

ARID ZONE ECOLOGY FORUM

**DROUGHT AS A DRIVER:
PHYSICAL, ECOLOGICAL AND SOCIO-ECONOMIC EFFECTS,
INTERACTIONS AND RESPONSES**

10 - 13 September 2007

Sutherland
Northern Cape Province



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ACKNOWLEDGEMENTS

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Committee Members: 2006 – 2007

Chairperson: Dr. Colleen Seymour – South African National Biodiversity Institute
Committee Members: Dr. Mark Anderson – Department of Tourism, Environment and Conservation
Mr. Clement Cupido – Department of Agriculture – Western Cape
Dr. Phillip Desmet – Conservation International
Prof. Sue Milton – University of Stellenbosch
Dr. Ute Schmiedel – Biocentre Klein Flottbek
Ms. Lee Saul – Agricultural Research Centre – Range and Forage Institute
Ms. Rhoda Malgas
Ms. Kirsten Fourie – Botanical Society

Secretariat: Ms. Kirsten Mahood

ARID ZONE ECOLOGY FORUM PROGRAMME – 2007

Monday 10 September 2007

Registration: NG Church Hall 16h00 - 18h30

Welcoming Cocktail Party: Sutherland Hotel: 19h00 – 21h00

Tuesday 11 September 2007

Registration: NG Church Hall: 07h30 - 07h50

Welcome	8.00-8.10	Colleen Seymour: Opening Remarks
Session 1: Climate Change		
<i>Chair: Colleen Seymour</i>		
8.10-8.50	<i>Vetter, S.¹</i> (keynote)	Planning and management for resilience in socio-ecological systems in arid areas
8.50-9.10	<i>Hewitson, B.</i>	Probabilistic scenarios of high-resolution climate change
9.10-9.30	<i>Jack, C.</i>	South African moisture sources, recycling and transport using a lagrangian moisture transport model
9.30-9.50	<i>Mosteller, D.</i>	Intraseasonal variations of temperature and precipitation over the Succulent Karoo Biome
9.50-10.10	<i>T. Hoffman</i> & P.J. Carrick	Is the Karoo drying up? The incidence of drought over the last 200 years and its impact on Karoo plants
10.10-10.50		TEA: Church Hall

Session 2: Hydrology

Chair: Patrick O'Farrel

10.50-11.20	le Maitre, D. (keynote) Pres. by <i>P. O'Farrel</i>	Hydrology: rill to river
11.20-11.40	<i>Brown, R., Mills, A. & Jack, C.</i>	Quantifying fog and dew as a soil water vector in arid zones; methodology and preliminary findings from the Knersvlakte
11.40-12.00	<i>Coop, L.</i>	Remote identification of advective fog events along the west coast of South Africa
12.00-12.20	<i>Opperman, D.; Archer, E.; Tadross, M., Conrad, J. & Munch, Z.</i>	Understanding climate change projections and implications for potato & rooibos farming in the Sandveld
12.20-13.30		LUNCH: Sutherland Hotel

¹ Presenter's name in italics

Session 3: Vegetation and Drought

Chair: Sue Milton

13.30-14.00	<i>Hendricks, H.</i> (keynote)	Does drought increase conservation-farming conflicts in a national park
14.00-14.20	<i>Hempson, G.</i>	Effects of drought on large mammal population dynamics and patterns of resource use: a case study using goats in the Richtersveld National Park
14.20-14.40	Todd, S. W. & Hoffman, M. T.	The Paulshoek fence-line contrast, has anything changed after 10 years?
14.40-15.00	<i>Coetzee, M.</i> & Jordaan, F.P.	The effect of different land-use practices on rangeland condition, herbaceous and seed bank composition – implications for land degradation and biodiversity management in semi-arid western rangelands of Southern Africa
15.00-15.30	TEA: Church Hall	

Session 4: Fauna and Drought

Chair: Mark Anderson

15.30-16.00	<i>Dean, R.</i> (keynote)	Responses of the avifauna to rainfall and drought
16.00-16.20	<i>Barnard, P.</i> , Altwegg, R. & Dean, W.R.J.	Tough or fragile? Vulnerability and adaptation of African dryland birds to climate change
16.20-16.40	<i>Taylor, S.J.</i>	Climate change and the threat to insect biodiversity in the arid zones of southern Africa

Poster Session 1: Landuse

Chairperson: Ute Schmiedel

17.00-19.00: Sutherland Hotel

11 presenters, 5 mins each

1	<i>de Beer, G.C.O.</i>	The Impact of drought on vegetation and the relation to climate change in Limpopo - a natural phenomenon?
2	<i>Coetzee, M.</i> , Jordaan, F.P. & Bloem, D.	The effect of different land-use practices on rangeland condition in semi-arid western rangelands of Southern Africa, with special reference to soil properties
3	<i>Keromecwe, O.</i> , Zweni, A., Bontsi, M., Samuels, M.I. & Allsopp, N.	Alternative sanitation in semi-arid South Africa: The case of the Sol Plaatjie Housing Company (Kimberley)
4	<i>Booth, A.</i> & Vetter, S.	Veld utility and diet quality: Can they provide insight into the long-term effects of two grazing systems with distinctly different key resources in arid land
5	<i>Cupido, C.</i> , Visser, N., Botha, J.C., Du Plessis, C. & Dyason, A.	Veld management guidelines to emerging and commercial stock farmers of the Karoo.
6	<i>Konje, M.</i> & Vetter, S.	The influence of rainfall vs. grazing on primary production, composition and diversity of annual-dominated vegetation in Richtersveld National Park
7	<i>Coetzee, M.</i> & Jordaan, F.P.	The effect of different land-use practices on woody species composition, density and structure of a semi-arid rangeland in Southern Africa – implications for land degradation and biodiversity management
8	<i>Lot, J.</i>	Biodiversiteit op die kommunale land in Paulshoek

9	Ramoelo, A., Munyati, C., <i>Vogel, M.</i> , LeMaitre, D. & van Aardt, J.	Land degradation mapping for modelling of ecosystem benefit flows in the Inkomati Catchment using remote sensing
10	<i>Lenka, M.</i>	Alternative sanitation in semi-arid South Africa: The case of the Sol Plaatjie Housing Company (Kimberley)
11	Fourie, K. & <i>Schumann, M.</i>	Bokkeveld Stewardship Project - creating biodiversity corridors to combat climate change
19.00-21.00	DINNER: Sutherland Hotel	

Wednesday 12 September 2007

Registration: NG Church Hall: 07h20 - 07h50

Session 5: Humans and Drought

Chairperson: *Nicky Allsopp*

8.00-8.30	<i>O'Farrel, P.</i> & Milton, S.J. (keynote)	Human response and adaptation to drought in the arid zone: Lessons from South Africa
8.30-9.00	<i>Naidoo, M.</i> , Hoffman, M.T., Allsopp, N. (keynote)	The "pulsing" of a semi arid system. A case study of herd dynamics in a communal grazing area.
9.00-9.20	<i>Joubert, D.F.</i> , Zimmermann, I. & Graz, F.P.	Testing a rangeland management decision support system with farmers in central Namibia: some preliminary results
9.20-9.40	<i>Atkinson, D.</i> & Marais, L.	Developmental priorities and expenditures in the Arid Areas of South Africa: The case of the Eastern Cape and the Free State Provincial Governments
9.40-10.00	<i>van Rooyen, D.</i>	DIFFERING WORLDS: Comparative study between how Western and Northern Cape Provincial Government views arid areas
10.00-10.40	TEA: Church Hall	

Session 6: Economics and Drought

Chairperson: *Kirsten Fourie*

10.40-11.10	<i>Blignaut, J.</i> (keynote)	Economics of drought
11.10-11.30	<i>Koelle, B.</i> & Brandt, R.	Tourism as an alternative livelihood strategy in the Succulent Karoo
11.30-11.50	<i>Oettle, N.</i> , Malgas, R.R. & Koelle, B.	Small grants for small growers: Farmer-driven mitigation against land degradation in the Cedarberg
11.50-12.10	<i>Sigenu, K.</i>	Low-income housing policy and practice in arid/semi-arid areas of South Africa: The need for a research programme
12.10-12.30	<i>Nel, E.L.</i> & Hill, T.	The changing role of small towns in an arid space economy: a case study of the Eastern Cape Karoo, South Africa
12.30-14.00	LUNCH: Sutherland Hotel	

Session 7: Open Theme

Chairperson: Dave Joubert

14.00-14.20	<i>Samuels, I.M. & Allsopp, N.</i>	Why do livestock keepers move their herds in communal Namaqualand?
14.20-14.40	<i>Shiponeni, N., Vogel, M, Keil, M. & N. Allsopp</i>	Vegetation Change at a Climatic Ecotone Between Bushmanland Arid Grasslands and Namaqualand Shrublands as Determined Using Remote Sensing
14.40-15.00	<i>Saul, L. & Allsopp, N.</i>	Long term monitoring of grazing exclusion from rangelands in Namaqualand
15.00-15.20	<i>Saayman, N. & Botha, J.C.</i>	Vegetation changes as a result of the control of <i>Prosopis</i> in the Nama Karoo
15.20-15.40	<i>Krug, R. M., Hoffmann, M. T. & Swart, E.</i>	Reconstructing recruitment events - the case of <i>Aloe pillansii</i>
15.40-16.00	TEA: Church Hall	

Session 7: Open Theme

Chairperson: Lee Saul

16.00-16.20	<i>Nchai, M.C.</i>	The response of invertebrate assemblages to land use in South African semi-arid region'.
16.20-16.40	<i>Anderson, M. & Dean, W.R.J.</i>	Increases in numbers of crows (Corvidae) over time in semi-arid South Africa: landuse, foraging opportunities or lack of competition?
16.40-17.00	<i>Haveron, S.</i>	Rodents and Rangelands: Is the grass always greener on the other side of the fence?

