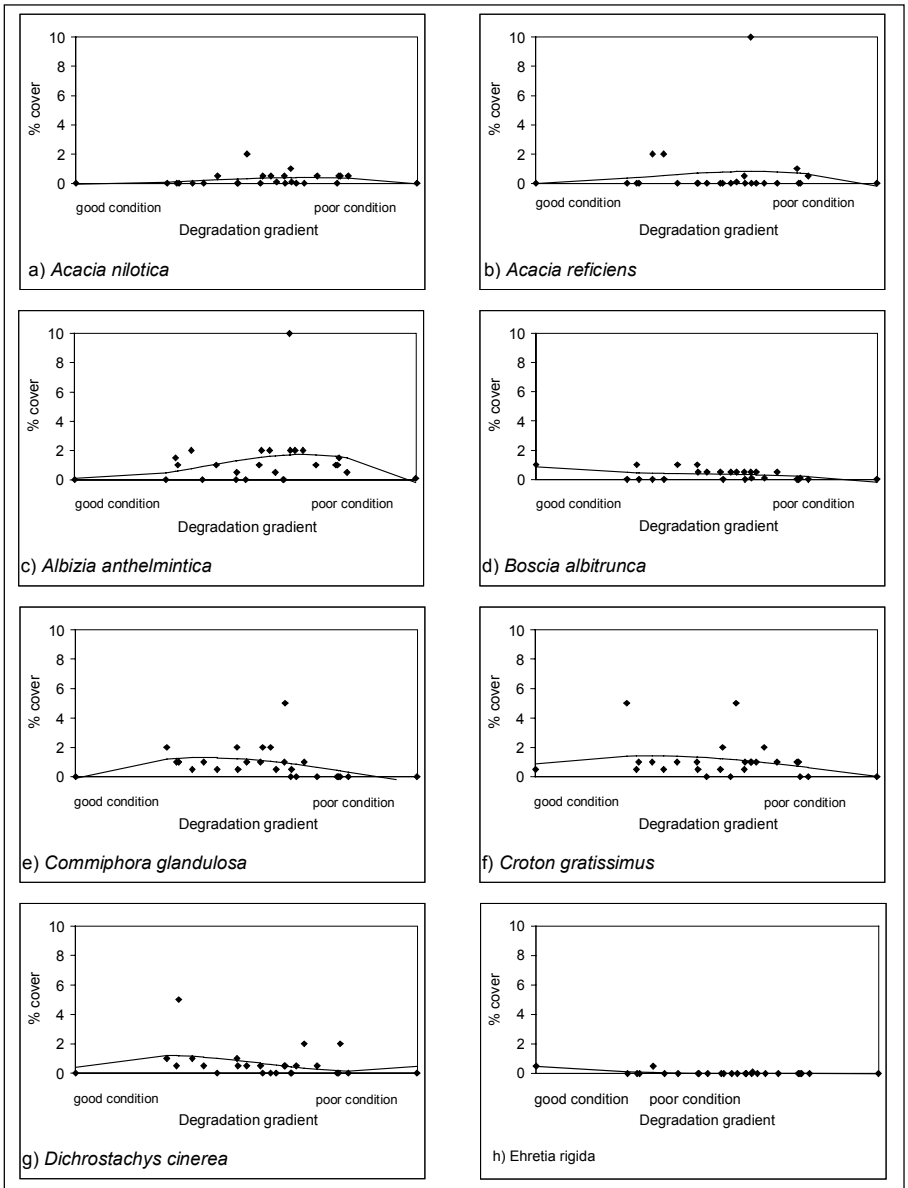


Figure 4: Reaction of various tree and shrub species to the degradation gradient.

