

Bush Encroachment: A Cause of Reduced Productivity and an Opportunity for Alternative Management

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Introduction

Communal and commercial farms in the central north highlands of Namibia are affected by encroachment of bush, and associated reduction in grassland productivity symptomatic of desertification. In spite of this encroachment of bush, many communal areas are suffering from a shortage of fuelwood (*Uariua-Kakujaha, pers. comm., Nov. 1997*). Namibia is severely affected by many inter-related aspects of land degradation (Seely and Jacobson 1994), and has an active programme, the Namibian Programme to Combat Desertification (NAPCOD), to combat their effects and increase public awareness in an effort to improve living standards while maintaining viable and sustainable ecosystems (Jacobson 1996).

The proposed project aims to develop a National Programme to address issues of bush encroachment in communal areas and on commercial farms. These are issues especially associated with self-employment, job creation, skills enhancement & training programs for management of bush. Justification for this is that in terms of total effect; financial, economic & ecological, bush encroachment & thickening has very large consequences. Remote sensing will be used to provide a temporal framework for the problem, and will be a component of the assessment and monitoring activities as well as of the bush-related user-friendly database for public outreach and information sharing.

The project will be divided into two phases, and will take a total of four years to complete. Existing data and information will be synthesized and gaps in information and

knowledge identified before the bush management programs are implemented. There is a strong component of local capacity building for NGOs [Planning Phase I & Implementation Phase II] and in local communities [Planning Phase I & Implementation Phase II], and many of the necessary specialists will come from the broadly based collaborating agencies, NGOs, ministries, and educational institutes as required. Ongoing monitoring & evaluation (M&E) and a small, strong management team will ensure that the project maintains flexibility but completes the proposed activities in a timely and efficient manner. Preliminary meetings and discussions have identified major participants (from communal & commercial sectors), and there is sense of urgency, commitment, and enthusiasm for addressing the issues and developing solutions.

Background

The invasion of grasslands by bush species is an effect of desertification and a serious issue in many areas of the world (*Schlesinger et al. 1990*). Bush encroachment results in a loss of species diversity, both floristic and faunal (*Brown 1985*), and a reduction in land use options, with concomitant loss in productivity, income and subsistence. Associated changes in soil chemistry and structure contribute to the "resource island" effect observed by Schlesinger et al. (*1990*) in North America, and hypothesized by Seely (*1991*) and Mouat and Lancaster to be significant in Namibia which, over time, typically results in irreversible changes in ecosystem structure and function.

Bush encroachment is defined as an increase in extent and/or density of woody vegetation species at the expense of grasses and forbs, and may be one of the most serious environmental problems in Namibia (*Bester 1996*) [estimates vary quite widely on the extent on bush encroachment hence the need for large scale monitoring on a long-term]. The main species include Black Thorn Acacia (*Acacia mellifera*) and Sickle Bush (*Dichrostachys cineria*). Subsistence losses in the communal areas resulting from desertification processes including bush encroachment have been estimated at over N\$110 million per year (*Quan et al. 1994*), are associated with considerable hardship,

and have necessitated changes in lifestyle in an attempt to continue a sustainable economy. In 1994, bush encroachment alone was estimated to affect between eight and 10 million hectares of commercially farmed rangeland in the northern region at an annual loss of over N\$ 100 million (*Quan et al. 1994*) [Quan's estimates are made based on Bessie Bester estimates of area affected which are among the highest of any made for the occurrence of this phenomenon in Namibia - hence importance of assessment of literature, surveys & ongoing long-term monitoring].

From conversations with Namibians associated with both communal and commercial farming, a recent assessment concluded that perceptions of bush encroachment and related problems are not universal. From the interviews they conducted, Mouat and Lancaster concluded that a considerable body of information exists for the commercial sector, but relatively little for communal areas, and that consolidation of data and information is an urgent need. There was agreement among the commercial farmers interviewed that total bush removal was not viable and that bush management was expensive, but there was no agreement that a single bush management method was optimal. Techniques to reduce the height of bush were considered the best option. In communal areas, bush provides valuable construction material and is important for fuel and animal browse. Although some species of *Terminalia* have been identified as problem species on some commercial farms, these or other species may be a desirable component of communal economies, providing vital fodder on a seasonal low rainfall and in times of drought.