Poster Session 2: Rehabilitation

Chairperson: Clement Cupido

17.00-19.00: Sutherland Hotel

10 presenters, 5 mins each

12	<i>Saayman, N. & Botha, J.C.</i>	Herbicide vs. brush-cutting for the control of <i>Pteronia paniculata</i>
13	<i>Botha, P.</i>	Rehabilitating Riverine Habitat In The Central Upper Karoo
14	<i>Mukuya, R.S. & Proepper, M.</i>	Illegal logging in the Kavango.
15	<i>Malan, Paul</i>	Vegetative propagation of some Karoo shrubs

Poster Session 3: Monitoring

Chairperson: Clement Cupido

16	<i>Mtleni, V., Isaacks, R. & Strohbach, B.</i>	Patterns of plant biomass in Namibia
17	<i>Joubert, D.F., Cunningham, P.L., de Cauwer, V. & Robertson, A.</i>	An invasive alien plant road count as a useful monitoring tool: a proposal and some preliminary results
18	<i>Theron, G.L. & Marais, E.</i>	Islanders in the desert: Arboreal insect diversity on <i>Acacia</i>
19	<i>Malan, Pieter</i>	<i>Prosopis</i> invasion in selected sites in the Molopo District - The effect on soil quality
20	<i>van der Merwe, H. & van Rooyen, M.W.</i>	Patterns of plant diversity in the Hantam-Tanqua-Roggeveld
21	<i>Najibzadeh, M., Adel sepehry-G.H. & Heshmati-A.A.rasouli</i>	Evaluating land capability of Yekkeh Chenar Maraveh Tappeh for range application using GIS
22	<i>Morgenthal, T.L., Kellner, K. & Pretorius, D.J.</i>	The development of an uniform ecological survey methodology for a national fix point monitoring system

19.00-21.00	DINNER: Sutherland Hotel
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Thursday 13 September 2007

Registration: NG Church Hall: 07h20 - 07h50

WORKSHOPS OR FIELDTRIPS

	PARALLEL A	PARALLEL B
8.00-8.30	Atkinson Workshop "Social and ecological dimensions of economic change: where nature meets nurture" Venue: Sutherland Hotel	FARMERS DAY & FIELDTRIP
8.30-9.00		Workshop B: Farmers day introduction and summary of meeting highlights (8.00-9.00)
9.00-10.00		Farmers day guest speaker (9.00-10.00)
10.00-10.15		Fieldtrip preparation (10.00-10.15)
10.15-10.45	TEA & COLLECT LUNCH PACKS	
11.00-11.15	Atkinson workshop continued	Travel to choice of 3 field trip sites
11.15-14.00		1. Natural ephemeral pans (led by Richard Dean) 2. Drought mortality in relation to forage value of shrubs, position in landscape (led by Sue Milton, Kirsten Fourie) 3. South Africa's Largest Telescope observatory tour.
		PACKED LUNCH
14.00-14.15	Travel back to conference centre	
14.30-16.00	EXECUTIVE SUMMARIES OF WORKSHOP & FIELDTRIPS (20 mins each) Key issues or observations and relevance for action	
16.00-16.30	Relax	
16.30-18.00	AZEF Annual General Meeting	
18.00-19.00	Relax	
19.00-21.00	DINNER & PRIZE GIVING: Sutherland Hotel	

PAPER ABSTRACTS

Session 1: Climate Change

Planning and Management for Resilience in Social-Ecological Systems in Arid Areas

Susanne Vetter

BOTANY DEPARTMENT, RHODES UNIVERSITY, P.O. BOX 94, GRAHAMSTOWN, 6140, SOUTH AFRICA.
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Arid areas are characterised by low productivity, unpredictable rainfall variation and recurrent droughts, which pose particular challenges to land users wishing to maintain them in desired states while making a living from year to year. These challenges are likely to be exacerbated by climate change which will have unpredictable effects on productivity, seasonality and inter-annual variation. At the same time, human populations are growing, moving and affected by political and economic changes which impact on the nature and sustainability of their livelihoods. Most arid areas are used as rangelands, for keeping domestic livestock under different tenure and land use systems, but other forms of land use such as game farming, conservation, tourism and industries like mining are also found side-by-side and often interlinked with livestock farming. Ecological, economic and social processes interact at different temporal and spatial scales to shape these systems and how they respond to change. Social and ecological changes are often characterised by thresholds which are poorly understood and often slow or costly to reverse. Resilience refers to how much disturbance a system can cope with before it crosses a threshold to a qualitatively different state controlled by a different set of processes and feedbacks. This paper explores the implications of resilience theory for managing arid systems. Predictions regarding factors thought to enhance or reduce resilience are discussed with reference to findings from case studies.

Probabilistic Scenarios of High-resolution Climate Change

B. Hewitson and R. Crane

Of the challenges currently dominating the climate change projections research agenda, developing regional scale pragmatic scenarios of climate change is one of the highest priorities. While the numbers may be readily generated, the question of what is credible, defensible, and critically, what is actionable, is a more subtle issue.

The presentation explores some of the latest regional scenario results currently emerging for southern Africa, and considers the question of how one might assess the probability of individual outcomes within the span of the projected envelope of possible change. The assessment includes consideration of the attribute of change in consideration, such as changes in the mean versus changes in the tails of the distribution.

We conclude with an outline of a suggested framework that users of regional climate change projections should consider in applying such data.

South African Moisture Sources, Recycling and Transport using a Lagrangian Moisture Transport Model

Jack, C.

Is Rainfall Becoming Less Frequent Over the Succulent Karoo Biome? An Investigation of Intra-seasonal Variability from 1950 to 1999

D. Mosteller¹

1. Climate Systems Analysis Group, Department of Environmental and Geographical Sciences, University of Cape Town, Private Bag X3, Rondebosch 7701, South Africa [donmosteller@egs.uct.ac.za]

Bioclimatic models incorporating the Climate Systems Model (CSM) and Hadley Centre Coupled Model, version 2 (HadCM2) climate change scenarios have predicted a staggering range reduction of 80% for the Succulent Karoo Biome's highly endemic flora. Other studies have shown that this collapse reflects 1) the decreasing rainfall frequencies along the western coast of southern Africa projected by six, empirically downscaled general circulation models (GCMs) over the 2070-2099 period, as well as 2) the flora's unlikely capacity to migrate over the Cape Fold mountains to more amenable habitats before climatic conditions deteriorate. Considering that the temporal distribution of total annual rainfall is more ecologically relevant for succulents than rainfall intensity, these projections are alarming.

Motivated by a dearth of research, the 10km interpolated daily precipitation record of Hewitson and Crane (2005) for the period of 1950-1999 is used to explore the intra-seasonal variability of precipitation intensities and frequencies, with special reference to the latter. This initial research serves as a launch pad to explore the most exigent question of whether or not the flora of the Succulent Karoo can survive current climate change scenarios by relying on the secondary, however more reliable moisture sources of fog, dew, and to a lesser extent, reverse transpiration.

Is the Karoo drying up? The Incidence of Drought Over the Last 200 Years and its Impact on Karoo Plants

T. Hoffman¹ & P.J. Carrick²

1. Plant Conservation Unit, University of Cape Town, Private Bag X3, Rondebosch, 7701
2. Namaqualand Restoration Initiative, Plant Conservation Unit, University of Cape Town, Private Bag X3, Rondebosch, 7701

Drought is thought to play an important role in structuring Karoo plant communities. It has been hypothesized that large-scale mortality in response to rare droughts drives the diversity of the Succulent Karoo biome. First, we explore several tools for measuring drought from rainfall and temperature records including the Mann-Kendall non-parametric test for trend and the Standardized Precipitation Index. Then we investigate the incidence of drought for selected climate stations in the Nama and Succulent Karoo biomes in the Karoo over the last 200 years. We show that drought has neither increased in intensity nor frequency in recent decades. On the contrary, the first half of the 20th century was in general significantly drier than that second half for many stations in the region. Next, we review the three key studies carried out in the Richtersveld, Worcester and Steytleville, which measured the impact of drought on Karoo plants and provide results from two additional unpublished studies carried out at Paulshoek, Namaqualand. We also review the impact of drought on leaf succulent seedlings grown in greenhouse experiments. We suggest from this review that the impact of drought has varied from locality to locality and that few general responses are evident. Certainly there is little evidence of wide-scale mortality of all growth forms following severe drought. Contrary to previous suggestions, seedlings of mesembs especially are extraordinarily drought tolerant. We conclude that at this stage there is not sufficient evidence to accept the hypothesis that drought is a fundamental driver of community dynamics or speciation within the Mesembryanthemaceae. We further show how small rainfall events (<10 mm) associated with the predictable rainfall regime of the winter rainfall region enables shallow-rooted, leaf succulent plants to persist over time. Finally, we relate our findings to the international drought literature.

Session 2: Hydrology

Water for Ecosystems and People in the Little Karoo: The Challenge of Development in a Water Scarce Area

David Le Maitre, Christine Colvin, Ashton Maherry
Natural Resources and the Environment, NRE, CSIR, Stellenbosch

The Klein Karoo area of South Africa is a biodiversity hotspot, where three biomes meet in a semi-arid basin of the Western Cape. Rainfall in the area varies geographically from over 1500 mm/yr on the southern mountains, to 200 mm/yr in the rain shadow of the central basin and increases again to 1000 mm/yr on the northern mountains. Surface water resources are dominated by the Gouritz primary catchment and groundwater resources by the Table Mountain Group aquifer. Low cloud cover results in high levels of solar radiation (80%) in the low land area, with potential evapotranspiration more than 10 times the rainfall at 2250 mm/yr. Mean annual run-off (MAR) is only 6% for the Gouritz catchment and much of the MAR is dominated by flood flow in seasonal systems. This high variability in flows results in low reservoir yields at 1 in 50 year probability of failure. The MAR for the Gouritz primary catchment is approximately 674 Mm³/yr, the groundwater recharge estimated for the same area is approximately 305 Mm³/yr, however the estimated combined 1:50 year yield Klein Karoo part of the Gouritz catchment is only 161 Mm³/yr. The demand at 182 Mm³/yr exceeds the available resources, including the water that comes from the Great Karoo part of the Gouritz catchment. Around 90% of the current demand is for irrigation. Water demand is projected to increase significantly by between 23% and 150% by 2025. The impacts of climate change are uncertain but likely to result in a reduction of available water resources. New approaches to water management are required, in particular: improving the efficiency of irrigation; reducing salinization effects of irrigation; managed aquifer storage; increased use of groundwater, particularly deep resources; implementing alien vegetation eradication; and piloting and implementing effective land-care activities to improve infiltration and reduce sediment erosion. The data and information available on the water resources of the Klein Karoo are predominantly desk top data at coarse Water Management Area or national scale with low levels of confidence in non-verified sources. Relatively few studies have quantified biophysical components of the socio-eco-hydrological system within the Klein Karoo at the sub-catchment and aquifer scale. Particular attention needs to be paid to verifying existing water use and water quality data and on improved monitoring of groundwater and surface water to support resource assessments.

Quantifying Fog and Dew as a Soil Water Vector in Arid Zones; Methodology and Preliminary Findings from the Knersvlakte

R. Brown¹, A. Mills^{2,3} and C. Jack¹

¹Climate Systems Analysis Group, University of Cape Town

²Department of Soil Science, University of Stellenbosch

³South African National Biodiversity Institute.

In arid zones there can be little doubt that non-rainfall water plays a critical role in eco-system function. However the components of non-rainfall, namely dew and fog, are notoriously difficult to quantify. Firstly, the quantities are thought to be small and secondly, the duration of non-rainfall water as soil water is thought to be short.

The microlysimeter (MLS) methodology employed in this study is recognised as suitable for capturing both the quantity and duration of soil water derived from dew and/or fog. For this study an experimental automatic MLS was developed. This involved coupling a sensitive electro-mechanical load cell through suitable amplification and signal conditioning to a microcontroller. A low-powered microcomputer was employed for overall system control and data logging. The resultant device utilises relatively cheap components and opensource software resulting in a cost more agreeable to project budget constraints.