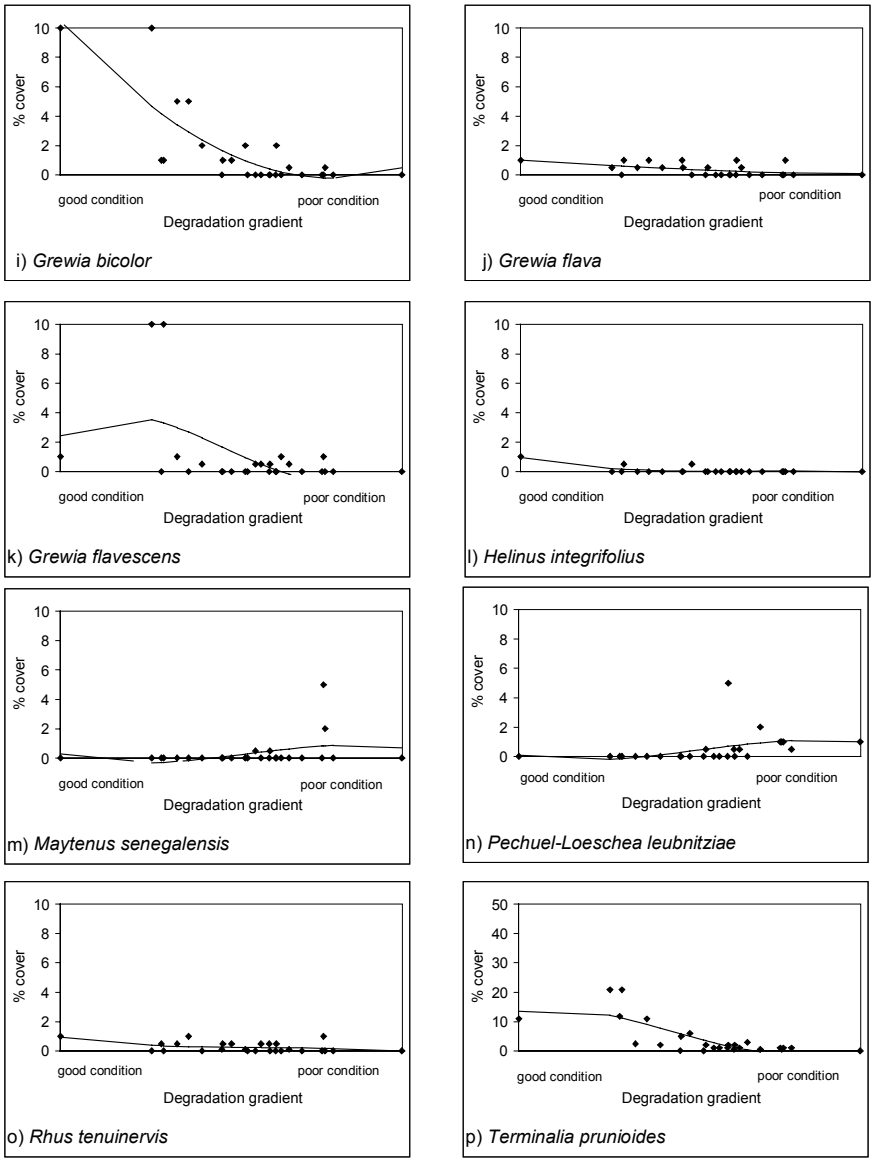


Figure 4 (continued): Reaction of various tree and shrub species to the degradation gradient.

Photo 4: *Terminalia prunioides* has a poor coppicing ability. The stump in the foreground is forming a dense leaf mass, but no twigs.

A number of shrub species are closely associated with the woodlands/thickets formed by *Terminalia prunioides*: *Boscia albitrunca, Ehretia rigida, Grewia flava, G. flavescens, G. bicolor, Helinus spartioides* and *Rhus tenuinervis* all show a tendency to decrease as degradation / deforestation progresses. The *Grewia* species and *Boscia albitrunca* are known as fodder shrubs; their reduction in abundance can easily be the result of overutilisation by browsing cattle. In contrast, *Acacia nilotica, A. reficiens, Albizia anthelmintica, Commiphora glandulosa, Croton gratissimus* and *Dichrostachys cinerea* all increase as degradation progresses, basically replacing *Terminalia prunioides*. Especially *Dichrostachys cinerea* in this way shows it's typical characteristic as encroaching species. None of these species persist; in the most degraded state they are also absent, or if present, at a very low abundance. *Maytenus senegalensis* and *Pechuel-Loeschea leubnitziae* both only appear in heavily degraded veld, indicating their weedy nature. Through unpalatablity (in the case of *P. leubnitziae* – see Wells *et al.* 1986) or strong thorns (*Maytenus senegalensis*) these two species are well protected to withstand overutilisation. In badly trampled areas like relevé 87166 (Photo 3), though, even these species do not persist.

