Managing Healthy Rivers in an Adverse Environment

SESSION CHAIR: BEN (C) BENADE

Wednesday, 21 July 2010, 14:00-15:00

Platform Presentations

KEYNOTE ADDRESS: CATCHMENT UTILISATION AND ORANGE RIVER SYSTEM HEALTH: A NORTHERN CAPE (ARID AREA) PERSPECTIVE

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The Orange River Basin (ORB), shared by four (4) southern African countries, *viz.* South Africa, Lesotho, Botswana and Namibia, encompasses an area of between 900 000 and 1 000 000 km^2. Approximately 70% of the ORB is situated in the south-western arid to semi-arid southern African sub-region, where mean annual precipitation ranges, from east to west, between 500 and 0mm, evaporation between 2900 and >3500 mm, and daily minimum and maximum temperatures, respectively, between 0 and 10°C and 28 and >32°C. In the South African context, the ORB stretches over six (6) of the country's nine provinces, *i.e.* Mpumalanga, Gauteng, North West, Eastern Cape, Free State and the Northern Cape. Approximately 50% of the South African component of the ORB is situated within the semi-arid to arid Northern Cape Province.

Topographically, the Orange River System (ORS), which drains approximately 47% of South Africa's total surface area and ±22% of the country's mean annual rainfall run-off, can be divided into an upper (origin to Orange-Vaal confluence), a middle, (Orange-Vaal confluence to Augrabies Falls) and a lower (Augrabies Falls to Orange River Mouth) section. Approximately 98% of the ORS's runoff is generated in the upper section, with median flow pattern analyses indicating an 82% summer/18% winter natural flow distribution.

The ORS has become highly regulated by virtue of 24 major impoundments (constructed within the catchment between 1884 and 1997), numerous minor impounding structures and six (6) inter-basin as well as five (5) inter-catchment water transfer schemes. These impounding structures and water transfer schemes have resulted in the natural 82%/18% summer/winter median flow distribution's changing to the present almost 50%/50% summer/winter situation. This, together with tremendous increases in other forms of catchment utilisation in the upper section, especially in the Vaal River sub-catchment, resulted in the fairly frequent minor to medium maintenance floods becoming virtually eliminated from the middle and lower Orange River sections. The ORS can now only rely on unpredictable, highly infrequent major episodic flood events as driving forces for resetting the system.

This paper presents an overview of the effects river regulation and catchment utilisation have thus far had on the general health of the ORS, and in particular on its middle and lower sections which traverse the semi-arid to arid Northern Cape Province.

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PLATFORM PRESENTATION: WATER SECTOR DEVELOPMENTS CURRENTLY TAKING PLACE IN SOUTH AFRICA: INTERACTIONS WITH LAND-USE

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Two major developments in South Africa warrant the attention of grassland practitioners, namely the formulation, via public participation, of Catchment Management Strategies under the National Water Act; and the deployment of National Freshwater Ecosystem Priority Areas into more general biodiversity and land-use planning. These two initiatives are topical and will soon influence recommendations, decision-making and potential compliance across a wide range of consultants and practitioners, and will be of interest to researchers inasmuch as they will often want or need to gear their approach to this new context.

The first Catchment management strategies under the Water Act began their development in Mpumalanga earlier this year. After an initial general orientation day run by the InKomati Catchment Management Agency (ICMA), they ran three separate subcatchment strategies for the Crocodile (East), the Komati, and the Sabie-Sand catchments. Between 60 and 120 stakeholders attended each meeting, covering each of about 15 interest sectors (including irrigation and rangeland, with many emergent farmers), the only one being consistently absent being mining. A prescribed process was followed which stressed wide and lateral thinking, and emphasised factors vital to each subcatchment. Participants engaged well, and discussions, though sometimes controversial, remained mostly cordial. The ICMA pulled together all findings and presented these in summary form during a feedback day. The process will now continue through ministerial screening for further public comment and acceptance phases, and eventually become the de facto guidelines that influence all stakeholders' livelihoods. Grassland practitioners can expect many interface points (such as, in these early examples, control of riparian aliens; and pressures for alternative land-uses to enhance water quality and flow) to emerge as this process unfolds nationally.

The National Freshwater Ecosystem Priority Areas are a consequence of South Africa's biodiversity legislation and international biodiversity obligations, but more particularly of a need to spatially integrate aquatic considerations into systematic conservation planning across the country and even across international bioregional domains. The process delivers freshwater ecosystem priority areas (e.g. with special biota) and support areas (e.g. providing underpinning services such as water production) which in each of the provincial biodiversity plans, are further manifested at finer scales in various ways (such as "critical biodiversity areas" and "ecological support areas"), each with locally developed recommended land-use guidelines and restrictions. These spatial layers will then in most provinces be stored in the same accessible databases already used by planners and EIA practitioners. This is very likely to have pervasive and hopefully constructive consequences for any land managers or consultants.