Initial field work took place between late September and November 2006 on Arizona farm, 30km north of Vanrhynsdorp in the Knersvlakte. In March 2007, subsequent work began at the Ratelgat BIOTA observatory. Manual soil weight sampling corresponds well with theoretical dew maximums, with measured maximum and minimum

dew/fog of 0.4mm and 0.07mm (± 0.08 mm) (both in September 2006). Measurements from the alpha prototype MLS were marred by large error figures, signal dropout from the Analog to Digital converter, and insufficient range at the required resolution. The beta prototype (field tested in March 2007 and still in use) provides much smaller errors. Calibration testing at Ratelgat indicates maximum overnight dew/fog contributions of .32mm (± 0.05 mm). Maximum dew/fog derived soil water occurs at a between 7am and 9:15am with slightly greater deviation from a mean in late rather than early summer. Surprisingly, the time of minimum soil water was shortly after 5:20pm. Again the deviation was greater in late summer than in early summer, where minimum soil water occurred at an earliest of 3:40pm and a latest of just after 6:30pm.

It must be noted here that these are preliminary findings and longer term testing and validation is necessary to fully confirm these figures and to explore the role of the white quartz and the succulents themselves in the interception of non-rainfall water.

Remote Identification of Advective Fog Events Along the West Coast of Southern Africa

L. Coop

Climate Systems Analysis Group (CSAG), ENVIRO Department, University of Cape Town

The remote detection of night-time fog makes use of the brightness temperature difference between two thermal Infrared bands (IR3.9 and IR10.8 channels). This technique relies on the fact that fog pixels display higher brightness temperature differences as compared to land pixels and those covered by other clouds. This fog detection method has been successfully used in other regions of the world; however it has been shown to be less accurate at detecting fog over sandy desert surfaces similar to that of the west coast of southern Africa.

This study first tests the skill of this simple night-time fog detection technique over this region. It compares the results obtained from the satellite data to those obtained from surface observations. These surface observations are also used to improve the discrimination of fog pixels from those of cold land surfaces or other cloud types.

Understanding Climate Change Projections and Implications for Potato & Rooibos Farming in the Sandveld

Opperman, D. ¹; Archer, E. ²; Tadross, M. ³, Conrad, J. ⁴ & Munch, Z. ⁴

1. Greater Cedarberg Biodiversity Corridor, Cape Nature, 31 Waterkant Street, Porterville 6810
2. School of Geography, Archaeology & Environmental Studies, University of the Witwatersrand, Pvt Bag 3, WITS 2050, Johannesburg
3. Climate System Analysis Group, University of Cape Town, Pvt Bag, Rondebosch 7701.
4. GEOSS - Geohydrological & Spatial Solutions International (Pty) Ltd., Unit 19, TechnoStell, 9 Quantum Street, TechnoPark, Stellenbosch 7600

We present here the preliminary findings of a project commissioned by Cape Nature Greater Cederberg Biodiversity Corridor (GCBC); Potato SA and the South African Rooibos to investigate climate change projections and implications for commercial agriculture in the Sandveld. The study included an analysis of the Sandveld's climate history, projected changes in rainfall for critical months, projected changes in maximum, minimum & average temperature and, finally, implications for groundwater availability (specifically recharge). Preliminary findings are, with caution, concerning. They include the majority of models showing reduced April rainfall and reduced August rainfall; and warmer monthly average temperatures, minimum temperatures & maximum temperatures – particularly towards the interior. All models show reduced groundwater recharge under climate change. The findings are likely to complicate an already challenging environment for ensuring best practice in commercial agriculture on the Sandveld, yet the process of undertaking the project, in partnership with commercial agriculture, has provided grounds for optimism.

Session 3: Vegetation and Drought

Does Drought Increase Conservation-Farming Conflicts in a National Park

Howard Hendricks

Effects of drought on large mammal population dynamics and patterns of resource use: a case study using goats in the Richtersveld National Park

Gareth Hempson

In arid ecosystems, where water is generally the main limiting resource, drought has important consequences for biological communities and the land users that rely on them. Severe drought was experienced in the Richtersveld National Park (RNP) in 1998. Using weekly herd movement data available for this period, and by comparing it to years surrounding this event, the impact of this drought on the habitat selection of goat herds in the RNP will be assessed. Habitat descriptions will include vegetation characteristics, topographical information and the proximity of surface water. Census data collected at three monthly intervals will be used to assess herd performance over this period which spans the 1998 drought. Herd dynamics will be related to habitat selection, and while considering the effects of local herd densities, will be used to assess the impacts of this drought on pastoralism in the RNP. These analyses will have bearing on the utility of key resource theory for understanding the ecology of arid regions. In addition, the ramifications of this drought for the livelihoods of local land users will be considered

The Paulshoek Fence-Line Contrast, Has Anything Changed After 10 Years?

S.W. Todd & M.T. Hoffman

Plant Conservation Unit, Botany Department, University of Cape Town

We investigate the impacts of communal vs. commercial land-use tenure on plant species richness and community composition over ten years in a dwarf succulent shrubland, in the Namaqualand uplands of the Kamiesberg. We interpret the results in terms of vegetation change and the implications for the current debate on non-equilibrium rangelands. We use 40 pairs of plots matched between the communal and commercial rangeland, sampled in 1996 and again in 2006, to record plant species composition and shrub density. The results indicate that the relative extent of community divergence between the communal and commercial rangeland has been maintained over time, overall and within different plant growth forms. Recruitment of some palatable shrub species occurred on the heavily grazed communal rangeland, indicating that a further decline in their populations is not inevitable. Recruitment of the unpalatable shrub *Galenia africana* on the communal rangeland was however disproportionately greater than that of the palatable species, re-enforcing the dominance of this species. Due to the longevity of karoo shrubs, short-term vegetation shifts are small, limiting the potential for the recovery of overgrazed shrublands during periods of low grazing pressure. The vegetation of Namaqualand can exist in two relatively stable states, each exemplified by the plant communities of the communal and commercial rangeland. On the commercial rangeland, it is the storage and inter-annual transfer of excess production that allows it to maintain steady livestock numbers in the face of a fluctuating environment. In contrast, there is little accumulated forage on the communal rangeland and so forage demand can only be met to the extent of the current seasons' production, thereby mediating the causal relationship between rainfall and livestock numbers. Although this is a semi-arid area, the results and their implications of this study are contrary to the predictions of the non-equilibrium theory of rangeland dynamics.

The Effect of Different Land-Use Practices on Rangeland Condition, Herbaceous and Seed Bank Composition – Implications for Land Degradation and Biodiversity Management in Semi-Arid Western Rangelands of Southern Africa

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In South Africa, the unsustainable use of natural resources has resulted in resource depletion and serious land degradation. Rangeland degradation is particularly acute in the North-West Province, where all districts show signs of desertification, loss of biodiversity resulting in a deterioration of human and animal health. It is important to recognise ecological change before irreversible changes occur. A trial, which falls within the Global Environmental Facility Desert Margins Programme (GEF-DMP), investigates to what extent vegetation (herbaceous production and quality, species composition, bush counts and seed bank studies) and soil in combination with ant communities can be used as indicators of ecosystem change due to human induced land-use patterns and how can this information be used in land degradation management and the conservation of biodiversity in the semi-arid western rangelands of Southern Africa. This paper addresses the impact of different land uses, with special reference to degradation and diversity patterns within and between land uses in order to establish best sustainable natural resource management practices. Results from the trial, focusing on the impacts of commercial, tribal and conservation land-use practices within the Molopo rangelands of the NW Province on the herbaceous species composition are presented. These land uses differ in management structure (multiple vs. single farmers), animal diversity, management of grazing resource (grazing system and pressure, vegetation diversity/uniformity) and products (quantity, quality, diversity, market). Surveys were performed in 72 sites, including benchmark exclosures. Sites, representing a degradation gradient (relative poor and relative good rangeland condition extremes) within each of 3 tribal-, 3 commercial- and 3 conservation areas were surveyed. The herbaceous species composition was determined using the descending point, nearest-plant method. Herbaceous species were classified according to the grazing-index, ecological-index, and life form (e.g. perennial/annual), and rangeland condition scores were calculated to convey multivariate information about the current state of the vegetation at a site. Because these arid rangelands are linked socio-ecological systems, it is not possible to address biophysical issues (vegetation composition & diversity and soils) associated with land degradation without including the human dimensions. Results suggest that these rangelands, irrespective of land use, and the presence of key resources do result in density-dependent processes linked to these key resources, with the effect of degradation being masked by climatic events (non-equilibrium events). State-and-transition models may be most useful to describe vegetation dynamics pertaining to the semi-arid rangelands of the Molopo study area, and should include the respective ecological paradigms. Land use was indicated as the primary determinant of structuring herbaceous compositional patterns, showing a degradation gradient across the larger study area. Results also suggested that the diversity indices are indicators of environmental change and disturbance rather than indicators of biodiversity *per se*.

Session 4: Fauna and Drought

Responses of the Avifauna to Rainfall and Drought

W.R.J. Dean

Patchiness in rainfall in time and space greatly influences local populations of birds in arid and semi-arid ecosystems. Birds respond to this patchiness by being either nomadic, moving to where the habitat is more productive or by remaining on their patch and widening their diet. In general, throughout the world, there are fewer residents, and greater nomadism and aseasonal breeding with decreasing rainfall, high co-efficients of variation in rainfall and variability in winter temperatures. Low mean minimum temperatures, with a low co-efficient of variation, probably select against residency and nomadism, and bird species in these areas tend to be migratory, with regular seasonal patterns of movement away from the cold and low productive environments in winter. Nomadic species only start to form a significant proportion of the avifauna at temperatures $>0^{\circ}\text{C}$.

Tough or Fragile? Vulnerability and Adaptation of African Dryland Birds to Climate Change

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The conventional wisdom of arid species being preadapted to increased climate variability, aridity and temperature may be valid, but “only so far.” We are moving into times which have seen no previous analogue in recent evolutionary history during the evolution of some bird taxa. What may be the thresholds for range shifts, population declines or population extinction?

Range shifts are significantly constrained now by land use and other pressures, relative to past times of relative warmth. Demographic, behavioural, genetic and evolutionary history data, plus land use change data and predictive climate envelope models, are needed to interpret how well birds may really cope with change. We present inferential data on species vulnerability for birds in several major taxa and outline a modest collaborative research framework for this field.

Climate Change and the Threat to Insect Biodiversity in the Arid Zones of Southern Africa

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Studies show that southern Africa could receive up to 30 % less rainfall in years to come, attributable to climate change. Biomes like the Succulent Karoo are highly at risk, are already showing signs of climate impact, and in fact could disappear in time as temperatures rise.

In terms of biodiversity conservation and ecosystem services, insect biodiversity is often overlooked. There is work being done on the possible expansion of ranges of harmful insects like mosquitoes due to climate change, but the biodiversity conservation aspects of insect are not making headlines.

Insects are reported to be very resilient as they have survived major extinctions in the past, but they won't survive very long if the plants they depend upon in the arid zones of southern Africa disappear. What can we expect in terms of insect survival in the arid biomes and climate change?

