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# PROGRAMME

MONDAY, 25 August 2003

- 16:00-17:30 Registration  
 17:30-18:00 Briefing Session  
 18:00-19:00 Leisure time  
 19:00 Dinner

TUESDAY, 26 August 2003

- 07:30-08:30 Registration  
 08:30-08:40 Welcome and announcements – Mark Anderson

**PAPER SESSION 1: COSTS AND BENEFITS OF BIODIVERSITY MAINTENANCE AND REPAIR IN THE ARID ZONE**  
 (Chairperson: Mark Anderson)

- 08:40-09:10 The hidden costs and benefits of Renosterveld conversion in a commercial agricultural landscape.  
*O'Farrell, PJ / Donaldson, JS / Hoffman, MT (INVITED SPEAKER)*
- 09:10-09:40 The costs and benefits of communal, commercial and conservation land use practices in Namaqualand.  
*James, I / Hoffman, MT / Allsopp, N (INVITED SPEAKER)*
- 09:40-10:10 Cost of rehabilitation: ecological sustainability versus financial inputs.  
*Van Rensburg, L (INVITED SPEAKER)*

10:10-10:40 **TEA**

**PAPER SESSION 2: COSTS AND BENEFITS OF BIODIVERSITY MAINTENANCE AND REPAIR IN THE ARID ZONE**  
 (Chairperson: Nelmarié Visser)

- 10:40-11:00 The costs and benefits of maintaining harvester termite predator biodiversity in semi-arid grasslands.  
*Mitchell, JD*
- 11:00-11:20 The selection and evaluation of drought-tolerant forage species for restoring degraded arid and semi-arid rangelands in China and South Africa.  
*Van den Berg, L / Kellner, K / Nan, ZB*
- 11:20-11:40 Assessing the rangelands of the Little Karoo – preliminary results.  
*Cupido, C / Milton, SJ / Visser, N*
- 11:40-12:00 Why is the Succulent Karoo full of Succulents: victors or victims?  
*Carrick, PJ*

**PAPER SESSION 3: RESTORATION OF DEGRADED LAND IN THE ARID ZONE**

(Chairperson: Loraine van den Berg)

- 12:00-12:30 Restoration and "emerging ecosystems" in the Arid Zone.  
*Milton, SJ (INVITED SPEAKER)*
- 12:30-12:50 Financial analysis of strip mine rehabilitation – A theoretical example.  
*Mahood, Kirsten / Mahood, Kyle*
- 12:50-13:10 EcoRestore – A Decision Support System tool developed to aid in the restoration of degraded rangelands in southern Africa.  
*Barac, A / Kellner, K*
- 13:10-14:00 **LUNCH**

**PAPER SESSION 4: ANIMAL STUDIES IN THE ARID ZONE**

(Chairperson: Sue Milton)

- 14:00-14:20 Vulture conservation issues in the Northern Cape.  
*Anderson, MD*
- 14:20-14:40 A new strategy for the control of the brown locust.  
*Price, RE*
- 14:40-15:00 ICOSAMP - Information core for southern African migrant pests.  
*Powell, ME*
- 15:00-15:20 Change in bird species composition and abundance in vineyards and native habitats in the Orange River valley.  
*Herrmann, E / Anderson, MD*
- 15:20-15:50 **TEA**

**POSTER SESSION 1**

(Chairperson: Anuschka Barac)

- 15:50-16:00 Are pollination services influenced by land use?  
*Mayer, C*
- 16:00-16:10 Influence of grazing intensity on the biodiversity of small mammals and arthropods in the Nama Karoo of southern Namibia.  
*Hoffman, A / Vohland, K / Giere, P / Zeller, U (Presented by Ute Schmiedel)*
- 16:10-16:20 Restoration of bare patches in a semi-arid grassland.  
*Snyman, HA*
- 16:20-16:30 Historical overview of revegetation trails at Sishen Iron Ore Mine.  
*van Wyk, S / Morgental, T / van Rensburg, L*
- 16:30-16:40 The evaluation of various restoration techniques applied on a bare patch in the Beaufort West district.  
*Visser, N / Botha, JC*
- 16:40-16:50 The influence of prolonged seasonal defoliation on veld yields in the central Free State.  
*Vorster, LF*
- 16:50-18:00 **INFORMAL ROUND TABLE DISCUSSION:** "Science in action: getting the message across".  
Facilitated by Timm Hoffman and Mark Anderson
- 19:00 **DINNER** (Guest speaker)

## WEDNESDAY, 27 August 2003

07:30 Collect lunch packs and depart on field trip.

08:00-17:00 **Field Trips**

### Field trip 1: Tswalu Kalahari Reserve

- Maximum of 40 people
- Own vehicles required to travel to/from Tswalu, mainly on gravel roads (distance of 100 km x 2 = 200 km)

Time	Activity
07h30	Collect lunch packs at Sishen Club
07h45	Depart for Tswalu (guided by Andrew Stainthorpe)
09h00	Arrive at Tswalu
09h00-09h15	Tea/coffee and brief introduction (Fred Stow & Andrew Stainthorpe)
09h15-16h30	Travel around reserve in Tswalu vehicles (each with a guide) with the following activities: description of vegetation and visit to areas of botanical interest; view black and white rhinos, roan and sable breeding project, self-sustaining predator-prey system, etc.
13h00	Lunch in field
16h30-17h00	Depart for Kathu

### Field trip 2: Kathu and environs

- Mine visit limited by number of hard hats and safety shoes

Time	Activity
07h45	Collect lunch packs from Sishen Club
08h00	Depart for Sishen Mine
08h30-09h00	Safety induction
09h00-11h00	Sishen Mine rehabilitation (Leon van Rensburg, Gert Bosch)
11h00-13h00	Khai Apple Nature Reserve: discussions about unique <i>Acacia erioloba</i> forest, tree mortalities, reserve management etc. (Tania Anderson, Robert Brownlee and Gert Bosch)
13h00	Picnic lunch in Khai Appel Nature Reserve
13h45	Drive to Gamagara River
14h15-15h30	Discuss <i>Acacia erioloba</i> harvesting: sustainability, biodiversity implications, etc. (Sue Milton, Colleen Seymour, Mark Anderson)
15h30-16h45	Discuss <i>Prosopis</i> invasion: WfW programme, success of eradication, biodiversity implications, etc. (Sue Milton, Richard Dean)
16h45	Return to Kathu

19:00

**BRAAI**

## THURSDAY, 28 August 2003

### **PAPER SESSION 5: BIODIVERSITY CONSERVATION IN THE ARID ZONE**

(Chairperson: Ute Schmiedel)

- 08:00-08:20 Conserving biodiversity and riverine vegetation in the central Karoo – the case of the riverine rabbit, *Bunolagus monticularis*.  
*Collins, K / du Toit, JT / Reyers, B*
- 08:20-08:40 Transfrontier Conservation – Keystone for optimal development in Gariep Centre.  
*Van der Walt, P*
- 08:40-09:00 Quantifying the dependence of the leopard (*Panthera pardus*) on herbaceous and browse production in semi-arid savanna.  
*Van Wyk, G / Smit, GN*
- 09h00-09h20 Porcupines: prickly pests or constructive critters?  
*Bragg, C*

### **PAPER SESSION 6: ARID ZONE LAND MANAGEMENT SYSTEMS**

(Chairperson: Timm Hoffman)

- 09:20-09:40 Freehold and communal land use: Empirical evidence of contrasts and convergence.  
*Schneiderat, U / Siegmund-Schultze, M / Buss, H-J / Falk, T / Nuppenau, E-A / Kirk, M*
- 09:40-10:00 A decision support system for the management of semi-arid savannas in Namibia, with emphasis on bush thickening by *Acacia mellifera*.  
*Joubert, D / Zimmermann, I / Graz, FP / Fendler, J / Dietrich, J*

10:00-10:30 **TEA**

### **PAPER SESSION 7: BOTANICAL STUDIES IN THE ARID ZONE**

(Chairperson: Tania Anderson)

- 10:30-10:50 Root biomass, spatial distribution and relations with above-ground biomass of savanna woody plants – a review.  
*Smit, GN*
- 10:50-11:10 Relationship of root mass and length under combined water stress and defoliation treatments of *Themeda triandra* Forsk.  
*Oosthuizen, IB / Snyman, HA*
- 11:10-11:30 Limitations for Sustainable Utilisation of *Portulacaria afra* in the Valley Bushveld.  
*de Ridder, CH*
- 11:30-11:50 A new classification of vegetation types of the arid zone of South Africa.  
*Rutherford, MC / Mucina, L / Powrie, LW*
- 11:50-12:10 Regional differences in the long-term population dynamics of a succulent tree, *Aloe dichotoma* in the semi-arid Karoo, South Africa as revealed by repeat photography.  
*Kaleme, P / Hoffman, MT / Rohde, R*
- 12:10-12:30 Plant species richness and cover in relation to livestock watering points in the Central Lower Karoo.  
*Todd, S*
- 12:30-12:50 Is ultraviolet radiation driving biodiversity in the Succulent Karoo?  
*Burgoyne, PM*

12:50-13:50 **LUNCH**

**POSTER SESSION 2:**  
(Chairperson: Nico Smit)

- 13:50-14:00 Conservation and livelihood issues of the Devil's Claw trade in South Africa.  
*Koali, N*
- 14:00-14:10 Assessing local knowledge on arid rangeland dynamics and its application to sustain livestock during drought in a communal rangeland.  
*Samuels, I / Allsopp, N / Knight, R*
- 14:10-14:20 A simple method of evaluating veld recovery.  
*Du Toit, PCV*
- 14:20-14:30 The impact of elephants on the Limpopo riparian forests in the semi-arid region of the Limpopo Province.  
*De Beer, G / Burger, L*
- 14:30-14:40 The monitoring of water abstraction in the Limpopo river and development of indicators to minimize deterioration of Limpopo riparian vegetation.  
*De Beer, G / Burger, L*
- 14:40-14:50 Ants as bio-indicators.  
*Netshilaphala, N / Milton, SJ / Robertson, HG*
- 14:50-15:00 Influence of water stress on root/shoot ratio and water-use efficiency of two *Opuntia* (spineless cactus pear) species.  
*Ramakatlane, ME / Snyman, HA*
- 15:00-15:10 Root dynamics of two *Opuntia* (spineless cactus pear) species.  
*Ratsele, C / Snyman, HA*
- 15:10-15:40 **TEA**

**POSTER SESSION 2 (continued):**  
(Chairperson: Nico Smit)

- 15:40-15:50 Assessing intra-seasonal land surface change and identifying long-term trends in the Succulent Karoo using low resolution satellite imagery.  
*Roberts, W / Hewitson, BC / Archer, E / Knight, R*
- 15:50-16:00 Large trees, productivity and biodiversity in the Kalahari: the influence of tree size on subcanopy plant assemblages.  
*Seymour, C*
- 16:00-16:10 The influence of subhabitat differentiation on the soil under varying competition regimes in Mopane savanna in South Africa.  
*Smit, GN*
- 16:10-16:20 Unplanned fires and sustainability of a semi-arid grassland.  
*Snyman, HA*
- 16:20-16:30 A contribution to determining the status of *Prosopis* as an alien plant invader in South Africa.  
*Lloyd, JW / van den Berg, E / Stoltz, C*
- 16:45-17:45 **ANNUAL GENERAL MEETING, PRIZE-GIVING AND CLOSURE**
- 19:00 **DINNER**



Paper

and

Poster

Abstracts



## PAPER SESSION 1

# COSTS AND BENEFITS OF BIODIVERSITY MAINTENANCE AND REPAIR IN THE ARID ZONE

### THE HIDDEN COSTS AND BENEFITS OF RENOSTERVELD CONVERSION IN A COMMERCIAL AGRICULTURAL LANDSCAPE

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Renosterveld vegetation has been extensively transformed and remaining fragments are still under threat of transformation to livestock pasture and wheat farming. Remaining fragments of Renosterveld were investigated in the Nieuwoudtville area to determine what ecosystem services are being derived from these natural fragments when compared with adjacent transformed areas. The aim of the study was to determine if services flow spatially from natural vegetation remnants to transformed lands or whether natural vegetation fragments provide services to farmers and the broader communities in the form of existence values. A number of field-based experiments clearly demonstrate that Renosterveld fragments render multiple ecosystem services. Services investigated include the prevention of soil erosion, the provision of shelter for livestock, soil health as measured by the presence of soil organisms and rainfall infiltration rates. These studies were guided by a series of interviews with farmers in the region who identified these services as important to their farming operations. The manner in which ecosystem services are currently being valued with consideration to the findings of this study, are presented.

### THE COSTS AND BENEFITS OF COMMUNAL, COMMERCIAL AND CONSERVATION LAND USE PRACTICES IN NAMAQUALAND

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Namaqualand is a region of high biodiversity and forms the focus of an internationally led conservation initiative to protect more of the region from the impacts of private and communal land use practices.

However, little is known of the value and long-term sustainability of the each of these sectors in the region. Using a model developed initially in a collaborative workshop, the change in primary and secondary production over thirty years and the per ha and Net Present Value (NPV) for the three sectors (private farming, communal farming, conservation) in the Upland Succulent Karoo region of Namaqualand are presented. Results indicate that when recommended stocking rates are adhered to, as in private farming systems, edible plant production and animal quantity and quality are sustained over 30 years. Communal area farmers, however, generally stock at twice the recommended rate.

