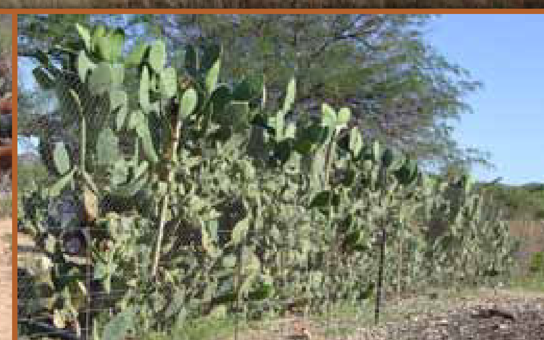
Managing Namibia's Rangelands



National Rangeland Management Policy and Strategy

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Name of Participant	**Affiliation**
Schneider, M. (Chairman)	Namiba Agricultural Union
Bockmühl, F	Freelance Consultant
Botha, H	Namibia Agricultural Union
Brown, C	Namibia Nature Foundation
De Klerk, N	Freelance Consultant
Du Preez, A	Namibia Agricultural Union
Fourie, M.L	Freelance Consultant
Friederich, R	Namibia Agricultural Union
Groenewaldt, AL	University of Namibia
Ipinge, I	Ministry of Agriculture, Water and Forestry
Joubert, D	Polytechnic of Namibia
Kamukuenjandje, RT	Polytechnic of Namibia
Kruger, B	Emerging Commercial Farmers' Support Programme
Libanda, B	Country Pilot Partnership
Lubbe, L.G	Ministry of Agriculture, Water and Forestry
Marggraff, H	Namibia Agricultural Union
Mate, S	Ministry of Agriculture, Water and Forestry
Munjanu, O	Namibia National Farmers' Union
Neumann, N	Ministry of Agriculture, Water and Forestry
Nott, C	Integrated Rural Development and Nature Conservation
Rothauge, A	Agra
Smith, ES	Namibia Agricultural Union
Stehn, H.C	Namibia Agricultural Union
Tjijahura, CK	Country Pilot Partnership
Van der Merwe, R	Namibia Agricultural Union
Volkmann, W	Freelance Consultant
Zensi, P	Namibia Agricultural Union
Zimmermann, I	Polytechnic of Namibia

The following participants formed part of a Technical Committee that was responsible for drafting the document and incorporating comments from the Steering Committee:

Name of Participant	**Affiliation**
Lubbe, L. (Chairman)	Ministry of Agriculture, Water and Forestry
De Klerk, N	Freelance Consultant
Kruger, B	Emerging Commercial Farmers' Support Programme
Neumann, N	Ministry of Agriculture, Water and Forestry
Nott, C	Freelance Consultant

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List of Acronyms

NRMPS - National Rangeland Management Policy and Strategy

MAWF - Ministry of Agriculture, Water and Forestry

NNFU - Namibia National Farmers' Union

NECFF - Namibia Emerging Commercial Farmers' Forum

MET - Ministry of Environment and Tourism

NAU - Namibia Agricultural Union

Contents

With the present poor situation of Namibia's rangelands and the current and potential impacts thereof on the livelihoods of a large number of Namibians in mind, it is of paramount importance that something be done drastically and urgently.

1 Introduction and rationale for the NRMPS

Agriculture is the predominant land use in Namibia, where some 70 % of the population depends directly or indirectly on the natural rangeland resource for their economic well-being and food security. Beef production is the most important livestock related activity in Namibia, followed by small stock (sheep and goat) production. Since 1990, the Namibian commercial livestock sector accounts for almost 70% of the overall annual agricultural output value. This activity is almost completely dependent on the country's natural rangelands.

The alarming state, in which much of Namibia's rangelands are, its inability to support a substantial portion of the nation and concomitant increase in poverty levels and the impact of land degradation on the national economy, is well known. It further impacts negatively on the tourist industry as the degraded state of the country's rangelands, seen most obviously in bush encroachment, soil erosion and deforestation, is also unacceptable from an aesthetic point of view.

Degraded rangeland near Okakarara in the eastern communal lands. (Bertus Kruger)

Grain yields in sub-Saharan Africa remained virtually unchanged since 1975, compared to ever increasing yields in the USA and Asia. A decrease in overall rainfall, more frequent droughts, a loss of more that 30% of the maize crop by 2030, and dramatic changes in land suitable for crops are predicted for southern Africa. This emphasizes the importance of beef and mutton production in Namibia and highlights the role that livestock will play as a pathway out of poverty. The climate for Namibia will become warmer and drier due to climate change. Seasonal rainfall patterns will be more erratic and Namibia will experience droughts more frequently. Evaporation is anticipated to rise by 5% per degree of warming. So, even if rainfall remains unchanged, the availability of water is likely to decrease. Water is already a scarce resource in Namibia, so decreases in rainfall and increases in evaporation will have an unfavorable effect on our biological and economic growth. These conditions will lead to a decrease in rangeland productivity and make the user/manager more vulnerable.

Reasons for rangeland degradation include too many people and livestock in one place for too long (between 60 and 70 % of Namibia's population practice subsistence agro-pastoralism on communal land, which constitutes approximately 41% of the total land area); land clearing for crop farming and in many cases the application of inappropriate cultivation techniques; inappropriate provision of artificial water points and poor range management associated with them; and over-exploitation linked to insecure land tenure arrangements. Long term land degradation could be costing families (in communal lands) around N$ 80 million/year in lost income and increased expenditure and it is generally accepted that the decline in the carrying capacity of Namibia's rangelands could be anything from 100% or more, with a concomitant loss of income of about N$ 1.4 billion per annum.

Towards bush encroachment in central Namibia. (Dave Joubert)

With this present situation of Namibia's rangelands and the current and potential impacts thereof on the livelihoods of a large number of Namibians in mind, it is of paramount importance that something be done drastically and urgently. The development and implementation of a National Rangeland Management Policy and Strategy (NRMPS) is therefore urgently required.

2 What should the NRMPS achieve?

The goal of the National Rangeland Management Policy and Strategy (NRMPS) should be to enable resource users (farmers and managers) to manage their rangeland resources in such a way that:

- animal production per hectare is sustainably improved;
- vulnerability of users to a highly variable resource base is decreased;
- awareness of the current situation is created;
- biodiversity is improved and maintained.

To sustainably improve animal production per hectare, care should be taken that the NRMPS contains strategies that are economically viable, socially acceptable, environmentally friendly and politically conducive.

2.1 Optimizing sustainable production/ha

In order to sustainably improve animal production, the NRMPS should focus on:

- improving the nutrient cycle
- improving the water cycle

2.1.1 Improving the nutrient cycle

Minerals and other nutrients are constantly used and reused, following a typical cyclical pattern. Minerals and nutrients have to be brought above ground by living plants and then returned underground for reuse. A good and healthy mineral cycle is where nutrients are prevented from escaping the cycle and where the volume of nutrients that are circulating within the cycle increases. The key to a healthy mineral cycle lies in the condition of the soil surface. The soil surface should be loose and covered by enough live plant material and litter to prevent capping and the creation of a harsh micro-environment with very little microbe activity. Capped soil surface reduces air exchange between the atmosphere and the soil, resulting in reduced oxygen and increased carbon dioxide levels. This in turn inhibits root growth and eventually negatively impacts on the dynamics of the mineral cycle.

The NRMPS should therefore contribute towards improving the nutrient cycle by:

- promoting a diversity of plants with diverse root systems to allow for maximum upward movement of nutrients from as deep and wide as possible;
- promoting an effective way of getting excess plant material (litter) back onto the soil surface as well as into the top soil;
- creating a healthy soil surface with active biological activity to speed up the process of putting minerals back into the soil for re-use;
- improving the structure (crumbing) of the soil in order to prevent unnecessary leaching of minerals beyond the root zone and to improve the aeration of the soil.

2.1.2 Improving the water cycle

In an effective water cycle plants make maximum use of rainfall. Very little water evaporates directly from the soil surface and runoff is slow and carries little organic matter with it. A good air-to-water balance exists in the soil, enabling plant roots to absorb water readily. In a non-effective water cycle plants get minimal opportunity to use the full amount of rainfall received. Most of the water is lost through surface evaporation or runoff and that which infiltrates is not always readily available to plants due to a poor air-to-water balance in the soil. An effective water cycle tends to even out the erratic nature of rainfall by making rain that does fall more effective. Effective rainfall means total rainfall received minus runoff, evaporation, interception, transpiration and percolation outside the root zone. Effective rainfall is water that soaks in and becomes available to plant roots, insects and micro-organisms or which replenishes underground supplies with very little subsequent evaporating from the soil surface. To make rainfall as effective as possible means producing a cycle that directs most water either out to the atmosphere through plants or down to underground reserves.

Improved soil cover through herding livestock (Colin Nott)

Water Use Efficiency (WUE) is the amount of dry matter produced by plants for a certain amount of water used. Veld in good condition produces with the same amount of rainfall received, nearly 4 times more fodder than in poor veld. Differently stated, 4 times more rainfall is needed to produce the same amount of fodder on poor veld than on good veld. Veld in poor condition can have as much as 180% more runoff than veld in a good condition. This situation is even further compounded by the fact that veld in poor condition produces fodder that is less palatable than fodder produced in good veld.

The NRMPS should therefore contribute towards creating and maintaining a healthy water cycle by:

- promoting the creation of a good soil cover;
- promoting the creation of sufficient organic matter (live plants and litter) in and on the soil surface;
- promoting good aeration of the top soil;
- reducing the competition for soil moisture between undesirable bushes and preferred grasses.

Bare soil surface, resulting into a poor water and mineral cycle. (Bertus Kruger)

2.2 Reduced vulnerability of users to a variable resource base

Namibia is the most arid country in sub-Saharan Africa with a very low and highly variable rainfall, both between different years and geographically over the country. Drought and aridity are two totally different phenomena, although they are closely related. Very often farmers confuse the two. The one (aridity) describes the general climatic conditions (e.g. low rainfall and high evaporation) that prevail in a certain area and should be seen as normal, while the other (drought) indicates an extremely dry situation created by a number of consecutive low rainfall years that negatively impact on the ability of rangeland to produce adequate fodder. The one is a given reality and the other needs to be mitigated through proper pro-active planning. As aridity increases, so does variation in rainfall between years as well as geographically. Climate change is definitely going to contribute towards an increased frequency of occurrence as well as the severity of drought.

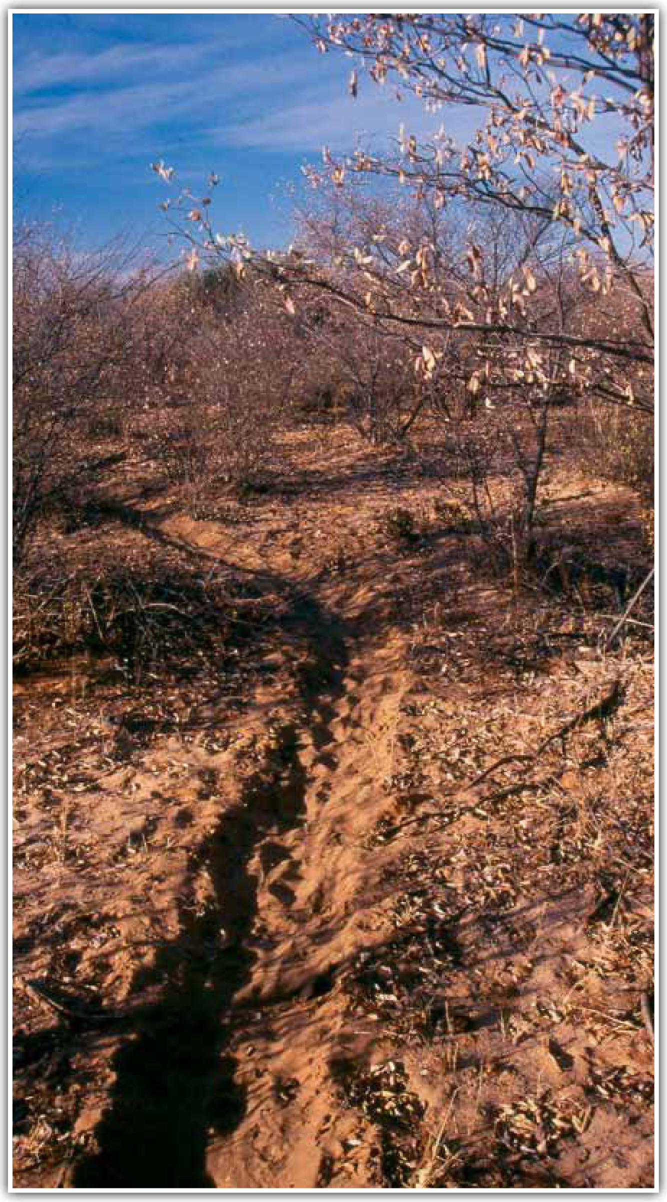
In order to reduce vulnerability of resource users to a variable resource base, the NRMPS should focus on:

- well-planned and proper rangeland management;
- timely and flexible adjustment of animal numbers to available fodder sources;
- timely provision for disaster drought situations;
- careful planning and developing further water infrastructure in unused and under-used areas.