In fact, bush encroachment may provide opportunities for some parts of Namibia through development of small businesses, creation of jobs, and diversification of land use practices. The community involvement and information sharing aspects of this project will provide an opportunity for increasing awareness of varying perceptions and values among communities in Namibia, and could be a blueprint for future projects. This aspect of community involvement could be similar to that currently occurring in the Cape Province of South Africa. Where, in the fynbos & Renosterbos habitat large quantities of water are being saved by removal of alien exotic trees esp. *Acacia mearnsii* BLACK

WATTLE [each bush uses 200 litres/day/bush (*FARMERS WEEKLY March 22nd 1996*)]. This kind of programme usefully employs people, restores ecosystem functioning & creates skills that can be used anywhere bush encroachment exists.

In addition, the creation of a diverse, user-friendly database integrating remote sensing and Geographical Information System (GIS) techniques will provide a service and capability that could be used by many agencies, NGOs and private companies to address issues on a nationwide basis.

Project Objectives

The project has five objectives:

1. Develop a National Program designed to address issues of bush encroachment.
[Phase I, II & ongoing after completion of project (self-financing)]
2. Acquire and synthesize existing information on issues related to bush encroachment in order to determine the current status of knowledge and experience, and to assess the need for additional research and analysis [Phase I].
3. Expand current program of awareness of bush encroachment issues [Phase I - planning, Phase II - implementation].
4. Develop "bottom-up" as opposed to a "top-down" approach to capacity building.
5. Develop and implement bush use and management programmes in conjunction with range monitoring, evaluation and management activities [Phase I – planning, Phase II – implementation].

Approach

In order to maintain flexibility and respond to evolving stakeholder needs, a phased approach is recommended. The two phases will consist of:

- 1) Concurrently, the collection and synthesis of existing information & studies to address specific issues.

2) Implementation, evaluation and testing of bush management and monitoring programs on implemented bush management. There will be an emphasis on community involvement in communal areas and on commercial farms, public outreach, information sharing, and scientific publication throughout all phases, and evaluation will be an ongoing process throughout the duration of the project.

In addition to bush management and use objectives, major goals of the program as a whole are the building of local capacity, creation of opportunity for self-employment, and job and skills training. These activities will be focused on farmers and rural communities in both communal and commercial farming sectors, and will also include the middle management and technical staff with collaborating agencies, NGOs, and other participating groups. The final product of the project will be an operational bush management, use, and monitoring program, with components of stakeholder integration, communication and information sharing. The database will provide a resource that will be useful for many other projects on a nationwide basis.

Phase I: Information collection, evaluation and synthesis

A priority activity in Phase I is the collection of existing data and information from all sources, and the evaluation and interpretation of these data to identify gaps. This will result in a synthesis of existing data and information, the creation of a dynamic and user-friendly bush encroachment informationbase for access by all stakeholders, and the initiation of a informationbase management program. The literature and experience review process will include investigation and reporting on differential success of past and current bush control and management methods, and also on various bush utilization efforts with particular attention to charcoal and fuelwood production techniques and market opportunities.

Phase I will also include the production of a series of vegetation and soils maps from recent satellite imagery. These maps will be imported into a GIS and used in conjunction with the bush management and use reviews to assess options and make

recommendations as to optimal strategies for both management and use. The vegetation and soils maps will be used as baseline data for components of Phases II.

A further activity under Phase I is the identification of stakeholders, particularly those actively farming, and their involvement in the program through information networking, contribution to information gathering, meetings and workshops. Stakeholder values, needs, concerns, and experiences will be ascertained and discussed in a series of perception studies, with the aim of identifying similarities and differences between communal and commercial sectors to assist in planning for Phase II of the project. In particular, stakeholder volunteer groups will be used as forums for discussion of self employment opportunities, job creation and skills training, selection of indicators of rangeland condition for the monitoring program, charcoal and fuelwood use and marketing, and to provide feedback on efficacy of the public awareness program and the interactive bush-issues informationbase. A particular emphasis of Phase I activity will be the collection of information and experiences on range condition and land use practices from older community members, and those who have been farming for long periods.