Results indicate that while edible plant production and animal production and quality are significantly lower than in private farming areas, they do not continue to decline appreciably over time. Because of the poor forage quality, however, communal farmers are much more likely to suffer from drought than is the case for private farmers.

Since the conservation areas in Namaqualand have no domestic livestock they show the highest levels of edible plant production over time. Per ha values were broadly comparable for communal and private farming areas at around R15/ha/yr. Profit (defined as revenue less running costs) for the conservation sector was always negative. However, if external funding and the wider contribution of visitors to the regional economy are considered, then the conservation

sector shows the highest values at around R10-R120/ha/yr. The problem of comparing value across different sectors is raised particularly since cash values are not the same as bartered or other non-cash transactions. The value of the model also lies in its ability to explore the impacts of management, economic and climatic influences. Four scenarios (current, increased and decreased stocking and a decrease in rainfall) under three different management practices (conservative stocking, pre-emptive selling and stocking at maximum ecological carrying capacity) are presented for the communal lands of Namaqualand. For all scenarios, except climate change, the results indicate that a pre-emptive selling strategy is the most beneficial since primary production is sustained, capital stocks are maintained and NPV values are acceptable. When mean annual rainfall is decreased and the coefficient of variation is increased by 20 %, all strategies collapse suggesting that livestock production in Namaqualand is going suffer significant hardship if the predicted climate change scenarios are realised.

#### COST OF REHABILITATION: ECOLOGICAL SUSTAINABILITY VERSUS FINANCIAL INPUTS

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Terrestrial mining in South Africa contributes some 16% towards the countries gross domestic product through sales of minerals and mineral products. Total mineral sales for 1999 amounted to R94.7 billion, of which 77.3% were from export revenues and the remainder from gold. In 1998, the South African mining sector employed 466 144 people in 703 mines to produce 53 different minerals. More than 10 million people are collectively supported by the South African mining industry, together with those industries that supply goods and services to it (CSIR, 2001). Based on these facts, it is clear that South Africa is dependent on its terrestrial resources to sustain its population and to contribute to the countries economic growth. These terrestrial systems are however, fragile and must be managed carefully and strategically. According to the United Nations, more than 90% of South Africa is classified as "affected drylands", which are identified as extraordinarily dry areas where rainfall is low, and potential evaporation is high (UNCCD, 1994). It is therefore essential that relevant indicators be developed to ensure that South Africa's land resources are managed in a sustainable manner (Arendse & Wilkinson, 2002). The consequences of land degradation include declining productivity and diversity of resources to support human livelihoods and commercial activities, as well as reduced biodiversity and loss of ecosystem functioning. Degraded systems are also less able to cope with change.

Although economically important and a provider of employment and training for local people, mining and industrial activities damage thousands of hectares in biologically diverse environments with enormous social and environmental consequences. In these areas, vegetation growth and recovery is limited by aridity and nutrient poor soils. Mining activities in South Africa currently generate 80 percent of the solid waste produced annually; most of it is inert material. This is followed by pulverised fuel ash (6.7%). A typical gold mine may produce 250 000 to 300 000 tons of solid waste a month. In most mines, the majority of rock broken ends up as waste. The waste, comprising waste rock, discard material and tailings (processed material), is disposed of on site on waste rock piles, discard dumps and tailings dams, respectively. Approximately 40 000 ha in the Witwatersrand basin in South Africa is covered by large tailings dams. Furthermore, approximately 28 million tons of ash is produced annually in South Africa. This fly ash has to be handled and stored on ash dumps, which in turn have to be rehabilitated.

Mine waste disposal sites vary greatly in their environmental impact. Economic rather than environmental factors previously dictated that siting of mine waste deposits. The siting of these deposits is currently, however, strictly controlled by law to minimise the impact on the environment. The Atmospheric Pollution Prevention Act (45) of 1965, and the Minerals Act (50) of 1991 both place an obligation on mines to rehabilitate the surface of the land which they mine on an ongoing basis, simultaneous to mining operations. Regulations of this act further specify that the mine manager has the duty to prevent fugitive dust from escaping the mine. Despite these regulations to reduce wind blown dust and aesthetic impacts, significant problems are still being experienced. Many communities on the West and East Rand are constantly exposed to health risks associated with fugitive dust and pollution. Mines remain reluctant to rehabilitate their mine dumps in Gauteng, despite the fact that there are 260 mine dumps on the Witwatersrand deemed to pose a health risk to mainly township dwellers. Beyond the confines of the mine, mining wastes if not properly contained, can potentially affect public health in both nearby communities and surrounding ecosystems. Mine waste may include cyanide compounds, heavy metals, radionulides and asbestos (never all in one stream). These can become solubilised or carried as suspended particles in waters leaching from the site. This leachate, together with drainage from the mine, is often highly acidic or saline, and may also carry a high sediment load. The common incidents of contamination, which could ultimately affect public health or well being, include pollution of drinking water

supplies, aquatic ecosystems including fishing grounds, agricultural soils and urban areas. Erosion and the loss of soil fertility and productivity may also result from the mismanagement of industrially disturbed areas. The rehabilitation of derelict and/or ownerless mines that pose environmental hazards and health implications to communities has become a prominent activity of the Department of Minerals and Energy in South Africa. By May 2001, approximately R50 million had been spent on the rehabilitation of derelict and/or ownerless asbestos mines in the Northern Cape, Northern Province and Mpumalanga. It is expected that another R150 million would be required to rehabilitate the remaining 68 derelict and/or ownerless asbestos mines. Attention is currently also being focussed on the rehabilitation of derelict and/or ownerless coal mines and gold residue deposits.

Due to the enormous social and environmental impact of the mismanagement of industrially disturbed areas and derelict and/or ownerless mines, the Environment Conservation Act (73/1989) has been applied to all land-use that transform natural vegetation. This legislation restricts damaging activities to the environment and requires that developers incorporate the cost of ecological rehabilitation into their operational budgets. Additional incentives for the rehabilitation of ecologically disturbed areas are the International Conventions on Biodiversity and Desertification that commit South Africa to reduce and mitigate the negative social and ecological effects associated with some types of agricultural and industrial activities. In compliance with the mitigation and rehabilitation requirements, many strip-mine rehabilitation projects cover waste rock piles and discard dumps with a layer of topsoil which is excavated from an adjacent borrow pit in order to prevent further environmental degradation and facilitate the rehabilitation of these sites. Changes that may occur in the topsoil after coverage of the waste rock piles or discard dumps include the potential for increased acidity and salt content, development of nutrient deficiencies or imbalances, surface crustiness or desiccation, etc. which all impact on the growth of vegetation. One approach for the rehabilitation of fly ash is the creation of artificial soil by the addition of sewage or industrial sludge to the fly ash. Agronomic approaches (cultivation, fertilisation, reseeding and irrigation) are then often adopted for the rehabilitation of these disposal sites and revegetation of the topsoil cover. The application of agronomic approaches for the rehabilitation of disposal sites, has worked well for the establishment of planted pasture where the annual rainfall was adequate to sustain the crop, but has failed dismally in the arid areas of Southern Africa (Milton, 2001). In these arid areas, inhibition of plant growth due to elevated concentrations of heavy metals in the mine dumps was previously prevented by the application of irrigation that contributed to the leaching of the heavy metals away from the soil surface. Furthermore, irrigation created anoxic zones that prevented the further oxidation of the pyrite often associated with coal and gold deposits. The recent establishment and enforcement of the National Water Act (36) of 1998 which requires that all effluents, including contaminated groundwater have to be kept within the borders of the mining area has restricted the intensive application of irrigation to maintain vegetation cover. This fact has placed significant limitations on the application of agronomic approaches for the rehabilitation of industrially disturbed sites in many areas of South Africa, where self-sustainable and ecologically stable post land use rehabilitation is urgently required. Milton (2001) reported that the sowing of annual pasture grasses in regions under conditions of irrigation gave a brief illusion of success while the grasses were green, but did not result in a self-sustaining vegetation cover. Experience has indicated that the addition of water (particularly in the dry season), fertilisers and planting of non-indigenous plants are uneconomical particularly if such inputs cannot guarantee the establishment of self-sustaining vegetation cover on rehabilitated sites. Despite the unsustainability of this practice, and the dismal failure of many rehabilitation projects in Southern Africa, numerous attempts at rehabilitation of industrially disturbed sites using conventional agronomic approaches are still being applied. It is likely that the resilience required to ensure that the vegetation cover persists on rehabilitation sites through extreme environmental conditions, including drought, fire and disease can only be achieved if diverse and self-perpetuating biological communities are established (Milton, 2001). It is, however, evident that compliance with mitigation and rehabilitation requirements cannot be enforced without ecological expertise and a thorough understanding of the ecological principles that ensure ecological stability and subsequent sustainability of ecosystems.

Industrial companies in South Africa have a social responsibility to ensure that post-land usage capability and subsequently soil quality and should be similar or better than its pre-land use capability as cited in the specific companies environmental progress report (EMPR) This places a huge responsibility on companies to minimise social risk and to monitor and improve the quality of the disturbed environment using the best available technology at minimal costs. In an attempt to rehabilitate ecologically disturbed areas, principles of environmental management must be adopted by industry. Recent literature on restoration ecology has focused extensively on the importance of the retention and capture of nutrients, water and propagules, as well as the re-establishment of natural processes (mineral cycling, resource capture, pollination, dispersal, etc. These processes are essential for the achievement of sustainable rehabilitation (Ludwig et al., 1997; Whisenant, 1999). These principles and processes are fundamentally related to soil quality. It is thus in the interest of industrial and mining companies as well as the environment that ways to achieve these goals are found.

**PAPER SESSION 2**  
**COSTS AND BENEFITS OF BIODIVERSITY MAINTENANCE AND**  
**REPAIR IN THE ARID ZONE**

**THE COSTS AND BENEFITS OF MAINTAINING HARVESTER TERMITE PREDATOR BIODIVERSITY IN SEMI-ARID GRASSLANDS**

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The grass-feeding harvester termite, *Hodotermes mossambicus*, is an important component of the semi-arid grassland ecosystems of southern and eastern Africa. The extensive network of tunnels that link the subterranean nest with the soil surface enhance soil condition by improving aeration and drainage. Up to 700kg/ha of soil with four times the nitrogen content of surface soil, is dumped on the surface during excavation of the tunnel system and grass storage chambers which has obvious benefits to plant growth. Termite workers forage openly by day on the soil surface chiefly harvesting dry grass, removing dead material from tillers and grass litter from the soil surface. The termite occupies a central position in the food chain in these ecosystems. It has a wide range of natural enemies, many of them highly specialised. Harvesting is most intense during the winter months when little other food is available. Nineteen species of small mammals, 65 birds species as well as a variety of insects and spiders have been recorded as preying on harvester termites. When predators are present in sufficient numbers their impact on the foraging worker population is potentially enormous. Termite populations fluctuate widely depending on the rainfall season. Populations are low ( $\pm 9,000$  workers/ha/yr) following seasons of above average rainfall, while following dry summers populations of workers can be as high as  $\pm 0.26 \times 10^6$  /ha/yr. This potential for eruptive population growth with consequent high off-take of grass during seasons of low primary productivity that has brought the termite into competition with larger herbivores (domestic stock and game animals). High termite populations remove all litter, thus exposing the surface soil which leads to compaction, low infiltration, erosion and loss of nutrients. Poor understanding of ecosystem functioning has resulted in mismangement of the semi-arid grasslands in many areas and the decline in predator numbers was noted as early as the 1930's. These factors have favoured the development of large residual termite populations, particularly in degraded areas. Evidence suggests that the likely benefits of conservation and even the reintroduction of a suite of predators appropriate to an area far outweighs the costs involved.

**THE SELECTION AND EVALUATION OF DROUGH-TOLERANT FORAGE SPECIES FOR RESTORING DEGRADED ARID AND SEMI-ARID RANGELANDS IN CHINA AND SOUTH AFRICA**

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China and South Africa are facing similar problems concerning the degradation of natural rangelands. By the year 1999, 80% of China's natural rangelands have degraded to some extent, while 25% of the natural rangelands in South Africa is estimated to be severely degraded. The major proportion of degraded areas in both the countries is situated in arid and semi-arid rangelands. It is clear that the problems regarding rangeland degradation and desertification are similar in both countries and the combating thereof is the common task of scientists and land users in these countries. Different grass species from South Africa are being tested and evaluated to determine whether they are suitable for use in restoration treatments in natural rangelands in China.

Twelve different South African grass species have been tested in China to determine the germination capacity and viability of the seed. The results of the germination tests indicated that most of the seeds germinated at a temperature of 30°C. Of all the species tested, *Themeda triandra* showed the best germination capacity percentage. It was also found that most of the species tested reached optimum germination rates three days after the initiation of the germination test. Pre-chilling at 5°C for seven days, significantly increased seed germination of some of the grass species.

Similar germination and viability tests will be carried out in South Africa in order to compare the results for each of the different grass species. During the course of the next two years field trials will be carried out in both South Africa and China to determine the establishment rate and viability of the different species in the natural rangeland environment. These tests will indicate different grass species that that could be used for rangeland restoration treatments in China and South Africa.

