Ecological Interactions in Rangelands

SESSION CHAIR: BEANÉLRI B JANECKE

Thursday, 22 July 2010, 11:00-12:10

Platform & Poster Presentations

POSTER PRESENTATION: PROGRESS ON THE NATIONAL RANGELAND MONITORING AND IMPROVEMENT PROGRAMME

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The National Rangeland Monitoring and Improvement Programme (NRMIP) was established by the Department of Agriculture, Forestry and Fisheries with the objectives of ensuring that current land use is sustainable. The programme was implemented by the Agricultural Research Council to measure the nature, direction and magnitude of change in water and soils, forage production and biodiversity, as well as the likely drivers of change. The monitoring results should inform management and policy interventions. Range monitoring programmes often overlap with similar programmes conducted at regional level by other institutions; therefore, a key strategy of the project has been the collaboration with institutions such as provincial agriculture departments.

The programme has been conducted as a series of smaller, regional projects with specific objectives. In East Griqualand, 72 historical sites were resurveyed. In the Western Cape, the programme assisted the Western Cape Department of Agriculture to survey 36 new sites for determining grazing capacity. In the Northern Cape, the programme assisted an ARC project to survey a number of sites in Namaqualand. In the moist grasslands, the NRMIP surveyed 32 sites as part of a soil carbon sequestration research project and 6 farms as part of a sustainable veld management pilot project. Long-term grazing trials in Kokstad were surveyed in 2008 and 2009, with more detailed data collected in addition to the routine surveys.

A number of surveys have been conducted to compare the suitability of different vegetation monitoring techniques, in particular focussing on operator effect. Twenty-five sites were surveyed on a transect from Pinetown to Harrismith as part of a pilot survey for a future national monitoring project.

Two team members are permanently stationed in the Lowveld as part of a long-term monitoring programme on the game farms and nature reserves in the region, as well as monitoring mine rehabilitation. The team now consists of twelve skilled technicians with experience in various biomes. Several research projects have been completed or are under way, and results have been reported at Congresses or are in preparation for publication.

A key strategy of the programme has been to involve land-users; however, better land-user involvement is needed for the programme to expand and the project will explore several successful options demonstrated by other, local-level monitoring across the sub-continent. If the programme is to continue to grow, it must complement other, similar projects; it must collaborate with related institutions; and it must help to empower land-users in the management of rangelands.

NOTES:

POSTER PRESENTATION: MEASURING EVAPOTRANSPIRATION IN GRASSLANDS OF THE EASTERN CAPE USING THE OPEN TOP CHAMBER

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South Africa will continue to experience a major water shortage, with currently only 500 – 1000 m^3 of water available per person per year. In the Eastern Cape, catchments that supply water are grasslands that are often inappropriately managed by the communities that inhabit them, leading to overgrazing, soil erosion and invasion of alien plants. This results in changes in evapotranspiration rates which affect the amount of water available to run-off and recharge of groundwater. This study aims to find ways of improving the run-off and recharge estimates within selected catchments of the Eastern Cape by measuring the mean annual evapotranspiration using the MODIS leaf area index (LAI) product as input into the Penman-Monteith equation.

These estimates are ground-truthed with a range of instruments for measuring evapotranspiration, including the open top chamber (OTC). The chamber is designed to be portable, consisting of a lower cylindrical base and a conical top (d=0.77 m, h=2.0 m, v=0.78 m^3). Ambient air is pumped into the bottom of the chamber, with an exit pipe at the top of the cone. The exit pipe has a vent for instruments that measure the temperature, wind speed and relative humidity. An in-line valve allows the rate of air entering the chamber to be adjusted. A 12 volt 100 Amp hour battery is used to power the chamber.