2.2.1 Timely and flexible adjustment of animal numbers to available fodder sources

Carrying capacity (and therefore fodder availability) is not fixed and varies greatly between years, depending on veld condition and the amount and distribution of rainfall received. The challenge is to objectively and reliably determine the fodder availability at the end of the rainy season (May) and to timely adjust livestock numbers to it. This must be done every year.

Continuous over grazing, resulting into the total loss of perennial grasses. (Bertus Kruger)



Footpath formation due to continuous overgrazing. (Bertus Kruger)

The NRMPS should promote the timely adjustment of animal numbers to available fodder sources by the:

- development of easy and reliable methods to determine fodder availability;
- promotion of the use of these methods by as many as possible rangeland users and managers;
- consideration of incentives to enhance the timely adjustment of livestock on an annual basis;
- promotion of flexible livestock systems.

2.2.2 Timely provision for disaster drought situations

A disaster drought refers to drought conditions so intense or protracted that they are beyond what can reasonably be dealt with in terms of normal risk management practices and which justify State intervention. It is anticipated that the frequency and severity of disaster droughts will increase in future due to the effect of climate change.

The NRMPS should promote the timely provision for disaster drought situations with the implementation of the national drought strategy. This will contribute towards:

- development of a timely and pro-active marketing incentive scheme during disaster droughts, making provision for tax wavers where applicable;
- creation of a special drought fund;
- promotion of diversification inside and outside agriculture;
- promotion of planted pastures and other forms of fodder preservation.

Timely marketing of excess livestock is the best way to mitigate the impact of drought. (Bertus Kruger)

2.3 Improvement and maintenance of biodiversity

Biodiversity in rangelands refers to the diversity of plants and animals within a given community. The more diverse and complex communities become, the fewer fluctuations in terms of numbers of species occur and the more stable communities tend to be. There is a strong connection between diversity of species, productivity and stability within the rangeland ecosystem as well as the ability of animals to efficiently use available fodder.

The NRMPS should promote the creation and maintenance of rangelands that are high in biodiversity by, amongst others:

- correct utilization of key plants (intensity of utilization);
- adequate recovery of utilized plants (frequency of utilization);
- reclamation of denuded rangelands;
- strategic erosion control.

3 How will the NRMPS achieve this?

The long term goal of the NRMPS is to: *"significantly contribute towards improving the livelihood of people directly or indirectly dependent on management and utilization of rangeland resources".* Over the short term however, the goal is: to empower rangeland managers and users to use their rangeland resources in such a way that *"animal production per hectare is optimized without the loss of rangeland productivity"* and *"that economic losses to a highly variable resource base is minimized."*

3.1 Objectives of the NRMPS

In order to achieve the short term goal and to significantly contribute towards achieving the long term goal, the following six objectives have to be realized:

Objective 1: The importance of Namibia's rangelands is raised at local, national and international levels.

Objective 2: The understanding of the national rangeland management principles amongst all stakeholders is improved.

Objective 3: Best practices and lessons learnt regarding sound rangeland management are identified, documented and widely shared.

Objective 4: Sufficient support structures to implement the NRMPS are in place and functional.

Objective 5: The policy environment for the implementation of the NRMPS is conducive.

Objective 6: The implementation of the NRMPS on commercial and resettled farms, in communal areas and in national protected areas is supported.

3.2 Major activities to achieve the different objectives

In order to achieve these objectives the following major activities need to be implemented:

3.2.1 Objective 1: The importance of Namibia's rangelands is raised at local, national and international levels.

- Brief decision-makers on the value of Namibia's rangelands by using multiple media sources like radio, TV, pamphlets, fliers, presentations at Parliamentary Standing Committees, line ministries and inter-ministerial forums.
- Brief international stakeholders like embassies, donors, scientific societies, etc. on the value of Namibia's rangelands by using lectures, multiple media sources, papers at conferences, etc.
- Brief non-governmental organizations on the value of Namibia's rangelands by using different media sources.
- Brief rangeland users and managers on the value of Namibia's rangelands by using different media sources.

Involvement of rangeland users in the planning and implementation of sound rangeland management practices. (Bertus Kruger)

3.2.2 Objective 2: The understanding of the national rangeland management principles amongst all stakeholders is improved.

- Publish and distribute national rangeland management principles in vernacular languages to all resource users and managers.
- Conduct comprehensive capacity building activities (e.g. training and exposure) for all users, managers and support agents involved in rangelands.

3.2.3 Objective 3: Best practices and lessons learnt regarding sound rangeland management are identified, documented and widely shared.

- Document and share best practices and lessons learnt from successful farmers.
- Conduct a national rangeland audit as a baseline for future monitoring.
- Collate existing rangeland related materials and share as widely as possible.
- Expose rangeland users/managers to best practices in the country and abroad.

- Conduct demand driven on-farm rangeland research.
- Share best practices and lessons learnt with rangeland users and managers.

3.2.4 Objective 4: Sufficient support structures to implement the NRMPS are in place and functional.

- Recruit and maintain adequate and competent rangeland management specialists in the government system.
- Provide bursaries to support students in rangeland management at recognized universities.
- Solicit adequate budgetary support to effectively operate government extension and research services.
- Create a Rangeland Advisory Committee to advise the Minister of Agriculture, Water and Forestry on rangeland related issues.
- Solicit adequate and affordable financial support to enable farmers to effectively address land degradation.
- Introduce rangeland management into primary school curriculums.

3.2.5 Objective 5: The policy environment for the implementation of the NRMPS is conducive.

- Amend and update the existing Soil Conservation Act to make provision for non-title deed areas.
- Provide for security of tenure over rangeland resources in non-title deed areas.
- Approve and implement the Bush Encroachment Management Policy.
- Address current uncertainties amongst commercial farmers regarding processes and modalities of land reform.
- Amend the act on the sub-division of agricultural land (Act 70 of 1970).
- Amend the labor act to provide for part time/casual workers to clear bush for their own accounts
- Raise awareness amongst government and the public at large regarding their rights and responsibilities towards the different polices and legislation.
- Implement the Drought Policy and Strategy.

3.2.6 Objective 6: The implementation of the NRMPS on commercial and resettled farms, in communal areas and in national protected areas is supported.

The following measures are very specific for different land uses:

3.2.6.1 Communal areas

- Raise awareness amongst traditional leaders and other stakeholders on the importance of rangeland resources and the need for sound rangeland management in their community.
- Improve understanding of farmers regarding sound rangeland management practices.
- Develop a common vision for participating farmers.
- Agree on size, location and extent of grazing areas.
- Develop a detailed map of the grazing area, including the major intra-structure and other features.
- Assess and evaluate the chances of current rangeland management practices towards achieving the new common vision.
- Form grazing groups or associations.
- Develop rangeland management plans.
- Implement local level monitoring.
- Do ongoing monitoring, evaluation and adjustments of the management plan (implementation of the plan over time).

3.2.6.2 Resettlement farms

- Develop a detailed map of the farm indicating the allocation of different land units to different settler families.
- Improve understanding of the principles of sound rangeland management.
- Assess current and potential management practices.
- Form a Joint Management Body.
- Develop a Joint Rangeland Management Plan.
- Introduce local level monitoring.
- Do ongoing monitoring, evaluation and adjustment of the management plan.

Allocation of farming units on resettlement farms. (Bertus Kruger).

3.2.6.3 National protected areas

- Assess current rangeland conditions and identify reasons for current status of rangeland condition.
- Evaluate current rangeland management plans.
- Develop sound rangeland management plans.
- Introduce local level monitoring.
- Do ongoing monitoring, evaluation and adjustment of rangeland management plans as part of the implementation.

Extensive root sytem of Acacia mellifera. (Nico Smit)

3.2.6.4 Privately-owned farms

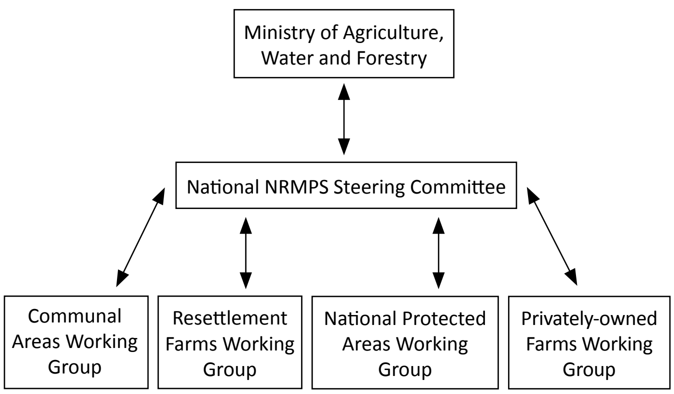
- Assess current rangeland management practices to identify challenges.
- Develop a detailed map of the farm.
- Develop (with the farmer) a sound rangeland management plan to implement rangeland management principles.
- Introduce local level monitoring.
- Do ongoing monitoring, evaluation and adjustment of the rangeland management plan by doing regular visits.
- Form study groups that share experiences and results regarding different rangeland management practices.

A study group discussing rangeland issues on a privately-owned farm. (Ibo Zimmermann)

4 *Institutional framework for implementation*

The implementation of the NRMPS is complex and it is recognized that government alone will not be able to do it. Successful implementation is dependent on various stakeholders from governmental and non-governmental levels and includes both decision-makers at higher levels and resource users and managers at grass root level. Government, via the Ministry of Agriculture, Water and Forestry, should have the overall responsibility for implementing the NRMPS, but implementation functions should be delegated and outsourced to other entities. This chapter suggests an institutional framework for the successful implementation of the NRMPS.

4.1 The structure



4.2 Leadership, roles and responsibilities

Each of these suggested structures will have specific functions. This section provides more information on the possible roles and responsibilities.

4.2.1 Ministry of Agriculture, Water and Forestry

The Ministry of Agriculture, Water and Forestry takes overall responsibility for the successful implementation of the NRMPS and reports directly to Cabinet on the progress and status of implementation. The budget for implementation is also provided by this Ministry.

4.2.2 National NRMPS steering committee

This body is chaired by the Ministry of Agriculture, Water and Forestry (MAWF) and consists of technical staff from the MAWF and representatives from the four working groups. This body is responsible for annual work planning and budgeting, policy decisions, monitoring and evaluation and reports to the MAWF on the status and progress of the implementation.

4.2.3 Communal areas working group

This working group consists of governmental and non-governmental rangeland experts and coordinates the implementation of the NRMPS in communal areas. It is chaired by the Namibia National Farmers' Union (NNFU) and is responsible for annual planning and budgeting, monitoring and evaluation and reports on progress and status of the implementation to the NRMPS Steering Committee.

4.2.4 Resettlement farms working group

This working group consists of governmental and non-governmental rangeland experts and coordinates the implementation of the NRMPS on resettlement and affirmative action loan scheme farms. It is chaired by the Namibia Emerging Commercial Farmers' Forum (NECFF) and is responsible for annual planning and budgeting, monitoring and evaluation and reports on the progress and status of the implementation to the NRMPS Steering Committee.

4.2.5 National protected areas working group

This working group consists of governmental and non-governmental rangeland experts and coordinates the implementation of the NRMPS in national protected areas. It is chaired by the Ministry of Environment and Tourism (MET) and is responsible for annual planning and budgeting, monitoring and evaluation and reports on the progress and status of implementation to the NRMPS Steering Committee.