### ASSESSING THE RANGELANDS OF THE LITTLE KAROO – PRELIMINARY RESULTS

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Various methods are available for assessing veld conditions of rangelands in arid areas. Some methods require many measurements and plant identification and can therefore be rather time consuming. The visual assessment technique of Milton and Dean (1996) is a quick method that was used to assess the veld condition on 100 randomly chosen livestock, ostrich and game farm units in the Little Karoo. This assessment forms part of a broader study on veld management practices of livestock, ostrich and game farmers of the region.

Indicators such as cover, percentage palatable species, grazing intensity, seedling ratio and species diversity was used to visually assess veld condition in 5m x 15m plots at distances of 100 m and 500 m from a water point in a veld camp. A maximum score of five was allocated for cover, percentage palatable species, grazing intensity and seedling ratio. To measure species diversity a count was made of all species that were observed within each plot. A subjective score was then allocated for each assessment. The state of veld condition was then compared at different distances from the water point for land use practices, stocking rate, soil type, slope and within the different vegetation types (Little Succulent Karoo, Renosterveld and Spekboom Thicket) of the Little Karoo. In most instances the vegetation of the Little Succulent Karoo scored the lowest and is most vulnerable when overstocked. It would seem that in all the three vegetation types the veld scored lower at 100 m than at the 500 m distance from the waterpoint due to the piothere effect. Ostrich camps seemingly scored lower than other camps with livestock and game, especially in the low-lying Little Succulent Karoo vegetation on soils with a higher clay contents and low percentage of rockiness.

### WHY IS THE SUCCULENT KAROO FULL OF SUCCULENTS: VICTORS OR VICTIMS?

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Recent climate change predictions have been interpreted as having dire consequences for the vegetation of the Succulent Karoo. However, the climatic drivers of ecosystem functioning are poorly understood. The adjacent semi-arid biomes of the winter rainfall Succulent Karoo and the summer rainfall Nama Karoo receive similar quantities of annual rainfall; however, different plant functional types dominate the two biomes. The Succulent Karoo contains about 20% of the world's succulents, and leaf-succulent shrubs of the Mesembryanthemaceae make up the majority of plant abundance and cover. Emphasis has been placed on the drought intolerance of this group, and hence importance has

been given to the reliability of annual rainfall in this region. Far from being drought intolerant, however, the Mesembryanthemaceae are able to tolerate longer periods without water than most other Karoo plants. New data indicates that the large number of small rainfall events is the key driver of the Succulent Karoo flora. The exceedingly shallow rooting systems of the Mesembryanthemaceae allow for the utilization of this water resource - a resource not utilized by the deeper-rooting non-succulent shrubs typical of the Nama Karoo.  $C_3$  - CAM flexibility may be the key innovation allowing succulents to make use of small rainfall events (and preventing leaf desiccation between rainfall events). Uptake and growth following small rainfall events is only possible because winter temperatures are mild. The role of temperatures in limiting the abundance of Succulent Karoo and Nama Karoo functional types is also explored, but is likely to be secondary to the role of small rainfall events.

## PAPER SESSION 3 RESTORATION OF DEGRADED LAND IN THE ARID ZONE

### RESTORATION AND "EMERGING ECOSYSTEMS" IN THE ARID ZONE

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Land denuded and later abandoned following agricultural, commercial, industrial use or alien invasive plant species control, undergoes changes driven by rain, wind and the colonising plants and animals. "Emerging ecosystems" is the tag recently given to such anthropogenically altered and changing ecosystems at a recent SCOPE-UNESCO workshop. The characteristics and trajectories and the values to people (in terms of goods, services and biota) of such ecosystems with and without mitigation are debatable. In this presentation I explore examples and options for "emerging ecosystems" of the arid zone.

### FINANCIAL ANALYSIS OF STRIP MINE REHABILITATION – A THEORETICAL EXAMPLE

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In South Africa the rehabilitation of post-mined areas is mandatory for commercial mines. Techniques employed in rehabilitation efforts should take mine location and end use once rehabilitation is complete into account. Restoration activities are inextricably embedded within an economic framework, as a mine has to be economically viable, while adhering to environmental regulations. Each rehabilitation option that a mine considers has costs and benefits, and it is becoming increasingly important that insights from ecology and economics are brought together if restoration efforts are to succeed from a business management and environmental point of view. In this paper we evaluate theoretical strip-mine rehabilitation scenarios using of Discounted Cash Flow (DCF) Techniques. We suggest that DCF Techniques could be suitable for the evaluation of different rehabilitation options within the strip mining industry.

### ECOSTORE – A SUPPORT SYSTEM TOOL DEVELOPED TO AID IN THE RESTORATION OF DEGRADED RANGELANDS IN SOUTHERN AFRICA

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Degradation is a process that causes the reduction in resource potential of natural rangelands and occurs widespread throughout southern Africa. Degradation is characterized by the loss in vegetation cover, which leads to the occurrence of bare and denuded patches, increased erosion, as well as bush encroachment/ thickening in savanna areas. This process has drastically extended at an alarming rate during the last few decades with the main causes being overstocking, overgrazing, drought periods and mismanagement of the land. Land users have however been applying a variety of technologies over the years in order to restore affected rangelands. These include passive and active (revegetation, stock reduction etc.) intervention methods, as well as a number of bush control technologies (chemical, mechanical, manual and biological).

Many different restoration technologies have been applied by the land users in both South Africa and Namibia. The technologies are captured as case studies in a computerized Decision Support System (DSS) named *EcoRestore*. *EcoRestore* serves as a user-friendly consulting tool, offering possible recommendations and solutions on 'best bet practices' for future rangeland restoration. It consists of two databases, *Grass Expert* and *Bush Expert*. *Bush Expert*

focuses on the control of bush encroachment and aims to evaluate the effectivity of the different bush control technologies applied.

The first 100 Namibian case studies, carried out in the central and northern arid and semi- arid regions, have been incorporated into the *Bush Expert* database. The results indicate that mostly chemical control methods were applied. The three main woody species causing encroachment problems were found to be *Acacia mellifera*, *Acacia reficiens* and *Dichrostachys cinerea*. A total of 76% of the cases occur within the 300- 450 mm average long- term rainfall zone. Although the wood of controlled problem species is mostly not utilized, some land users produce charcoal in order to gain financial returns. It was found that the most important aspects that need to be taken into account concerning bush control included: rainfall, soil clay percentage, height classes of trees, density of woody species before and after control, as well as the possible increase in herbaceous vegetation cover. The most important lesson to be learnt is that it is an absolute necessity to apply a proper after- care programme as a management practice following the initial control of problem bush species. This will determine the final success rate of any applied bush control technology as a restoration practice within a rangeland.

## PAPER SESSION 4 ANIMAL STUDIES IN THE ARID ZONE

### VULTURE CONSERVATION ISSUES IN THE NORTHERN CAPE

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Nine vulture species occur in southern Africa, seven as breeding species. In the arid parts of southern Africa, two vulture species are relatively common, the White-backed Vulture and the Lappet-faced Vulture. Where they occur, vultures fulfil an important ecological role and their presence is often indicative of a healthy environment. Seven vulture species are included in *The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland*, with both the White-backed and Lappet-faced Vultures being listed in the 'vulnerable' category. The primary threats are: (1) poisoning, (2) a reduction in food availability, (3) electrocution on pylons, and (4) drowning in farm reservoirs. An as yet unquantified threat is habitat change, such as nesting tree removal and encroachment of alien and indigenous vegetation, and its impact on vultures. An additional threat is non-steroidal anti-inflammatory drugs (which are used to treat livestock), with one NSAID (namely diclofenac) recently found to be responsible for the catastrophic decline of vulture populations in Pakistan and India. In the Northern Cape the most important threats are being addressed, mainly through an awareness campaign and as a result the population status of both the White-backed and Lappet-faced Vultures is improving.

### A NEW STRATEGY FOR THE CONTROL OF THE BROWN LOCUST

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The brown locust, *Locustana pardalina* (Walker), produces outbreaks of varying intensity almost every year in the semi-arid Karoo areas of South Africa and southern Namibia. Locust control is the responsibility of the National Department of Agriculture and for the past 100 years the control strategy has relied on the tracking down and spot spraying of thousands of individual locust targets, by an army of temporary employed locust officers and assistants. Locusts are currently sprayed using fast-acting, broad-spectrum synthetic pyrethroid insecticides, applied from ground-based knapsack and vehicle-mounted spray equipment. However, this traditional system of locust control system is becoming increasingly difficult to sustain due to the high costs of insecticide and transport, coupled with the fact that locusts are not being reported from the many unoccupied farms in the remote areas of the Karoo. There is also concern over the negative impact that the repeated application of insecticides may have on the unique Nama-Karoo biome, rich in endemic invertebrates and reptiles. Some farmers are also switching to the organic production of small stock and game animals and cannot tolerate the spraying of insecticides on their land.

There is thus an urgent need for a new strategy for the sustainable control of the brown locust. Various control options will be presented and the potential of an IPM approach to locust control, using modern application techniques, will be discussed.

**KEYWORDS:** brown locust, insecticides, impact, control strategy, control options.

**ICOSAMP – INFORMATION CORE FOR SOUTHERN AFRICAN MIGRANT PESTS**

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Migrant pests such as locusts, armyworm, and Quelea birds, annually plague the southern African region, and in some years have been known to cause devastating damage to food crops within member countries of the Southern African Development Community (SADC).

Preventive control of these pests before they become a serious problem is the major management technique, and it is thus important to know the current distribution and scale of infestation. This is especially relevant in the case of armyworm where the sudden appearance, rapid development, and disappearance of the insect calls for quick action. In addition, as these pests are highly mobile and often cross political boundaries, communication and collaboration between neighbouring countries is the key to early warning of impending invasions.

ICOSAMP has established regional co-operation between migrant pest officers in SADC, and developed a forum where information relevant to these migrant pests is regularly collated. Monthly Bulletins and situation maps are circulated to national and regional decision makers, as well as to international organisations. This close collaboration not only encourages communication, but also provides a platform for technical co-operation and sharing of research information.

ICOSAMP utilises modern technology such as the internet and email to distribute this information to SADC stakeholders and interested parties. A computer based information system records the migrant pest data and facilitates production of situation maps. Since its inception in 2000, ICOSAMP has regularly issued monthly Bulletins and GIS (Geographical Information System) maps which are also published on the world wide web.

The ICOSAMP website can be viewed at <http://icosamp.ecoport.org>

**KEYWORDS:** migrant pests, armyworm, locusts, Quelea, forecasting, southern Africa, network, information system.

**CHANGE IN BIRD SPECIES COMPOSITION AND ABUNDANCE IN VINEYARDS AND NATIVE HABITATS IN THE ORANGE RIVER VALLEY**

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Species composition and abundance of bird populations was investigated across four bird habitat types during a single summer season (September 2001 to February 2002) in the Orange River valley, including vineyards and three native habitats (riparian bush, Karroid veld and drainage lines). Populations were surveyed monthly using a standard point-count technique. Bird densities varied significantly between the four habitat types, which exhibited marked differences in structural diversity, with average densities for all species combined being  $76 \pm 34$ ,  $275 \pm 84$ ,  $43 \pm 11$  and  $7 \pm 2$  birds/ha in vineyards, riparian bush, drainage lines and Karroid veld, respectively. A total of 88 bird species were recorded, while total species richness was fairly similar (range 50 to 58) between the habitats. Species composition, based on presence/absence, did not vary greatly between the habitats although the relative abundance of species did. Resident mixed-feeders were the most abundant species within vineyards and riparian bush, although temporary but large influxes by nomadic granivores occurred in the former habitat, primarily in response to the availability of seed resources. There was a greater amount of variation in the density of all feeding guilds in vineyards than in the native habitats. The arid drainage lines and Karroid habitat were dominated primarily by resident and nomadic granivores, as well as resident mixed-feeders, with fairly low variation in population densities. Resident-mixed feeders and frugivores responded positively to the availability of grapes in vineyards, with significance increases in density that coincided with the period of highest bird damage to grape crops. Throughout the grape harvest season a number of common mixed-feeders exhibited higher densities in vineyards than any other habitat, while the populations of others appeared as subsets of those occupying riparian bush, suggesting an adaptation to this artificial and expanding environment.

## POSTER SESSION 1

### ARE POLLINATION SERVICES INFLUENCED BY LAND USE?

Poster

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Pollinating insects provide a vital service for plant reproduction, and play a fundamental role for the functioning of an ecosystem. However, there is a worldwide perception that pollination systems are increasingly under threat by human activities and land degradation. In the Succulent Karoo of Southern Africa livestock grazing is considered to be one of the major causes of degradation, especially in communally grazed lands.

The present thesis illuminates possible perspectives of pollination under different grazing intensities for both, plants and animals.

The following hypotheses were investigated:

1. Plants bear fewer flowers in heavily grazed areas than in ungrazed areas.
2. Insect diversity is limited on overgrazed land.
3. Fruit set is limited on heavily grazed farmland because of limited pollination.

The investigations took place on two BIOTA-Observatories in Namaqualand, in the area of Leliefontein. One observatory is heavily grazed, while the other one, separated by a fence, is almost not grazed at all.