The grass cover trends are shown in Figure 5, whilst the reaction of a number of individual grass species to degradation is shown in Figure 6. Grass cover does not exceed 35 % (due to the rather dense woody plant cover). In undisturbed situations the perennial grasses dominate but soon disappear under degraded conditions.

Typical Decreasers (*sensu* Vorster 1982) are *Schmidtia pappophoroides* and *Stipagrostis uniplumis* (Figure 6c and d). The latter also represents the bulk of the grass biomass, covering roughly 30 % of the veld under good conditions. Other perennial grasses are known Increaser III or IV grasses like *Eragrostis trichophora* and *Cynodon dactylon* respectively (Figure 6a and b) (van Oudtshoorn 1999, Strohbach 1992).

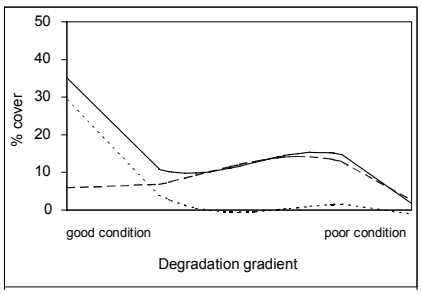


Figure 5: Grass cover trends in relation to degradation. Continuous line: Total grass cover; stippled line: perennial grass cover; dashed line: annual grass cover

The annual grass cover shows an expected peak of roughly 15 % under mediocre conditions, although under these conditions the cover of annual grasses could be as high as 70 %. Typically *Anthephora schinzii* dominates the annual grass cover (Figure 6e). According to Müller (1985), this species is well utilised by animals as it is soft and palatable. The cover of these species drops to less than 5 % under poor conditions. Other grass species reacting as Increaser II and III's are *Chloris virgata, Dactyloctenium aegyptium, Enneapogon cenchroides, Tragus berteronianus* and *Urochloa brachyura* (Figure 6g-i, k & l). Interestingly enough, *Tragus berteronianus* shows a peak under good conditions, occurring at an abundance of 5 % cover at relevé 87098. This peak is interpreted as an anomaly as both *Tragus berteronianus* and *T. racemosus* are generally regarded as pioneer species (van Oudtshoorn 1999). *Aristida stipoides* and *Schmidtia kalahariensis* both react as typical Increaser IV species, having their highest abundance under poor conditions (Figure 6f and j respectively).

Most herbaceous species show only an indistinct reaction to degradation, with a few notable exceptions. The average herb cover never exceeds 10 %, although as much as 30 % has been recorded on degraded plots. Under extreme degradation the herb cover also drops to less than 5 % (Figure 7a). *Clerodendron ternatum* (as well as *Commelina forskaolii*) are both associated with the denser woodlands / thickets under

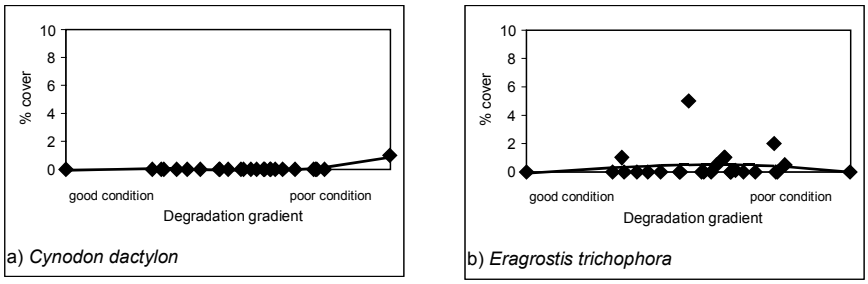


Figure 6: Reaction of various grass species to the degradation gradient.