4.2.6 Privately-owned farms working group

This working group consists of governmental and non-governmental rangeland experts and coordinates the implementation of the NRMPS on existing commercial farms. It is chaired by the Namibia Agricultural Union (NAU) and is responsible for annual planning, budgeting, monitoring and evaluation and reports on the progress and status of the implementation to the NRMPS Steering Committee.

5 Principles of good rangeland management

The development of sound rangeland management principles aims to improve rangeland productivity. These principles will however need to be supported by an effective implementation strategy and an enabling policy environment. The principles for good rangeland management include:

5.1 Know your resource base

The land user must be knowledgeable as the following must be understood in order to manage the land effectively and to grow more fodder.

- The difference between annual and perennial grass plants. An annual grass plant grows from seed and dies at the end of the growing season. Annuals have small root systems, require significant rainfall events to germinate and generally put more energy into producing seed than into growing leaves. Their small root systems do not hold the soil well. A perennial grass if well managed will develop a strong tuft that keeps growing year after year.

Abundant perennial grasses. (Ibo Zimmermann)

- It is important to know the botanical composition, which species (grass and shrub) are "key" to production and at what times of the year.
- The user/manager must be aware of the state of the soil surface. The soil surface is a very good indicator of how effective your management is. If the soil surface is bare and hard and there is no organic matter on or in the soil, the soil tends to form a hard sealed surface layer (capped). Rainwater runs off these soils and evaporation is high (poor water cycle) and conditions are very hostile for germination and growth. Productivity from bare ground is low.

Veld that is dominated by annual grasses. (Bertus Kruger)

5.2 Manage for effective rest

Rest is applied to make provision for:

- The recovery of grasses after utilization by means of root re-establishment and the restoration of plant reserves (recovery period depends on the utilization level of the grass plant and growing conditions immediately after utilization);
- Organic matter to build up in this area so that it can be utilized to increase soil cover in the following season, as a drought reserve or for strategic marketing (usually achieved by applying a full growing season rest);
- Unhindered seed production;
- The establishment of seedlings.

5.3 Manage for effective utilization of plants (grasses and shrubs)

Managing the utilization levels of both grasses and shrubs is important. Perennial grass plants and favorable browse species are managed with the intention of increasing their vigor and productivity. Utilization of perennial grass plants is the defoliation of grass plants in such a way as to maintain or increase plant vigor and production over time. This is achieved by allowing grass plants enough time between grazing periods to recover and restore their root reserves. The higher the intensity of defoliation, the more time is needed for the grazing plant to recover. Active and healthy root systems are vital for aeration and nutrient cycling from the lower soil layers.

Herding of livestock contributes towards seed bed preparation and planning of adequate recovering periods. (Colin Nott)

Perennial grasses will be overgrazed if they are re-grazed before the plant's root reserves have been replenished. A sure sign of an overgrazed grass plant is leaves and flowers growing along the soil surface (often forming a rosette). Continued overgrazing over time results in the plant dying off. Perennial grasses are overgrazed if teethed animals (horses and donkeys) are able to pull them out by the roots. It is important to know that overgrazing can still take place, despite low stocking rates.

A perennial grass plant is underutilized if there is old grey standing material within the tuft. Underutilization results in decreased vigor and productivity of grasses. Parts of the rangeland may be underutilized if there are plants with large amounts of grey oxidizing plant material in the tuft. It is also possible to have an overgrazed plant next to an underutilized plant.

Moribund grass due to under utilization. (Bertus Kruger)

If the stocking density is too high for the available feed then feed will be consumed too fast and animals will return to the grazed area before the plants have recovered from the last grazing event. This depletes reserves, weakens the plant and eventually kills it. If animals are left too long in the same area during the growing season, animals may re-graze a plant they grazed when they entered the area to start with. The amount of time that plants need to recover is determined by the growth rate of the plant, which in turn depends upon factors such as, amongst others, rainfall distribution and temperature. When a plant has seeded it has generally recovered, but recovery often occurs well before this as well.

It is imperative that the amount of fodder on the farm should be assessed each year at the end of the growing season (end of the rainy season), which is around April/May. In doing this, provision is made to ensure that there is enough fodder for the animals until the rains can be expected (with a drought reserve built in). It also suits perennial grass plants in that they should be utilized during this period to enable their growth points to be exposed to the sunlight to enable effective growth in the next season. Too severe utilization in the dry season can result in the physical removal or damage of active growth points and should be avoided at all costs. Available fodder changes from year to year simply because of the variability of rainfall and other growth factors. Making use of a fixed grazing capacity should therefore be avoided. The timely adjustment of animal numbers to available grazing is beneficial to the user/manager. The sooner de-stocking is done (various ways exist) the fewer stock will need to be removed later on and rangeland users will be less vulnerable to fodder shortages for their animals.

Good fodder production. (Wiebke Volkmann)

5.4. Enhancing soil condition

In any grazing ecosystem there is a strong interaction between soil and vegetation. If the soil is in a good condition then it can support the vegetation needed to protect itself, provide fodder for the grazing animals and provide the organic material which influences the physical and chemical fertility of the soil. If it is in a degraded condition, then nutrient cycling, water infiltration, seed germination, seedling development and a number of other ecological processes are disrupted. It is therefore imperative that the land user should strive towards maximum protection of the soil by managing for a maximum basal cover by perennial grasses and increased organic matter on and in the soil.

Good organic matter cover on topsoil. (Bertus Kruger)

Apart from the soil protection function it introduces, it ensures low run-off levels and so creates a situation where water can penetrate the soil. Having the maximum amount of vegetation on the land is probably the best mechanism against soil erosion. This holds especially true for grass plants, as their fine root systems are far more effective in holding soil than the tap root systems of many woody plants.

Poor organic cover on topsoil. (Bertus Kruger)

5.5 Addressing bush encroachment

It has been shown that in areas where bush is a problem, very little rainwater succeeds to infiltrate and reach the underground water table, and where bush densities are decreased, water tables start to rise again. Various control measures and guidelines exist to address the problem.

Biological control is a viable way of tackling bush encroachment. Large tracks of bush encroached rangeland are affected by the fungus *phoma glomerata,* resulting in the die-off of mainly *Acacia* bushes. Browsers like certain game species and goats can play an important role as after-treatments once thick bush densities have been cleared.

The inclusion of goats as after-care after eradicating bush encroachment should form an integral part of sound rangeland management. (Bertus Kruger)

The utilization of bush for charcoal and other products is seen as an asset, rather than a liability. If the goal of utilizing bush is to restore rangeland for improved livestock productivity, application and after-care methods will differ significantly from those where bush is seen as a sustainable resource for continuous utilization. In both cases, incentives from government are needed to support farmers to reach their specific goals.

Charcoal production. (Nico de Klerk)

A lot of work has been done on the chemical control of bush in Namibia, and a substantial amount of data is available on the effectiveness of the method, arboricides and cost aspects involved. The costs of this are well documented. The success over the long term is variable depending on follow-up management.

Chemical control of invader bush. (Nico de Klerk)

Mechanical control involves the use of bulldozers, axes, chainsaws and so forth. Bulldozing leads to severe soil surface disturbance and often leads to an even denser woody component than before. It is for this reason that it is not recommended as a method to deal with bush encroachment. Using axes, chainsaws and other such tools is only recommended if bush is removed in such a way that the coppicing buds are destroyed, or, where coppicing does occur, the stumps are treated with an appropriate arboricide.

Mechanical control of invader bush. (Nico de Klerk)

Veld burning has for long been a controversial aspect of range management and remains so. Fire, like animals, has evolved with savannas and the absence of fire is seen by many as one of the major reasons for bush encroachment. Care should be taken if and when fire is used to ensure that the neighbor's veld is safe. Fire can also be used as an after-care to keep savannah veld open. Fire does remove an accumulation of biomass, brings browse to available levels and it stimulates out of season growth. The effectiveness of fire in destroying parasites, controlling the encroachment of undesirable plants in the veld and altering vegetation composition is less conclusive. Injudicious burning can result in a degradation of the environment (deterioration of the botanical composition, reduction in plant biomass, reduction in crown and basal cover, higher run-off, destruction of grass seeds and erosion, to name a few). The timing, frequency, physiological plant conditions, environmental conditions, fuel load and other factors will influence the effect that the fire will have.

Fire as a means of addressing bush encroachment. (Dave Joubert)

5.6 Drought planning

Droughts are not a result of poor rangeland and animal management. Droughts are extended periods of below average rainfall. In Namibia it is not a question of if drought will occur, but when it will occur. Planning for drought is therefore crucial. Key aspects of this need to be:

- The promotion of good market prices and a supportive marketing environment in May when it is clear whether animal numbers will exceed fodder availability and by how much (severity index). Farmers not adjusting their numbers early and selling late should not enjoy these incentives;
- Making provision for a "spare camp" or key resource area is another strategy that can be followed. As a guideline it is suggested that at least 10% of the total surface area of the farm or grazing area should be set aside each year on a rotational basis to accumulate standing hay and so make provision for drought;

- Those areas receiving more than 500 mm/year can possibly plant pastures and/or drought resistant fodder crops. Planted pastures can either be grazed or the practice of zero grazing can be applied, which entails the process of haymaking;
- Making hay from natural grass lands, as well as grass material growing in the road reserve, are also possibilities to build up a fodder bank.

Making fodder on the road reserves as a means of providing for fodder. (Andre van Rooyen)

During drought it is recommended that redundant and unnecessary animals be marketed as quickly as possible. It is also best practice to first graze those areas in which the quality of the rangeland decreases the quickest and to ensure energy supplementation receives the same attention as protein supplementation for livestock.

Plant prickly pear to serve as drought reserve. (Bertus Kruger)

5.7 Monitoring of the resource base

Proper monitoring includes keeping record of the veld condition that enables the user to detect early changes in a number of important range condition parameters over time, for example: changes in soil cover, soil organic matter on and in the soil, density of perennial grasses, changes in botanical composition, vigor of the grazing plants and the occurrence of seedlings of both desirable and undesirable plants. The productivity of the land unit in kg/ha and N$/ha needs to be monitored.

It is also important to keep a record of veld management. Information that needs to be recorded here includes the numbers and type of animals in a camp, as well as the date-in, date-out (documenting the grazing plan applied). From this one can gain important information on data such as stocking rate, stocking density and season of grazing.

Veld in good condition. (Ibo Zimmermann)

It is also important to regularly (biannually) monitor water levels in boreholes (depth from surface to water table). Building a water level data base can also serve as an early warning system to land users.

5.8 Planning land use infrastructure

It is vital that the user/manager plans the infrastructure development on the farm or grazing area in such a way as to be able to apply the rangeland principles outlined above. The most important of these is the provision of water at strategic places.

The decision to put in more camps is an expensive one and may not be required if herding in existing camps is utilized. This is important for both communal areas where fencing is illegal as well as parks and game farms where fencing is undesirable.

Good water infra-structure is needed to water large numbers of livestock. (Ibo Zimmermann)

6 Policy Analysis

Technical solutions to a biophysical problem often fail because of an in-conducive socio-economic policy and legislative environment. In this regard, the National Agricultural Policy states that if macro-economic policies do not create a stable and conducive environment, then specific policies to strengthen the agricultural sector are likely to fail. Land degradation and its prevention are therefore much wider than the biophysical aspect of the problem. As far as land degradation is concerned, government has committed itself in terms of direct involvement and support to the agricultural sector through the introduction of several new policies and laws, directly relevant to a rangeland management strategy. These include:

- The Constitution of the Republic of Namibia
- National Agricultural Policy, 1995
- National Drought Policy and Strategy, 1997
- Soil Conservation Act (No 76 of 1969)
- Subdivision of Agricultural Land Act (No. 70 of 1970)
- Forest Act (No 12 0f 2001)
- Forest Development Policy of Namibia, 2001
- Forestry Strategic Plan, 1996
- Guidelines on National Forest Fire Management
- National Land Policy
- National Resettlement Policy
- Agricultural (Commercial) Land Reform Act (No. 6 of 1995)
- Communal Land Reform Act (No. 5 of 2002)
- Poverty Reduction Strategy of Namibia, 1998
- Import and Export Control Act (No 30 of 1994)
- Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act (Act 36 of 1947)
- Weeds Ordinance (19 of 1957)
- Labor Act (No. 6 of 1992)
- Water Resources Management Act (No. 24 of 2004).