The first results from two successive field campaigns (2001 and 2002) were the following:

1. Two of the four investigated plant species (all Aizoaceae, Mesembryanthema) show significantly lower flower numbers on the heavily grazed site than on the adjacent ungrazed site, while one species shows moderately significantly greater flower numbers under grazing.
2. Malaise trapping showed much higher bee diversity and abundance on the ungrazed land in two subsequent years.

Walking transects, where all insects within 2m were recorded on a length of 100m for 30 minutes, showed significantly higher individual and species numbers of insects on the ungrazed site only very close to the fence, at 20m distance. Individual numbers were significantly lower on the grazed site at 100m distance from the fence as well. In 500m distance from the fence, no significant differences could be found.

Colour traps on the other hand, placed in different distances from the fence, mainly caught more individuals as well as more species numbers of bees (superfamily Apoidea) and pollen wasps (Family Masaridae) on the heavily grazed site.

3. For all four investigated plant species, fruit set was significantly lower on the overgrazed site.

### INFLUENCE OF GRAZING INTENSITY ON BIODIVERSITY OF SMALL MAMMALS AND ARTHROPODS IN THE NAMA KAROO OF SOUTHERN NAMIBIA

Poster

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As part of the multidisciplinary BIOTA project, the present study focuses on aspects linked to the diversity of small mammals and arthropods on permanent biodiversity observatories that follow a transect along a climatic gradient from western South Africa to northern Namibia.

As part of the transect, two adjacent observatories with different forms of land use are in the center of our interest. Gellap-Ost (a governmental research station) has a controlled grazing regime with little impact by Karakul sheep whereas the neighbouring communal land of Nabaos is overgrazed by goats and some donkeys. The dividing fence is the boundary between bare soil (Nabaos) and a mosaic of herbs and grasses (Gellap-Ost).

Here, results from an ongoing study on small mammal population ecology and arthropod diversity are presented. The data were taken four times a year. The precipitation recorded during the investigation was about average in 2001/2002, but nearly absent in 2002/2003.

Arthropod diversity and abundance as trapped with pitfall traps was higher in Gellap-Ost compared to Nabaos.

The same applies to small mammals. In Gellap-Ost, the dominant species was found to be *Tatera leucogaster*, whereas *Gerbillurus vallinus* was the most abundant species in Nabaos. *T. leucogaster* prefers a savanna environment, while *G. vallinus* is a typical desert inhabitant. The population structure of the mice indicate the strongly deteriorated ecological conditions at Nabaos, where *T. leucogaster* cannot find food and shelter.

Future work will further emphasize this aspect of human use by including more pairs of observatories with differences in land use practises. The restoration potential of the communal land should be investigated by enclosure experiments.

### RESTORATION OF BARE PATCHES IN A SEMI-ARID GRASSLAND

Poster

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Different over-sown species and mechanical restoration techniques (hollows with dyker plough, furrows with ripper/sub-soiler and walking-stick planter) were evaluated for the restoration of bare patches on both a sandy (11% clay) and clayish (22% clay) soil types. Survival, change of species composition and plant density over time (1987/88 to 1996/97 growing seasons) was determined. The hollows (1m x 30m and 200 mm deep) with a rip action (400 mm deep) in one operation, remained over a longer period and therefore caught more water for better establishment of grass species, compared with making only hollows where it silted up more easily. Although the well establishment of *Eragrostis curvula* over the first three years, after 10 years no plants survived on both clay and sandy soils. Establishment was poorest when only the walking-stick planter was used. Regardless of cultivation treatment or soil form, *Digitaria eriantha* subsp. *eriantha* survived the best after 10 years and even spread into adjacent areas. *Antheophora pubescens* and *Cenchrus ciliaris* only established successfully on sandy soil. Grassland restoration is a long-term process in the semi-arid areas and will not again deliver sustainable animal production after only a short period. After a 10-year period, vegetation was still unstable and dominated by many pioneer species.

### HISTORICAL OVERVIEW OF REVEGETATION TRAILS AT SISHEN IRON ORE MINE

Poster

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Extensive spoil heaps with steep and long slopes are a common feature of open cast iron ore mining in South Africa. Iron ore mines occur predominantly in semi-arid areas of the Northern Cape and Limpopo Province further complicating rehabilitation efforts. A solution is needed to rehabilitate these spoil heaps to ensure a self-sustaining vegetation cover not exceeding excessive financial cost. Rehabilitation experiments at Sishen iron ore mine started in 1985. The aims of these trails were to investigate the possibility of revegetating the steep slopes and to evaluate alternative materials as growth medium during rehabilitation. The poster gives a historical background on a surface trial used to evaluate different growth mediums and a slope trail to evaluate the possibility of using these materials on the natural slope of repose (35° slope) in comparison to a graded slope to 18°. *Eragrostis echinochloidea*, *Chloris virgata*, *Aristida scabrivalvis* dominated the trials at the onset of the experiments. *Cenchrus ciliaris* became the dominant species after three years in 1990 and observations during May 2003 indicated that *Cenchrus ciliaris* remained dominant. *Salsola kali* was a problematic weed in the first two years of the flat surface trails but totally disappeared over time. Other species frequently occurring after 16 years were *Heteropogon contortus*, *Hyparrhenia hirta* and *Stipagrostis uniplumis*. Well-weathered fine lime, iron ore discard or ratios of these mixed with stone were the best alternatives. Un-weathered limestone was unable to sustain a closed vegetation cover, even on 18° slopes. The study further point out that 35° slopes could not sustain a viable indigenous vegetation cover over the long-term.

## THE EVALUATION OF VARIOUS RESTORATION TECHNIQUES APPLIED ON A BARE PATCH IN THE BEAUFORT WEST DISTRICT

Poster

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Bare patches are a common phenomenon in the Arid Nama Karoo of South Africa where the average rainfall is  $\pm 200$  mm/annum. The study was conducted on a bare patch with a size of  $\pm 1$  ha on the farm Montana ( $32^{\circ}08'43''$  S and  $23^{\circ}08'23''$  E). Three different treatments and combinations thereof as well as a control (C - no treatment) were applied. A randomized block design with three replications was applied. The treatments and their combinations were: seeding (S); brush packing and seeding (SB); tilling (T); tilling and seeding (TS); and tilling, seeding and brush packing (TSB). Seeds of the following species were used in the seeding treatments: *Atriplex semibaccata*, *Cenchrus ciliaris*, *Chaetobromus dregeanus*, *Pteronia membranacea* and *Tripteris sinuata*. The treatments were applied in November 1999 and plant surveys were done on an annual basis from 2000 to 2002.

Over the three-year period the T treatment showed the best results (12.21 plants/m<sup>2</sup>) followed by the S (11.09 plants/m<sup>2</sup>) and TS treatments (9.25 plants/m<sup>2</sup>). The T treatment was also shown to be a cost-effective method, being the cheapest (R104/ha) of the different treatments (excluding the control). Twenty-seven different species established successfully in the different treatments of which 19 occur in the T treatment. Six of these species has grazing value, including *Aridaria splendens*, *Pentzia incana*, *C. ciliaris* and *A. semibaccata*. Of the seeded species *P. membranacea* did not establish, while the seeded species which established most successfully in the different treatments were *C. ciliaris*, *C. dregeanus* and *A. semibaccata*.

It is important to break the soil crust. While the provision of organic matter, refuge sites and seeds of desirable species played an important role in increasing the rate of re-establishing vegetation on these bare patches this effect did not persist beyond the second season. Restoration in arid areas depends on the amount and distribution of rainfall the area receives. In the current study above average annual rainfall was recorded in all three seasons. The favourable rainfall probably contributed to the positive results obtained over the short three-year experimental period.

## THE INFLUENCE OF PROLONGED SEASONAL DEFOLIATION ON VELD YIELDS IN THE CENTRAL FREE STATE

Poster

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Natural veld of the Dry *Cymbopogon-Themedra* veld type was grazed by Africander cattle and Merino sheep during various fixed seasons and all combinations of seasons, over a period of ten years. At the termination of the experimental period, the veld was rested for a complete year and then cut for hay to determine the treatment effects. Due to good rainfall in the rest period of a year, high yields were obtained. Grazing in the late summer was most detrimental to the production of the veld, whereas spring and late winter was especially beneficial to the veld. The experimental period was characterised by summer droughts and autumn rains. It is clear that grazing after and during a rainy period after a drought is harmful to the veld and should be avoided.



## PAPER SESSION 5 BIODIVERSITY CONSERVATION IN THE ARID ZONE

### CONSERVING BIODIVERSITY AND RIVERINE VEGETATION IN THE CENTRAL KAROO - THE CASE OF THE RIVERINE RABBIT, *BUNOLAGUS MONTICULARIS*

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Large-scale destruction and fragmentation of the unique riverine biotic communities in the central Karoo has occurred in the past. It is here that the riverine rabbit, *Bunolagus monticularis*, an extreme habitat specialist, has become known as one of the most endangered mammals in the Southern African Subregion. To identify riverine vegetation and suitable habitat available to *Bunolagus*, remote sensing techniques were applied to Landsat TM imagery. In determining the effectiveness of remote sensing imagery for identifying and calculating the area of suitable habitat, the principal objective of this study was to contribute towards the conservation and long-term survival of *Bunolagus*. Suitable and unsuitable habitat types were defined and shown to be associated with distinct patterns of spectral reflectance using a layer-slice of Normalized Difference Vegetation Index (NDVI). The results show a significant difference between spectral values of riverine vegetation and surrounding Karoo vegetation. The use of layer-slice NDVI demonstrated a very high accuracy in identifying and calculating the total area of riverine vegetation. This information can now be used to provide area of suitable habitat remaining as well as give estimates of the total population size for *Bunolagus* based on known densities within the distribution area. The use of Landsat TM imagery can thus contribute significantly towards the conservation of *Bunolagus* and the development of metapopulation management strategies.

### TRANSFRONTIER CONSERVATION – KEYSTONE FOR OPTIMAL DEVELOPMENT IN THE GARIEP CENTRE

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Conservation and sustainable development of the unique ecological landscapes, wilderness character and cultural heritage of the Ai-Ais/Richtersveld Transfrontier Conservation Park through joint management and co-operation for the benefit of Namibia and South Africa.

Yet another bold and very exciting initiative in the geopolitics of transfrontier regionalism is now a reality in southern Africa. As part of the fast expanding set of 22 TFCA's, viewed as the most ambitious wildlife dream of the millennium in this sub-continent, the wonders of a jointly managed pristine Namib system transcends the rigid concepts of national sovereignty.

The ultimate vision of this desert border challenge is to manage the entire Namib and its associated Gariiep Centre of floristic endemism, as the world's second largest protected area estate of c. 300 000 km<sup>2</sup>. Some 72% of this world renowned 2 000 km ancient Namib Desert belt, has already some protected status. The Namib is generally accepted as mostly a 200 km wide tract of land from the Olifants River in South Africa, the entire coastline of Namibia, to San Nicolan in southern Angola.

With global warming and the resultant climate change a reality, deserts and their margins have gained foremost importance in the world's ecology. The inherent arid southern Africa, will no doubt contribute to the increase of desert's 30% of the Earth's surface. Decades of desertification because of human intervention, have paved the way for this to happen.

Now eco-regional integration of conservation and economic perspectives, to achieve peace and cooperation along the sub-continent's oldest and most persistent 670 km long borderline, is acknowledged on presidential level as the inbuilt answer to the problem of softening a barrier between two friendly states.

## QUANTIFYING THE DEPENDENCE OF THE LEOPARD (*PANTHERA PARDUS*) ON HERBACEOUS AND BROWSE PRODUCTION IN SEMI-ARID SAVANNA

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The main objective of the management of a game ranch with only herbivores is to ensure that the nutritional requirements of the herbivores are met in such a way that they maintain an acceptable level of productivity, while the productivity of the vegetation is also maintained or improved. With the addition of a predator into such a system, an additional trophic level in the food pyramid is established. The same principle of sustainability, however, will apply. The given number of predators (leopards in this case) must be able to satisfy all their nutritional requirements by preying on the available prey species, but in such a way that the prey animals themselves are able to, at least, maintain their population size, or preferably be able to grow in numbers. An average leopard female weighs 35 kg and a male 65 kg. Due to their size, prey selected in the southern African savanna weigh an average of 40 kg (range: 20 - 80kg), except in certain circumstances where larger prey is killed. It was found that the daily food requirement for an average female is 3.68 kg (3.3 - 4.58 kg) and for an average male 6.86 kg (5.04 - 7.43 kg). From these norms it is now possible to quantify the ecological- and economical impact of leopards on those herbivores on a game ranch with an economic value. Since the basic requirement of management systems for sustainable game production from veld is to balance the stocking rate of the various herbivore game species with the grazing and browsing capacity of the veld it is now also possible to calculate the sustainability in the third trophic level (predators) from quantitative plant survey procedures.

### PORCUPINES: PRICKLY PESTS OR CONSTRUCTIVE CRITTERS?

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Porcupines in semi-arid agricultural areas are considered pests. Farmers tend to perceive them in terms of cost alone: they chew plastic water pipes; they dig holes under fences; they eat agricultural crops such as potatoes. However, there are benefits that porcupines provide to farmers and to ecosystem health and species diversity. In this study I investigated the role porcupines play in Nieuwoudtville, a hotspot of geophyte diversity.