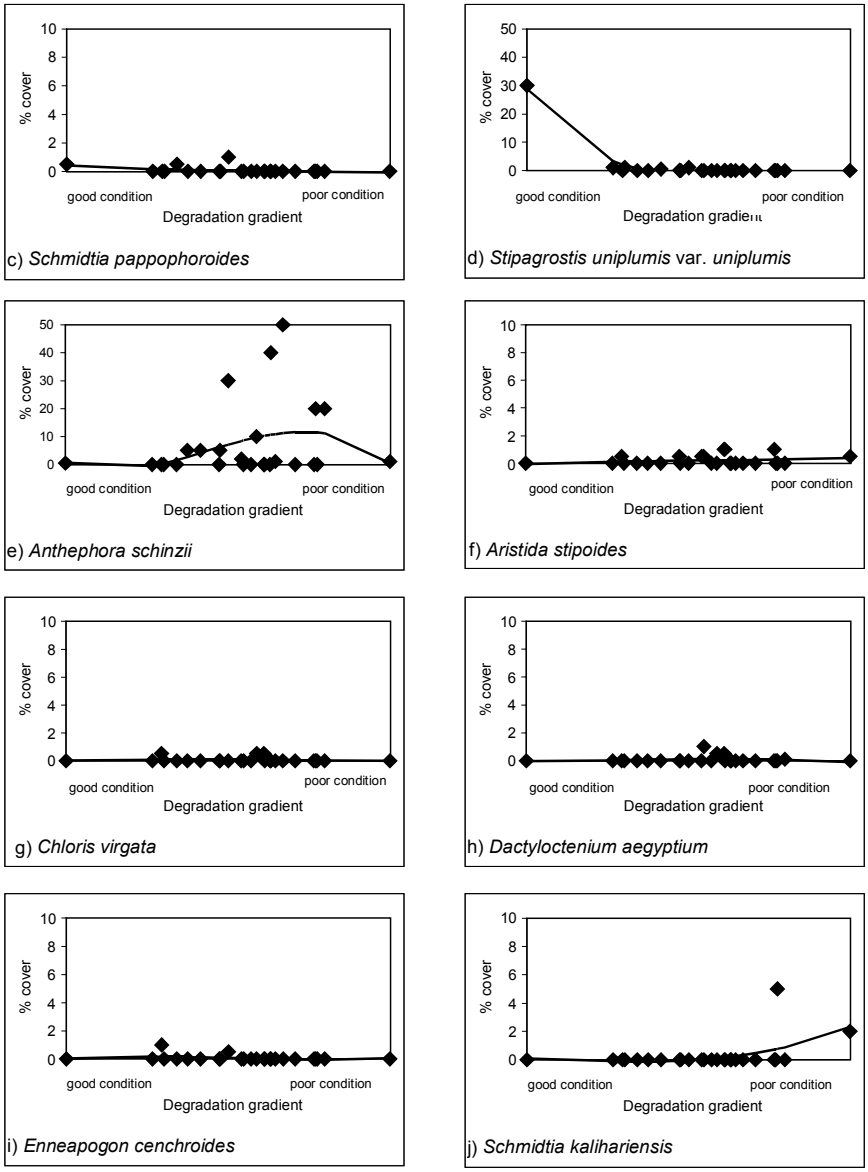


Figure 6 (continued): Reaction of various grass species to the degradation gradient.