Two test sites were selected in natural grassland in the commonage surrounding Grahamstown, one representing high biomass state and the other low biomass state. At each site, the OTC was set up on several clear, sunny days during the growing season of 2009/2010. All measurements were taken using a Kestrel 3000 vane anemometer at 30 minutes intervals from around 9 am to 3 pm. The dew point was measured for air entering and leaving the chamber and transpiration was calculated using the wind speed, relative humidity and temperature which were measured at the inlet and the outlet of the chamber. The evapotranspiration results obtained from the OTC were negative on all occasions for both sites. This could be attributable to the fact that accurate measurement of dew point requires a more sensitive instrument than the Kestrel 3000. The prevailing dry conditions could also have contributed to the negative results. Further improvement in the quality of instrumentation is planned.

NOTES:

PLATFORM PRESENTATION: PROFITABLE CONSERVATION FARMING (EXTENSIVE ANIMAL PRODUCTION) - EASIER SAID THAN DONE!

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The main aim of this paper is to demonstrate to researchers involved in rangeland management research how complex the practical adoption of research results can get in a real world situation where sustainability of conservation management actions are often determined by financial sustainability.

The success of rangeland management strategies as interpreted by rangeland researchers are often determined by its ability to maximize the production of palatable, accessible fodder on a long term sustainable basis. The main indicators of success in conservation farming are often determined in terms of its ability to maintain or improve rangeland condition. Rangeland in a good condition is often described as rangeland with a high abundance of highly productive, accessible and palatable plant species.

When animal production is compared to "rangeland condition" indices, it often leads to poor correlations and anomalies that are very difficult to explain in the absence of factors that determine animal productivity and well being. The poor and/or incorrect adoption of rangeland research results are often the result of a lack of understanding of the complex interaction between rangeland management variables (animal numbers, type of animals, movement and distribution of animals) on the one hand and variables determining animal performance and production (quality and quantity of diet on offer, animal behavior and experience, spatial distribution of nutrients that affect the general health of animals, pollution of fodder by animal impact, soil-plant-micro-temperature interactions and variables affecting bite size, total intake and quality of diet) on the other hand.

The chances for any conservation farming strategy to gain large scale acceptance amongst farmers is heavily dependent on its ability to improve animal production and profits simultaneous with the improvement of the natural resource. If improved rangeland condition doesn't lead to improved animal production and profits, it will never be an economical sustainable alternative. Profitable, sustainable conservation farming is characterized by the following components:

- Higher plant production with the emphasis on "protein production" (kg protein ha^{-1} 100 mm^{-1} rainfall).
- High voluntary utilization efficiency by animals (as complete as possible utilization of the ecosystem with as little as possible animal stress); (kilogram plants utilized as a percentage of total ecosystem plant production).
- High rainfall utilization efficiency (kilogram marketable meat produced per hectare per 100 mm rainfall).
- Management strategies for optimized plant production and optimized animal production to be separated in time and space.
- Increased carrying capacities to be followed with higher animal numbers, otherwise there is poor utilization efficiency.
- As little as possible investment into infrastructure with as complete as possible utilization of the ecosystem.

This paper illustrates the "holistic playground" that rangeland researchers need to understand to enable the development of profitable, practical and ecological sustainable rangeland utilization models.

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POSTER PRESENTATION: THE DETERMINATION OF RELATIONSHIPS BETWEEN GULLY CHARACTERISTICS AND ENVIRONMENTAL FACTORS USING GIS AND REMOTE SENSING IN THE ZHULUBE MESO-CATCHMENT OF ZIMBABWE

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The study focused on determining the accuracy of remote sensing and geographical information systems (GIS) techniques in gully identification and testing the relationships between gully characteristics and environmental factors in relation to gully erosion. Field surveys, GIS and remote sensing techniques were used to identify gullies within the Zhulube Meso-catchment of the Limpopo Basin in Zimbabwe's Matabeleland South Province.

Soil core samples were collected and analysed for 13 characteristics (pH, electric conductivity, bulk density, particle density, clay, silt, sand, total nitrogen, Ni, Ca, Mg, K, Fe, Cu, Zn.), while soil profiles along gully walls were observed and gully characteristics (length, density, area, volume,

width and depth) were recorded. Geographical information systems and remote sensing techniques were used to determine the stream power and sedimentation.