In addition, Namibia signed the United Nations Convention to Combat Desertification in 1994 and it was ratified in 1997. As such the Government has a serious intention to address this problem with all the means to its disposal. Furthermore, Namibia is also a signatory to the United Nation's Convention on Biodiversity, the United Nations Framework Convention on Climate Change and the Convention on Wetlands of International Importance especially as Waterfowl Habitat, 1971 which entered into force in 1995 (Ramsar Convention).

A very favorable environment exists in which the threats of rangeland degradation and desertification can be addressed. The National Agricultural Policy in particular regards land degradation as a serious problem. A major shortcoming, however, is that neither this policy nor others, nor any available legislation, provide any guidelines on how to deal with these issues. The major gap in this policy is however that no incentives are provided to prevent and mitigate the negative impact of land degradation. While the Soil Conservation Act provides for the payment of subsidies and grants to erect soil conservation works, the National Agricultural Policy questions the payment of subsidies.

Although the management of bush encroachment, as part and parcel of land degradation, is not explicitly addressed in the current policy framework, current policies – particularly in the agriculture and forestry sectors – provide important parameters within which bush management policies will have to be formulated. A number of specific issues can be mentioned in this regard:

- Policies in the agricultural and natural resource sectors have changed the respective roles of the State and farmers dramatically. The National Agricultural Policy, the National Drought Policy and Strategy and the Namibia Forest Development Policy devolve the responsibility for managing natural resources to resource owners and users. The role of the State is limited to regulatory functions and providing technical support that will enable farmers to improve their capacity to manage resources more effectively. The State will only provide direct financial support in emergencies. This implies that farmers will have to bear the responsibility of managing their rangelands. More specifically, they will be responsible for the prevention of bush encroachment and its eradication where densities are too high.
- It follows from these new roles of the State and farmer that the thinking on subsidies has changed as well. It should however be emphasized that bush encroachment can already be regarded as a national disaster and that State and society should be co-responsible for reversing the process. The study titled 'Bush Encroachment in Namibia' rightly points out that the farmers are not the only ones to be blamed for the present state of affairs. In terms of the National Agricultural Policy long-term or continuing subsidies will be

avoided. However, the policy still allows for the possibility that well-targeted subsidies can play an important part in achieving short-term agricultural and socio-economic objectives.

The formulation and implementation of a policy to manage savannas on both freehold and non-freehold land needs to be regarded as a priority. Thus, policy needs to create a socio-economic environment that provides incentives for farmers to improve the productivity of their rangelands by controlling intruder bush and preventing re-infestation in an environmentally sustainable way. At the same time, improved rangeland management practices need to be encouraged to minimize the risks of future land deterioration.

It is however not recommended that separate legislation be introduced to deal with bush encroachment and its thinning. As a first prerequisite the provisions of the Forest Act and the Soil Conservation Act should be amended to incorporate issues pertaining to encroached savannas that fall outside the definition of forest and classified forest. In its present form the provisions of the Forest Act apply to classified forests only. The roles and responsibilities of ministries that are directly involved in resolving the bush encroachment problem need to be defined in this policy as well as these two acts. This will ensure that directions for the management of all savannas in Namibia are much clearer. A Bush Encroachment Management Policy is urgently needed to facilitate and encourage the control of bushes on an economical and profitable basis. A draft policy, with the involvement of all key stakeholders and national consultation, was finalized more than two years ago. Since then nothing has been done to submit this important document to Cabinet.

Some Water Point Users Associations (WPUA) and Water Point Committees (WPC) do not interact with land boards and traditional leaders at all times unless traditional authorities are members of these bodies or have designated representatives there. The main reason for this is that the users of water points have obtained full ownership of the resource. Control over water resources could also *de facto* means control over surrounding rangeland resources. The incorporation of sound rangeland management principles into constitutions of local WPCs and the subsequent promotion of good relations with local traditional authorities, should be supported.

Background:

The Namibian Rangeland Forum (NRF) is an unconstituted group, including farmers, extension workers and scientists, with a common interest in the ecologically and economically successful management of Namibia's rangelands. Being part of this group BIOTA hosts the 2009 forum. Linking to the major research interest of BIOTA, this year's forum will focus on the role that biological diversity plays in providing ecological services that contribute to rangeland health and productivity as well as the impacts of different types of rangeland management on biodiversity's ecological services. One of the objectives of the forum is to produce policy relevant findings. It therefore critically assesses the extent to which Namibia's draft Rangeland Management Policy and Strategy (NRMPS) promotes biodiversity.

BIOTA (Biodiversity Monitoring Transect Analysis in Africa) conducts integrated biodiversity research across several climatic gradients, one long one across the winter rainfall Cape Region into the summer rainfall region of northern Namibia, and a shorter transect across the very steep rainfall gradient from the central Namibian coast inland. A flyer on BIOTA is enclosed. BIOTA monitors changes in biodiversity and does research into human impacts on, and consequences of, biodiversity change, with the aim of improving management. One of BIOTA's approaches is to conduct standardised monitoring at observatories of one square kilometre. There are about 20 observatories in Namibia.

Biodiversity is essential for supporting our lives. It provides lots of species that we can use for products, such as grasses and bushes for our animals to feed on, wood for construction and energy, numerous foods and medicines. Valuable new uses are constantly being found for species that were previously thought useless or even considered a weed or pest. Biodiversity also regulates ecological support services that make it possible for us to survive on earth. It is biodiversity that is responsible for regulating the water cycle that brings us valuable rain, allows it to enter the soil and recharge the limited ground water without eroding away the soil. Biodiversity also keeps the nutrient cycles going, which maintain the fertility of the soil. If it were not for biodiversity, then some pests and diseases would proliferate and take over. For example, termites are kept in balance by mammals such as antbears and aardwolves, birds such as guinea fowls and francolins, reptiles such as chameleons and geckos, insects such as praying mantis and spiders, while many species of microorganisms also play their role hidden from our view because of their tiny size. Our water, air and soil are kept purified by biodiversity, unless we upset the balance through our mismanagement.

Why do we need to monitor our environment? It is necessary to recognize changes and their causes, and also to understand the extraordinary effects of episodic events. We need to recognize and understand these things in order to have sustainable development, as without it we don't know what management practices are sustainable. Since our memories may play tricks on us, and lessons may be lost if not recorded, we observe and record the status of indicator parameters. These are features that serve as indicator of the State of the Environment. Monitoring thus promotes enlightened decision-making and policies. The point about monitoring is that it needs to be continuous, and is based on repeated measurements that can be compared across long periods of time and large areas of country.

Monitoring produces information, but information on its own is useless unless it gets applied. We need to ensure that the results of monitoring get put to good use. The results of the monitoring should form the basis of wise decision making on how to manage the land. Hence BIOTA is involved not only with monitoring, but also with research to better understand people's incentives to mange land in particular ways and the consequences for biodiversity and hence also ecological processes that keep us alive. Your contribution towards this at the forum is gratefully appreciated.

13th NAMIBIAN RANGELAND FORUM

Programme & Index:

The role of biodiversity in rangeland management and policy

Tuesday, 27 October 2009:

Wednesday, 28 October 2009:

08:00 – 08:25	**Leon Lubbe *et al.*:** Towards a national rangeland policy and strategy (NRMPS) for Namibia	**18**
08:25 – 08:50	**Riaan Dames:** The controlled fodder flow grazing management strategy	**19**
08:50 – 09:15	**Sebastian Prediger *et al.* :** Cooperation in the commons: evidence from a cross-cultural field experiment on common-pool resource management	**20**
09:15 – 09:40	**Stephanie Domptail:** Can land taxes be a tool for rangeland conservation?	**21**
09:40 – 10:05	**Angelique Groenewaldt:** The practicalities of implementing the NRMPS from a legal perspective	**22**
10:05 – 10:30	**Taimi Kapalanga (on her behalf):** Land degradation monitoring and assessment methods: A review	**23**
10:30 – 11:00	Coffee break	
11:00 – 11:30	**Hugh Pringle (on his behalf):** Rangelands as catchment ecosystems	**24**
11:30 – 12:00	**Axel Rothauge:** What does it need to repair the condition and productivity of Namibian rangelands	**25**
12:00 – 12:30	**Axel Rothauge:** Brainstorming a national restoration plan	
12:30 – 13:30	**Louisa Mupetami:** Workshop to address Namibia's rangeland management policy and strategy	**28**
13:00 – 14:00	Lunch	
13:30 – 15:00	**Louisa Mupetami:** Continuation of workshop to address Namibia's rangeland management policy and strategy	**28**
15:00 – 15:30	Coffee break	
15:30 – 16:00	**Louisa Mupetami:** Drafting of recommendations	
16:00 – 16:30	AGM to arrange next NRF, and closure of indoor deliberations	

Thursday, 29 October 2009: Field visits

08:00 – 11:00	**Dave Joubert:** Field visit to research sites at Neudamm	**26**
11:00 – 12:30	Drive to Farm Lichtenstein-sud	
12:30 – 13:30	Packed lunch	
13:30 – 15:30	**Ibo Zimmermann:** Field visit to restoration site and untreated control	**27**

The scale of grazing – its influence on rangeland quality, carrying capacity and herbivore population performance.

Richard W.S. Fynn, Harry Oppenheimer Okavango Research Centre,
Maun, Botswana
rfynn@orc.ub.bw

The influence of scale on ecosystem responses and processes has often been poorly understood and infrequently addressed in ecological experiments. There is, however, a growing awareness that scale may have marked effects on ecosystem responses and processes. It is shown from a review of the literature that two major facets of scale: 1) herd size and density, and 2) total area available for foraging (home range extent), may have marked effects on ecosystem properties and animal performance. Herd size and density influences the degree of selective grazing, trampling and dung inputs, grassland structure, forage quality and nutrient cycling. The total area available for foraging influences resource heterogeneity and the ability of herbivores to adapt to spatial and temporal shifts in forage quantity and quality, which influences animal performance. At large scales, the ability to track stochastic pulses in forage quality driven by patchy rainfall and spatial shifts over the season in forage quality on rainfall and altitudinal gradients, enables herbivores to pursue an energy-maximizing strategy. Greater tracking of spatial and temporal shifts in forage quality in large-scale systems reduces the probability of returning to a specific foraging site each year and increases the ability to avoid local drought, which reduces negative grazing impacts on drought-stressed grassland. Thus greater resting of forage in large-scale systems, especially during drought, combined with grazing by large, dense herds, results in a stimulation of grassland production and the maintenance of grazed areas in a short nutritious state. Consequently, animal performance and rangeland quality are expected to be enhanced in large-scale grazing ecosystems. It is doubtful, therefore, that rangeland and animal performance responses to various grazing management treatments in small-scale experiments accurately reflect responses at much larger scales. Suggestions for designs of multi-scale grazing experiments are given.

The role of the soils in rangelands:
Supporting biodiversity and biomass production

A. PETERSEN, A. GRÖNGRÖFT & N. CLASSEN
University of Hamburg, Institute for Soil Science (for BIOTA)
A.Petersen@ifb.uni-hamburg.de

The analysis of biodiversity and biomass production requires a profound knowledge about the abiotic ecosystem compounds. Soils as integrative elements reflect various environmental influences and are therefore a valuable indicator of abiotic diversity and resource availability. Moreover, soil as a major compartment of terrestrial ecosystems has a significant impact on the composition and the productivity of flora and fauna.

Namibian rangelands are characterised by a high number of soil units which provide a broad range of ecological settings. Combined with the different amounts of rainfall within the biomes and a high inter-annual variability of the precipitation these settings result in a wide range of productivity which mainly depends on the capture, storage and redistribution of water and the availability of nutrients.

This presentation will give a brief overview of the soil investigation concepts and approaches within the BIOTA-Southern Africa project with a focus on the Namibian rangeland soils. The main topics such as variety of soils, nutrient supply and especially the dynamics of soil water supply will be addressed on different scales, accompanied by general information on Namibian soils.

Quantitative measures of soil diversity were tested on a dataset of the BIOTA Southern Africa transect. The results show that soil variation has a strong correlation to biodiversity of higher plants. The activity of mound building termites is a key element in the small scale pattern of soil conditions and also creates nutrient hotspots. The nutrient supply and soil water dynamics of the matrix soils are mainly substrate driven and therefore strongly influences the vegetation pattern and the biomass production. The installation of soil moisture monitoring sites in the central savannah which produces times series will be presented and discussed. It provides a database which improves the understanding of soil water dynamics and its influence of the productivity as well as the understanding of processes such as bush encroachment and the development of bare patches.