- Porcupine density in the study area was estimated at 8 animals/km<sup>2</sup>. This exceeds porcupine density in other similar semi-arid areas. The high porcupine density is probably due to the abundance of geophytes for which the area is renowned.
- Levels of porcupine disturbance in the ecosystem were found to be very high and thus they can be considered to be ecosystem engineers. Density of foraging pits in some habitats exceeded 3900 diggings per hectare, higher than recorded for any other *Hystrix* species. These foraging pits have been shown in other studies to provide sites for plant recruitment and propagation. Porcupine activity resulted in up to 1.6% of the soil surface being disturbed and up to 3.3 cubic meters of soil being displaced annually. Disturbance also aids in propagation of geophytes with vegetative reproductive features such as cormlets and bulbils.
- To determine if porcupine predation has a differential effect on different geophyte species, I investigated porcupine utilization of geophytes in response to geophyte morphological traits, including energy content, water content, size and depth. Selective predation might result in differential effects upon geophyte populations, altering geophyte distribution and abundance. Field observations and cafeteria experiments indicated that porcupines prefer larger, more energy-rich corm species but will also eat watery bulb geophytes occasionally. Energy-rich corms tend to be deeper and have more cormlets, possibly to aid in predator avoidance. Porcupines consume the majority of geophyte species, even some that are toxic to livestock, and also many species classified as endangered and endemic.

Porcupines thus play a key role in the ecosystem in terms of both disturbance and trophic impacts. Porcupines should be considered in conservation strategies for the area due to their influence on geophyte dynamics and their role in the maintenance of ecosystem processes in general.

PAPER SESSION 6  
ARID ZONE LAND MANAGEMENT SYSTEMS

FREEHOLD AND COMMUNAL LAND USE: EMPIRICAL EVIDENCE OF CONTRASTS AND CONVERGENCE

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**ABSTRACT NOT AVAILABLE**

**A DECISION SUPPORT SYSTEM FOR THE MANAGEMENT OF SEMI-ARID SAVANNAS IN NAMIBIA, WITH  
EMPHASIS ON BUSH THICKENING BY *ACACIA MELLIFERA***

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The Chameleon System is a rule-based expert system designed to support rangeland managers make decisions. Decisions are based on an existing conceptual model of vegetation dynamics in the Highland Savanna, a semi-arid savanna in Namibia. This model explains changes within a state-and-transition framework, and focuses on the life history dynamics of *Acacia mellifera*, the main bush encroaching species. Of particular note in this model is the potential transition from open savanna to bush encroached savanna initiated only during two or more consecutive good rainy seasons. The first good rainfall (well above average) is required for seed production, and the second "good" (average or more and well spaced) is required for seedling survival. The seasons should be consecutive, since seed banks are mostly ephemeral. This transition can most easily be interrupted by applying fire to kill seedlings. Such a fire requires a good fuel load, and thus resting the veld is recommended. This might be counterintuitive to farmers. Resting and fire is mainly required near to bush thickets or parent trees, since dispersal is generally inefficient.

A total of \*\* decisions are based on the answers to questions and the rules associated with them. Decisions range from focusing the manager to "Monitor bush seedlings next season" (after good seed production) to more active management decisions such as "Burn, rest for early rainy season and graze" (based on the outcome of the monitoring of bush seedlings).

The Chameleon System has been developed as a Web Application and is accessible worldwide through the internet. It is based on the Mandarax class library for deduction rules. Chameleon is completely free of charge. It runs on a standard PC and is platform independent. The system is currently being refined.

Expert systems hold promise for improving decision making in natural resource management for a variety of reasons, provided that potential users can be convinced of their value. We hope to verify and validate our expert system through a trial run with dedicated farmers, and subsequently refine it.



**PAPER SESSION 7  
BOTANICAL STUDIES IN THE ARID ZONE**

**ROOT BIOMASS, SPATIAL DISTRIBUTION AND RELATIONS WITH ABOVE-GROUND BIOMASS OF SAVANNA  
WOODY PLANTS - A REVIEW**

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The botanical composition of any mature stand of vegetation is largely determined by competition. The roots of woody plants are fundamental in their competitive interactions with herbaceous and other woody plants. A better understanding of the distribution and biomass of the roots of savanna woody plants, and how they relate to above-ground biomass, would be invaluable in the understanding of the competitive interactions in savanna ecosystems. With this in mind a review of the literature was undertaken. In a general sense the roots of savanna woody plants extend far beyond their projected crown radius. In some species the lateral roots commonly extend linearly up to seven times or more the extent of the canopy, that is, over an area about 50 times the area covered by the canopy. The below-ground biomass of woody plants can be substantial and often exceeds the above-ground biomass on a dry mass basis ( $>30\ 000\ \text{kg ha}^{-1}$ ). Soil water availability, light and competition from herbaceous plants are important determinants of root growth of woody plants. Impenetrable layers in the soil also inhibit root distribution and deficiencies in soil oxygen may reduce or completely inhibit root growth. Root distribution from the stem normally shows a negative exponential drop near the stem followed by a relatively uniform region to the area of no influence. The roots of some species may penetrate to considerable depth but ample evidence exists that suggests that the roots of savanna trees are often concentrated at very shallow depth, which implies direct competition with herbaceous plants for soil water. However, the competition for soil water between herbaceous and woody plants proved to be more complex. The elimination of certain components of a multi species plant population would not necessarily mean that more soil water would be available to the other components due to differences in root distribution. It was suggested that that increased yields of species mixtures in comparison to monocultures indicate niche separation of roots. This finding, based on cultivated crops, presents another possible explanation why a regular dispersion pattern and a positive correlation between the size of trees and the distance to nearest neighbours exists for *Acacia* species, while the spatial analysis of all individuals regardless of species, show a random dispersion.

**RELATIONSHIP OF ROOT MASS AND LENGTH UNDER COMBINED WATER STRESS AND DEFOLIATION  
TREATMENTS OF *THEMEDA TRIANDRA* FORSK.**

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Plant growth in arid and semi-arid regions is mainly determined by rainfall; which include the annual and seasonal distribution thereof as well as management. A well-established and distributed root system is thus of utmost importance in these ecological sensitive rangelands. Therefore this study aimed at determining the combined influence of water stress and defoliation on root growth and development of *Themeda triandra*, a dominant grass species in these drier areas. Three growth stages was studied, namely, vegetative, pipe and reproductive. Four water treatments (T1 = 0-25%, T2 = 25-50%, T3 = 50-75% and T4 = 75-100% depletion of plant available water) were applied to plants in pots in a glasshouse. After six weeks of water stress 108 planted pots were defoliated, soaked with water and re-growth allowed to one, three and six days after defoliation and then washed out at the end of the experiment. Root length and mass were determined. Root length was measured using a root length counter. Root length increased ( $P<0.01$ ) with an increase in water stress from T1 to T4. Root lengths were the highest ( $P<0.01$ ) during the reproductive growth stage for all the water treatments. The root mass within T4 increased ( $P<0.01$ ) from the vegetative, through the pipe to the reproductive growth stage. Root mass and root length increase ( $P<0.01$ ) with increased water stress. Moderate to low levels of plant available soil water stimulate root growth in *Themeda triandra*. This enable the plant to better utilize the available soil volume for plant available water and survive extended periods of drought. Root mass and root length correlated 86% ( $r^2=0.86$ ,  $n=143$ ). No definite conclusion could be made on the influence of defoliation on root growth (due to the short period of six days from defoliation to sampling of the plants) in this study and needs further investigation.

## LIMITATIONS FOR SUSTAINABLE UTILISATION OF *PORTULACARIA AFRA* (SPEKBOOM) IN THE VALLEY BUSHVELD

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It is believed that the dramatic degradation of the Xeric Succulent Valley Bushveld can be ascribed to over-use by livestock. Many speculate that the use of livestock is incompatible with sustainability and that game would be the only sustainable option. *Portulacaria afra* (Spekboom) constitutes the largest portion of the diet of domestic animals and Kudu. This is only true where Spekboom is still in abundance. The crucial importance of this plant species can therefore not be over emphasised. Spekboom is severely depleted in most areas and it's only chance for survival is to propagate itself through vegetative and or seedling recruitment. Investigations into the recruitment and survival potential of Spekboom seedlings was then initiated.

Although the preliminary results have proven that seedling recruitment and survival were a possibility, other questions still remain unanswered, for example, the effect of bush density, stocking rates and various farming practices on the survival of seedlings over time under different localities and distributions. This brought about the need for various field trials which concluded the following.

- \* It was again proven that under domestic stock farming conditions:
  - seedlings only survived well in moderately dense bush
  - in dense bush (high plant competition/trampling) few seedlings survived
  - open bush (no bush / protection) has an even lower seedling survival rate.
- \* All seedling losses could not be attributed to goat browsing
  - goats were not yet allowed to browse the camps
  - after goats were removed from stocking rate camps, there were still seedling losses.
- \* The results from game alone did not compare to that of domestic stock farming, dense bush had the highest seedling survival rate compared to that of open and moderately dense bush.
- \* Points to consider when comparing these differences are
  - Dense bush: goats are concentrated in small areas / game move at will over large areas (low trampling)
  - Moderately dense: some game species prefer these areas and usually move within the area in large groups (impala)
  - Open bush: goats in camp systems are concentrated in these areas / game on the other hand seem to avoid them
- \* On average, higher survival rates were achieved with game farming alone (17%) compared to that of goats / cattle (16%) and game / goats continuous heavily stocked (9%).

### A NEW CLASSIFICATION OF VEGETATION TYPES OF THE ARID ZONE OF SOUTH AFRICA

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The VEGMAP collaborative project is close to finalizing a relatively detailed map of the vegetation types of South Africa, Lesotho and Swaziland. The project is based on newly synthesized data and has resulted in the recognition of close on 400 vegetation types. For the core biomes of the arid zone the number of newly recognized vegetation types

range from 14 for the Nama-karoo Biome through 17 for the Desert Biome to 62 types for the Succulent Karoo Biome. The concept of Desert Biome has been significantly expanded compared to its extent in some other recent works. The largest and smallest vegetation types in each arid core biome are, respectively, the Eastern Upper Karoo and Lower Karoo Gwarrie Veld (Nama-karoo), Namaqualand Klipkoppe and Aughrabies Mountain Succulent Shrubland (Succulent Karoo) and Gariiep Stony Desert and Tatasberg Mountain Desert (Desert). The last-mentioned type has an area of only about 1100ha which makes it one of the smallest vegetation units on the entire map of South Africa. Vegetation types are grouped into intermediate level hierarchical units, namely Bioregions with 2 Bioregions in Desert, 3 in Nama Karoo and 7 in Succulent Karoo. Twenty-three vegetation types are recognized in the Kalahari Dry Savanna Bioregion of the Savanna Biome. There are also several azonal vegetation types recognized within the arid zone which include coastal habitats, freshwater and saline wetlands, and various corridors of alluvia. Concomitant with the level of detail in the map, various fragmented intrusions of neighboring biomes (e.g. Grassland) into biomes of the arid zone appear superficially to form part of the arid zone. The vegetation type with the highest mean annual temperature in the core biomes of the arid zone is Helskloof Canyon Desert (19.6°C) with the lowest mean annual temperature occurring in Roggeveld Karoo (14.5°C). Number of frost days per year for the same zone range from 1 day for the Namaqualand White Sand Plains to 54 days in Roggeveld Karoo (with Eastern Upper Karoo marginally lower (51 days)).

### **REGIONAL DIFFERENCES IN THE LONG-TERM POPULATION DYNAMICS OF A SUCCULENT TREE, *ALOE DICHOTOMA* IN THE SEMI-ARID KAROO, SOUTH AFRICA AS REVEALED BY REPEAT PHOTOGRAPHY**

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*Aloe dichotoma* is a succulent tree up to 9 m, which is widely distributed in the drier western parts of South Africa and Namibia. The dramatic collapse in some populations in the last several decades has recently been used as evidence for climate change in the region. This study aimed to 1) analyze the growth dynamics and life history of *A. dichotoma* and 2) to assess the extent and rate of change in several *A. dichotoma* populations. Research was carried out at nine sites in both summer and winter rainfall areas in the Karoo. Methods used were matched photographs, combined with transects in the field to record the size class distributions. Although little is known about the growth of *A. dichotoma*, anecdotal information and matched photography show that the growth rate of the species is higher in the juvenile stage which lasts for approximately 50 years. The adult stage, lasting about 150 years, is characterized by a relatively small increase in plant volume with few major changes in the external architecture of the plant. The senescent stage may last for as long as 50 years and the life span of the species is thought to be approximately 250 years although considerable variation exists. Analysis of photograph pairs taken 41 - 98 years apart reveals a significant difference between populations occurring in the summer and winter rainfall areas in terms of the mortality rate, the recruitment rate and in the percentage change in the population. Transect data confirm these patterns. Lower recruitment, higher mortality and a decrease in population size were observed in the summer rainfall areas supporting the hypothesis of climate-induced effects, particularly extended drought, on *A. dichotoma* populations occurring in these areas. Populations in the winter rainfall area on the other hand, show a different pattern with relatively high recruitment, lower mortality and an increase in the number of individual trees in the population over time. Populations occurring in areas which receive both winter and summer rain appear to be healthiest. These results confirm earlier reports and interpretations of the population dynamics of *A. dichotoma* in the region and provide clear evidence for both an increase and a decrease in population size in different parts of the country.