There are many ethical and policy issues at stake, for instance, in terms of the Convention on Biological Diversity which urges South Africa to conserve all aspects of biodiversity, will South Africa be released from having to conserve the biodiversity in the biomes at risk or will SA be able to source the Adaptation Fund to do whatever is needed to conserve this regional biodiversity?

This paper will review some of the concerns linked to declining biomes in South Africa and to illustrate that this area is significantly under-researched and that as plant species decline, regional insect species could be in decline too.

Session 5: Humans and Drought

Human Response and Adaptation to Drought in the Arid Zone: Lessons from South Africa

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Drought is an inherent part of life in the arid regions of South Africa and has far reaching social, economic and ecological implications. People living in these regions have developed complex responses and adaptation strategies in minimising and mitigating the effects of drought. This paper provides a review of these responses. We consider the role of transhumance grazing strategies, nomadism and trekking, utilised by the indigenous pastoralists and subsequently adopted by colonial settlers, as a drought avoidance strategy. The implication of settlement, private ownership, and technological advances including fencing and boreholes, to drought vulnerability is examined. Government policy responses including stock reduction and drought relief programmes are presented in conjunction with individual's responses such as the establishment of fodder reserves, saving schemes and land-hire. Finally we highlight the need for developing drought safety nets particularly with regard to future land-reform policies and emerging farmer livelihoods.

The "Pulsing" of a Semi-arid System: A Case Study of Herd Dynamics in a Communal Grazing Area

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Namaqualand is characterized by extensive livestock farming areas of which 1.3 million hectares (about 27 % of the total area) fall under communal tenure. In spite of widespread commonages in Namaqualand, little is understood about communal livestock farming with regard to the effects of seasonality and drought on the animal production system. This study aims to examine the effects of climatic variability on livestock fecundity and herd recovery in a communal area in Namaqualand. The variation in herd size and composition serve as an indication that a communal system should be viewed as a whole to understand the dynamics that exist within such a system. The collection of data was confined to the Paulshoek Commons in Namaqualand. Monthly weight gains of all the small stock within the commons were recorded since January 2006 and changes in herd size and composition were obtained from a long term data base that was established since 1998. Preliminary results indicate that drought and post drought periods have variable effects on livestock mortality of different species. The recovery in animal numbers between herds also differs after a drought. This study confirms that communal grazing areas in a semi-arid environment is indicative of a complex and dynamic animal production system that is dictated by environmental variability as well as the intricacies of people's livelihoods.

Testing a Rangeland Management Decision Support System with Farmers in Central Namibia: Some Preliminary Results

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A Decision Support System (DSS) for rangeland management with emphasis on bush encroachment has been developed. Workshops to inform managers of the DSS, and to test it, were held with rangeland managers in semi-arid

savanna in Central Namibia in 2004 and 2005. As part of the workshops and in order to involve farmers as well as developing insights into farmer decision making, DSS decisions were compared with 19 rangeland managers' decisions for six rangeland scenarios. This comparison is presented and the implications of differences in decisions are discussed. Responses were categorized into seventeen response types, although within the response types some significant differences in approach could still be noted. For each of the six scenarios, ten to fourteen response types were noted, suggesting that there is great variation in the management of semi-arid rangelands, even among neighbours, although the responses are not a guarantee of actual management actions. The least agreement (0 %) between respondents' responses and those suggested by the DSS were related to the use of arboricides to control seedlings in the absence of a healthy perennial grass sward, which our DSS does not suggest. We suggest pulling out most surviving seedlings and rest for the whole growing season. The greatest agreement between respondents' responses and those suggested by the DSS was related to leaving bush already affected with dieback (in the absence of a dense grass sward) (60 %), and the use of fire in preventing seedling establishment (in the presence of a dense grass sward) (53 %). Despite farmers suggesting fire in a number of their responses, in reality fire is rarely applied as a tool. A number of reasons are given for this, including, from most important to least important, the temporary loss of grazing, legal implications of a runaway fire, and damage to the ecology of the soil.

The exercise provides some insights into decision making by farmers, but more importantly perhaps allows a vehicle for meaningful communication and debate amongst farmers and rangeland scientists, as do some other aspects of the DSS, that are further discussed.

Developmental priorities and expenditures in the Arid Areas of South Africa: The case of the Eastern Cape and Free State Provinces

Atkinson, D and Marais, L

The paper is based on interviews with provincial government stakeholders in the Eastern Cape and Free State, with regards to the arid areas in their jurisdictions (Eastern Cape Karoo and southern Free State "False Karoo"). Documentary evidence (government policies, programmes and reports) were also consulted. The paper analyses the priorities and initiatives of key departments, including Departments of Agriculture, Economic Affairs, Land Affairs, Tourism, Housing, and Transport, as well as developmental agencies such as the Eastern Cape and Free State Development Corporations. The paper compares the policy and expenditure priorities between arid and non-arid areas. It argues that, in both cases, the arid areas receive insufficient policy attention. This is at least partly due to the National Spatial Development Perspective (NSDP), which encourages infrastructural investment only in areas of "economic potential". Neither of these provinces has identified sufficient economic potential in the arid areas, to encourage significant public spending. Consequently, despite some innovative local initiatives, there is a policy vacuum at provincial level regarding the future of development in the arid areas. Ironically, the high level of poverty in the southern Free State's Xhariep District may be the main incentive for future attention to arid areas in the Free State; in contrast, the Eastern Cape Karoo is regarded as relatively privileged (in comparison with the Transkei and Ciskei), and therefore does not share the same emotional appeal for future investment effort.

"Differing worlds: The Western and Eastern Cape Provincial Government views on arid areas, and prospects for future developmental integration"

Deidre van Rooyen and Doreen Atkinson

The Western and Northern Cape Provinces share a common heritage, because they derived from the erstwhile Cape Province. This paper is based on qualitative interviews with provincial and district government officials, as well as documentary research (government policies, programmes and reports). In the case of the Western Cape, the arid areas are regarded as a hinterland, far from the non-arid areas of economic potential. The Northern Cape does not have similar non-arid areas which can compete for policy attention. In the Western Cape, the Central Karoo area is selected as a Rural Development node, but it is largely because the Central Karoo is an economically deprived area. In the Northern Cape, the arid areas (Karoo, Namaqualand and Kalahari) are regarded as assets in their own right, with major economic potential, particularly in terms of tourism and agriculture. This reflects the fact that the economic development potential arid areas are not evaluated objectively; they are evaluated in the context of other provincial

development options. The rational response to this schizophrenic view of arid areas is to promote interprovincial collaboration, so that a more holistic perspective of the developmental potential of arid areas can be obtained. The paper makes suggestions for integrated, inter-provincial and inter-sectoral co-operation.

Session 6: Economics and Drought

Drought as an Economic Driver: Evidence from Agriculture in Arid Areas²

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Using a panel data approach, the economic sensitivity to changes in rainfall will be analysed for a selection of agriculture commodities in Namibia, Botswana, and six of South Africa's arid provinces from 1970.

This paper will provide an indication as to the elasticity (sensitivity) of the economic performance of the various agricultural commodities in the selected regions for changes in rainfall and other variables. In conducting this study it is anticipated that an answer will be given to the basic question of:

???% change in profit due to a 1% change in rainfall, by region and by product

This paper should identify both the region and the commodity most susceptible to changes in rainfall (with the focus on drought), and to what extent. This should enable policy-makers to formulate targeted drought relief responses in terms of the projected size of the relief, by region and by commodity based on the change in rainfall in a specific year.

Tourism as an Alternative Livelihood Strategy in the Succulent Karoo

Koelle, B. & Brandt, R.

Small Grants for Small Growers: Farmer Driven Mitigation against Land Degradation in the Cederberg

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Small-scale rooibos farmers experience land degradation in a number of ways, including desiccation from winds and sun, soil erosion and loss of fertility in production areas. Frequently they are unable to address the problems, seeing them as the natural consequences of land use and environmental change. State extension and technical services have generally not reached these farmers, and they have received little advice and no material support. Nevertheless, the Wupperthal Rooibos Association recognized that the problem should be addressed if they were to produce sustainably.

With support from the GEF Small Grants Program, EMG and Indigo have engaged with land users in the Wupperthal areas to assist them to analyse the land degradation problems that they experience, and to design measures that they are able to implement on their own, or with limited outside assistance. Farmers provide their own labour and equipment, and project funding provides additional labour and inputs that are not available in the area.

² Views expressed are those of the authors and not necessarily that of any institution they might be involved with.

Local problem owners have played a key role in developing and managing the project. A locally based Co-ordinator liaises with farmers and makes practical arrangements. Exchange visits to farmers in the Suid Bokkeveld who have experience in these approaches stimulated creative thinking and provided concrete examples of success. Formal training in ecological farming has further stimulated this. Although the project is in its early stages, initial results show a high level of enthusiasm and a greater understanding of the role of ecosystems in sustainable rooibos production.

Low-Income Housing Policy and Practice in Arid and Semi-Arid South Africa: Policy Lessons and Implications

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Post-apartheid housing research has focused primarily on the main urban areas of South Africa. This trend is not surprising, as these areas have probably borne the consequences of increasing urbanisation, as well as the historical legacy of influx control. However, this paper focuses on the question: To what degree is low-income housing policy relevant and applicable to the arid and semi-arid areas of South Africa? (Depending on the specific definition followed, approximately 45% of South Africa's surface can be classified as arid/semi-arid.) The paper is comprised of five sections. First, a literature review contextualises the changing paradigms in viewing arid areas, and identifies the socio-economic implications of drylands. Against this background, an overview of arid South Africa is provided, followed by an assessment of socio-economic research, low-income housing research and low-income housing practice in arid South Africa. It is concluded that there is very little understanding of the socio-economic implications of aridness for housing policy. Concepts such as remoteness, distance, variability and resource dependency have not been central to housing policy and practice in South Africa.

The Changing Role of Small Towns in an Arid Space Economy: A Case Study of the Eastern Cape Karoo, South Africa

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This paper is framed within the context of Marginalization literature which recognises that economic and environmental processes, as much as political and perceptual ones, marginalize regions both in absolute and relative terms. These considerations are regarded as being particularly appropriate in the context of South Africa's semi-arid interior. The Eastern Cape Karoo districts specifically are examined over a period of 100 years, using available data to establish the degree to which economic and demographic change does in fact indicate whether marginalisation is in fact taking place. Using agricultural, demographic and business data and focussing specifically on small towns, the paper details the nature of changes which have taken place. It is apparent that while pastoral output has declined, possibly in response to improved management practises, the amount of land grazed remains constant. In demographic terms while there has been rural depopulation, small service centres, by contrast, have grown significantly. In economic terms the larger regional centres are experiencing significant cumulative growth partially in response to the more central role they play in the region's economy and the commensurate contraction in the economic role played by smaller centres. A clear need exists to extend this research focus over the remainder of the Karoo to develop a more thorough profile of the nature of change over the last 100 years and its associated implications.

Session 7: Open Theme

Why and When do Livestock Keepers Move Their Stockposts in Namaqualand?