Evidence of impact of bush encroachment on groundwater resources

Frank Bockmühl
bockmuhl@mtcmobile.com.na

The impact of increasing densities of woody plants in Namibia's grazing areas on grass production has been well documented and research in this regard is ongoing. In this presentation, the significant impact of bush encroachment on the general water balance will be discussed.

The **Platveld Aquifer Study** area, covering some 1 million hectares of commercial farm land in the central north of Namibia, consists of the **Platveld Kalahari Aquifer Area** (PKAA), and in particular the **Platveld Kalahari Basin** (PKB). In this area no significant surface drainage patterns are developed, and it should thus be ideally suited for optimal recharge to groundwater. This evidently was the case in earlier times, with shallow waterlevels and free-flowing fountains recorded all over. However, declining water levels have been observed since the early 1930's, corresponding to both a changed abstraction pattern and to the increase in densities of certain woody plant populations over the investigation area.

Although changes in water usage have occurred over the past 50 years, abstraction volumes have not changed significantly. Drastic changes however have been recorded regarding livestock numbers and vegetation cover. The catastrophic impact that bush-encroachment has on deteriorating grazing conditions nationally, certainly has a similar, or even more drastic impact on groundwater resources. Some examples of water level reaction to rainfall in the Study Area indicate a clear inverse relationship between the volume of water available for recharge to groundwater resources and percentage canopy cover.

Declining water levels are evident not only in areas with high densities of various acacia species (e.g. *Acacia mellifera*), but also in areas where dense cover of *Colophospermum mopane*, *Terminalia prunioides* and *Dichrostachys cinerea* is causing a reduction of grazing potential. Evapotranspiration has been researched for *A. mellifera*, however, the water balance for some of the other potential encroaching species can only be assumed at this stage. Photographic evidence of extensive root mass development of some of these species has been collected and this supports the assumption that these species are opportunistic and very effective in utilizing available water. The collected evidence should be sufficient to motivate for further specific multi-disciplinary research in this field.

The dynamics of *Acacia mellifera*, implications for bush encroachment management

Joubert, D.F.[1*], Smit, G.N[2]
[1] Nature Conservation Department, Polytechnic of Namibia, P/Bag 13388, Windhoek, Namibia (for BIOTA)
* djoubert@polytechnic.edu.na
[2] Dept. Animal, Wildlife and Grassland Sciences, University of the Free State, P.O. Box 339, Bloemfontein, South Africa

Keywords: fire; seedling; sapling; mature shrubs; transitions

A recently proposed conceptual state-and-transition model describes transitions from open savanna to bush thickened savanna, based on limited data and observations. Fire is proposed as the major factor interrupting the transition, and small browsers, in particular lagomorphs, are proposed as modifying thicket density by thinning out seedlings and saplings. Recently initiated experimental research is testing the respective roles of fire, competition and browsing in interrupting or modifying this transition, which potentially occurs very infrequently and is dependent upon 3 consecutive well above average rainfall seasons. Seeds were planted in January 2008 in situations able to test 3 hypotheses (situations in square parentheses):
1. Fire interrupts the transition to bush thicket by killing seedlings and young saplings [burnt area and control with seedlings planted, and saplings and mature shrubs already present];
2. Competition with climax grasses is sufficient to interrupt the transition to bush thicket by weakening seedlings [seedlings growing next to and away from clipped and unclipped grass]; browsing of seedlings by hares (and other browsers) thins potential thickets out [seedlings growing inside exclosures and in controls].
Whilst one more season of data needs to be collected, and data analysis is not complete, the following tentative conclusions can be drawn:
Fire is the major factor interrupting the transition from open savanna to bush thicket, through its effect on killing seedlings, whereas it is generally ineffective in killing larger saplings and mature shrubs.
Competition between climax grass tufts and seedlings is insufficient to kill seedlings, rather a good climax grass cover is necessary for a fire.
Browsing of seedlings and saplings particularly by hares plays a role in thinning out thickets.
Evidence from field experiments supports the conceptual model.

Pilot restoration project in a key fertile valley of the Highland Savanna

[1] Kauatjirue, J., [2] Shamathe, K., [3] Pringle, H.J.R. and [4] Zimmermann, I.
[1, 2 & 4] Agriculture Department, Polytechnic of Namibia (for BIOTA)
[1] s200547062@students.polytechnic.edu.na
[2] Current address: shamatek@mawf.gov.na
[4] izimmermann@polytechnic.edu.na
[3] Ecosystem Management Understanding (EMU) Project, Alice Springs, Australia.
[3] hpringle@bushheritage.org.au

The rain use efficiency of some rangelands has been lowered by the legacy of historic degradation, thus reducing the effectiveness of grazing management in restoring rangeland health. Management that treats symptoms is usually too costly to apply over large areas, but if targeted at key productive landscapes may be worth the effort. During a workshop farmers of the Auas-Oanob Conservancy identified upland fertile valley systems as key features in their rangeland. Periodic waterlogging used to ensure that these valleys were dominated by perennial grass, but many of the valleys have been cut by gullies that drained them and allowed bushes to encroach. The pilot restoration site is in one such fertile valley with a slope of about 1:70. The gully system was treated in March 2007 with filters made of branches cut selectively from *Acacia mellifera* that was growing in dense stands nearby. The branches were packed at strategic locations, with the branches sometimes woven with wire and tied to nearby trees or steel posts. The restoration work along roughly 2 km of rills and gullies took about 100 person days to complete and used up 30 steel posts of 0.9 m length and about 900 m of fencing wire.

Half of the measured features were fenced to exclude cattle, both at the treated gully system and the unfiltered systems that acted as the control. The sampled features were measured, by landscape function analysis (LFA), with transects running across rills or gullies, and perennial grass densities were measured in 2009. When the changes in depth over the first two years at all measured features were analysed, they indicated slightly higher deposition at treated features, but none of these differences were significant ($P>0.05$) and fencing provided no demonstrable effect on deposition. The density of perennial grasses was lower underneath the filters in gullies or rills, probably due to the dense shade from the packed branches. However, there were almost twice as many perennial grasses above and below the filters within rills and gullies than outside rills and gullies. The perennial grass density was more than three times higher underneath branches placed alone on higher land between rills and gullies. This higher density of perennial grass under loose branches and nearby packed filters is likely to take over the filtering function from the branches that are decaying. This will hopefully flip the system from losing resources to capturing them and thereby allow self-repair to proceed.

Restoration work requires substantial resources and so it is critical to stop new incision early. Strategic surveillance of targeted vulnerable areas through the Ecosystem Management Understanding (EMU) process will allow rapid and cost-effective response. Factors that could lead to "nick points" can be removed from most productive, vulnerable areas. Prevention and early response are critical in extensive beef systems.

Engineering options may be required in places where the legacy of degradation is so immense that local bush packing (turning the problem into the solution) is impractical. In those cases, it is critical to be led by ecological assessment of the whole system in which the problem areas are a part and plan carefully an implementation strategy before any on-ground work is commenced.

The influence of thermo-chemical conversion on rangeland condition

Dagmar Honsbein
honsbein@gmail.com

Bush encroachment is not a new phenomenon in Namibia. However, due to the growing challenges it poses on economic performance in especially the agricultural sector, many initiatives to combat bush encroachment have been assessed and a number of these have been tried rendering limited success to clear or thin bush with subsequent value addition carried out. To date, thermo-chemical conversion in the Namibian context concerns 'traditional' charcoal making mainly. However, thermo-chemical conversion offers a variety of technological and resultant product choices which largely remain unutilised in Namibia.

The variety of technological options offered through thermo-chemical conversion includes combustion, gasification and pyrolysis. The resultant products are ash, woodgas and wood liquids, and charcoal. These products can also be used as precursors to energy and non-energy products, whereby products like fuel, biochar and fertilisers are rendered.

In a recent cost-benefit analysis the possibilities to utilise encroachment bush in thermo-chemical conversion processes (among other issues) to thereby (i) improve rangeland condition; (ii) ameliorate income from rangeland, and subsequently, (iii) socio-economically and technologically develop Namibia, have been investigated.

This presentation thus attempts to present the main results of the cost-benefit analysis and review as many as possible thermo-chemical conversion initiatives, future or already implemented, that could be useful in managing Namibian rangeland.

Quantifying farmers' perceptions and willingness; as well as availability of encroaching aboveground Acacia bush biomass on CCF commercial farmlands in north central Namibia

Matti Ngikembua, Cheetah Conservation Fund
matti_ngh@yahoo.com

The study was aimed at investigating certain key social and environmental aspects related to aboveground bush biomass on Namibian north-central commercial farmlands - and highlights on the identified requirements for effective bush thinning operations.

Social aspects were investigated with a questionnaire survey conducted on 51 farms in the Grootfontein, Otjiwarongo, Outjo and Tsumeb districts during June - September 2007. The survey revealed that 92.15% of the farmers depended on diesel powered generators for electricity production. The use of renewable energy technology (e.g. solar, wind) was not widely employed. About 96.07% of the respondents regarded bush encroachment as a problem, with the average encroachment rating per farm recorded to be 66.33 ± 5.07%. About 84% of the farmers attempted bush thinning by making use of different methods. Electivity analysis showed that most farmers interviewed preferred to use chemical application and manual harvesting with E = 0.235 and 0.220, respectively. About 70% of bush clearing operations were conducted by the owners and staff of the farms. The level of involvement by contractors and other individuals remained low at 21% and 9%, respectively. The majority of farmers (representing 50% of the responses) identified the lack of capital investments as the major impediment towards aboveground bush biomass use. Farmers considered the cost of 278 ± 31.87 Namibian dollar (NAM$) as being economically feasible in thinning a 1 hectare bush encroached area. The average economically feasible cost identified was lower than the actual cost of NAM$350 – 370 applicable to bush thinning during 2007. Findings on methods of financing showed that most farmers (representing 50% of the responses) preferred to cover their own expenses. Identified target areas where assistance may be required, were highest in the harvesting (34%), chipping (21%) and training/awareness (17%) categories. Overall, results revealed that both technical and capacity aspects should be strengthened for an effective bush thinning operation.

Environmental aspects were investigated with a vegetation survey conducted on the Cheetah Conservation Fund (CCF) farms *Elandsvreugde* (#367) and *Cheetah View* (#314) in the Otjiwarongo district. A data set comprising of 238 circular plots (each 113.14m^2) collected during the period 2003 – 2007 was used for analysis. Plots consisted of two previously completely cleared sites and three natural (non-thinned) sites. The survey revealed that the encroaching woody species density was dominated by *Dichrostachys cinere*a (37%), *Acacia reficiens* (24.4%) and *A. mellifera* (17.7%). Other species such as *A. fleckii* and *A. tortilis* were not commonly found. The *D. cinerea* species was mostly abundant in non-thinned sites, whereas *A. tortilis* occurred mostly in the recently completely cleared areas (e.g. Plot 1). Woody species diversity was highest in the non-thinned sites such as plot 3 (H' = 0.64) and plot 4 (H' = 0.63). The recently completely cleared plot 1 had the least woody diversity index (H' = 0.49). Comparisons of tree/shrub density among all study sites were not significant. Cylindrical aboveground biomass volumes for plot 4 were significantly different (higher) than those for any other studied site (F = 11.60, df = 4, p = 0.000). Using a harvesting scale of approximately 80%, findings have shown that harvestable aboveground biomass yields were 5.38 ±1.50 dry tons/ha (excl. moisture content). Tree/shrub densities were found to be lower than figures reported in the literature. Possible reasons for these differences may be methodological differences between various studies. Overall results revealed that standardization survey techniques and stratification over different habitat types, with a particular focus on aspects such as adequate sample size and variability in vegetation, should be considered for future surveys. Aboveground bush biomass could be considered a potential energy resource, however, the crux of this issue is restoring the savanna to its natural productivity without significant negative effects to the environment.

The role of bio- and landscape diversity in farming strategies - the case of the Keetmanshoop commercial farms.

Domptail S.E. Institute for Agricultural policy and market research, Senckenbergstrasse 3, 35390 Giessen, Germany. (for BIOTA)
Stephanie.domptail@agrar.uni-giessen.de

Introduction. This is a descriptive empirical analysis of land use strategies of commercial farmers with a focus on the role of bio and landscape diversity. The study aims at investigating the links between the ecological characteristics and dynamics of the rangeland and the management strategies of ranches. This is of particular interest if on-farm conservation should be fostered in the 40% of the Namibian territory used as private ranches for livestock production.