### **PLANT SPECIES RICHNESS AND COVER IN RELATION TO LIVESTOCK WATERING POINTS IN THE CENTRAL LOWER KAROO**

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The distribution of animal impact in rangelands is uneven and tends to be concentrated around water points and other foci of animal activity. In this study, changes in plant cover and species richness around piospheres, the zone of attenuating animal activity associated with water points, were investigated at a site in the Nama Karoo near to Beaufort

West. The results show that cover increases quickly away from water points and reaches an asymptote within 500m. Species richness also tends to increase rapidly with increasing distance from water points but did not appear to reach an asymptote within the distances available in the study area. Changes in plant species composition thus continue to take place beyond the zone in which cover is impacted. The responses of different plant species to the gradient of animal impact associated with the piosphere could be characterised into five distinctive patterns. The first group represented species that were restricted to the highly disturbed zone immediately adjacent to the watering point. The second group were species that occurred throughout the rangeland at a low density but increased near to the watering point. The third group represented species that did not respond to proximity to the watering point. The fourth group contained many of the dominant shrub species and showed a rapid increase away from the watering point and then remained stable beyond approximately 100m. The final group represented those species most sensitive to animal impact and increased more slowly away from the watering point and did not reach an asymptote within the distances available in this study. Highly palatable species tended to be restricted to areas distant from water points. Larger camps therefore provide a refuge for sensitive species that might otherwise be lost from the rangeland as a whole. The stocking rates generally applied in the karoo apparently do not allow for the persistence of grazing sensitive species except in areas distant from watering points that are seldom accessed by animals

### **IS ULTRAVIOLET RADIATION DRIVING BIODIVERSITY IN THE SUCCULENT KAROO?**

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The Mesembryanthemaceae is the largest succulent plant family in southern Africa, with  $\pm 1\ 680$  species currently grouped into  $\pm 123$  genera. Their evolutionary success is particularly strong in the Succulent Karoo. Recent work has shown that active speciation is ongoing in the Succulent Karoo "Hotspot", making it a highly unique study area.

The break-up of Gondwana resulted in various environmental changes, many of which were the driving force behind diversification within the mesembs (and succulents in the region in general). The way in which these environmental changes and particularly ultraviolet radiation have affected the evolution of this group is revealed.

## POSTER SESSION 2

## CONSERVATION AND LIVELIHOOD ISSUES OF THE DEVIL'S CLAW TRADE IN SOUTH AFRICA

Poster

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Devil's claw is the common name for plants in the genus *Harpagophytum*, which is indigenous to Southern Africa. The plants have a long history of use by local people (Matlhahare, 2002) and have been exported to Europe since the 1950s (Hachfeld 2003) for the treatment of rheumatism and arthritis. The volume of trade has increased substantially in the past 10 years and there is a concern that plants is being removed from the wild at a rate that could cause wild populations to collapse. This research covers the scientific and socio-economic aspects of Devil's Claw trade in South Africa. The study determined:

1. The distribution of Devil's Claw (DC) in South Africa and areas of resource concentration.
2. The amount of DC currently being harvested in South Africa.
3. Socio-economic information pertaining to DC harvesting and trade in South Africa, such as which South Africans are harvesting the plant, and what role it plays in their livelihoods.
4. The sustainability of the DC Trade in South Africa.

The two species of *Harpagophytum*, *zeyheri* and *procumbens* occur in South Africa. *Harpogahpytum procumbens* occurs in the Northern Cape, North West, Free State and Limpopo Provinces and the largest populations are found in the communal areas of the North West Province and the north eastern parts of the Northern Cape. *Harpogophytum zeyheri* occurs in the North West, Limpopo, Gauteng and Mpumalanga Provinces. *Harpogophytum procumbens* is the only species that is harvested commercially in South Africa.

Most harvesting takes place in the communal areas of the North West Province where the trade is monitored and regulated by the North West Department of Agriculture, Conservation and Environment (NW- DACE). There are currently 2 381 trained and registered harvesters by DACE in the North West and in 2002 they have harvested approximately 90 tonnes of dry DC plant material. Registered harvesters in the NW earn on average R 782.00 each per year.

A large number of marginalized people living in communal areas of the Kalahari in South Africa depend on harvesting DC for an income. The majority of DC harvesters are Tswana women, over the age of forty. Harvesters are generally marginalized people who have limited resources of income and who depend heavily on cash generated from DC.

Current management of the trade by NW-DACE is not consistent over the area where DC is harvested. Some villages have effective training programmes and the trade is carefully monitored, while there is insufficient training at other villages and sometimes no monitoring of trade. Population recovery rates after harvesting varied between populations with from 32% to 80% recovery. Harvesting methods influenced recovery and better recovery was observed where the quadrant method of harvesting was used.

In order to ensure sustainability, NW-DACE needs to expand their training programme to reach all harvesters, improve the local level of monitoring, and enforce harvesting in quadrants to allow plants sufficient time to recover after harvesting. It is therefore important that national and local government structures facilitate sustainable trade in DC and continue to regulate the use of this species.

## ASSESSING LOCAL KNOWLEDGE ON ARID RANGELAND DYNAMICS AND ITS APPLICATION TO SUSTAIN LIVESTOCK DURING DROUGHT IN A COMMUNAL RANGELAND

Poster

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Many technological solutions that have been proposed to address problems in rural communities have failed because they do not take into account local knowledge and practice. Several case studies argue that participatory and sustainable approaches to rural development can be greatly enhanced through an understanding of the local knowledge of relevant stakeholders. As a result, the importance of involving farmers perspectives in the development process are now increasingly recognized by researchers and development professionals throughout the world.

This study is aimed at acquiring local knowledge about arid ecosystem processes and gaining insight into people's perceptions of their local environment through stakeholder interviews. We determined the herding strategies and habitat utilization patterns of all the herds in the 20 000 ha of rangeland commons around Paulshoek village in Namaqualand, during a drought. We tested whether different levels of understanding and different perceptions of the veld manifest into distinct herding strategies and grazing patterns.

Preliminary results show great diversity in herding strategies and habitat utilization patterns amongst the herds in Paulshoek. Different levels of understanding of local ecosystem processes and spatial perceptions of the veld were also found.

## A SIMPLE METHOD OF EVALUATING VELD RECOVERY

Poster

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### Introduction

Large areas of the Arid Karoo and Desert Grassveld, called the "*panne en vloere veld*", are virtually devoid of vegetation. This condition comes about on account of the fact that these areas are very flat, water spreads over the surface area in a thin film, seldom get time to settle and do not really get the opportunity to infiltrate, because it gets blown from side to side. The soil surface also seals on account of millions of minute clay particles which settles in the cavities, blocking the natural infiltration route.

### Method

In one such an area, on the farm Goodhope in the Carnarvon District, several methods of soil disturbance were tried out, as well as the bulldozing of a diversion contourbank, designed to let the water out at specific points, in order to obtain large volumes in selected places to encourage infiltration by prolonging contact time with the soil and the consequent development of a dense stand of vegetation. The contourbank was erected at the water-inlet side of the farm and surveys were conducted afterwards, from the inlet side across the farm up to the end where the water eventually flowed off the farm. Four sites were selected and the plant growth monitored every second year, by conducting botanical surveys of 500 points, using the line-point method (1). The data were computed using the objective grazing index values of the species (2) and, the grazing capacities estimated by comparison to the Boesmanskop benchmark (3).

## Results

Year		1984	1986	1988	1992	1994
<i>Goodhope 1</i>	cover %	12.8	36.0	35.8	43.6	54.2
	VCI	24.8	69.8	75.6	108.9	141.4
	ha/LSU	144.0	51.1	47.2	32.8	25.2
<i>Goodhope 2</i>	cover %	18.4	28.6	31.6	28.8	31.6
	VCI	36.7	60.0	66.4	72.2	76.0
	ha/LSU	97.3	59.5	53.8	49.4	47.0
<i>Goodhope 3</i>	cover %	22.6	33.8	50.6	37.2	31.8
	VCI	44.8	83.8	131.7	97.1	78.1
	ha/LSU	79.7	42.6	27.1	36.8	45.7
<i>Goodhope 4</i>	cover %	22.6	29.4	33.4	40.6	31.0
	VCI	58.2	73.9	84.5	111.5	82.2
	ha/LSU	61.3	48.3	42.2	32.0	43.4

## Discussion

Originally, the site (site 1) at the water inflow side had a very low vegetative percentage cover, the closest paddock to the homestead, was previously under severe grazing pressure. The cover increased almost five-fold over a period of 10 years. The grazing capacity improved from a ridiculously low 144 ha/LSU to a very acceptable 25 ha/LSU, while the grazing capacity norm for the area is in the region of 34 to 39 ha/LSU. The cover for sites 2 to 4, being in the middle and towards the far side of the farm, did not improve dramatically. Where-as the grazing capacities originally improved with increasing distance from the homestead, i.e. 97.3, 79.7 to 61.3 ha/LSU, after a period of 10 years, the current grazing capacities are very similar, 47.0, 45.7 and 43.4 ha/LSU. This marked improvement came about simply by the construction of one diversion contourbank in the appropriate place.

## Conclusion

The line-point method of botanical survey coupled to the use of the species' unique index values is a simple and practical method to monitor rehabilitation of previously degraded sites.

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## THE IMPACT OF ELEPHANTS (*Loxodonta africana*) ON THE LIMPOPO RIPARIAN FORESTS IN THE SEMI-ARID REGION OF THE LIMPOPO PROVINCE

Poster

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The Limpopo riparian forest has been under severe pressure by agricultural and infrastructure development in the past and has been identified as an endangered plant community. Damage to the forest between the Shashi and Motloutse Rivers in recent years by the Tuli elephant has become more visible.

The natural habitat of the Tuli elephant, which historically migrated from Botswana into Zimbabwe and South Africa, is steadily decreasing as a result of increased development resulting in the Tuli elephant population (which is not controlled) being forced into the Tuli block which has common boundaries between Botswana, Zimbabwe and South Africa. Increased agricultural development and the security and veterinary fences towards South Africa hindered migration of elephants, which resulted in concentrations of large numbers of elephants in the Limpopo riparian forest.

The study was conducted to determine the impact of elephants on the Limpopo riparian forest between 1999 and 2003. Specific trees such as *Ficus sycomorus*, *Feadherbia albida* and *Acacia xanthophloea* (preferred by elephants) and *Croton megalabotrys* (not preferred by elephant) were studied in twenty transects (500X 20 m) on the lower river fringe. Data such as stem diameter, height, type and % elephant damage were recorded.

Results of the study show a decrease in the density of all tree species over a six-year period. Small trees of *F. sycomorus*, *F. albida* and *A. xanthophloea* disappeared completely whilst larger trees declined drastically. This decline in numbers is accompanied by an increase in the % damage (mostly ring barking). The population structure of *C. megalabotrys* shows no change, damage limited to broken branches.

The percentage damage to the preferred tree species varies between 76-90%, whilst damage to *C. megalabotrys* is less than 10%.

Although elephant numbers were estimated at 500 (1980) it is believed that the numbers are continuously increasing. Trans-border movements are steadily increasing as well as the time spent in the forest. The concentrations of elephants here could also be caused by severe drought in Botswana, hunting pressure and continuous development that decreases the size of habitat (spatial limitation). The elephant population exceeds their forage supply as is evident in the decrease in tree species density and increase in damage. This includes *C. megalabotrys* trees, where damage was limited to individual trees in 1999.

Bearing in mind the increased agricultural activities and development planning of future dams in the Limpopo River system, the elephant migration route will be increasingly blocked forcing elephants into smaller areas, which will eventually lead to a breakdown of the system. The degradation of the forest is evident in the change in closed canopy to open canopy forest, resulting in the disappearance of a number of bird habitats.

In order to minimize the increased elephant damage to the Limpopo riparian forest it is essential to firstly, determine the elephant numbers according to the ecological capacity and secondly to establish a Management Committee consisting of members from Botswana, Zimbabwe and South Africa is recommended, in order to exchange data regarding the numbers of elephant, their movements, size of habitat left and trends in habitat degradation.

Control of elephant numbers is inevitable to ensure the continued existence of this once highly productive system. Further degradation of the system will ultimately lead to a loss in biodiversity and land degradation.

#### **THE MONITORING OF WATER ABSTRACTION IN THE LIMPOPO RIVER AND DEVELOPMENT OF INDICATORS TO MINIMIZE DETERIORATION OF LIMPOPO RIPARIAN VEGETATION**

Poster

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The development of Venetia diamond mine in 1990 in the Limpopo Province was primarily dependant on water from the Limpopo River for operational functioning. DWAF issued a permit for the abstraction of 4 million m<sup>3</sup> water from the Greefswald and Schroda well fields that border the Limpopo River and are now situated in the Vhembe/ Dongola National Park.

An "early warning monitor system", to detect imbalances in plant water status and indicate the degree of plant moisture stress of riparian vegetation at different levels of water abstraction was developed. Comparative plant moisture stress (PMS) measurements of leaves of *Croton megalabotrys* under equilibrium conditions were used due to this species inherent sensitivity and rapid response to changes in soil moisture, extensive distribution and the shape and size of the leaf, which are ideal for pressure chamber applications.

PMS monitoring has been carried out since 1991. Seven monitoring sites were identified within representative *Croton megalabotrys* plant communities. Three sites occur upstream of the well field, 3 within the well field, and 1 down stream of the well field.