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The aim of this study was to examine why and when communal farmers move their stockposts around in the commons of Namaqualand. Data were collected through semi-structured interviews with livestock keepers from ten villages in the Leliefontein Communal Area. All stockposts used in the last ten years by approximately 200 herds in the study area were visited and their locations recorded with a GPS. All the water points used by the herds were also mapped and their conditions noted. Results show that both environmental and social factors are considered when stockposts are relocated. Environmental factors include temperature, seasonality, water, forage availability, toxic plants and croplands. Social factors considered include herder health, animal condition, overcrowding, conflict avoidance, stakeholder relationships and herder comfort. Stockpost movement due to environmental factors is mainly seasonal whereas movement due to social factors is irregular. In villages where dryland cropping is still practiced farmers move their stockpost during the ploughing period and return after harvesting. Livestock keepers in the highest parts of the commons move every winter down the mountain due to cold temperatures. Movement due to forage availability and water is opportunistic and mainly occur during the dry season. Avoidance of croplands and areas with high abundance of toxic plants by herders also occurs mostly during dry periods. Stockpost relocation due to social reasons occurs throughout the year but the time of movement differ between herds and villages.

Vegetation Change at a Climatic Ecotone Between Bushmanland Arid Grasslands and Namaqualand Shrublands as Determined Using Remote Sensing

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The Bushmanland/Namaqualand ecotone lies in the zone separating the dominantly summer rainfall Nama-Karoo and the predominantly winter rainfall Succulent Karoo biomes. The vegetation along the ecotone is characterised by communities of Bushmanland arid grasslands and Namaqualand shrublands. In this study, two independent change detection methods were used to investigate vegetation change at the ecotone. In the first method, a classification independent change detection method was applied to multitemporal Landsat TM and ETM acquired between 1986 and 2005 to detect spectral changes that are related to an increase or decrease in vegetation cover. This method derives change information by spectral thresholds and band ratios of bi-temporal difference images and modified selective Principal Component Analysis datasets independently from explicit vegetation maps as input information. In the second method, spectral properties of grasslands and shrublands at the ecotone were used in an image differencing change-detection technique, using the same datasets, to derive spectral changes reflecting vegetation shifts between grasslands and shrublands.

The results indicated that most of the detected areas of change were characterised by fluctuations in the direction of vegetation change, and only a small area showed signs of directional vegetation change. Where directional change was detected, it was related either to a decrease in general vegetation cover or to an increase in grass cover. High fluctuations that dominated the detected change areas indicate that the vegetation has been relatively stable in terms of directional change, but evidence of increasing grassiness is of significance to the ecotone, given the perceived climate change.

Long term monitoring of Rangelands in Namaqualand from 1999-2007

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This study was initiated in 1999 in the communal area of Paulshoek in semi arid Namaqualand. We used the process of rehabilitation to gain an understanding of the ecological factors that may be sustaining altered vegetation states on these rangelands. For eight years we have monitored the rangelands to answer the following questions. (a) Is rest alone sufficient to revert an altered landscape to a palatable shrubland? (b) Can this transition take place in a time frame that is suitable to landowners? (c) What biophysical manipulations are needed to ameliorate the condition of the rangelands? and (d) What has been the effects of these manipulations on the cover and composition of the vegetation? Our methodology involved monitoring of vegetation cover and composition in plots from which grazing was excluded, to study vegetation dynamics under ambient climatic conditions. Grazed and ungrazed vegetation adjacent to an exclusion fence was compared to assess the impact of grazing on vegetation dynamics. Biophysical manipulations such as microcatchments, brushpacks and vegetation clearing were revisited after eight years to evaluate their impact on vegetation cover and composition. We report on some of the results of these eight years and highlight some of the changes and patterns.

Vegetation Changes as a Result of the Control of *Prosopis* in the Nama-Karoo

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Prosopis spp. was introduced to South Africa from Mexico and South-western USA in the late 1800's for fodder, fuel and shade in the arid areas. Invasion of *Prosopis* into riverine areas started in the 60's and 70's to such an extent that it became impenetrable for livestock. In the Western Cape 420 000 ha are invaded, lowering the grazing capacity and biodiversity of the area. Working-for-Water and farmers are trying to control the invasion over a large area in the Karoo.

The objective of this paper is to show whether control of *Prosopis* leads to vegetation changes in grasses and shrubs in the under-storey.

The study was done from 2003-2007 on the farm Brandwag near Beaufort West in the Plaatdoorns river catchment area. The study site was divided into three 1 ha plots representing 3 treatments namely: trees cleared (controlled); Trees intact (uncontrolled); and veld without invasion (Veld). Each was subdivided into a grazed and ungrazed area. Species composition and plant density were measured annually in each sub-plot and % cover in 2004 and 2007.

In the Veld the species composition and density remains the same over the 5-year study period. Grasses with moderate grazing value remains the same in the controlled plots but decrease in the uncontrolled, with more than 14 plants.m⁻² in the ungrazed plots. Grasses with no grazing value increased with 8-12 plants.m⁻² in the grazed plots of the controlled and uncontrolled plots respectively. Only the Karoo shrubs with no grazing value show a decrease in density in all the plots, while the rest remain constant. The dominant species in the Veld plots are *Stipagrostis obtusa*, *Fingherhuthia africana* and *Aristida adscensionis* while only a few of the first two mentioned occurred in the controlled and uncontrolled plots where *A. adscensionis*, *Chloris virgata* and *Cynodon dactylon* were the dominant species. While the density and % cover changed in the treatments over the study period, few changes took place in the species composition, with the same species remaining dominant over the period. Five years are probably too short a period of time to see any significant changes.

Reconstructing Recruitment Events – the Case of *Aloe pillansii*

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Recruitment in arid regions is often dependant on extraordinary years, providing enough moisture through rain or fog to enable successful germination and establishment of a species. Based on their germination requirements and climatic conditions at a particular site, different species have varying recruitment intervals. If the spacing of recruitment events is too long, a species can not persist over a long time scale, even if established individuals could survive. Through climate change, especially with more dry and hot spells, certain species will go extinct as conditions for recruitment events are not occurring regular enough any more. Therefore it becomes more important to determine past recruitment events and intervals in order to detect changes in climate and to estimate their impact. Certain populations of *Aloe pillansii*, an endemic tree aloe regarded as a key stone species of the Richtersveld, a semi-desert region in northern South Africa and southern Namibia, show a lack of individuals of intermediate age, although recent recruitment is taking place. A number of reasons have been cited for the lack of this age class, among them climate change, grazing by life stock and poaching. As direct observations of the demography are impossible due to the longevity of the species, it becomes necessary to reconstruct the recruitment events from existing populations in order to judge the impacts of the above mentioned factors. In this paper, we will present a method used to reconstruct recruitment events for this species, and the advantages and disadvantages of this method.

The Response of Invertebrate Assemblages to Land use in a South African Semi-arid Region

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Historically, the Succulent Karoo has been under extensive livestock farming and cultivation. The land tenure system of the area resulted in privately owned farms having the recommended stocking rates and the communal areas which are severely overgrazed due to overstocking. Cultivation of fodder crops is also a common practice in the area and depending on availability of rainfall; the cultivated fields may be left fallow in dry years. We sampled the flying and ground-dwelling invertebrates using coloured pan traps and pitfalls from a recently cultivated field, heavily and lightly grazed areas, with the objective of determining changes in invertebrate composition and relating them to the vegetation changes. Line transects were used to sample the vegetation. Lightly grazed sites were dominated by succulent perennials while the heavily grazed and cultivated sites had a high percentage of annuals and unpalatable perennials such as *Galenia africana*. Insect morphospecies richness was highest at the heavily grazed sites while species diversity was highest at cultivated sites though these differences were not significant. Assemblages differed significantly between sites; with Cecidomyiidae, Acroceridae and Phoridae abundant in heavily grazed sites while Acroceridae in cultivated sites. The Termitidae were mostly abundant in lightly grazed areas; Lygaeidae and Carabidae in heavily grazed sites.

Increases in Numbers of Crows (Corvidae) Over Time in Semi-Arid South Africa: Landuse, Foraging Opportunities of Lack of Competition?

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Increases in distribution and abundance of certain bird species are not uncommon in southern Africa; examples include Hadedda Ibis *Bostrychia hagedash*, Rufous-chested Sparrowhawk *Accipiter rufiventris* and Acacia Pied Barbet *Tricholaema leucomelas*. Range expansions, and the reasons for them, vary from changes in landuse to decreases in the distribution of competitive species. Crows (Corvidae) are a group of species that are thought to have expanded ranges and increased in abundance within the last 100 years in South Africa. The increase in abundance has only been documented for one species, the Pied Crow *Corvus albus*, for which there is convincing evidence of increases in numbers within the last few decades at some localities. The expansion of range by this species, or expansions in range and increases in numbers by the other two southern African species, the Cape Crow *C. capensis* and White-necked Raven *C. albicollis* has not been as well-documented. Reports of range expansions by Cape Crow and Pied Crow are based on anecdotal reports and the fact that Cape Crows now nest in formerly treeless areas and Pied Crows benefit from human activities allowing them to move into areas from which they were formerly absent. No expansion of range for the White-necked Raven has been suggested; on the contrary the birds have disappeared from certain areas although numbers may have increased locally in other areas. This paper attempts to answer the question: "Have corvids increased in distribution range in semi-arid southern Africa, and if so, what are the likely causes of this expansion?" We addressed this question by comparing data collected on counts of birds, including crows, along roadsides in the Western and Northern Cape Provinces. We support these results with relative abundance notes on crows given in the historical literature and more recent local checklists published in the ornithological literature. We conclude with a brief discussion on the implications for an increase in the range and abundance of crows in semi-arid southern Africa.

Rodents and Rangelands: Is the Grass Always Greener on the Other Side of the Fence?

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Two land management practices, set apart by grazing intensity, were investigated. Small mammal assemblages were compared quarterly for 1-year across three fence-line contrasts using paired trapping grids. Species richness and diversity indexes were calculated for small mammals and vegetation within the communal and commercial treatments, high and low grazing intensities respectively. Species richness and diversity differed between rangelands but were not necessarily higher in sites with low grazing intensities. *Rhabdomys pumilio*, the only diurnal species, was exclusive to Remhoogte commercial rangeland, while *Elephantulus edwardii* and *Desmodillus auricularis* preferred communal rangelands. *Aethomys namaquensis* and *Mus minutoides* were found only on the commercial rangelands of Kuile and Kleinfontein, while *Gerbillurus paeba* and *Macroscelides probiscideus*, found on both rangeland types, preferred commercial rangelands.