Including a four-month period for identifying and hiring key project personnel, the first phase will be completed within 18 months from the start of funding, and will include detailed planning and preparation for Phase II. The bush management plots, and charcoal and fuelwood production studies are linked to the vegetation assessment and stakeholder identification activities in Phase I, and therefore it may be possible to begin these two studies late in Phase I. The core activities involved in Phase I are as follows:

Literature review

A comprehensive literature, information and experience review will be compiled in association with a number of groups, organizations and individuals including DRFN, NANGOF, the DEA/MET, NAU (commercial farmers) and NNFU(communal farmers), the UNAM, Polytechnic of Namibia, MAWRD, NGOs and CBOs, community groups, and other stakeholders. The review will synthesize information on the origin and extent of issue, relevant government policy, the parties involved, management and use methods

and results, and an international perspective on bush encroachment issues. Published material, results of previous management activities, studies and experiments, unpublished information and oral contributions will all contribute to the review. The personnel involved in the literature and information review will also conduct a review of bush management methods, and also of bush use methods.

Informationbase development and management

Results from the review of existing information and experiences will be used to develop a bush encroachment informationbase with a user-friendly format for stakeholder access. This will form the core for the National Bush Program informationbase, which could become an inter-agency collaborative effort with multiple potential contributors and users. There will be a relatively heavy investment of effort in Phase I establishing the informationbase and GIS components, involving assessment of the quality of existing data, retrieving existing digital data and creating GIS coverages from non-digital data. A part of the Phase I component will be the investigation and development of alternative strategies for making the bush encroachment informationbase available to all stakeholders in digital, printed and graphic forms, and as oral and workgroup presentations. The techniques developed and tested in this project could be blueprints for future public outreach programs in Namibia.

Vegetation and soils assessment

An assessment of the current vegetation composition and cover based on recent Landsat imagery will provide up-to-date information on the spatial extent of bush, and on its relative density. It will also provide a picture of desertification as a framework for the bush encroachment issue. It is anticipated that the National Remote Sensing Center (NRSC) will take the lead in this activity, with some assistance in an advisory capacity from DRFN. It may be necessary to hire additional staff for image processing and GIS, as many of the NRSC staff are on training during 1998.

Recent satellite imagery will be acquired, processed, and classified into vegetation types based on a suitable vegetation classification scheme and results from field-based

vegetation surveys (including the bush management test plots). The computer driven supervised vegetation classification will be verified in the field, and the resulting image imported into GIS. It will then be integrated with soil survey data, hydrology, and ancillary data as needed. The GIS will be used to generate vegetation composition and cover maps and summary statistics that will be used as management and policy planning tools as well as graphic displays for information sharing at all levels. Results of this activity will be available on an interactive basis to participants for their contributions, access, and review.

Identification of stakeholders, values and perceptions

In association with NGOs such as NANGOF, Agricultural Extension Officers, health and community workers and others, a series of workshops will be conducted in communal areas, at Farmers Groups meetings, and in urban centers to identify stakeholders. We recommend that a specialist in public outreach, health or social services be involved in this process, as a number of interest groups are involved and an outsider may be more successful in acquiring stakeholder participation and setting up mechanisms for feedback. A range of presentation material and questionnaires will be developed, and then two or three pilot workshops will be conducted with groups who will provide feedback for revision of workshop content and presentation material. Ideally, there will be several participating stakeholder volunteer groups from each sector of the community, and their farms in both communal and commercial areas will have some variation in degree of land degradation and bush encroachment.

The in-depth interviews with stakeholder volunteer groups will be used to gather information, particularly from older community members, on land status and land use practices which will provide input and feedback to the vegetation and soils assessment and landscape change analysis activities. Groups will also be encouraged to share their perceptions regarding charcoal use, the market potential for charcoal and fuelwood sales, and the nature and extent of incentives/rewards that would facilitate this form of bush utilization industry.

Bush management plot study

Different bush management treatments were tried on test plots in the central-north commercial farming area in the 1980s, in conjunction with a systematic vegetation survey. These plots represent an excellent opportunity to compare the efficacy of various type bush management by repeating the vegetation survey and comparing it with earlier results, and also by analyzing vegetation and soil samples for chemical content. In addition the plots, with known vegetation composition and cover, will be test sites for verification of the computer based vegetation classification. The following tasks will be involved:

- ◆ Revisit test plots and repeat original methodology for vegetation measurement
- ◆ Collect soil and vegetation samples
- ◆ Determine chemical content of soil and vegetation
- ◆ Assess relative effectiveness of different treatments based on productivity and maintenance of floral and faunal diversity
- ◆ Disseminate information and solicit feedback from participating groups
- ◆ Input data and results into database and GIS.