A correlation was found between PMS values and changes in water levels (due to seasonal availability and higher tempo of water abstraction). PMS readings show low values during the wet season and high values during dry season,

associated with higher demand for water (July–October). These trends correspond with an increase and decrease in water levels.

In 2000 sensors were put in place to ensure a “constant water level”. Data from 2000 to 2002 reveals less variation in PMS values between the sites.

As large quantities of water are withdrawn during July to October, a model has been constructed which proposes lower water abstraction tempo during these critically dry periods in order to decrease water stress in the riparian vegetation.

The impact of higher water demand can be mitigated by a holistic approach in water management that includes lower water abstraction in the well fields during the critical periods as well as the maintenance of sensors regulating changes in water level. It is believed that the refinement of these sensors in order to manage the well field could be beneficial to the riparian vegetation, and would probably result in lower PMS values, especially during the dry season. More data is required, especially during severe drought periods to refine limits that can then be used as indicators. PMS values higher than 15 bar will indicate high stress levels in vegetation, and a change in operation to alternative resource such as the off channel dam must be implemented.

A holistic approach for water abstraction on both the Greefswald and Schroda well fields, as well as the off channel dam is necessary to ensure sustainable water utilization within this sensitive river system. Guidelines with indicators (PMS values and water level) must be implemented to ensure sustainable utilization of this resource. Indicators must be revised and implemented according to the flow diagram. PMS monitoring must be continued in order to verify the abovementioned refinements.

A management system for the Limpopo River system, which includes other water users, should be developed to ensure sustainable utilization of the entire river system.

### ANTS AS BIO-INDICATORS

Poster

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Ants (Hymenoptera: formicidae) have been used in Australia, Brazil and elsewhere as indicators of environmental health. Ant communities were sampled at the Namakwa sands mine using pitfall traps on three sites, one in natural vegetation and the other two on the mined landscape one and two years after rehabilitation. Fifty traps per site were placed in a grid pattern (i.e. 10 traps per transect, 10 m apart). Sampling was done during autumn (April) as well as during winter (July). During autumn sampling a total of 1315 individual ants of 8 species were caught in the natural vegetation, 780 individuals of 6 species on mined ground two years after rehabilitation, and 621 individuals of 4 species on mined ground one year after rehabilitation. Similarly, a total of 855 individual ants of 8 species, 60 individuals of 3 species and 1 individual of 1 species were caught respectively on these treatments. On average, natural vegetation was the more species-rich. Natural vegetation also contained some rare species (i.e. those species that were not found on either one of the two minespoil sites). Mining has a large impact on ant communities; as was demonstrated by the difference in the abundance of ants between natural vegetation and minespoil sites. Ant communities appear to be good indicators of environmental health in this area of Namaqualand.

**INFLUENCE OF WATER STRESS ON ROOT/SHOOT RATIO AND WATER-USE EFFICIENCY OF TWO *OPUNTIA* (SPINELESS CACTUS PEAR) SPECIES**

Poster

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Cactus pear has great potential to improve productivity in semi-arid areas, the main reason being its Crassulacean Acid Metabolism pathway, which is very efficient in water requirement. The root system of *Cactaceae* is very complex, which is characterised by a shallow, fleshy system, with horizontal root spreading. The cladodes which are modified stems, fulfil the function of photosynthesis and consist of water-storage tissue with a high water-binding ability. The study aimed at determining the influence of water stress on the productivity and survival of *Opuntia robusta* (cultivar: *montery* – blue pad) and *O. ficus-indica* (cultivar: *morado* – green pad). The cladodes were planted in pots (210 mm diameter and 550 mm deep soil) and grown in the glasshouse at day/night temperatures of 30/18°C. The water treatments applied were 0-25%, 25-50%, 50-75% and 75-100% depletion of total plant available water. After four weeks of keeping at field water capacity, the water stress treatments started. The planted pots were washed out when reaching the different stress levels, after which root lengths, root mass, cladode mass and water-use efficiency (dry matter produced per mm water used) were determined. Water-use efficiency decreased ( $P < 0.01$ ) with an increase in water stress for *O. ficus-indica*, while in contrast increased for *O. robusta*. The finer root system of *O. robusta* could be responsible for the more efficient water uptake with water stress, compared to the other species. In both species root mass decreased and root length increased with water stress. The main reason is that more, smaller side roots formed and greater main roots die-off with water stress. The root/shoot ratios for *O. ficus-indica* and *O. robusta* decreased with water stress from 0.1364 to 0.0924 and 0.1443 to 0.0749 respectively. The amount of water needed to fill up a cladode, increased with water stress from 0.58 to 11.40 mm and 1.15 to 10.97 mm for *O. ficus-indica* and *O. robusta* respectively. The water percentage in the cladodes decreased with water stress from 90.31 to 86.86% and 91.29 to 86.44% for *O. ficus-indica* and *O. robusta* respectively. It is clear that *Opuntia* species can use water more efficient than most other fodder plants and can therefore utilize arid areas to its full potential.

**ROOT DYNAMICS OF TWO *OPUNTIA* (SPINELESS CACTUS PEAR) SPECIES**

Poster

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The roots of cactus pear, which are extensive and dense near the soil surface have a high capacity taking up water from light rain showers. In contrast with the shoot system, the roots of *Cactaceae* have received little attention, however, they certainly differ from other plants, as they develop xeromorphic characteristics, enabling the plants to survive prolonged periods of droughts. The aim with this study was therefore to quantify some characteristics of the root system of *Opuntia robusta* (cultivar: *montery* – blue pad) and *O. ficus-indica* (cultivar: *Morado* – green pad) for survival in arid and semi-arid areas. Cladodes were planted in root boxes (650 x 100 mm, with 900 mm deep soil), which were kept in the glasshouse at day/night temperatures of 30/18°C. The development of the roots growing behind a glass (root boxes placed at 15% slope), were measured by periodically removing a steel plate in front of the glass. Root lengths, which were divided into main roots (tap-roots), rain roots and side roots were measured each hour. The average daily increase in length of the main roots, growing in soil between field water capacity and permanent wilting point, were 39 mm and 26 mm for *Opuntia ficus-indica* and *O. robusta* respectively. With water stress the growth of the main roots, regardless the species, daily decreased from 12:00 to 18:00, but increased from 06:00 to 12:00 and from 18:00 to 06:00. The decrease during the afternoon could be due to higher soil temperatures. The higher the water stress, the more growth of the main roots took place during the night, while side roots also start to develop. The thinner side roots comparing to the main roots, unable the plant to absorb water more efficiently under lower soil water conditions. When lifting water stress rain roots develop and grow 1 mm after only an hour (*O. ficus-indica*). These roots stop growing after three days for both species at an average length of 21 mm and 12 mm for *O. ficus-indica* and *O. robusta* respectively. The function of the rain-roots is mainly for recovering of the plant after water stress and to fill up the cladodes with water as quickly as possible. *Opuntia* species is a multifunctional crop (fodder and human use), which can be of great value in both developed and underdeveloped countries. The quick reaction on rainfall makes the plant adaptable under very low rainfall conditions.

**ASSESSING INTRA-SEASONAL LAND SURFACE CHANGE AND IDENTIFYING LONG-TERM TRENDS IN THE SUCCULENT KAROO USING LOW RESOLUTION SATELLITE IMAGERY**

Poster

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Rainfall and moisture availability is one of the greatest limiting factors to plant growth and distribution (Cowling & Desmet: 1999). Semi-arid rangelands are usually characterized by variable and inconsistent rainfall patterns, which can have a major influence on semi-arid productivity and or degradation status. The study identifies relationships and trends in rainfall and vegetation change on an intra-seasonal time scale in the Succulent Karoo biome of South Africa.

Time series analysis of 15 years (1985-2000) of monthly low-resolution satellite data (NOAA AVHRR) and various rainfall parameters will be analysed using multiple regression analysis. The trends and variance observed in the land surface change data may be a result of some outside influence or driving force. The strength of the relationship between the rainfall parameters and land surface change will be used to suggest whether or not rainfall effects can explain change seen in a specific area. The slope of the regression line and residual values will be used to determine the strength of the relationship.

Results of the analysis will provide valuable information on the driving forces behind vegetation change. Study results will also help identify areas exhibiting change not related to rainfall (zones of potential critical change). The zones of potential critical change will then be identified for future research using medium resolution satellite data in conjunction with GIS. Farming practices, vegetation types, soil types and other ancillary data could then be used to explain the changes being observed on the ground.

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**LARGE TREES, PRODUCTIVITY AND BIODIVERSITY IN THE KALAHARI: THE INFLUENCE OF TREE SIZE ON SUBCANOPY PLANT ASSEMBLAGES**

Poster

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It is widely recognised that large trees often contribute to overall biodiversity in savannas by creating distinct microhabitats for establishment of certain plants (Milton and Dean 1995, Leistner 1996, Dean et al. 1999). This contribution has seldom been quantified, however. Furthermore, energy-species diversity theories predict that all else being equal, plant assemblages on the equator-ward side of trees should be more diverse than those found on the opposite side, owing to higher solar radiation (see e.g. Wright et al. 1993). However, if competition for water is assumed uniform around the tree bole, water availability may be higher on the southern side because shading lowers evaporation rates. A comparison of species diversity along a north-south axis from the tree bole can therefore enable testing the relative importance of energy and water to species diversity at the microhabitat scale.

I therefore report the results of an investigation into species richness, beta diversity, plant cover and community composition beneath large and small trees and the matrix, under two rainfall regimes in the southern Kalahari, South Africa. I surveyed subcanopy plant assemblages of twenty large (>4m high) and twenty small (<4m, >1.5m) *A. erioloba* at three sites in the Kimberley area (Rainfall = 450mm/year), to ascertain species assemblage composition and diversity. In addition, I surveyed subcanopy assemblages of eight large and eight small *A. erioloba* from a site of greater aridity (Van Zyl's Rus, Rainfall = 250mm/year), to ascertain the relative importance of large trees to subcanopy communities under different aridities.

Subcanopy communities were distinct and richer in species than those of the matrix. Subcanopy assemblages in drier areas had lower diversity, although large trees enable a suit of species to exist in harsher arid areas.

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### THE INFLUENCE OF SUBHABITAT DIFFERENTIATION ON THE SOIL UNDER VARYING COMPETITION REGIMES IN MOPANE SAVANNA IN SOUTH AFRICA

Poster

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The investigation was conducted on a densely wooded area in the Mopane savanna of South Africa dominated by the tree species *Colophospermum mopane* interposed with a few individuals of *Salvadora australis*. Seven plots were subjected to different intensities of tree thinning, ranging from a totally cleared plot (0 %) to plots thinned to the equivalent of 10 %, 20 %, 35 %, 50 % and 75 % of the leaf biomass of a control plot (100 %). Distinction between five subhabitats was made. These included the following: between tree canopies, under *C. mopane* trees, where *C. mopane* trees have been removed, live *S. australis* and where *S. australis* have been removed. Ten topsoil samples (to a depth of 150 mm) per subhabitat were randomly taken in each experimental plot, bulked, thoroughly mixed and one subsample taken for analysis. Differences between subhabitats were large and significant. Soil under *C. mopane* canopies had a significantly ( $P < 0.001$ ) higher % total N, % organic C, P, Na, K, Mg, and pH in comparison to soil from between tree canopies, while Ca and electrical resistance did not differ significantly ( $P > 0.05$ ). The soil from the *S. australis*-subhabitats differed radically from that of the *C. mopane*-subhabitats in respect of all the investigated soil variables with the exception of P. Few of the investigated soil variables, on the short term (3 years), changed significantly as a result of the various tree thinning treatments.

### UNPLANNED FIRES AND SUSTAINABILITY OF A SEMI-ARID GRASSLAND

Poster

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Although fire is regarded as a natural factor of the environment of southern Africa, accidental fires either by lightning or man influence the fodder flow planning in both agricultural and conservation areas. Therefore, it was the objective of this study to quantify the short-term (two years) response in productivity following an unplanned fire in a semi-arid climate. Basal cover was 40% and 18% less due to fire, 4 months and two years after the fire respectively. Burnt grassland takes at least two full growing seasons to recover in terms of above- and belowground phytomass production. The unburnt area produced nearly twice as much as the unburnt area over the first growing season. Crude protein content of plant material was significant ( $\leq 0.01$ ) greater in burnt than unburnt grassland, but over only the first growing season. Root mass decreased significantly by 59% over the first 100 mm depth due to fire. More than 80% of the root mass was found in the top 0 to 300 mm soil layer. The belowground growth is more sensitive to burning than the aboveground production. Fire reduced the root/shoot ratio from 1.44 to 1.30. Accidental or unplanned fires contribute towards the so-called man-made droughts, and therefore influencing the short-term sustainability of the grassland ecosystem.

**A CONTRIBUTION TO DETERMINING THE STATUS OF *PROSOPIS* AS AN ALIEN PLANT INVADER IN SOUTH AFRICA**

*Poster*

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*Prosopis* species were introduced and propagated throughout the arid areas of South Africa to provide shade, wood for fuel and pods for fodder. They, and their hybrids, became invasive in because of their adaptability, vigorous growth, prolific seed production, longevity in soil seed banks, absence of natural seed-feeding insects, and efficiency of seed dispersal mechanisms.