Vegetation abundance was, in general, higher on commercial rangelands. However a shift during spring at all sites, and winter at Kleinfontein, was seen where it became more abundant on communal rangelands possibly owing to the higher occurrence of annual species during these periods. Vegetation was classified to life-form through using non-metric multidimensional scaling communal and commercial rangelands were identified as distinctly separate during all seasons, except winter where some degree of overlap between Remhoogte communal and Kleinfontein commercial sites was observed. A higher abundance of perennial grasses and annual shrubs characterised communal rangelands together with a higher rock cover and higher perennial shrub abundance during all seasons except summer and spring, respectively. While a higher abundance of perennial succulents characterised commercial rangelands. Vegetation structure will often determine species occupancy in specific habitat types. It may be possible

that commercial treatments, with their higher vegetation species richness, offered a larger quantity of vegetation which may bear preferred food items as well as offer more cover, which may in turn reduce diurnal and nocturnal predation.

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POSTER ABSTRACTS

Poster Session 1: Landuse

The Impact of Drought on Vegetation and the Relation to Climate Change in Limpopo - A Natural Phenomenon?

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The aim of the National Environmental Management Act (No. 107 of 1989), National Water Act (No. 36 of 1998), Conservation of Agricultural Resources Act (No. 43 of 1983) and the National Forests Act (No. 84 of 1998) is the protection and wise use of the country's natural resources. The sustainable utilization of natural resources is also acknowledged by the Constitution. South Africa, and the RSA, as a signatory to the National Convention of Desertification and Biodiversity Convention is committed to the sustainable use of natural resources and protection of biodiversity.

The impact of climate change has been advocated in all spheres of the scientists and general public. This led to the impression that climate change and veld degradation is the product of global warming, neglecting the impact of man on the natural resources prior to climate change. Visual and scientific assessments of the environment, which includes condition of riparian forests, agricultural and forestry development, impact of drought on natural vegetation, habitat degradation, impact of development on sensitive areas and resource utilization show that man has and continued to mismanage the resources resulting in it being less resilient during droughts and climate change impacts.

Data revealed that areas severely utilized are in poor condition and in many cases this is blamed on climate change. Other areas that have been managed according to sound principles in the same vegetation group are however, still productive even during droughts.

It can be concluded that land degradation in the Limpopo is highly active and occurs in aquatic and terrestrial ecosystems, with a resulting negative impact on plant communities and animal and human life. Although climate change will affect degraded areas to a larger extent, present land use practices need to be evaluated. Non-compliance of legislation is not taken seriously by departments or the private sector and in many instances people are unaware of practicing unsustainable management. An integrated approach is needed to promote cooperative sustainable management between all role players in Limpopo. Cooperative governance should include an awareness program, capacity building in government to execute their function to ensure sustainable development and compliance with legislation.

The Effect of Different Land-Use Practices on Rangeland Condition in Semi-Arid Western Rangelands of Southern Africa, with Special Reference to Soil Properties

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Rangeland degradation is particularly acute in the North-West Province, where all districts show signs of desertification, loss of biodiversity resulting in a deterioration of human and animal health. This has a major impact on rangeland and livestock productivity and the economic viability of livestock farming. Soil and vegetation quality is interdependent. Soil properties can influence vegetation through nutrient provision, soil water, soil temperature and soil biology cycles. Soil erosion is an important process and is largely influenced by soil properties such as organic carbon, exchangeable sodium percentage and clay mineralogy. It is also well known that species composition is influenced by soil properties. Plant dynamics on the other hand can influence soil properties, where, organic carbon can be depleted due to poor rangeland management. A trial, which falls within the Global Environmental Facility Desert Margins Programme (GEF-DMP), investigates to what extent vegetation (herbaceous production and quality,

species composition, bush counts and seed bed studies) in combination with ant communities can be used as indicators of ecosystem change due to human induced land-use patterns. The poster presents results from the trial, and focuses on the effects of commercial, tribal and conservation land-use practices within the semi-arid western rangelands of the NW Province on rangeland condition, with special reference to the soil properties. Surveys were performed in 72 sites, including benchmark exclosures. Sites, representing a degradation gradient (relative poor and relative good extremes) within each of 3 tribal-, 3 commercial (commercial beef ranching)- and 3 conservation areas were surveyed. Soil samples from beneath the dominant woody component, within each site, as well as from the "open" herbaceous area were collected, analysed and related to the vegetation and other environmental properties. Understanding and quantification of the mentioned soil-vegetation dynamics holds important implications for rangeland management. Information can be used in land degradation management and the conservation of biodiversity in the semi-arid western rangelands of Southern Africa. Because these arid rangelands are linked socio-ecological systems, it is essential to address the biophysical as well as the human dimensions.

Impact of Livestock on Vegetation Around Water Points in Namaqualand

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The aim of the study was to investigate the impact of livestock on vegetation cover and composition around water points in the Leliefontein Communal Area in Namaqualand. The impacts of watering points were investigated by measuring vegetation cover and composition along four transects (0-350m) per waterpoint for 18 numbers of watering points. Gradients of animal impacts known as piospheres tend to develop around artificial water points, particularly in semi-arid zones. The waterpoints were found in different habitats and had different histories of usage. Preliminary results indicate that vegetation cover decreases closer to the water point. Vegetation composition also changes along the grazing gradient. Annuals and unpalatable plants increase towards the water points and palatable species decreases towards the water point.

Forage Utilization and Impact by Goats (*Capra hircus*) in the Richtersveld, South Africa

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Herd management techniques in the Richtersveld are variable. During the dry season some herds make use of the riparian zone along the Orange River while others make use of the forage surrounding water points away from the river. The key resources available to the two distinct groups differ during the dry season, but during the wet season the distinction falls away. During wet months herds require less or no water and extensive pastures become available for grazing/browsing. The question at the centre of this study is whether the impact of the two herd groups (as defined above) on their wet season resource, differs or not? Due to the absence of fence line contrasts, methods used focus on differences in goat behavior and resource utilization.

Giving Up Density (GUD) trays were used to assess the herds perception of the forage available to them. A GUD measures the point at which foraging costs begin to exceed benefits; higher GUD's are associated with better forage, in other words the more utility a pasture has to offer the faster goat herds are inclined to stop feeding from the GUD trays.

Herds were tracked for the first hour of the day and the speed between marked points along the trail was calculated. Forage decisions were recorded every 10 minutes for 5 goats by identifying the plants on which they fed and the 5 closest plants to the foraged plant.

Preliminary results indicate that some pastures provide goats with forage of greater utility than others. This division is not clear cut between herds that utilize the river and those that do not. The speed and variation in speed attained by herds varies substantially. Herds that have been based at a stockpost for a long time demonstrate the most variability in speed for the first hour of the day. Plant selection varies between herds and pastures. Most of this variation is

explained by what is available, although some plants available to all herds are only fed on by those using "inferior" pastures. Data collection is incomplete at time of abstract submission.

Veld Management Guidelines to Emerging and Commercial Stock Farmers of the Karoo

Cupido, C., Visser, N., Botha, J.C., du Plessis, C. & Dyason, A.

The Influence of Rainfall Verses Grazing on Primary Productivity, Composition and Diversity of Annual-Dominated Vegetation in Richtersveld National Park

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The Richtersveld National Park is located in an arid winter rainfall area with high inter-annual rainfall variability (mean annual rainfall is 80 mm with a C.V > 45%) and is thus predicted to exhibit non-equilibrium vegetation dynamics. Grazing is thought to have minimal effect on vegetation in non-equilibrium systems as they are driven primarily by stochastic abiotic factors such as rainfall. The aim of this study was to test whether biomass production and plant species composition, richness and diversity of annual-dominated vegetation are driven primarily by rainfall or grazing. Other environmental variables such as landscape (plains vs. foothills), rockiness and soil texture were also included. We used a grazing gradient away from stock posts at 100m, 500m and 1000m and rainfall data for 5 study sites in July and September 2006. Canonical Correspondence Analysis (CCA) showed that rainfall had an overriding influence on plant species composition, reflecting differences between sites, but there are also trends with distance from stock post, soil texture and rockiness. Biomass production was found to be strongly correlated with rainfall but not significantly affected by distance from stock posts. Plant species richness and diversity were higher at wetter sites but declined significantly with distance from stock posts, and this gradient was steeper on plains than on the rockier foothills. The data show that while biomass production is strongly driven by rainfall, as predicted by non-equilibrium theory, the composition and diversity of annual plants is significantly altered by grazing which is contrary to the predictions of non-equilibrium theory.

The Effect of Different Land-Use Practices on Woody Species Composition, Density and Structure of a Semi-Arid Rangeland in Southern Africa – Implications for Land Degradation and Biodiversity Management

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Rangeland degradation, especially bush encroachment and soil erosion, is particularly acute in the North-West Province, where all districts show signs of desertification and loss of biodiversity. This has a major impact on game and livestock productivity and the economic viability with serious consequences for the livelihoods of communities dependent on these resources. An increase in woody plant density beyond a critical density causes the suppression of herbaceous plants, mainly through severe competition for available soil moisture, resulting in lower herbaceous yields and thus lowering the grazing capacity. It often accentuates the effects of droughts and often gives rise to pseudo-droughts (fodder shortages during normal or dry years). Research, however, has shown that woody plants form an essential component of certain savanna systems and total clearing can be detrimental to the production potential of such areas. The natural savanna vegetation of Africa evolved in the presence of multiple species of herbivores with a wide range of diet preferences, making it reasonable to assume that these herbivores and vegetation were in a dynamic balance, with both the herbaceous and woody components being utilised. Consequently the removal of browser ungulates may have contributed to bush encroachment. A trial, which falls within the Global Environmental Facility Desert Margins Programme (GEF-DMP), investigates to what extent vegetation (herbaceous production, quality, and species composition bush counts and seed bank studies) and soil in combination with ant communities can be used as indicators of ecosystem change due to human induced land-use

patterns and how this information can be used in land degradation management and the conservation of biodiversity in the semi-arid western rangelands of Southern Africa. The woody component was surveyed to establish whether it reflects a rangeland degradation gradient across the larger study area, or whether patterns were isolated to certain land uses. Woody compositional patterns were also related to soil and herbaceous species composition data, and to ant compositional data to establish possible congruent patterns within and between these biotic and abiotic parameters pertaining to the rangeland condition, land use type and the diversity indices. Surveys were performed within 72 sites (including benchmark exclosures) within commercial, tribal and conservation land-use practices within the Molopo rangelands of the NW Province. Sites, representing a degradation gradient (relative poor and relative good extremes) within each of 3 tribal, 3 commercial (commercial beef ranching) and 3 conservation areas were surveyed. Bush density and woody species composition were expressed in terms of TE/ha, area cover/ha, number of individuals/species within each site and woody structural form of each species within each land use. Results from the study showed that the woody diversity indices could be considered as indicators of environmental changes (e.g. habitat modification), rather than indicators of biodiversity. Results from this study suggests monitoring and management practices should recognise the spatial variability of these semi-arid rangelands before widely extrapolating woody control strategies across different land uses. A "Key assessment matrix" as an adaptive management tool was compiled.

Biodiversity the Treasure of the Paulshoek Communal Land

Lot¹, (M.) J. & Schmiedel, U. ²

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Biocentre Klein Flottbek, University of Hamburg, Ohnhorststrasse 18, 22609 Hamburg / Germany

The poster will present the various aspects of the diversity of species and habitats in the Paulshoek Commonage in the Kamiesberg mountains / Namaqualand.