Statistical analysis focused on the correlation and regression of soil chemical properties, and gully characteristics to identify areas susceptible to gully erosion. The results depict 36% of major gullies as discernible using Landsat TM imagery, 56% using Spot panchromatic and 77% on orthophotos. The results showed a significant relationship between gully depth and bulk density at r^2= 0.87 (P<0.05). A significant relationship was evident between gully depths and slope gradient, resulting in accelerated erosion with an increase in slope, at r^2= 0.62 (P<0.05). There was a significant relationship between gully development and stream erosive power while streams sediment loadings showed a non-significant effect on the gully depth at r^2= 0.02 (P<0.05).

It can be concluded that remote sensing and GIS techniques are applicable in gully identification; however, the accuracy levels vary greatly depending on the spatial, spectral and temporal resolution of the imagery. The inherent susceptibility of soils to detachment and transport by various erosive agents is a function of soil properties including among others, physical and chemical soil properties the effects of each soil property differing between sites thereby influencing the degree of vulnerability of soil to destructive erosion forces. Soil erodibility assessment using simulated stream erosive forces and sediment loadings revealed that sediment yield and erosive power of the streams in the study area increased with increasing slope gradient depending on the clay content of the soils.

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POSTER PRESENTATION: SPATIAL VARIATIONS IN COMMUNITY AGGREGATE SPECIFIC LEAF AREA OF GRASS IN KWAZULU-NATAL, SOUTH AFRICA

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Understanding the response of aggregate specific leaf area (SLA) to management and environmental variables can inform on the response of plant communities to these environmental variables in a way that some current approaches can not for example species composition alone. This study investigated response of aggregate specific leaf area to environmental variables, specifically temperature and rainfall.

SLA is a functional trait, the ratio of the area of photosynthetic surface to the dry matter produced. Functional traits are important characteristics of plants, expressing the difference in probability of survival and individual fitness. Aggregate SLA is the weighted mean of the SLAs of the dominant species of a community. Aggregate specific leaf area allows comparisons of effects of management and environmental variables on plant communities, independent of geography or taxonomy limitations. Furthermore, measuring a functional trait across an environmental gradient may facilitate better understanding of how various plant species manage to populate and dominate an area, i.e. the effect of environmental variations on the spatial arrangement of plant communities.

Sixteen sites were surveyed along an altitudinal gradient from the eastern Free State to the coast of KwaZulu-Natal. Grass species composition was determined using the step-point method with 100-200 points, and the aggregate SLA was determined for each site by summing the mean SLA of 2-3 dominant species, weighted by their relative abundance. These data will be used to examine the relationship between environmental gradients and aggregate SLA.

PLATFORM PRESENTATION: ENVIRONMENTAL AND MANAGEMENT INFLUENCES ON SOIL CARBON STOCKS IN MOIST HIGH-ALTITUDE GRASSLANDS

Tony Knowles[1], Alan D Short[2#], Cobus (J) O Botha[3], Alan Manson[3] and Brent J Corcoran[4]*

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Payment for ecosystem services is potentially an important financial incentive for improving management of rangelands, and one ecosystem service that has been explored recently is sequestration of carbon in soil. A project was established to understand the determinants of soil carbon stocks and the rates of carbon sequestration in moist Highveld grasslands on the border of Mpumalanga and KwaZulu-Natal, as well as in the Ukuhlamba-Drakensberg Park and neighbouring farms. The project focussed on the two management factors over which land-users had the most control, namely fire and grazing regimes.

Sixteen fence-line contrasts were identified to compare differing fire or grazing regimes. Nine contrasts focussed on the effect of historical grazing regimes on soil carbon stocks, four on the effect of past fire regimes and one on the effect of a complete absence of fire or grazing. In addition, two sites compared old lands to virgin veld. Soil cores were extracted from soil pits at 5 depths, as well as from the top layer of the soil around the pit using a Beater auger. All soil samples were analysed for total carbon and nitrogen and the undisturbed soil cores extracted from the pits were also analysed for bulk density and soil texture. In addition, the soils were described by form and family, depth and rockiness, and a standard veld condition survey and landscape function analysis was conducted on each site.