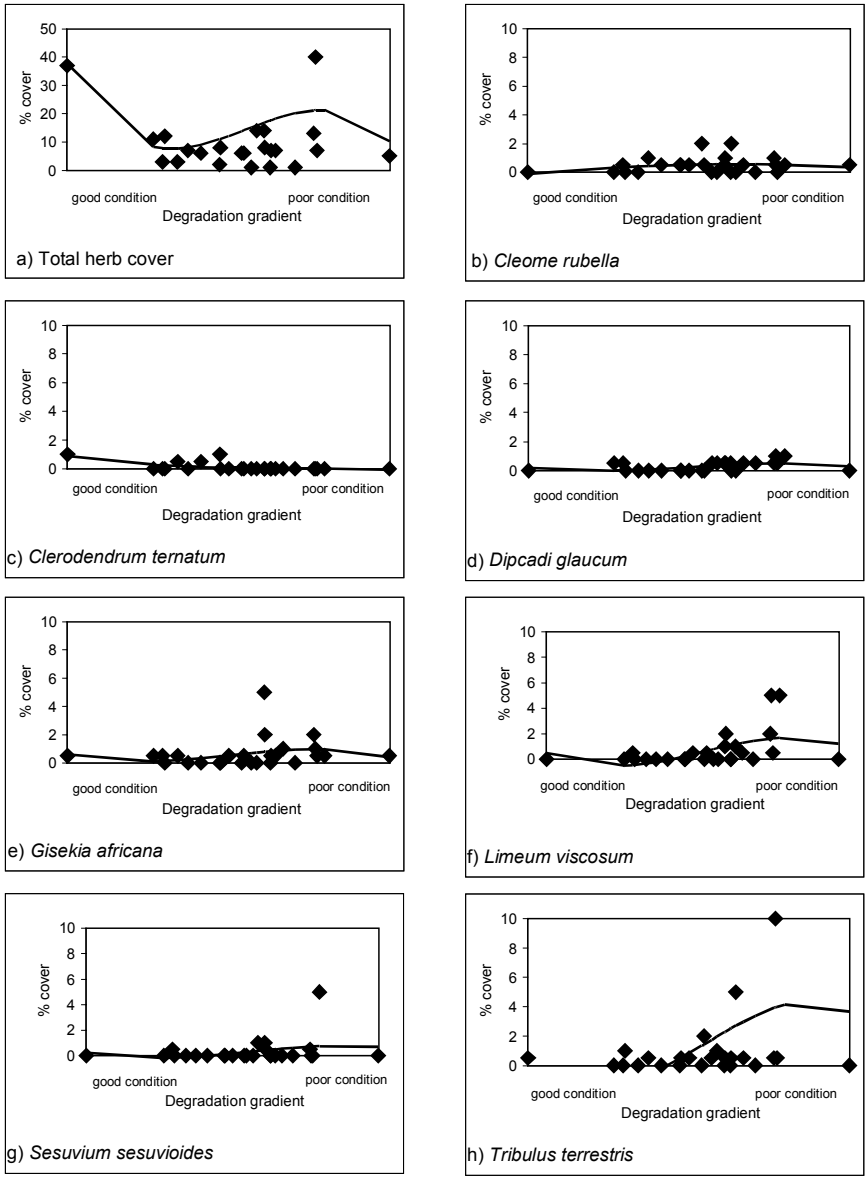


Figure 7: The cover trend of the herbaceous layer (a), and the reaction of individual herbaceous species to the degradation gradient.

better condition (Figure 7c). *Cleome rubella, Dipcadi glaucum* and *Gisekia africana* can all best be described as Increaser III species, occuring in veld in poor condition (Figure 7b, d and e). Of concern is the increase in abundance of *Dipcadi glaucum* as degradation progresses: although this species has not yet attained a high abundance, this could possibly happen. This species, better known as "malkopui", causes stock poisoning (Kellerman *et al.* 1988). Also known to cause stock poisoning when wilted is *Tribulus terrestris* (Kellerman *et al.* 1988), which reacts as a typical Increaser IV (Figure 7h) Similarly, *Limeum viscosum* and *Sesuvium sesuvioides* also react as Increaser IV's (Figure 7f and g). These species have been found to react as Increaser IV's in the *Colophospermum mopane* shrublands as well (Strohbach 2000b).

**The Andoni grass plains**

Four relevés were compiled south of Okashana Research Station along the old Namutoni road (87169 - 87172). The species composition is similar to that described by le Roux (1980) for the Andoni plains, with *Sporobolus spicatus, Odyssea paucinervis* and *Wilkommia sarmentosa* dominating the vegetation. Some clumps of *Dichrostachys cinerea* have also been found, which, according to le Roux, are invaders in these plains.

Photo 5: The Andoni grasslands south of Okashana Research Station. Note the clump of *Dichrostachys cinerea* in the background – according to le Roux (1980) encroachment – and the signs of severe sheet erosion (hollowed out bare patches) in the foreground.