Paulshoek as a site with a long-lasting history of natural science research is renowned for its very high biodiversity which has been analysed and discussed in various scientific publications. The poster will show another view on the biodiversity of Paulshoek: the perspective of the land users presented by the BIOTA para-ecologist at Paulshoek.

The natural environment in general and biodiversity in particular form an important base for the everyday's life of the local land users: Natural resources are used as fodder for the domestic animals, building material, fire wood and medicinal purposes but also the mere beauty of the landscape and the plants and animals are appreciated. The poster will give an overview on the different aspects.

Land Degradation Mapping for Modelling of Ecosystem Benefit Flows in the Inkomati Catchment Using Remote Sensing

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The Inkomati catchment straddles South Africa's border with Mozambique and encompasses land with intense competition from land uses such as plantation agriculture, subsistence farming, irrigated commercial farming, rural and urban settlement, as well as nature conservation as part of the southern zone of Kruger National Park. Severe land degradation has occurred here due to high human concentrations in parts of the catchment, particularly the former homeland areas of Kangwane.

Remote sensing techniques have been used to map the degradation in supplement to degradation mapping undertaken by the National Land Cover (NLC) 2000 project, as input to a project in the Ecosystem Earth Observation research group of the Council for Scientific and Industrial Research (CSIR). The overarching aim of the project is to

model ecosystem benefits and their flows, with degraded areas playing an obvious role in defining ecosystems benefits.

Four full scene digital Landsat ETM+ images (28 April and 25 May 2001) covering the catchment were used. The images were georectified and atmospherically corrected using ATCOR 3 software, to provide general spectral comparability of the scenes by converting DN values to reflectance values and to eliminate sensor inherent, bi-directional reflectance distribution function (BRDF), atmospheric effects and illumination effects at mountainous areas. Human-altered land use categories (cultivation, plantation, urban and mining) from the NLC 2000 map of the area were masked out from the respective image scenes, enabling the degradation mapping to focus on natural land cover categories. Vegetation removal was taken as indicative of degradation. An albedo model was constructed so as to highlight highly reflective (e.g., vegetation bare equals high albedo) pixels as a supplement to NDVI computation, the results of which were submitted to pixel aggregation procedures involving a combination of digital number thresholding and image classification. Results were then validated in the field using randomly generated pixel locations. Although naturally highly reflective features such as bare rocks, dry grass and dry river beds introduced error in the degradation mapping, the outcomes were a significant improvement to the degradation mapping for the area undertaken by the NLC 2000 project. The results will be presented at the conference.

Alternative Forms of Sanitation and Energy in Low-Income Housing Projects: The Case of the Hull Street Project in Kimberley

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Three factors have influenced the type of waterborne sanitation systems in the world and more specifically so in arid areas, namely the scarcity of water, global warming, and the emphasis on sustainable development. Mainstream sanitation systems do use large quantities of water but has serious ecological footprints if they are not managed well. Alternative forms of sanitation have been introduced to reduce the pressure on water and in the process to shift management to individuals. Yet, its social acceptability has been limited. The case study in Kimberley confirms that the social acceptability of alternative forms of sanitation is extremely low. The poster will outline both the approach in Kimberley as well as the problems that are being experienced.

Bokkeveld Stewardship Project - Creating Biodiversity Corridors to Combat Climate Change

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Botanical Society Conservation Unit: Bokkeveld Stewardship Project, P.O. Box 142, Nieuwoudtville, 8180, South Africa

Off reserve conservation, involving commitment from private landowners, has been identified as crucial if national biodiversity conservation targets are to be achieved. Stewardship aims to encourage private landowners to place more focus on biodiversity conservation and sustainable utilisation, ensure long term commitment to conservation and to significantly expand the protected area network across all the biomes in South Africa. The development of off reserve conservation, under the umbrella of biodiversity stewardship is a nationally mandate for all Provinces. Off reserve conservation is included in the Sector Plan for the Environmental Sector (2007-2012 - Department of Environment and Tourism). The Biodiversity Stewardship South Africa Project (under the auspices of DEAT) is developing a generic, simple, but effective stewardship model for the provincial authorities and conservation agencies (including NGOs). Once all provinces begin to consider and implement off reserve conservation, through interactions with private landowners, this will significantly expand the effective protected area network across the landscape, in all biomes of South Africa. Planning this protected area network is crucial in ensuring that corridors of natural vegetation are secured into perpetuity. These natural corridors serve as "highways" for plant and animal specie movement in response to climate change. The Northern Cape is currently third, as far as progress in implementing a stewardship program in the provinces, to date. The Bokkeveld Stewardship Project, which is a collaboration between the Botanical Society and DTEC (Department of Tourism, Environment and Conservation) is a two year pilot project mandated with developing the structure and process to deal with stewardship in the Northern Cape, within DTEC. The project is focusing on the Bokkeveld Plateau, a global biodiversity hot spot and identified by CAPE and SKEP as a priority area.

Successes of the project to date include interaction with the Government departments, the creation of an additional post and uptake of a stewardship facilitator by DTEC and the initiation of improved communication between departments. Challenges have included implementing effective communication to all levels of the Government departments and across the vast expanse of the Northern Cape. It is the aim of the project to identify the challenges and priorities which are reality to DTEC and to ensure that a stewardship framework/programme complements and assists in achieving current goals.

Poster Session 2a: Rehabilitation

Vegetation Changes as a Result of the Control of Prosopis in the Nama-Karoo

N. Saayman & J.C. Botha

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Prosopis spp. was introduced to South Africa from Mexico and South-western USA in the late 1800's for fodder, fuel and shade in the arid areas. Invasion of *Prosopis* into riverine areas started in the 60's and 70's to such an extent that it became impenetrable for livestock. In the Western Cape 420 000 ha are invaded, lowering the grazing capacity and biodiversity of the area. Working-for-Water and farmers are trying to control the invasion over a large area in the Karoo.

The objective of this paper is to show whether control of *Prosopis* leads to vegetation changes in grasses and shrubs in the under-storey.

The study was done from 2003-2007 on the farm Brandwag near Beaufort West in the Plaatdoorns river catchment area. The study site was divided into three 1 ha plots representing 3 treatments namely: trees cleared (controlled); Trees intact (uncontrolled); and veld without invasion (Veld). Each was subdivided into a grazed and ungrazed area. Species composition and plant density were measured annually in each sub-plot and % cover in 2004 and 2007.

In the Veld the species composition and density remains the same over the 5-year study period. Grasses with moderate grazing value remains the same in the controlled plots but decrease in the uncontrolled, with more than 14 plants.m⁻² in the ungrazed plots. Grasses with no grazing value increased with 8-12 plants.m⁻² in the grazed plots of the controlled and uncontrolled plots respectively. Only the Karoo shrubs with no grazing value show a decrease in density in all the plots, while the rest remain constant. The dominant species in the Veld plots are *Stipagrostis obtusa*, *Fingherhuthia africana* and *Aristida adscensionis* while only a few of the first two mentioned occurred in the controlled and uncontrolled plots where *A. adscensionis*, *Chloris virgata* and *Cynodon dactylon* were the dominant species. While the density and % cover changed in the treatments over the study period, few changes took place in the species composition, with the same species remaining dominant over the period. Five years are probably too short a period of time to see any significant changes.

Rehabilitating Riverine Habitat in the Central Upper Karoo

P Botha

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Rehabilitation of degraded and eroded riverine habitat is crucial for the survival of South Africa's critically endangered and highly specialised Lagomorph, the Riverine Rabbit (*Bunolagus monticularis*). This rehabilitation project is concerned with improving Riverine Rabbit habitat connectivity through the re-establishment of natural vegetation cover. The Karoo is vulnerable to several land use pressures, particularly overgrazing, ostrich farming, mining and the illegal collection of plants and animals for trade, not to mention the expected impact of climate change on the region's biodiversity. The climate is harsh, droughts are common, and seasonal and daily temperatures fluctuate considerably. Degradation in the Central Upper Karoo is characterized by large bare and denuded areas and as these areas recover very slowly through natural succession processes, some sort of active intervention has become

necessary in order to avoid aridification and possibly also desertification. Many of the highly degraded and heavily eroded areas occur along the river courses where *Bunolagus* occurs. These river courses together with the riparian zones have an important biodiversity function as well as an economic value in the Karoo. The denser structures of vegetation are high in productivity and are extremely important refuges for many animal species. The goal is to improve the natural system to a good working order by re-vegetating degraded and eroded areas, and slowing down the process of erosion. To re-vegetate the areas, rehabilitation nurseries will be established in order to provide the necessary indigenous vegetation, seeds and seedlings. Through this project the Endangered Wildlife Trust's Riverine Rabbit Working Group will provide jobs and skills to the local community and build capacity amongst them. The success of this project depends on the involvement of all relevant stakeholders, especially the land owners, to create a high level of awareness of the importance of rehabilitation. They will have to be convinced that the perceived benefits of the rehabilitation work will be to their advantage and therefore deserving of their support. Aside from the benefits to the landowner, the communities and river hydrology, the implementation of the rehabilitation project will definitely improve the connectivity between the remaining patches of *Bunolagus* habitat.

Wiza Wetu! – Our Forest!

Mukuya, Robert S. & Pröpper, Michael

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This poster will present the *ethnographic awareness film* "Wiza Wetu! – Our Forest" which depicts the problem of illegal logging in the Kavango Region in Northeast Namibia. The film will be screened twice at AZEF 2007. Today the Kavango is one of the few remaining forest resources of a country that is confronted with the problem of increasing desertification. Deforestation in Kavango is mainly caused through illegal logging, human caused fires, and agricultural clearing.

The film focuses on the problem of *illegal logging* as exemplary for a complex situation. In Kavango large parts of the population depend on subsistence use of resources on communal land. Poverty, high transaction costs and lack of education have to be considered as important factors contributing to exploitative behaviour. The fact that logging targets valuable trees that are irreplaceable due to their long growing period makes these activities a severe environmental problem in the region.

The film's main intended audience are the rural people of the Kavango Region as well as various local stakeholders. In order to avoid further environmental damage the film aims at raising awareness for the value of natural resources and initiating a discussion on a local and trans-local level. Potentially it can contribute to a change of perceptions and attitudes towards us of biodiversity.

The film assesses the situation of landusers who practise logging, investigates backgrounds and presents exemplary community-based forestry projects initiated by the Namibian Authorities (Directorate of Forestry) and the German development organisation DED. It consists of documentary footage, re-enacted parts as well as interviews with relevant experts and most importantly local people: villagers who have to suffer from environmental degradation; labourers who have been risking prosecution for a minimal amount of money; participants of successful projects, and traditional authorities. The film has been achieved within the interdisciplinary research project BIOTA (www.biota-africa.org). A central feature of the film is the narrator: the Para-Ecologist of the BIOTA Project investigates the problem and travels to all the settings and places which are documented in the film. The documentary has a length of 52 minutes and is produced in Rukwangali with English subtitles.