Methods. The case study was carried on mainly in 2005 among 22 commercial farmers of the Keetmanshoop area, Karas region. We conducted a small appraisal of farmers' perception of the rangeland resources and of rangeland dynamics and assessed elements of decision making in land use. For this purpose, we used a series of open and structured questions to herd and rangeland management as well as a series of exercises designed to conduct a cultural domain analysis.

Results are articulated around three axes: 1. the temporal use strategies; 2. the spatial use strategies; 3. regeneration strategies.

1. The temporal component of land use in the rotational systems considered refers to the timely movements of animals. Results show that 37 different plants corresponding to 20% of the plants identified in the near-by BIOTA observatory were cited. Yet, species are not used as indicator for range management: in most cases indicators are related to biomass, differentiating only between shrubs and grasses.
2. The spatial component assumes that the location of stock on the farm has an importance. Results show that different veld types appear at the farm level. Farmers understand soil-vegetation interaction through this concept and associate particular ecological and production characteristics to each type. Veld type as well as production-related parameters and breed characteristics enter in the spatial land use strategies.
3. Regeneration strategies are linked to the perception of the farmers on degradation and regeneration ecological processes. Those are not species based but rather distinguish only between main vegetation types: perennial versus annual grasses and dwarf versus higher shrubs. Factors perceived to impact on the vegetation of a rangeland include land use practices and rainfall.

Implications:

- ⇨ At landscape scale, there is a need for an official recognition of veld diversity and an assessment of rangeland vegetation other than with the use of biomass standards. Such a perception is supported by farmers' knowledge. The veld type concept, when related to the concept of key resources (Scoones 1998), can be helpful in the design of land attribution and farms structure or at least for farm management.
- ⇨ At the smaller scale, the capacity to monitor biodiversity is restricted. The benefits of biodiversity for production, especially of grasses, are not well known. A study of the role of biodiversity in farming systems themselves would be necessary to improve scientific understanding and increase awareness and knowledge among farmers of the benefits of biodiversity.

Application of an ecological-economic rangeland management model for interactive role-plays, scientific analyses and training purposes

Dirk Lohmann, Thomas Falk, Eva Rossmanith, Niels Blaum, Michael Kirk, Florian Jeltsch (for BIOTA)
falkt@staff.uni-marburg.de

The ongoing degradation of savannah ecosystems has significant long term ecological and economic consequences. One of the central management parameters of livestock farmers is the adjustment of stocking rates depending on different factors such as rain, biomass production, the state of the livestock, costs, and herd composition.

We used an eco-hydrological model to simulate the vegetation dynamics in the Omaheke region/Namibia depending on environmental conditions. By dynamically linking this model to an agent-based economic model we are able to include decisions of land users. The ecological-economic model was used (1) to identify optimal land use strategies under different environmental, ecological and socio-economic conditions by running simulation experiments, (2) as a tool to conduct empirical experiments in order to deepen our understanding of the rationale of farmers, and (3) to develop a user friendly computer tool which allows farmers to experiment in a playful way with different management options.

Simulation and empirical analyses show that mal-adapted management strategies as well as high financial pressure lead to sub-optimal outcomes. Our approach produces context specific information for stakeholders as a means to support their search for solutions to achieve biodiversity maintenance as well as rural development objectives.

The training tool – a preview of which is launched at the Namibian Rangeland Forum (NRF) – is a computer farming simulation game. It is a simplification of reality which shows specific interactions between management decisions, production systems, environmental variations and/or changes on ecological consequences as well as the qualitative impact on the farming income. The programme is planned to be extended in future for instance to consider also the impact of grazing rotation in more detail. We present this early version of the tool at the NRF because we highly appreciate feedback that, if possible, will then be included in the final versions of the software.

Key words: rangeland management, ecological-economic model, training tool, Omaheke, companion model

Cooperative rangeland management of neighbouring resettled farms

Bertus Kruger
bertus@agrinamibia.com.na

Livestock production under natural rangeland conditions forms the backbone of the agricultural industry and plays a significant role in the livelihoods of a large section of the people of Namibia. Rainfall in Namibia is very low and variable and is expected to decline and become more variable in future with the impact of climate change. The major challenge facing livestock farmers in the country is thus to develop and implement strategies to reduce their vulnerability to the adverse impacts of climate change.

Land reform is a reality in Namibia and the government intends to settle at least 15 million hectare of currently white-own commercial land with previously disadvantaged black farmers by 2020. Under the current government land resettlement model, multiple families are resettled on a farm formerly owned by a single farmer. These farmers find it very difficult to apply proper rangeland and livestock management practices due to limited number of camps and other infra-structure. Conflicts very often arise regarding the pumping of water and the use and maintenance of infra-structure on the farm. These farms were initially planned and developed for central decision-making by a single person. Currently, various units are allocated to different farmers and central decision-making is not possible any more, resulting in inadequate flexibility of farming practices (e.g. mating and weaning seasons, rotational grazing, etc.) to be applied. This leads towards increased rangeland degradation, inadequate improvement of farm productivity and subsequent increased vulnerability to droughts.

This presentation shares experiences gained by three resettled farmers on the farm Onjossa in the Erongo region over the past 12 months. Farmers agreed to merge smaller herds into bigger ones and to use all their camps together. This allowed for more camps per herd and shorter grazing and longer resting periods. Once farmers signed a memorandum of agreement, livestock of all the farmers were evaluated and sorted, with the support of the mentors. Mating seasons were introduced and high quality bulls were made available from stud breeders in the country for the duration of the breeding season. Important husbandry practices like vaccination, branding, dosing, castration, etc. were performed on all the animals. This presentation further describes the process used to set up the joint management approach; present some achievements to date and highlight challenges faced by such an approach.

The influence of patch burning in the Thornbush Savanna

Lahja Tjilumbu & Ibo Zimmermann
Agriculture Department, Polytechnic of Namibia (for BIOTA)
s200234536@students.polytechnic.edu.na izimmermann@polytechnic.edu.na

Although fires have shaped savanna rangelands for millennia, most farmers have controlled lightning induced fires on their farms for past decades, with resultant change in rangeland condition. A few farmers have tried to apply prescribed burning to portions of their farms, mainly to try controlling bushes that have thickened on the land, while very few apply patch burning for biodiversity. The application by farmers of prescribed patch burns provided an opportunity to measure the effect of the fires on five patches of rangeland spread over three farms in Namibia's Thornbush savanna. Four of the patches, burnt for bush control, were roughly 100 ha each, while the other, burnt for biodiversity, was about 10 ha. The beginning and end of 50-m transects were permanently marked in patches destined to be burnt, in nearby unburnt controls and, on one of the farms, in strips of 30-40m width destined to become firebreaks by grazing cattle within temporary electric fencing.

Plants of four different categories nearest to sample points spaced 2.5 m along the transects were marked and measured in the growing seasons before and after the fires, but only if they occurred within 5 m of the point. The plant categories were:
(i) perennial grasses of at least 5 cm living basal diameter;
(ii) woody plants taller than 0.5 m;
(iii) woody plants shorter than 0.5 m; and
(iv) current season seedlings of woody plants.
The patches were burnt with a head fire towards the end of the dry season.

There was almost no mortality amongst the taller bushes, with the fires only reducing their heights on two of the farms. Taking *Acacia mellifera* in the burnt zones as an example, the height reduced by medians of 2%, 72% and 68% at each of the three farms, while the canopy diameters increased by approximately 20% on two of the farms. It seems that the regrowth spreads out more from bushes that were burnt down. A considerable number of smaller plants died, even in the unburnt controls, probably due to the exceptionally long dry season in which the fires were applied. In the case of *Acacia mellifera*, only one seedling (3%) survived in an unburnt zone, while 65% of saplings survived in the unburnt zones, with no clear pattern of difference between zones among the three farms. For most perennial grass species the mortality was higher in the burnt patches and firebreak.

On the farm where patch burning was done for biodiversity, soil augured to 15cm was collected at three burnt patches and used for radish bioassay to determine overall fertilities. The lengths of intercepted dung were measured along 50m transects as an index of herbivore pressure. The fresh mass of radish plants grown on soil from a patch burnt two years previously was much higher than those grown on soil from the nearby unburnt control, presumably resulting from dung and urine of cattle and game attracted to the burnt patch. The dung cover one year after the most recent fire, when compared to that in the unburnt zone, was seven times higher in the firebreak and three times higher in the burnt patch. Radishes grown on soils of firebreaks and more recently burnt patches were heavier than those grown on soil from unburnt controls. The burning of small patches appears to create nutrient hotspots. However, the use of fire after such a premature end to the rainy season may be inappropriate for most rangeland management objectives. Rather than being applied regularly, fire should only be used strategically, and only after season's of above average rainfall when an abundance of forage and fuel is likely and perennial grasses could regrow on residual moisture from the previous season in case of insufficient rain after the fire.

The influence of high stocking density followed by rest on grass density and soil moisture in the Camelthorn Savanna

Ibo Zimmermann, Justus Kauatjirue & Tjijamemua Tjeriko
Department of Agriculture, Polytechnic of Namibia (for BIOTA)
izimmermann@polytechnic.edu.na

There is still a lot of controversy around trampling as a rangeland management tool. Some promote animal impact for a variety of benefits including removal of old plant material, invigoration of existing plants, mulching the soil surface with trampled vegetation, favouring establishment of new plants, returning nutrients to the soil surface and breaking soil crusts that interfere with seed germination and rainfall absorption. On the other hand, others warn that trampling tends to result in lower infiltration rates where it destroys stable soil aggregates and leads to a deterioration of soil structure. Those who promote trampling all agree that it must be followed by sufficient rest to allow recovery after trampling. An innovative farmer, Jan Labuschagne, has gained considerable experience with trampling, through his adaptive management. His observations suggested that brief trampling after good rain, on soil with the right texture and organic matter content, conserved soil moisture, possibly by breaking the capillary connections that suck moisture from lower layers in untrampled soil. Therefore Gypsum blocks were buried at 10, 25, 50 and 80cm depths, both in and outside exclosures, replicated five times on each of three farms where livestock rotate rapidly through many paddocks. Vegetation in and outside exclosures was measured by point-centred quarter (PCQ). Initial results from the gypsum blocks are inconsistent among replicates and correlate poorly with soil moisture determined by weighing on augered samples. However, a few examples with greater consistency hinted that the infiltration was greater on trampled sites from where evaporation was less. The density index of plants – mostly annual grasses – was significantly ($P<0.05$) higher outside most of the exclosures. This increase of annual grasses on trampled sites may be responsible for subsequently sucking more water out from the soil, resulting in higher grass productivity from trampling (if followed by sufficient rest), but not in moister soil by the end of the growing season.

Observations by Jan Labuschagne suggest that if trampling is applied strategically in relation to rainfall events and soil conditions, and if followed by sufficient rest in the growing season, then trampling could be used over localised areas for improving rangeland condition. His management applications of the tool of trampling including the following:

- Only apply intensive trampling where the soil organic matter content is high or where there is abundant standing dry grass to trample down into the mulch layer.
- Only apply trampling to sandy soil in the growing season, when it is moist (if soil organic content is sufficient).
- Reduce the stocking rate on loamy soil in the growing season, to avoid compaction.
- Avoid trampling after good rains on soil where few perennial grasses grow, as the extra soil moisture tends to favour bush growth. Rather trample such poor paddocks after the first rain of the season, to encourage perennial grass emergence.
- Farm mainly with Damara and Van Rooi sheep that provide a better trampling service, mixed with limited Dorper genes to provide the larger animals demanded by the market.
- Control jackals to a limited extent and sacrifice the loss of a few sheep, so that the herd bunches well and mothering instincts continue to be selected for.

Trampling is a complex tool and should be differentiated between its variables of type of animal, stocking density and timing, season, soil texture, soil moisture profile and organic matter content of the soil. Farmers willing to apply the tool of animal impact need to bear in mind that long rest should be provided after the trampling and that animal performance may be sacrificed to some extent.