Rangeland productivity interactive study [Phase I information gathering→Phase II Long Term monitoring & evaluation of information for feedback into implementation components]

Based on the assumption that bush is a natural component of the ecosystem, and that it would be unwise (and also very difficult and expensive) to eradicate it completely, we propose to investigate alternative ways to improve productivity of a system including bush. Reducing bush height to increase its turnover of new shoots and make it accessible to animals was suggested by several farmers, and other strategies will emerge as a result of this study. The following tasks are involved:

- ◆ Conduct literature and experience search to investigate methods to improve shrub dominated grassland productivity
- ◆ Discuss the methods currently in use with communal and commercial farmers, and conduct vegetation and soil surveys at relevant plots

- ◆ Use participatory stakeholder groups to conduct cost-benefit analysis of different methods
- ◆ Integrate data with GIS database
- ◆ Conduct analyses and make recommendations.

Charcoal and fuelwood production interactive study

This study will be completed as part of the 18 month Phase I, and it is not anticipated that it will continue beyond Phase I with one exception:

- Development of charcoal quality improvement strategy to investigate DIN standard achievement
- Solicit feedback from participating stakeholder groups [part of Phase II implementation]
- Cost-benefit analysis and assessment of need for interim financial assistance
- Investigate potential for utilizing bush as a fuelwood supply for northern and southern regions of Namibia.

Spatial and temporal landscape change analyses

The earliest available aerial photography will be integrated in a GIS with Landsat Multispectral Scanner (MSS) and Thematic Mapper (TM) imagery and used to quantify changes in spatial extent of bush encroachment from the 1950s to the present. Natural cycles of bush increase or dieback and relative densities in different areas and of different species, and the correlation between drought, soil type and bush dynamics will be investigated, and interactively correlated with experiences of older farmers. This task involves the following steps:

- ◆ Acquisition of aerial photography
- ◆ Acquisition of multi-date imagery
- ◆ Image processing and data integration into GIS
- ◆ Change detection and associated studies
- ◆ Incorporate feedback from older farmers
- ◆ Workshop data with relevant participatory groups and include input from these discussions.

Participatory selection of indicators and planning for monitoring program

The establishment of a long-term monitoring program is one of the objectives of this project. Measurements made at site level provide a detailed picture of vegetation and soils that may be interpreted in the context of desertification - which is the process generating bush encroachment. However, ecosystem units based on catchment, soils, and vegetation are far larger than the individual site, and a useful assessment of desertification should be based on large ecosystem units. Remote sensing provide a method of integrating site-based measurements into the regional perspective, and GIS is a tool that will improve interpretive capability and also provide graphics and statistics for information sharing, management decisions, and policy making.

Stakeholders based on the land will be actively involved in the indicator selection process through discussions and fieldwork, and may provide some of the labor necessary for indicator measurement. Vegetation composition and cover will be measured, soil variables such as erosion, crusting, and salinity noted, as well as topography. This activity involves the following tasks:

- ◆ Development of candidate indicator list
- ◆ Interactive field work to assess measurement viability and develop methodology
- ◆ Indicator selection involving participating groups and individuals
- ◆ Measurement at the selected test sites (discussed below)
- ◆ Input of data to remote sensing and GIS database.

Participatory selection of test sites in communal areas and on commercial farms

The bush management and monitoring programs will begin on test sites, ideally in areas differentially affected by bush encroachment and desertification processes. It is anticipated that stakeholder group members will volunteer sites, and will also provide some of the labor necessary to evaluate and document the sites before the management program begins. In preparation for Phase II it will be necessary to do the following:

- ◆ Solicit volunteers for participation in the management program who will provide test sites, or labor, or information and experience

- ◆ Visit candidate sites and assess degree of desertification and bush-related problems using previously agreed indicators
- ◆ Precisely locate site for reference to satellite imagery and GIS database
- ◆ Input results of indicator measurement to database
- ◆ Pool knowledge and experience with participants to develop long-term monitoring strategy.

Participatory planning for self employment and job creation and skills programs

This important component of the bush control/enhancement project will require considerable organization to make sure that the task forces are effective, and that at the end of the project the task working group participants have both the self confidence and opportunity to enter the job market at higher levels. The following tasks will be involved:

- ◆ Identify sponsors, funding, and participants for bush encroachment working groups
- ◆ Work with communities in communal areas to identify self-employment opportunities and sources of funding for bridging or start-up loans.
- ◆ Find instructors for skills program associated with bush encroachment task force - possible skills include literacy, construction, and service industries.