Le Roux reports that this veld type is utilised by game during the dry season from the late winter onwards till the onset of the rainy season. The area south of Okashana has been declared a communal grazing area by King Kauluma (Verlinden, personal communication[2]). With the highly saline soils, this area cannot be used for anything but grazing. Overgrazing will either lead to encroachment by *Dichrostachys cinerea*, or desertification. First signs of soil erosion have already been noted in this area (Photo 5). Sodic/saline soils are known to be highly unstable regarding water erosion (Stocking, 1987).

## Discussion

Unfortunately the *Terminalia prunioides* woodlands, being a transition between the Broad-leafed savannas to the north and east and the saline Andoni plains to the south forms a linear feature, more or less parallel to the main road between Ondangwa and Tsumeb. This coincides with the main settlement pattern in the area along this main road due to the fact that transport is available and water has been supplied in previous water supply schemes (Lund Consulting Engineers *et al.* 1999). As most people are poor, they depend on the environment to provide building and fencing material (in the form of wood and brush) as well as fuel. Added to this is the fact that fields are cleared for subsistence farming. This overutilisation of the available resources, added to the poor coppicing ability of the dominating tree species, leads to a rapid degeneration of this veld type. Eventually this will lead to the formation of a desert-like barrier between the ecosystems to the north of the Etosha National Park and the National Park itself. Concern exists that such an artificial barrier could lead to the genetic isolation of certain populations not only of plant species, but animals and various other organisms as well.

It would therefore be wise to establish nodes for industrial development along this road and at the same time start establishing community-based conservation areas e.g. forest reserves to (a) conserve at least patches of this limited vegetation type and at the same time (b) conserve some linkages between two major ecosystems to the north and south of this vegetation type.

From the results presented in Figures 6 and 7, herbaceous species showing a distinct reaction to grazing pressure have been classed 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 fairly strong habitat gradient dominating Axis 2 of the ordination, and the relative low number of samples from these woodlands necessitate a word of warning to use the above results cautiously. This is also indicated by the low number of species which could be classed as Increaser II's, as well as the often extremely low r2 values. At least double the amount of sample sites would be needed to obtain a more reliable result in terms of

[2] Dr Alex Verlinden, Northern Namibia Environmental Project, Ongwediva

key species, cancelling out the, at present strong, effect of the habitat. 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 2000a and b). This is also shown by the fact that *Stipagrostis uniplumis* reacts as a decreaser in this area, whilst it has been classified as an Increaser II in a similar rainfall area east of Grootfontein (Strohbach 1992). The same is true for *Urochloa brachyura* (Increaser II here, Increaser III in Grootfontein) and *Tragus berteronianus* (Increaser III here, Increaser IV in Grootfontein).

Table 1: Key herbaceous species in the *Terminalia prunioides* woodlands.

| Species | Fitted polynomial regression formula | $r^2$ value |
|---|---|---|
| Decreasers | | |
| *Schmidtia pappophoroides* | $y = 0.442 – (0.00331x) + (0.00000962x^2) – (0.0000000107x^3)$ | 0.151 |
| *Stipagrostis uniplumis* var. *uniplumis* | $y = 28.914 – (0.3661x) + (0.00139x^2) – (0.00000166x^3)$ | 0.963 |
| Increaser II's | | |
| *Urochloa brachyura* | $y = 0.551 + (0.104x) – (0.000563x^2) + (0.000000738x^3)$ | 0.0785 |
| Increaser III's | | |
| *Anthephora schinzii* | $y = 0.585 – (0.0972x) + (0.000966x^2) – (0.00000173x^3)$ | 0.108 |
| *Tragus berteronianus* | Unreliable polynomial regression | |
| *Eragrostis trichophora* | $y = -0.0819 + (0.00372x) – (0.000000574x^2) – (0.0000000182x^3)$ | 0.0215 |
| Increaser IV's | | |
| *Cynodon dactylon* | $y = -0.0544 +(0.00406x) – (0.0000331x^2) + (0.0000000673x^3)$ | 0.884 |
| *Limeum viscosum* | $y = 0.518 – (0.0248x) + (0.000165x^2) – (0.000000241x^3)$ | 0.268 |
| *Schmidtia kalihariensis* | $y = 0.110 – (0.00166x) – (0.00000626x^2) + (0.0000000521x^3)$ | 0.241 |
| *Tribulus terrestris* | $y = 1.794 – (0.0645x) + (0.000400x^2) – (0.000000559x^3)$ | 0.167 |

## Acknowledgements

Barry Mwifi is thanked for his assistance during field work. The work was financed by the Directorate of Rural Water Supply of the Ministry of Agriculture, Water and Rural Development.