Vegetative Propagation of Some Karoo Shrubs

Malan P.J.

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Rooting of plant material is generally used for mass production of plant species that usually have poor seed germination or for the production of clones of selected individual plants of the same species. This trial was a pilot trial to test the ability of vegetative propagation, through stem cuttings, of some Karoo shrub species. Genetically identical plants were needed for a larger project. Plant material were collected during autumn at Grootfontein Agricultural Development Institute in the False Upper Karoo and included the following species: *Tripteris sinuata* (Geelbietou), *Salsola calluna* (Swartganna), *Limeum aethiopicum* (Koggelmandervoetkaroo), *Nenax microphylla* (Daggapit), *Plinthus karoicus* (Silver karoo), *Hermannia cuneifolia* var *glabrescens* (Geelpleisterbos), *Phymaspemum parvifolium* (Witblommetjie), *Pentzia incana* (Ankerkaroo), *Eriocephalus ericoides* (Kapokbos) and *Walafrida saxatilis* (Pypsteelbossie). Stem cuttings were treated with three hormonal regimes: 0 g/kg (T1), 1 g/kg (T2) and 3 g/kg (T3) IBA [4-(indol-3-yl)-butyric acid]. Treated cuttings were placed in two growth media (filter sand and hygro seedling mix) in a mistbed for one month. No significant differences were found between the two growth media. For the more woody species T3 had the best rooting, while T1 generally showed the best rooting. Only *Nenax microphylla* (76%) and *Pentzia incana* (71%), rooted very well while *Limeum aethiopicum* and *Salsola calluna* showed no rooting at all. Rooting of the other six species varied from 13% to 18%. Rooting of *Nenax microphylla* and *Pentzia incana* was satisfactory, but might even be increased with further refinement of the rooting procedure. As this trial was conducted during the autumn, its repetition during the other three seasons might show different results. It is therefore recommended to repeat this during the other seasons, while the Karoo shrubs are in different phenological stages.

Poster Session 2b: Monitoring

Patterns of Plant Biomass in Namibia

Mtleni, V., Isaacks, R., & Strohbach, B.

An Invasive Alien Plant Road Count as a Useful Monitoring Tool: A Proposal and Some Preliminary Results

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Namibia has a relatively modest invasive alien plant problem. Unfortunately, this has led to a perception that the status quo will remain. Recent research initiatives and the rapid rate of development in the country, suggest that the situation will change, and that early detection and control could be the most cost effective strategy for Namibia to follow.

In this context, an invasive alien plant road count form was devised, and then tested on a 600 km stretch of a major north south road in Namibia in 2006. The form was easy to use and generated a large amount of useful information rapidly, including relative measures of density of different species, frequency, species richness and the discovery of two naturalised species previously deemed unlikely to be invasive in Namibia (*Jacaranda mimosifolia* and *Caesalpinia gilliesii*). Altogether, 17 species were recorded. Although data analysis is still underway, species richness and frequency measures of invasive alien plants was highest in the relatively high rainfall area between Otavi and Grootfontein, which also supports a high level of intensive agriculture. The Karst Savanna, a unique endemic rich vegetation type currently without formal protected areas, occurs here. *Prosopis glandulosa* had the highest frequency (number of kilometre stretches recorded), but almost exclusively within 100 km of Windhoek. A low species richness and frequency was recorded in the woodlands on dystrophic sands in the Kavango, presumably due to low soil fertility

and the previously limited developments occurring in the area. Recent agroforestry and biodiesel initiatives in the region are changing this situation, particularly along rivercourses.

An Invasive Alien Plant road count programme could be used in conjunction with a more conventional invasive plant atlas programme to serve as an early warning system for detecting newly naturalised plants. This information could be used to influence decision makers of the value of an explicit policy regarding invasive alien plants.

We propose the introduction of this programme, in conjunction with other forms of monitoring and mapping. The repeatability and sensitivity of the system for change detection has not been tested yet.

Islanders in the desert: Arboreal insect diversity on *Acacia*

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Arbodiversity was investigated along a W-E aridity gradient in Namibia for three tree species: *Acacia erioloba*, *A. tortilis* and *Faidherbia albida*. The objectives are:

- To compare the entomological diversity found on each of the 3 selected tree species.
- To determine the possible population changes associated with these trees caused by increased aridity, and
- To investigate the effect of seasonal climatic changes on the diversity associated with each tree species.

Sampling was undertaken along the ephemeral Omaruru River. The river runs for 330 km in an east-west direction with a catchment area of 13 100 km². Sampling was done from May 2004 until March 2005 on a bi-monthly basis. The sampling sites are as follows: Otjikoko Hunting farm (300-350 mm); Omaruru town area (250-300 mm); Okombahe town area (200-250 mm); 50 Km SE of Uis town (NeiNeis) (100-150 mm) and 5 km down river of Omdel Dam (50-100 mm).

Fogging was carried out at dawn using a Pyrethroid insecticide. Between sampling regimes the material was identified and sorted into Orders, and within selected groups to families and genera, before counting all individuals. Identification was only done on morphic level (Relative Taxonomic Units or RTU). Rainfall was also recorded at each station and Data loggers recorded temperature and humidity.

A total of ± 380 000 insects (also including some Arachnida) were collected. Although RTU diversity has not yet been determined for all Orders, it appears that diversity follows a rainfall gradient, and that humidity is also important as diversity increased in the fog-zone, against the rainfall aridity gradient. Abundance follows the same trend.

Of the orders grouped into RTU's, including Coleoptera, Hemiptera, Mantodea and Orthoptera *A. tortilis* supported higher diversity and population densities than *A. erioloba*.

The final identification and analysis of data is still to be completed.

***Prosopis* Invasion in Selected Sites in the Molopo District – The Effect on Soil Quality**

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The encroachment of *Prosopis* species into grasslands and savannas has significant socio-economic and environmental impacts on lands that have been predominantly used for livestock grazing. *Prosopis* species is among the 25 top invading species in South Africa. Invasion of *Prosopis* and its effect on grass species development was

studied in Phitsane in the Molopo District (North West Province) and compared to two reference sites (benchmark sites), one in a communal area and the other on a commercially managed farm. The encroached study area has a significantly higher ($p > 0.02$) woody species density than both benchmark sites. Woody species in the study area recorded a density of 7 831TE/ha, compared to the 1 184TE/ha and 2 193TE/ha in benchmarks 1 and 2 respectively. Nutrient enrichment of the soil is also evident. Virtually all nutrients are significantly higher ($p > 0.02$) in the soils of the study area, compared to the benchmark sites.

Patterns of Plant Diversity in the Hantam-Tanqua-Roggeveld

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The Succulent Karoo Hotspot stretches along the southwestern side of South Africa and Namibia. A lack of botanical information on the Hantam-Tanqua-Roggeveld subregion of the Succulent Karoo was identified during the SKEP (Succulent Karoo Ecosystem Plan) process. A grant from CEPF (Critical Ecosystem Partnership Fund) enabled a study to collect baseline botanical data in the subregion.

Forty plots were surveyed in the spring of 2005 using the Whittaker's plant diversity plot technique to gather biodiversity data for the Hantam, Tanqua and Roggeveld areas. Seven plot sizes (1 m², 5 m², 10 m², 20 m², 50 m², 100 m² and 1000 m²) were used to construct species-area curves for each of the plots sampled using three different models namely: the untransformed linear function, the power function and the exponential function.

Generally, the power and exponential functions produced a more significant fit to the data than the untransformed linear function. The exponential and untransformed linear functions produced similar slopes for the Mountain Renosterveld and Winter Rainfall Karoo vegetation which were significantly higher than the slopes of the Tanqua Karoo vegetation. The slopes of the power function did not differ significantly across the three vegetation associations.

To illustrate the patterns of plant diversity in the Hantam/Tanqua/Roggeveld subregion a transect across the three broad vegetation associations is used. The transect stretches eastwards from the Tanqua Karoo vegetation through the Winter Rainfall Karoo vegetation into the Mountain Renosterveld vegetation and again into the Winter Rainfall Karoo vegetation bordering the summer rainfall Nama Karoo Biome. Each vegetation association produced its own species-area curve characteristics as well as species richness values.

Evaluating Land Capability of Yekkeh Chenar Maraveh Tappeh for Range Application Using ERAMS Model& GIS

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Land destruction in arid areas is a common phenomenon that influence world rangelands. Utilization in a wrong way of ranges and nonsuitable handling with landcapability of ranges in using of these lands can cause land destruction. It is obvious to avoiding damage of environmental resourceses be in harmony with natural and use the natural potential of land in logical way. To have both sustainable development and optimum use factor from environment, we need to evaluating its development capability. In this studing our target is to present a suitable model in ranges evaluating. We choose Yekkeh Chenar Maraveh tappeh's area ranges and try to find a suitable model for this area and collect

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necessary information for this model from available sources and complete it with field studies. In this study to assign range application, we use (ERAMS) model between various evaluating land capability models. This model includes 4 parameters: Slope, Soil salinity, Soil depth and Rainfall. This model presents suitable range land application for each land with using these 4 parameters. It is prepared map of Slope, Soil salinity, Soil depth and isohyet and compose of all these maps each other by overlay method to get the final land capability map. It is used cross tabulation to assign agreement values. According to the results Kappa index of agreement value it is calculated 41%. That means (ERAMS) model ables to assign the potential changes of area with 41% accuracy. At the next level that we entered changes in rainfall classification, KAPA index of agreement value be calculated 43%. That means this method can assign the high density vegetation areas. So this model is recommended to use at vast and high density vegetation areas.

The Development of a Uniform Ecological Survey Methodology for a National Fixed Point Monitoring System

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The National Department of Agriculture (DoA) is in the process of implementing a national fixed point monitoring programme for South Africa. The monitoring programme will be employed at 2000 survey points, randomly stratified according to land use, land capability and site homogeneity, within all biomes of South Africa. The monitoring programme emphasizes the state of natural resources in terms of soil-resource and rangelands to set a benchmark for resource assessment studies. The Agricultural Research Council (ARC) in collaboration with the North West University has been tasked to develop an ecological sampling methodology for the fixed point monitoring programme. The sampling methodology must be supportive of the objectives of the monitoring programme which are to:

- Provide a national statement on the natural resources important to agriculture.
- Provide a spatially representative dataset suitable for the calibration and verification of coarse resolution satellite derived models.

Methodologies for major structural classes (herbaceous/woody) will be developed to ensure intra-comparable analysis over biomes. The methodologies will have to provide quantitative data on cover, abundance and structure for the calibration and verification of spatial models using coarse resolution satellite imagery. Due to the extent and nature of the programme the survey methodology must be cost and time effective and easily applicable. The ArcPad input application as part of a computerized field survey database, previously developed by the ARC will also be evaluated. A review of existing vegetation survey methodologies developed by rangeland scientists and experts in the different biomes, locally and internationally, will form the basis of the newly developed methodology. Workshops and on-site practical applications, together with local ecologists, will be carried out in all biomes for the testing and verification of the methodology.

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