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PLATFORM PRESENTATION: PROGRESS AND LESSONS ASSOCIATED WITH ADAPTIVE MANAGEMENT OF KRUGER NATIONAL PARK'S RIVER SYSTEMS

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Towards the end of the 1990s, a Strategic Adaptive Management (SAM) system, including a Vision, Objectives Hierarchy and Thresholds of Potential Concern (TPC), was in place to adaptively manage the Kruger National Park rivers. However, the last decade has seen continued deterioration of the park's major river systems due to upstream impacts. Reasons include: a) partially implemented SAM system for rivers within the Kruger National Park; b) lags in broader implementation of recommended environmental flows (Ecological Reserve) associated with ecosystem sustainability, exacerbated by uncertainties in managing complex socio-ecological systems; and therefore c) the need to develop a catchment wide culture and adoption of adaptive management principles within water resource management. However, dealing with uncertainty and complexity, embracing learning-by-doing, are relatively new concepts for management of water resources. A three year, SANParks led Water Research Commission funded project was instigated to investigate adaptive processes in river management within the Kruger National Park, aiming at improving feedbacks related to TPC implementation, including documentation of learning along the way. Additionally, three case-studies undertaken are currently investigating best approaches for integration of the Kruger National Park system into the wider catchment areas, i.e. promoting use of adaptive principles to meet environmental flows. This presentation provides key learning opportunities associated with developments in the Kruger National Park river SAM system. Additionally, progress with promoting use of adaptive approaches in the wider catchment areas is given, focusing on the Letaba catchment where key stakeholders are embracing adaptive thinking associated with water resource use and protection.

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PLATFORM PRESENTATION: SOUTH AFRICA'S NON-PERENNIAL RIVERS: PROPOSING A NEW PROTOTYPE METHODOLOGY FOR ASSESSING ENVIRONMENTAL WATER REQUIREMENTS

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A large percentage of southern African rivers are non-perennial - mainly as result of the highly variable and unpredictable climate experienced over much of the region. These rivers are primarily distinguished by their spatially and temporally variable hydrological regimes and by the loss of surface water connectivity when flow periodically fails - confining surface water to isolated pools. With the climate expected to become increasingly warmer, drier and even more variable over large parts of southern Africa, pressure to provide freshwater with an acceptable degree of assurance is expected to increase. The South African National Water Act requires that an environmental reserve be determined for each significant water body before water-use licenses are issued. Previous studies have shown that methods used to determine the environmental water requirements for perennial rivers are not ideally suited for non-perennial rivers with their specific challenges. This paper proposes a new prototype methodology for setting environmental water requirements for non-perennial rivers. The methodology was developed during a multi-disciplinary research study funded by the Water Research Commission. The first half of the initial three-year project was used to develop a field-based understanding of an ephemeral river ecosystem under wet and dry conditions. The second half focused on method development and application. The methodology was then tested on the Seekoei River, an ephemeral tributary of the Orange River. The multi-disciplinary team selected seventeen indicators capturing the most important attributes of the system. The relationships between water level/flow and each indicator, as well as between indicators, were then described in order to translate water level/flow changes into changes into indicators.

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PLATFORM PRESENTATION: A METHODOLOGY TO ESTIMATE THE MINIMUM WATER REQUIREMENTS FOR SHALLOW ROOTED PLANTS IN THE RIPARIAN ZONE: A CASE STUDY OF THE MOKOLO RIVER

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Riparian vegetation plays an important role in non-perennial river ecosystems. International and local literature increasingly reports on the importance of the riparian zone in determining the minimum water requirements for non-perennial rivers. In South Africa, methods have been developed to assess these requirements in perennial rivers, but they are not always applicable to non-perennial systems with their unpredictable flow regime. Due to the variability of flow in non perennial systems, it is difficult to determine the minimum water requirements for riparian vegetation using perennial methods.

The riparian zone is an integrated and interactive zone and not well understood in non-perennial systems. This area represents the convergence between vegetation, hydrological and soils processes. In this paper a methodology is proposed to estimate the water requirements for shallow rooted plants in the riparian zone. The Mokolo River Catchment was used as a case study.

Fieldwork was conducted at the Mokolo River at the end of April 2010. Transects were measured at the five sites indicated in Figure 1. Vegetation sampling were undertaken on each transect and species composition, cover and abundance were recorded. The methodology that was developed included GIS based methods to delineate the boundaries and surface area of the riparian zone along the Mokolo River and to identify the canopy cover.

Existing land type and soil data was used to determine the storage capacity of the riparian zone.

With this information a conceptual model was developed to estimate the upper and lower limits of water available for shallow rooted vegetation in the riparian zone. This methodology will also be tested on other non-perennial systems to aid understanding of these systems.