## References

DE PAUW, E., COETZEE, M. E., CALITZ, A. J., BEUKES, H. & VITS, C. 1998/99. Production of an Agro-Ecological Zones Map of Namibia (first approximation). Part II: Results. *Agricola* 10:33-43.

GEOLOGICAL SURVEY, 1980. *Namibia Geological Map* (reprinted 1990). Geological Survey of Namibia, Windhoek.

GIESS, W. 1971. A Preliminary Vegetation Map of South West Africa. *Dinteria* 4:1-114.

KELLERMAN, T.S.; COETZER, J.A.W. & NAUDÉ, T.W. 1988. *Plant Poisonings and Mycotoxicoses of Livestock in southern Africa.* Oxford University Press, Cape Town.

LE ROUX, C.J.G. 1980. *Vegetation classification and related studies in the Etosha National Park.* D.Sc. thesis, University of Pretoria, Pretoria.

LUND CONSULTING ENGINEERS, MIRIAM TRUEBODY DEVELOPMENT CONSULTANT & ENVIRONMENTAL EVALUATION ASSOCIATES OF NAMIBIA. 1999. *Feasibility Study on Water Supply to the Oshivelo - Omutsegwonime - Okankolo Area and the related Environmental Assessment*. Briefing Notes for the Honourable Minister Mr H.K. Angula, Ministry of Agriculture, Water and Rural Development, Windhoek.

LUND CONSULTING ENGINEERS. 1998. *Proposal for Consultancy Services for a Feasibility Study on Water Supply to the Oshivelo - Omutsegwonime - Okankolo Area*. Technical Proposal, Lund Consulting Engineers, Windhoek.

MÜLLER, M.A.N. 1985. *Grasses of South West Africa/Namibia*. Dept. Agriculture and Nature Conservation, Windhoek.

STOCKING, M. 1987. A methodology for Erosion Hazard Mapping of the SADCC Region. *Paper prepared for the Workshop on Erosion Hazard Mapping Lusaka, Zambia, April 1987*, Maseru, SADC ELMS. Paper prepared for the Workshop on Erosion Hazard Mapping Lusaka, Zambia, April 1987, SADC ELMS P.O.Box 24 Maseru Lesotho.

STROHBACH, B. J. 1992. Loss of genetic diversity due to veld degradation -A case study in the northern Kalahari, Grootfontein district. *Dinteria* 23:102-105.

STROHBACH, B. J. 1999. *Impact Assessment on the bio-physical environment: Oshivelo - Omutsegwonime - Okankolo Piped Water Supply Project*. Environmental Evaluation Associates of Namibia, Windhoek.

STROHBACH, B.J. 2000a. Vegetation degradation trends in the northern Oshikoto region: I. The *Hyphaene petersiana* plains. *Dinteria* 26:45-62.

STROHBACH, B.J. 2000b. Vegetation degradation trends in the northern Oshikoto region: II. The *Colophospermum mopane* shrublands. *Dinteria* 26:63-75.

VAN OUDTSHOORN, F. 1999. *Guide to grasses of southern Africa.* Briza Publications, Pretoria.

VORSTER, M. 1982. The development of the ecological index method for assessing veld condition in the Karoo. *Proceedings of the Grassland Society of southern Africa* 17:84-89.

WELLS, M. J., BALSINHAS, A. A., JOFFE, H., ENGELBRECHT, V. M., HARDING, G. & STIRTON, C. H. 1986. *A Catalogue of problem plants in southern Africa incorporating The National Weed List of South Africa*. Memoirs of the Botanical Survey of South Africa No 53. Botanical Research Institute, Department of Agriculture and Water Supply, Pretoria.