The effect of management regimes on soil carbon stocks was small and unpredictable, with the exception being the difference between a very lightly grazed nature reserve and a heavily grazed commercial farm, in common with previous studies. The lightly grazed reserve showed significantly greater soil carbon stocks than the heavily grazed farm (0.087 vs. 0.053 $gC.cm^{-3}$, respectively). Ploughing significantly reduced carbon stocks, even after several decades of rest. The influence of fire was also unpredictable.

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POSTER PRESENTATION: SURVIVAL AND GROWTH OF SAVANNA TREE SEEDLINGS: EFFECTS OF NUTRIENTS, WATER, LIGHT, GRASS COMPETITION, FIRE AND HERBIVORY

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The savanna biomes are unique with regard to co-existence of trees and grasses. The ratio of grasses and trees varies exceptionally, ranging from open savanna grasslands with few trees to tall woodlands underlain by grass. An intimate knowledge of the dynamics of savanna ecosystems is required to manage the ecosystem. Tree seedling recruitment is known to be the major deterministic factor for the existence of a savanna ecosystem. Understanding the role of factors that influence the distribution and abundance of tree species in a savanna ecosystem is of global interest, particularly because woody plant encroachment is so widespread. Water (resource), nutrients (resource), fire (disturbance) and herbivory (disturbance) are the environmental factors generally considered as important in the dynamics of savanna. Although there have been several attempts to understand the dynamics of savanna ecosystems, there is a notable scarcity of formal experiments to elucidate the relative importance of competitive suppression versus resource limitation for seedling growth. Research on tree seedling growth in savannas could help to resolve whether the recruitment of tree seedlings is influenced by disturbance and resource availability alone or whether competition with the grass layer further limits recruitment.

The effects of shade, nutrients, water, defoliation, grass competition (grass species *Eragrostis curvula*) on mesic (650 mm annual rainfall) savanna tree seedlings (*Acacia nigrescens, A. tortilis, Combretum apiculatum* and *Colophospermum mopane*) and humid (around 1000 mm annual rainfall) savanna tree seedlings (*A. karroo, A. sieberiana, Schotia brachypetala* and *Strychnos spinosa*) are being studied in the field in KwaMbonambi, South Africa. Four tree seedlings of each species are planted into each

2 m^2 sub-treatment plots consisting of different combinations of water (W), nutrient (N), light (L) and grass (G) in a factorial design. Water (continuous watering for 24 weeks vs. natural rainfall), light (80% shade vs. no shade) and defoliation (D) (to the 3rd node vs. no defoliation) are treated as whole plot treatments, with grass and nutrients being treated as sub-plot treatments (2 m^2). The total number of sub-plot treatment combinations: (2W x 2N x 2L x 2G) + (1W x 2N x 2G x 1D) = 20 sub-plots, which is replicated five times.

Two seedlings of each of the mesic savanna tree species (*Acacia nigrescens, A. tortilis)* and humid savanna tree species (*Acacia karroo, A. sieberiana*) are being studied under greenhouse conditions at the University of KwaZulu-Natal, Pietermaritzburg. Each of the tree species is treated with five different levels of nutrients (i.e. control, 0.5N, 1N, 2N and 4N of N: P: K fertilizer, where 1N = 26 g, considered appropriate fertilization for container size) and two levels of fire (control, fire). This design is replicated three times. Thus, there are: 5 fertiliser treatment levels x 2 fire treatment levels x 4 tree species x 3 replicates = 120 pots.

The results of this research will enable us to understand the ability of the tree seedlings to establish themselves under various environmental conditions and can ultimately be used to formulate better management strategies for the ecosystem.

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