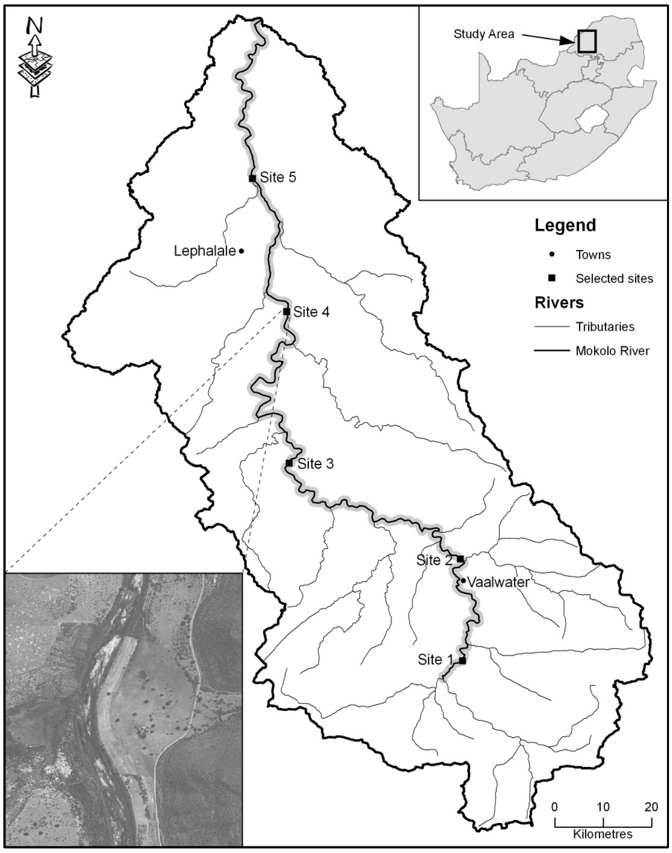

Figure 1: The Mokolo Catchment, indicating the five study sites and an image of Site 4.

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POSTER PRESENTATION: EXPLORING TRENDS IN ABOVE-GROUND HERBACEOUS BIOMASS AND EVAPOTRANSPIRATION IN THE KRUGER NATIONAL PARK: TOWARDS A WATER USE EFFICIENCY MODEL FOR SEMI-ARID SAVANNAS

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Annual veld condition assessments and herbaceous biomass measurements have been undertaken throughout the KNP since 1989. These data include an estimate of above ground herbaceous biomass based on the descending plate (disk pasture meter) measurements. These data provide an opportunity to explore the relationship between above ground herbaceous biomass (AHB) and a range of satellite-derived remote sensing products. Using these data, we prepared a regression model of the relationship between AHB and the MODIS LAI product. Individual point-based measures did not yield a significant relationship. This was possibly a consequence of the absence of woody biomass estimates from each plot as well as issues of scale (sample plot size is small in relation to MODIS pixel size). We sorted the data on the basis of sections within the KNP and developed a new model based on mean MODIS LAI and mean herbaceous biomass values per each section within the park. This yielded a positive non-linear relationship which may be used to predict the above-ground herbaceous biomass at Section scale. We further explored the relationship between the VCA biomass data and MODIS fPAR for the season of data capture. Once again the relationship was not significant. We modelled $ET_{actua}l$ from weather station data, using the MODIS LAI as the stomatal conductance component of the Penman Monteith equation. The results were compared with ET_{actual} from the large aperture scintillometer. These results are promising and enabled us to model daily ETactual for 2007 for Skukuza and Malekutu. Further validation of these daily estimates will be undertaken using data from Fluxnet.

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POSTER PRESENTATION: IMPACTS OF OVERGRAZING ON HYDROLOGICAL FLOW RESPONSES

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Hydrological responses are sensitive to changes in land-use and amplified by variable climate. Thus, change in land-use may be exacerbated by the varied hydrological flow responses, with rapid local scale changes being more significant than those at regional scale. Degradation of the landscape grassveld owing to overgrazing as management practice directly affects runoff components, i.e. stormflow and baseflow, hence sediment yield. The stormflow responses over disturbed landscape may lead to enhanced soil erosion, hence further degradation. The aim of this analysis was to determine the hydrological responses resulting from overgrazing as a management practice on the stormflow and baseflow components of runoff. Hydrological variables derived to represent grassveld management scenarios, i.e. grassveld in good condition (>75% cover and > 40% mulch layer) and in poor condition (<50% cover and 20% mulch layer), were used to account for Veld under natural and degraded natural (overgrazing) grassveld conditions, respectively. The simulations were conducted using a daily time step *ACRU* agro-hydrological model for Limpopo Catchment under dryland conditions with Acocks' (1988) Veld Types representing baseline land cover, baseline land type and baseline climate station data (1971 – 1990) assigned to each catchment within the Limpopo, and for the above mentioned management scenarios. Simulated stormflow responses to degradation of grassveld conditions, from well to poorly managed condition, indicate that stormflow would increase over the Limpopo Catchment by more than 5% to over 50%. Baseflow, on the other hand, were reduced. The results suggest that degradation of the landscape can further increase hydrological responses, which would result in corresponding increments in sediment yields. The management of upstream land-uses could have significant implications on downstream hydrological responses, in terms of changes in the runoff component.

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