Helminth management in sheep for healthy rangeland

Sagaria Muheua & Ibo Zimmermann
Agriculture Department, Polytechnic of Namibia (for BIOTA)
s200448420@students.polytechnic.edu.na izimmermann@polytechnic.edu.na

Sheep and goat production is threatened by the development of resistance among helminth parasites to anthelmintic chemicals. This leads to a vicious circle if higher dosages of more toxic chemicals are applied more often. The toxicity of the chemicals furthermore threatens dung beetles, which provide critical services such as maintaining the health of rangeland soils and clearing away fresh dung that would otherwise harbour parasites and flies. There are Namibian farmers who manage to produce healthy livestock without the use of any toxic chemicals. They tend to treat the root causes, thus preventing the conditions that favour parasites. By leaving their animals out in the rangeland they avoid the close contact between dung and animals that would otherwise occur during kraaling. This requires good control over jackals and other small predators. The ways they achieve this include conservation of wild animals to provide favoured prey for the predators; hunting down of individual problem animals; regular maintenance of jackal-proof fencing; raising puppies with lambs to imprint them to become guard dogs; narrow breeding seasons to avoid providing predators with year-round lambs; and the use of indigenous sheep breeds with strong mothering and herding instincts. A few farmers even welcome low densities of jackals for the selective pressure they apply by removing the sick and weak animals from the herd and maintaining mothering and herding instincts. One farmer in South Africa strictly prevents his sheep from seeing any domesticated dogs, and he no longer experiences any loss to predators. However, more farmers apply their own selection by selling or slaughtering individual animals with high parasite loads. Farmers who practice rotational grazing are able to interrupt the life cycle of parasites so that the larvae which hatched after sheep were removed from a paddock find no host and die before the sheep return to the paddock. There are also a few farmers who treat the root cause of aggressive handling of their livestock by applying methods of stress-free herding, based on animal behaviour.

When farmers are still forced to overnight their livestock in kraals, there are ways to administer toxic chemicals that minimise their negative effects, and there are non-toxic treatments that will at least avoid harm to non-target species. One of these treatments involves the use of Effective Microorganisms (EM), which can be used to ferment cheap organic matter, such as barley waste obtained from Namibia Breweries, into a product known by its Japanese name of “bokashi”. Eighty sheep belonging to each of five farmers in the Rehoboth District were marked and divided into four groups of twenty. Forty of the sheep are fed daily by the farmer with about 100g each of bokashi. Twenty of these sheep are also dosed with 40ml of straight EM twice a year. Out of the forty marked sheep that do not receive the bokashi supplement, twenty continue to be treated in the normal way that the farmer used to treat them, usually by applying chemical anthelmintics a few times per year. The remaining 20 sheep serve as control, with no treatment against internal parasites at all. All marked sheep are weighed every 2nd month and egg counts performed on dung samples.

Neither the toxic chemicals conventionally applied by the farmers, nor the EM treatments, appeared to make much difference to the liveweight changes and parasite loads in the dung of the sheep. Despite the lack of evidence from the research, at a workshop the farmers were very enthusiastic about the EM. They notice improvements that are not detected by the research, such as the meat quality they observe when slaughtering their sheep. They agreed to continue with bokashi after the project, and discussed how they would organise themselves to purchase the ingredients. The cost of ingredients and materials for the EM treatments was approximately N$21 sheep / year. One of the farmers even used EM to successfully treat animals that were weakened by ingesting poisonous plants.

Bridging the gap – para-ecologists in action. A film project to promote capacity development and awareness raising.

R.S. Mukuya, J. Swartbooi, S. Swartbooi, R. Isaacks, M. Gruber, D. Kotze, M. Lot, V.S. Mtuleni, W. Pieters, and U. Schmiedel (for BIOTA)
rmukuya2005@yahoo.com swartbooij@gmail.com

Capacity development and involvement of local, indigenous communities around the world in applied research activities is a tool to bridge the gap between scientific and indigenous knowledge which can brighten the future for them and for the generations to come. Using this opportunities effectively and productively can be beneficial for all the parties involved by helping land users to better understand the effects of climate change and land use on their natural resources in order to jointly develop adaptation and mitigation strategies for the future.

With this in mind, in April 2009 the South-African and Namibian para-ecologists conceived and made the film “Bridging the Gap – Para-Ecologists in Action”, in order to show how they bridge the gap and facilitate the exchange between local knowledge and academic science. In the documentary, the eight para-ecologists from various rural communities in South-Africa and Namibia introduce their every day’s activities in the field of research and knowledge exchange to the broader public. The film aims to encourage other organizations, agencies, research projects and land user communities to get involved in rural capacity development as a contribution to the sustainable development of our society.

The concept development and production of the film itself was a great learning opportunity and has been part of the para-ecologist training course in April and May 2009 in Nieuwoudtville / South Africa. In the talk we will present the participative film project as part of the capacity development component. We will present the aims and target groups of the film, how we conceived, planned and filmed the documentary and discuss the major learning experiences of the process were. The 20 minutes-long film will be screened on one of the evenings during the conference and free DVD copies are available on request.

Towards a National Rangeland Policy and Strategy for Namibia

Leon Lubbe, Nico de Klerk, Colin Nott & Bertus Kruger
LubbeL@mawf.gov.na

The alarming state in which much of Namibia's rangelands are, its inability to support a substantial portion of the nation and concomitant increase in poverty levels and the impact of land degradation on the national economy, is well known. Currently, the degraded state is most pronounced in the form of soil erosion, bush encroachment, loss of perennial grasses and deforestation. Effects on ecosystem processes from current unsustainable livestock management practices include: (1) negative impacts on the water cycle with bare and/or capped soils resulting in poor infiltration of water into the soil, high evaporation rates, high run-off, and erosion; (2) negative impacts on the mineral cycle where the soil surface is repeatedly grazed bare, resulting in little or no conversion of soil surface litter into organic matter in the soil; and (3) loss of biodiversity due to these hostile conditions in which many perennial plants are lost, leaving behind a largely annual grass community dominated by a few species. With this current situation of Namibia's rangelands and the current and potential impacts thereof on the livelihoods of a large number of Namibians in mind, it is of paramount importance that something drastically and urgently be done. It was against this background that the Ministry of Agriculture, Water and Forestry (MAWF), in cooperation with the private sector and non-governmental organizations, developed a draft Rangeland Management Policy and Strategy (NRMPS). This document should serve as framework and guideline towards implementing strategies that will: 1) enable rangeland users and managers to manage their rangelands in such a way that productivity and biodiversity is restored and maintained; 2) reduce vulnerability of rangeland users and managers to the adverse impacts of climate change and seasonal environmental variation; significantly contribute towards improving the livelihoods of people that are directly or indirectly dependent on rangelands; and serve as basis for monitoring the effect of bush encroachment on underground water levels.

This presentation will discuss: 1) the rationale for having a national rangeland management policy and strategy; 2) major goals and objectives of such an initiative; 3) the basic principles of sound rangeland management; and 4) how these principles could be applied under different situations on the ground.

The controlled fodder flow grazing management strategy (Dames, 1996) and "grass fed beef production": a sustainable, proven, environmentally friendly, extensive animal production model for the semi-arid and arid environments of southern Africa.

Riaan Dames, Rangeland Management Specialist, Department of Agriculture, Conservation, Environment and Rural Development, Vryburg, North West Province, South Africa. POBox 112, Vryburg, 8600, South Africa.
rdames@nwpg.gov.za; narhee@topmail.co.za

Almost the whole of Namibia receives a long term average rainfall of less than 500 mm per annum and can therefore be classified as Semi-Arid and Arid rangelands. The low and often unpredictable rainfall makes the planning and execution of sustainable animal production models extremely difficult and management in such environments is often driven by short-term decisions in a "reactive" mode. Management decisions are often led by short-term weather patterns and fodder flow management is very difficult.

The development and subsequent refinement of the controlled fodder flow grazing management strategy by Dames (1996) could be seen as a real time solution towards more effective fodder flow control and better drought tolerance in the above mentioned areas. The strategy was developed from interim results from a long term grazing experiment at the Adelaide research station in the False Thornveld of the Eastern Cape. In this trial the effects of animal number, distribution and type on rangeland and animal performance is tested. Initially the Controlled fodder flow grazing management strategy was based on one third of grazing to be rested annually and the other two thirds to be grazed rotationally. After implementation on various farms in South Africa, it was refined to the point where 50% of the grazing is rested annually while the other 50% is grazed. In other words a specific grazing area receives biannual full year resting from August to July and is subsequently grazed for a year following the yearlong resting.

This flexible management strategy proved to be extremely successful in practice with numerous examples in the Northern Cape, North West and Free State Provinces of South Africa. Farmers practicing the strategy have been recognized nationally with various awards e.g. The ARC's best performing stud in South Africa 2007 (Op Die Aarde Bonsmara). They also received the Voermol award for best Beef farmer in South Africa during 2008. In communal rangelands various successful operations implemented the strategy. The best performing example is probably the Maketlele land care project, initiated and developed by the NW DACE and now part of the Northern Cape Province. Veld condition and animal production improved significantly at Maketlele since the incorporation of the strategy into their grazing management despite stocking rates much heavier than Departmental norms.

In general, carrying capacity at all locations where the strategy has been implemented increased between 30 and 50% within 5 years of implementation. This can be seen from the increase in animal numbers in commercial projects and better animal performance in communal projects. The higher grass production subsequent to yearlong resting has been proven at the Nooitgedacht research station, at Ermelo, South Africa.

Grass fed beef production is a low cost beef production model ideally suited to the arid and semi arid rangelands of Southern Africa with sweet and mixed veld. It is a niche market with a growing demand world wide and in South Africa. Small framed cattle with special reference to indigenous African breeds and their crosses is ideally suited to the production of grass fed beef due to the fact that they can be easily finished on natural rangelands without the need for grain (no grain is allowed in true grass fed beef production). Grass fed beef and game meat is regarded as the most healthy red meat on earth. The healthy aspects include a much longer shelf life, 4 times higher Vitamin E, 3 times higher Omega 3 fatty acids , 10x lower E coli counts and much higher CLA as compared to grain fed beef(www.eatwild.com). It has properties that significantly reduce the chances for heart attacks, cancer and modern lifestyle diseases. The South African market for grass fed beef is growing and well known retailers like Pick 'n Pay and Woolworths are offering it to the public especially in Gauteng Province. Brand names like "Kalahari Beef" etc are used to market the products. A-grade prices are fetched for B-grade grass fed beef cattle. Namibia and Botswana are exporting grass fed/free range beef to the EU.

Economists like Prof Johan Willemse from the University of the Free State believe that grass fed beef is the lowest risk alternative for sustainable beef production in Southern Africa, because the risk in financial sustainability for grain fed beef is rising and it is forecasted that it will become more and more difficult to produce grain fed beef in a financially sustainable way due to the fact that a larger and larger chunk of maize available for meat production will be utilized for mono gastric meat production (chicken and pork) and mono gastric animals are up to 300% more efficient in conversion of grain to meat as compared to ruminants (beef, sheep, goats).

Therefore the well proven controlled fodder flow grazing management strategy incorporated into "grass fed beef production" could be seen as a sustainable, environmentally friendly production model for extremely healthy red meat from arid and semi-arid rangelands of Southern Africa.

Cooperation in the commons: evidence from a cross-cultural field experiment on common-pool resource management

Sebastian Prediger, Björn Vollan and Markus Frölich (for BIOTA)
prediges@staff.uni-marburg.de

The presentation reports on some major results obtained from a series of economic experiments carried out in the Namaland in Namibia and the Namaqualand in South Africa. The experimental set-up aims to mimic a typical common-pool resource dilemma communal farmers are faced with in their everyday lives. However, in contrast to standard experiments, our experimental design is framed according to the grazing situation in semi-arid regions, and thus has features of path-dependency of previous use, spatial resource availability and non-linear revenues. We analyse farmer's propensity to cooperate and find substantial differences between Namibia and South Africa which we attribute to the different historical developments the communities experienced. We further analyse the preferred choice among three real-life institutions: rotation, lottery and a regulation rule. A huge majority of people in both areas chose the rotation rule and it seems that this choice was driven by a combination of advancing self-interest and, in Namibia, good network connections within the village. However, rule breaking, especially in Namibia was highest with the rotation rule which led to lower earnings and worse grazing conditions.