Planning and conducting other studies

The need for other studies may be identified as a result of the literature search, interviews with stakeholders, and compilation of existing data. Such studies will be conducted in a cost effective manner, and will be carefully planned. If possible they will be completed before Phase II begins.

Phase II: Implementation of identified strategies

The initiation of selected management and monitoring methods at test sites and associated self-employment and job creation components will begin at the start of Phase II. Public awareness, two-way information sharing, and informationbase development will be an ongoing process with new components being added as results from studies,

experiences, discussions and workshops come in. The bush management and self-employment/job creation activities will be the main focus of this phase, in association with implementation of aftercare programs, and alternative futures land use modeling.

Involvement for stakeholder groups will continue with their direct input in review processes, self-employment/job creation, and visits to test sites during bush management activity. Stakeholders are expected to provide the bulk of local information on aftercare methods. Database development will continue with input of data, and upgrades to the system based on user feedback. Milestone reviews in the final months of the project will ensure that activities are completed, and information made available in varied format.

Initiation of selected control/enhancement methods at test sites

Working groups will be formed which will implement selected bush control methods on test sites in the commercially farmed area as well as in communities in communal areas to address desertification issues (e.g., by testing different methods to increase *Terminalia sericea* productivity).

Development of job creation and skills training

The bush management working groups will provide manual and supervisory jobs and other members will be generate opportunities for literacy and skills training programs.

Effect of alternative future land use scenarios

The ultimate aim of this project is to recommend methods for bush management and use. These recommended activities will have different effects in different physical and cultural and management landscapes. That is, land capability and landscape vulnerability and recoverability to land use pressures will have different manifestations depending on how the landscape is managed and used. We think it is extremely important to assess the impact that current policy, land use and land management procedures will have on the physical and cultural landscape. In other words, what will

the future landscape look like in, say the year 2020 given existing trends and alternative land use management scenarios.

In order to address this, we propose to examine existing trends and to workshop with the stakeholders (including regional and national policy-makers) to determine their picture of future land uses in the study area region. The framework for this work follows that of Steinitz (Harvard University, Graduate School of Design) and makes use of existing in-country data layers and data management systems as developed or modified during Phase I of this project. The alternative future scenarios framework asks the following questions:

- ◆ What are the biological, hydrological, physical, and socio-cultural characteristics of the present landscape ?
- ◆ How does the landscape operate? What are the functional and structural relationships among its elements?
- ◆ Is the landscape working well? How does the landscape respond to land use issues such as bush control efforts and grazing practices in both communal and commercially farmed areas?
- ◆ How might the landscape be altered - what are the current trends in plans, policy and management alternatives?
- ◆ What predictable differences might these alternations in landscape cause?
- ◆ How should the landscape be changed - based on values and interests of stakeholders, ideas, suggestions and plans?

Aftercare study

Most bush management methods require aftercare to maximize their efficiency. It is possible that the degree of aftercare may be an important factor in the control methods chosen, but stakeholders opinions and experiences will be solicited and literature will be reviewed for information on methods tried elsewhere. Methods may also vary for different vegetation species and soils types. Selected aftercare treatments will be implemented toward the close of Phase II, and assessed as part of the long-term monitoring program.

Expected Products

There will be five main products from Phase I: (1) a comprehensive literature and information review of bush encroachment issues in Namibia suitable for publication in a peer-review journal, and reviews specifically targeting bush control and bush utilization to be published locally. (2) an informationbase in formats contributed to and accessible by stakeholders, and (3) results of stakeholder participation in workshops and discussions for the values and perception studies.

(4) Material for information sharing will be developed throughout all phases, and will include posters and displays, summary reports, workshop formats, and oral presentations. During Phase I the focus will be on community group findings, the perception studies, and the information evaluation leading to recommendation of bush management strategies. (5) Plans for implementation of bush management, job creation and skills enhancement programmes.

The main product expected of Phase II will be functioning bush management programmes practised in a variety of locations. Job creation and skills enhancement programmes will be fully developed and institutionalised. In addition, the spatial and temporal landscape change analyses completed during Phase II will result in a journal article, and the bush management and bush management plot and rangeland productivity studies should both provide material for reports or locally based journals. Publications resulting from Phase II will include the alternative future land use scenarios study and coverage of the self-employment/job creation program. It will be possible to identify other deliverables as Phase II progress.