The formulation of a long-term management strategy for *Prosopis* in South Africa requires its status as an alien plant invader to be more accurately determined and its socio-economic and ecological costs and benefits to be taken into account (Marais, 2001). The one way in which the status of *Prosopis* as an invader can be defined is:

Status = f{Current Extent, Rate of Spread, Potential for Invasion}

Where,

Current extent = f{Area, Density, Population Profile}

Rate of spread

Potential for Invasion = f{Suitable Habitat, Extent of Suitable Habitat}

Mapping the spatial extent and density of *Prosopis* invasions over a large part of the Northern Cape Province using remote sensing and geographic information system technology has been completed (Lloyd, van den Berg & Badenhorst 2002). Future research needs to focus on the development of monitoring techniques to assess rates of spread in selected areas, and establishing its potential for invasion. Landscape analysis is required to determine where *Prosopis* tends to invade, taking into account factors such as soil type, climate, slope, aspect, and position in the landscape (Marais, 2001). This would then enable an assessment of habitat potentially suitable for invasion by *Prosopis* to be made.

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Abstracts

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THE POTENTIAL OF *CEPHALOPHYLLUM INAEQUALE* FOR THE RESTORATION OF DEGRADED ARID LANDSCAPES IN NAMAQUALAND, SOUTH AFRICA

Poster for Display only

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The potential of *Cephalophyllum inaequale* for use in initiating ecosystem restoration in degraded landscapes of Namaqualand, South Africa, was investigated. A bioclimatic envelope was modeled to establish the area in which this species might feasibly be used. The regional bioclimatic potential for *C. inaequale* proved to be extensive covering approximately 17 500 km<sup>2</sup>. An examination of the functional role of *C. inaequale* showed it to facilitate early seedling survival in this community. A nearest-neighbour study found no evidence of interspecific competition between *C. inaequale* and its dominant co-occurring species, possibly due to vertical stratification of rooting structures. It was demonstrated that *C. inaequale* significantly reduces wind speed and soil erosion. Experiments to test the feasibility of propagating, re-introducing and establishing this species, showed that it is easily germinated from seed, and transplanted cuttings have a high survival rate. This study demonstrates that *C. inaequale* has potential for use in initiating the restoration of degraded lands.

A LONG-TERM CONSERVATION STRATEGY FOR HIPPO (*Hippopotamus amphibious*) IN THE LIMPOPO RIVER SYSTEM, LIMPOPO PROVINCE

Poster for Display only

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The Limpopo River system is one of the main drainage systems in the Limpopo Province and maintains a high biodiversity. Hippo is regarded as being of regional and national importance. The Limpopo River system is a closed system and therefore monitoring of hippo population trends is important for the management and conservation thereof.

Injudicious water use, poor veld management practices, agricultural development, uncontrolled grazing by cattle from Botswana and the location of the veterinary fence can be regarded as the main contributors to water and grazing shortages for hippo, especially during the winter seasons. Drought periods worsened the above situation and animals had to be fed.

A medium term conservation strategy was implemented with the forming of NGO's namely the Platjan Wildlife Management Committee and Mogol Hippo Committee. The aims of these committees are the monitoring of trends in the hippo population and to ensure funds are available to buy feed for the hippo, especially during periodic droughts.

The habitat of hippo was evaluated and aspects such as distribution patterns of hippo, numbers, level of dams, veld condition and state of the river were investigated. Views of landowners and the functioning of NGO's were also investigated.

The average rainfall between the Magalakwena River and Buffelsdrift in the northwest was less than 20 % of the long-term annual. The lack of sufficient rainfall together with continuous grazing by cattle from Botswana enhanced grazing shortages and resulted in extremely poor veld condition.

The Limpopo River has now stopped flowing and water is limited to pools, weirs and off-channel dams scattered along 600 km. Hippos are moving up and down the Limpopo River and concentrating in these pools. A proactive feeding program ensures survival of specific hippo populations.

The conservation status of hippo outside the KNP in the Limpopo Province, especially the Limpopo River system, is a cause for concern. The over utilization of the natural resources in this river system, in combination with the recent drought, is threatening the survival of the hippo populations, which are driven by available water and grazing resources.

The short-term strategy of proactive feeding of hippo during 1992, 1993 and 2003, prevented high mortalities. This is however costly (R600 000/ year) and not sustainable over the long-term.

Although a medium-term strategy exists, it operates on an ad hoc basis. Continuous monitoring of hippo numbers, distribution patterns and trends in veld condition, which are essential for decision-making with regard to specific type of options (feeding/ capture), is essential for maintaining sustainable populations of hippo.

A long-term conservation strategy is required in order to secure viable hippo populations in a sustainable manner.

Maintaining the natural functioning of the Limpopo River system is the responsibility of the Government as well as landowners. It is recommended that:

- \* A long-term strategy be implemented with the aim of improving existing hippo habitat. Although suitable habitat occurs, it is limited by the veterinary fence, agricultural development and cattle in Botswana. Key areas have been identified and the formation of informal and formal conservation areas should be developed.
- The medium term strategy, which include monitoring of numbers and habitat conditions, and which is driven by the private sector with the support of Government, should be managed on a continuous basis in order to obtain reliable information for better decision-making with regard to specific type of options (feeding/ capture/) required to maintain sustainable population of hippo in the Limpopo River system.
- Although the short- term strategy is in place, it should be managed as such, with more emphasis on the medium and long-term strategies.
- An integrated approach involving all role players is required in the management of hippo populations in the Limpopo River system as the Limpopo River forms the boundary between South Africa, Botswana and Zimbabwe.

## SOIL VARIATION ON AND BETWEEN HEUWELTJIES IN ARID AND SEMI-ARID REGIONS OF SOUTH AFRICA

Poster for Display only  
28/8/2003

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Large areas of the arid (mean annual rainfall < 250 mm) and semi-arid regions (< 450 mm), especially the western (Namaqualand) and south western and southern (Little Karoo) parts of South Africa, are characterized by the occurrence of large circular ( $\approx 30$  m diameter and  $\approx 1$  m high) mounds (locally known as "heuweltjies"). They are caused by the harvester termite *Microhodotermes viator* and cover about 25 % of the landscape where they occur. The mounds are virtually absent on base-poor parent material (e.g. sandstone). The pedoderm (0 – 10 mm surface horizon) of 18 representative heuweltjies was sampled from Springbok in the north to Oudtshoorn in the east. Each heuweltjie was sampled along a line from the center (middle) outwards so as to cover the center zone, periphery and any transitional zone on the heuweltjie and the between heuweltjie zone. Munsell soil colour measurements, field estimates of soil texture and presence of free carbonates, pH and electrical conductance (as fairly qualitative estimates of base status and salt content) were done on all samples. Data of 189 samples that were taken on and between heuweltjies in the Vredendal area during an irrigation soil survey were also used to determine the fertility status (using citrus acid P content) of the surface and deeper horizons. Heuweltjies are dominated by a calcareous topsoil horizon on a hardpan carbonate (calcrete) subsoil horizon near the center with a non-calcareous topsoil on a dorbank (hardpan silica cemented) subsoil horizon on the periphery. Dorbank, as a subsoil horizon, is commonly present in the areas between heuweltjies on the more level terrain in Namaqualand and the Little Karoo. Soils on the heuweltjies are more fertile (average P content for topsoil horizons = 50 mg/kg) than between heuweltjies (P = 2 mg/kg). Results of the

investigation of selected properties (average values) of the pedoderm of 18 heuweltjies are summarized in the following table.

Property	Heuweltjie		Between heuweltjies
	Central zone	Periphery zone	
Redness rating values	Lowest	Higher	Highest
pH (water)	Highest	Lower	Lowest
Conductance	Low	Low	Highest
Test for free lime (n=18)	16 Positive	14 Negative	17 Negative

From field observations and the results reported above it is clear that the great variation in soil properties that were observed in the heuweltjie landscape is largely responsible for the large variation in plant species composition that occur. The matching of the soil properties with specific plant communities on the experimental sites is currently in progress.

### ASSESSING THE RELATIONSHIP BETWEEN INTRODUCED INVASIVE ALIEN SPECIES, INCREASED FLOOD DISTURBANCES AND INDUCED CHANNEL CHANGE IN THE GOURITZ RIVER CATCHMENT, KLEIN KAROO

Poster for Display only

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Semi arid regions have shown distinct tendencies to periodic flooding, which hold socio-economic implications. These river systems are the focus of this study and are also heavily infested by *Arundo donax* (Giant reed) and *Poplar sp.* It has been hypothesised that an increase in the extent and density of alien vegetation will lead to increased water abstraction in river systems and possible ecological impacts. This study will investigate whether alien vegetation can increase flood risk and whether this occurs through channelling. Using the classification and data collection system of Rowntree and Wadeson (1999) and Braun-Blanquet cover abundance, maps will be generated to assess the ecological and geomorphological impact of *Arundo donax* and *Poplar sp.* on river channels and margins. Standard vegetation assessment usually focuses on species cover and abundance, however, it is difficult using these techniques to define relationships between ecology and geomorphology. Consequently use will be made of standardised photography to assess height and density measurements. This together with GPS-based mapping will capture additional information that might help elucidate these relationships. Given that the photographic images will be standardised and georeferenced, these visual records can also be used at a later date to facilitate analyses of how the area changes with time if the process is repeated. This would likely offer management insights, as mapping and classification combined with the photographic record would record geomorphological processes as well as characteristics of the environment.

### EFFECTS OF SOIL IMPEDIMENTS ON THE GROWTH PATTERNS OF THE STRANDVELD SUCCULENT KAROO IN NAMAQUALAND

Poster for Display only

28/8/2003

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Mining operations for diamonds and heavy minerals are destroying vast areas of the Strandveld Succulent Karoo, an area of exceptionally high biodiversity and endemism. Natural strandveld vegetation exhibits a highly complex mosaic pattern. An understanding of the site-specific environmental conditions such as soil properties and various other biotic influences is necessary to determine the environmental driving forces associated with different components of the mosaic. The combined influence of surface water repellency and texture and sub-surface impediments such as cemented (calcrete or

dorbank) hardpans or significant more clayey (cutanic, luvic) horizons on the water storage capacity of the soil mantle, effects the vigour and species composition of the natural vegetation. A definite correlation was found between the vegetation units and occurrence of pedological features such as the depth of cemented hardpans and the occurrence and sequence how diagnostic horizons, such as E-horizons, are spaced with depth. Mining operations destroys both surface and subsurface features. Diamond mining processes changes the topography, destroys subsurface dorbank and calcrete layers and exposes highly saline, clayey sediments to erosion. Heavy mineral mining processes changes the micro topography, destroys the subsurface dorbank layers in some places and removes most of the clay and silt from the already sandy soil. Eradication of the natural soil properties will limit the ability of the soil to support the ecosystem that occurs naturally in this area. Change and homogenisation of the natural soil properties will also result in a sharp decline in biodiversity. Natural plant communities are very complex and the decline in biodiversity and complexity will result in a decline in stability of this system. The exposure to drought would increase the possibility of desertification in the areas affected by mining operations. A better understanding of the edaphic factors associated with undisturbed areas in the strandveld of the succulent karoo, and especially the role that soil plays in evening out the supply of scarce water, could provide useful clues on how to mimic the abiotic environment during the rehabilitation of areas disturbed by mining.

### **ORTHORECTIFIED LANDSAT ETM PRODUCTS FOR SOUTH AFRICA (NDVI AND BSI)**

**Poster for Display only**

van den Berg, EC  
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**POTCHEFSTROOM 2520**

The Landsat ETM image data set consists of 74 images covering South Africa, Lesotho and Swaziland. The images were orthorectified using a high resolution Digital Elevation Model (DEM) and topographic 1:50 000 digital sheets. Vegetation cover was classified using the Bare Soil Index (BSI) and the vegetation activity into four Normalized Difference Vegetation Index (NDVI) classes.

The BSI (from Landsat ETM) was scaled using almost 1700 field points collected during 2002. The images were classified into 5 classes, four main BSI classes and one class that include cloud, water and heavy industrial plants. Each BSI class was colour ramped into five classes. No fixed thresholds were determined because the images were not radiometrically and atmospherically corrected. Scaling of the BSI was made difficult because fieldwork could only be done one year after image acquisition dates. The diverse climate and vegetation of South Africa made it difficult to use the same scaling calibration.

The NDVI (from Landsat ETM) was scaled using image interpretation and NOAA NDVI derived data for that same year. Each image was scaled into 5 classes, 4 vegetation classes and 1 class for cloud and water.

The Multi Spectral, Pan resolution merge enables one to integrate imagery of different spatial resolutions (pixel size). Since higher resolution imagery is generally available in a single band (for example Landsat ETM PAN band, 15m resolution), while multispectral imagery generally has the lower resolutions (for example Landsat ETM 30m), the technique is often used to produce high resolution, multispectral imagery. This improves the interpretation of the data by having high-resolution information, which is also in color.

These products will provide a tool to the Directorate Land Resource Management (which funded the project) to monitor the conservation status of natural resources at a provincial and national scale. The data were produced in ERDAS Imagine 8.5 and are in .img format. It can be viewed in ERDAS, ARCVIEW or any image processing package that can import this format. All the data are in Geographic (Lat,Lon), WGS84.



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