Can land taxes be a tool for rangeland conservation? – Application of bio-economic modeling for on-farm conservation

Stéphanie Domptail, Ernst-August Nuppenau, University of Gießen, Germany, Institute of Agricultural Policy and Market Research, Senckenbergstr. 3 35935 Giessen, Germany
Alexander Popp. Potsdam Institute for Climate Impact Research (PIK, Telegraphenber, A 31, 14473 Potsdam, Germany (for BIOTA)
Stephanie.domptail@agrar.uni-giessen.de

– Introduction and aim

In the context of the land reform, land taxes have been designed and implemented in Namibia for all privately owned agricultural land. Land valuation was carried on throughout the country to create a basis for the taxation. During the process of land tax design, concerns were raised about the financial burden that the tax represents. Will the tax lead farmers to change their farming strategies and would this change impact on veld management and veld condition? Another question concerned the possibility of developing a taxation system, which would reward good veld maintenance or veld conservation. Answering these questions is the aim of this contribution. First we conduct a positive impact analysis and in a second step, we develop two alternatives of rangeland condition-differentiated taxation schemes and compare impacts of the actual and the alternatives on stocking strategy and veld condition.

– Methods

We use a bio-economic model, based on optimization techniques and programmed in GAMS. The advantage of this tool is that the impacts of rainfall, a major driver of the socio-ecosystem, and of stocking decisions are explicitly modeled. Bio-economic models represent management decisions and the ecological dynamics of the veld. Resources, objectives of the decision making and possible activities are inputs in the model and outputs consist in the optimal land use strategy in terms of stocking rates over time to suit the defined objectives for the modeled farm. Rangeland ecology is incorporated in the model using the concept of state-and-transition.

– Results

We first found that at the actual level, the fixed tax does not lead to a major change in farming strategies, nor has an impact on the veld condition, according to modeling results. Second, thanks to a shadow price analysis, we were able to calculate land values for the rangeland, depending on its condition, that is in which ecological state the rangeland is in. Values for a system involving only Dorper monoculture in southern Namibia vary between 21 NAD/ha for healthy states to -78 NAD/ha for degraded states. Based on this, we third found that the rangeland condition-differentiated tax schemes create an incentive for the modeled farmer to change its strategy and increase conservation on the farm. This is especially the case when resting in rainy years is favored, as in the scheme rewarding good practices, as opposed to the scheme penalizing bad practices.

Conclusions

The land tax at its actual level would not lead to changes in the land use strategies of farmers. Incentive tax design can bring the same amount of income to the state and foster on-farm conservation.

The practicalities of implementing the NRMPS from a legal perspective

AL Groenewaldt, UNAM (for BIOTA)
al.groen@live.com

There is a plethora of research that indicates the existence of degraded pastures and farming lands in Namibia. The solutions to such a dilemma often fail because of an unfavourable socio-economic, legislative and policy environment. Namibia is signatory to various international, African and regional environmental legal instruments. While the Namibian Constitution does not guarantee the right to a healthy environment, it enjoins Government to adopt policies aimed at the protection of the environment. In addition the Ombudsman has the mandate to investigate complaints regarding the misuse or abuse of natural resources. However some provisions of the Constitution, or a lack thereof, may inadvertently compromise these clauses. The Namibian Government has made a pledge already in 1992 through its Green Plan to promulgate laws that would support the sustainable use of land. Despite this commitment coupled with its international and national obligations, there is not a single law to date that deals explicitly with the conservation and management of rangeland. There are a number of pre-and-post independent statutes, policies and strategies currently on the law books of Namibia that deal indirectly with the issue. While they may highlight land degradation as a serious problem, none of these laws provide direct guidelines on how to deal with the degradation of rangeland. In addition they contain gaps that beg the necessity of rangeland policy (NRMPS). Furthermore the lack of, or the partial implementation of, existing laws might also be a major stumbling block in the implementation of a future rangeland policy. It is therefore imperative to consider measures to the effective implementation of the proposed NRMPS. There are generally two ways through which land degradation may be controlled, *viz* direct or indirect controls. Direct controls means to set standards or to prescribe or prohibit certain actions by the land user. To control unsustainable management of rangeland, the government can for instance prescribe what the carrying capacity on a particular farm should be. The question that arises in this context is to what extent direct implementation of the NRMPS will affect the concept of land ownership? The key to a practical rangeland policy is control of land use, and there is a close relationship between control of land use and ownership of the land, since the owner's use of his land may be extensively curtailed or limited by means of direct land use control measures, such as the prescription of how many cattle or livestock a farmers may keep on their land. This approach therefore presents a clash between the owners' right to property as guaranteed by the Constitution and a conservation policy. A less direct way to influencing environmental behaviour and promoting the economically efficient and equitable use of rangeland in the country, is the application of economic incentives (indirect controls). Economic incentives or measures such as land taxes (done by Ms Domptail); subsidies; environmental bonds; compensation; benefits and market permits, would endeavour to correct market signals which lead to environmentally damaging activities. Both approaches have merits and demerits, but one has to strike a balance between the two competing interests, namely the land owner' rights and the need to conserve and protect the environment.

Land degradation monitoring and assessment methods: A review

Taimi Sofia Kapalanga, Junior Researcher, Gobabeb Training and Research Centre, P.O.Box 953, Walvis Bay, Namibia; Tel: (0) 64 694199, Emailfax: 088 617325, Email: *tskapalanga@gmail.com*

Land degradation is an increasing problem in many parts of the world. Success in fighting land degradation requires an improved understanding of its causes, impacts, degree and acquaintances with climate, soil, water, land cover and socio-economic factors. Therefore, land degradation monitoring and assessment is a primary goal in decision support systems for reversing degradation. Scientists around the world identified this problem early on and developed several monitoring and assessment methods for land degradation. This study explores and reviews existing land degradation monitoring and assessment methods used globally, regionally, locally and at field/farm level in an attempt to recommend sustainable approaches applicable to Namibia. Results of this study lead to the conclusion that there are several approaches for assessing and monitoring land degradation worldwide. Expert opinion, field measurement, field observation, land user´s opinion, productivity changes, remote sensing and modelling approaches act as basal studies for other approaches used to assess and monitor land degradation at different levels. The first distinction that has to be made is land use, land types and scale. Methods or techniques need to be cautiously selected, taking into account suitability, applicability and adaptability to local/farm levels. These assessments coupled with stakeholder participation leads to higher adoption of proposed techniques ultimately aiding land use, restoration planning and prioritization of projects. Furthermore, researchers have reported that statistical methods, ordination, and modelling approaches are costly, complicated, and time consuming. Therefore a lack of experienced personal and availability of resources are some of the main barriers to successful assessment and monitoring systems. This review also revealed that, stories of failures in using different monitoring and assessment methods are very few which is somewhat surprising. Does that means everything works?

Rangelands as catchment ecosystems

Hugh J. R. Pringle

Ecosystem Management Understanding (EMU) Project, P.O. Box 8522, Alice Springs, Northern Territory 0871, Australia thambolenje@yahoo.com.au

Rangeland ecology is steeped in the traditions of plant community dynamics of pasture or veld types and their internal dynamics. Attention to managing veld types has proved to be very important in raising landscape productivity and agricultural production. What has yet to be fully understood and harnessed is the promise of a more hierarchical, catchment-based understanding of rangelands. Two key issues demonstrate this promise.

Firstly, veld types are not permanent features of the landscape as vegetation maps might suggest. Instead, physical landscape succession processes driven by broadscale erosion, transfer and deposition fundamentally change the spatial conditions for plant growth over time. Thus, at the edges, “apples” can become “oranges” and vice-versa and grazing management needs to attend as much to the relationships between desired veld types and their neighbours as the internal dynamics of individual veld types. A good example of this is when floodplains contract and the more bushy adjacent vegetation expands to take up vacated space. These dynamic edges are very useful for “early warning” monitoring.

Secondly, some key processes related to drainage patterns not only link adjacent veld types, they unify whole catchments. Thus, if a river channel cuts down because a rock bar across it snaps, lowering the base level, gulley erosion of most fertile parts of each successive veld type will proceed all the way to the top of the catchment. This process may run through whole farms, not just camps. It is a good example of why farmers need to collaborate in maintaining the health of the connected network of valley floor systems from main rivers and their floodplains all the way back to upland dambos. This incision-driven drying out of rangeland catchments is a pressing, overlooked global issue and is driving bush encroachment as water-ponding surfaces no longer pond effectively. Affected catchments – especially the most arid catchments - experience downward spiralling of rain use efficiency and greater drought vulnerability. This is clearly of national and global importance in the context of climate change and ever increasing populations.

What does it need to repair the condition and productivity of Namibian rangelands?

Axel Rothauge
Technical Advisor: Animal Production, AGRA Professional Services,
Private Bag 12011, Windhoek (axelr@agra.com.na)

Mismanagement of the natural rangelands of Namibia, based mainly on a lack of appropriate knowledge, is playing havoc with the productivity of the livestock and game sector of the national agricultural economy. Effects are well-known and range from severe loss of rangeland productivity due to bush encroachment on millions of hectares of savanna rangelands, to the halving of the national commercial cattle herd, to an estimated loss of foregone beef income of N$700 million per year (in 2004).

While the extent of the crisis is clear, remedial measures are not. In 2008, at the request of organized commercial agriculture, a committee of technical experts and stakeholders in rangeland management identified some major principles of sustainable rangeland utilization, which were to be integrated into a National Rangeland Management Policy, currently with Government. These principles, in no particular order, are:

- Know and understand the natural resource base and its indicators.
- Plan the farm (ranch) so that forage is utilized effectively
- Allow forage, especially the perennial grasses, effective rest after defoliation.
- Apply adaptive forage management for farm animals.
- Restore the rangeland at every possible opportunity.
- Make pro-active provision for the next drought.
- Monitor rangeland utilization and use records to inform grazing management.
- Take care of the soil, especially the top layer of soil.
- Take care of underground water resources.

The application of these principles will certainly slow the rate of rangeland degradation and even reverse it, as restoration is a critical element of sustainable rangeland management. However, this specific principle lacks detail and innovative ideas on how degraded rangeland can be restored and rehabilitated to its former condition and productivity; in the short, medium and long term.

Some short-term measures that may contribute to rangeland restoration are:

- Avoid degradation in the first place.
- Correct balancing of stocking rates with carrying capacities.
- Selective thinning of invasive bush species.

Medium- and long-term measures include the following:

- Contingency planning and opportunistic management to face challenges and exploit opportunities.
- Restore the botanical composition of the grass sward.
- Improve soil cover so that top soil conditions improve and the water cycle recovers.

These are just some of many specific suggestions that would restore degraded rangelands. It is hoped that the members of the Namibian Rangeland Forum gathered here today can identify many other strategies during the subsequent brainstorming session. These inputs should then be brought to the attention of the relevant authorities to back up with extension, research, monitoring and material support and be publicized amongst the farming community to implement. *After the shock of recognition, it is time to face the challenge of restoration!*

Field visit to research sites at Neudamm

Dave Joubert

A visit will be paid to the Neudamm sites where research into the dynamics of *Acacia mellifera* are being conducted (page 7). At the site burnt last year, and another burnt last week, the effects of fire will be visible. At the unburnt sites evidence of hare browsing will be pointed out, while the effects of hare exclusion will become apparent at the exclosures. The research into the effects of perennial grass on vigour of *A. mellifera* seedlings will be explained and discussed.

Burnt rangeland recovers in the growing season after the fire

The cage (above & below) excludes small browsers, such as hares

A burnt *Acacia mellifera* seedling was a victim of the fire

Field visit to restoration site and untreated control

Ibo Zimmermann, Kuniberth Shamathe & Justus Kauatjirue

Participants of this field visit will be able to witness the results of the pilot restoration project in the Auas-Oanob Conservancy (page 8). A walk along the treated gully system will allow viewing of, and discussion on, the strategic placement of filters made from chopped branches of *Acacia mellifera*. Some "before treatment" photos will be passed around, to provide an impression of the changes that have taken place. Visitors will also be able to view the exclosures, both at the treated gully system and at one of the untreated controls.


A gully head is packed with branches


Same site as top left, 18 months later


Wire is woven through branches in the filter and tied to nearby trees


One branch got turned 180^0 by the water flow, but the wire held it within the filter


Grasses filter a gulley as branches rot


A filter row between two gullies

Namibia's draft National Rangeland Management Policy and Strategy is a separate document that appears from here onwards in the printed version. Electronically, it appears as two separate files, named NRMPS_cover and NRMPS_contents.