Management

The bush management program will operate under the umbrella of NAPCOD, and will be supervised by DRFN staff. A Steering Committee comprising representatives

from communal farms, the commercial farming sector, NANGOF, the Ministry of Agriculture, the Agricultural Unions, farmers groups, and others, will report to the NAPCOD Steering Committee and meet at intervals. These meetings will be used to review the progress of the program, to ensure that information sharing and public outreach are up to date, to make modifications to the program, and to ensure that stakeholders needs and concerns are being addressed. Specific working groups comprising participatory stakeholders and others involved in the activity may be formed as necessary.

This program will need a manager with outstanding oral and written communication skills and the ability to develop partnerships with all stakeholder groups. A background in rangeland ecology is desirable, as is experience in education or public participation. The successful candidate should have worked in southern Africa, and be familiar with both environmental and social issues involved in bush encroachment. Local administrative assistance would be sourced from DRFN. In addition, it is recommended that the program hires part-time specialists from within the local community (if qualified people can be hired locally) in specific fields of community health and social work; informationbase development; remote sensing, GIS, and landscape modeling; vegetation; and soils.

Personnel

Program Manager [will hire consultants, on a suitable timescale, as appropriate]

Namibian participants will include:

DRFN

NAPCOD

NANGOF

Representatives from communally farmed areas

University of Namibia (UNAM)

Polytechnic of Namibia

Ministry of Agriculture, Water and Rural Development (MAWRD)

Ministry of Lands, Resettlement and Rehabilitation (MLRR)

Ministry of Environment and Tourism (MET)

National Agricultural Union (NAU)

Namibian National Farmers Union (NNFU)

Farmers groups

Bush Industry

Additional specialists may be needed in the following areas: Social work and community health; Remote sensing, GIS, and landscape modeling; Informationbase development; Information production and dissemination; Communication; Soils; Vegetation

Milestones

Project momentum, continuity and integrity will be maintained through a series of milestone reviews at which the Project and Administrative Managers and specific activity participants will report to the Steering Committee and other involved stakeholders as appropriate. The milestones are scheduled at semi-regular intervals to coincide with the completion (or start) of activities and midterm through phases, with the first in month nine at the end of the information and literature review process in Phase I, and the second in month 18 at the conclusion of Phase I. Public participation and awareness, the informationbase management system, evaluation and testing, communication and team building will be reported upon at each milestone review. These meetings will also present an opportunity for revisions to the project schedule and activities in the light of results to date, or changing perceptions and needs.

Project status at month 18 review

Completed activities

Literature and information gathering review

Bush control methods review

Bush utilization methods review

Informationbase development

Vegetation and soils assessment

Stakeholder identification, values and perception information gathering and workshops [Phase I]

Discussion of Phase II activities and initiation of planning where possible will be done in Phase I

Selection of test sites for bush control

Self-employment, job creation, and skills training program

Bush Management plot study

Charcoal and fuelwood production study

Review planning for:

Range productivity study

Selection of indicators for monitoring

Landscape change analysis

Implementation of Bush management program

Self-employment, job creation, and skills training programme [re. South Africa

Acacia mearnsii {black wattle} control in the Fynbos]

Project status at month 24 review

Review results of completed activities

Bush management plot study

Charcoal and fuelwood production study

Range productivity study

Selection of indicators for monitoring

Landscape change analysis

Ongoing activities:

Bush management program

Job creation and skills training program

Future scenarios modeling

Project status at month 30 review

Ongoing activities

Bush management

Job creation and skills training program

Future scenarios modeling

Review planning for:

Bush management & Aftercare program

A final review of the project will take place during the 36th month.

References

- Bester, F.V. 1996. Bush encroachment: a thorny problem. *Namibia Environment* 1:175-177.
- Brown, C. 1992. Namibia's Green Plan. DEA, Ministry of Environment and Tourism.
- Jacobson, K M 1996. An overview of research issues relating to sustainable natural resource management in drylands. Report prepared for Napcod.
- Quan, J., D. Barton and C. Conroy. 1994. A preliminary assessment of the economic impact of desertification in Namibia. DEA Research Discussion Paper no. 3.
- Schlesinger, W.H., J.F. Reynolds, G.L. Cunningham, L.F. Huenneke, W.M. Jarrell, R.A. Virginia and W.G. Whitford. 1990. Biological feedbacks in global desertification. *Science* 247:1043-1048.
- Seely, M K 1991. Drought and desertification. Gamsberg-Macmillan, Windhoek.
- Seely, M K and KM Jacobson. 1994. Desertification and Namibia: a perspective. *Journal of African Zoology* 108(1): 21-36.