THE WATER WHEEL
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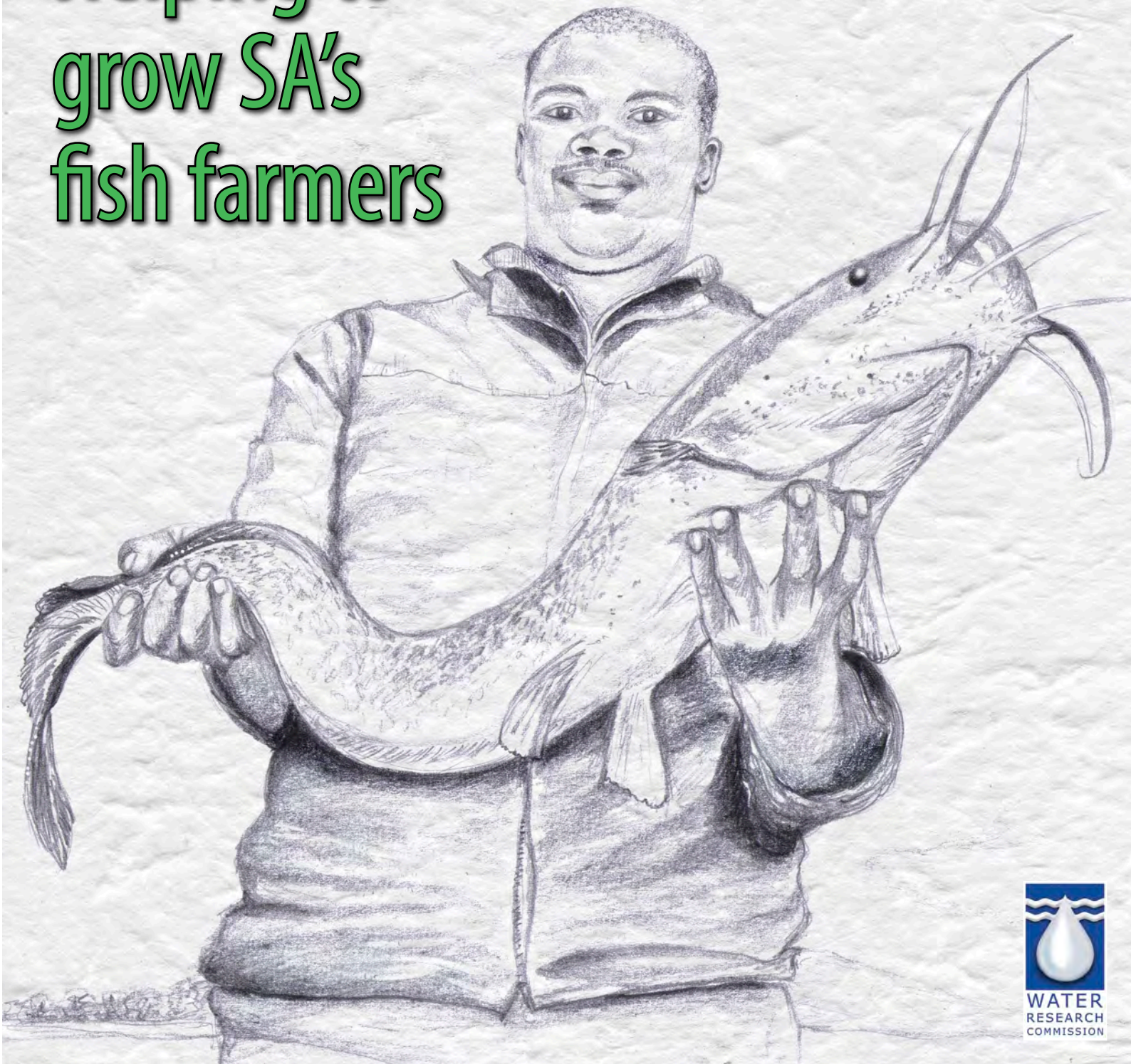
Helping to grow SA's fish farmers



WATER RESEARCH COMMISSION

16th SANCIAHS National Hydrology Symposium

1-3 October 2012
University of Pretoria (Main Campus)
Pretoria
South Africa

Hydrology in a Changing Environment: Science and Policy Interface

First Announcement and Call for Abstracts

The 16th SANCIAHS Symposium, jointly organised and sponsored by the Water Research Commission, the University of Pretoria and the Department of Water Affairs, will be held on 1-3 October 2012 at the University of Pretoria, South Africa.

The Symposium will bring together scientists in the fields of hydrological sciences to share experiences and to exchange ideas on advances in hydrology for the management of finite water resources in the face of potential climate change impacts. Therefore the Symposium calls for abstracts (poster or oral) on the following sub-themes:

- *Advances in hydrological prediction and climate change forecasting*
- *Hydrology, climate variability, climate change and water resource management*
- *Advances in earth observation, hydrological observation and water resources management*
- *Paleohydrology and climate change nexus*
- *Water and Energy*
- *Hydropedology and hydrology*
- *Groundwater and surface water interactions*
- *Ecosystems and Hydrology*
- *Water Quality and Hydrology*
- *Alternative sources of water in a water scarce country*
- *Hydrology, uncertainty and decision-making: the interface between science and policy*

Guidelines for Abstracts and Papers

Abstracts should be a brief summary of the paper's primary premise and findings, no more than **500 words** and should adhere to the example template given below. The **deadline** for submission of abstracts is **27 April 2012**. Participants will be notified of the outcome of the selection process and whether the submission has been accepted for a poster or verbal presentation by 15 June 2012.

Participants whose submissions (posters and verbal presentations) are accepted for presentations will be expected to produce a full written version of the **paper** (the example template will be provided later), before **15 August 2012** for inclusion in the proceedings which will be available on CD at registration.

Conference fees

Delegates:	R1700.00
Full-time students:	R800.00

The conference fees (exclusive of VAT) will cover all teas, lunches, Symposium function (cocktail party and dinner), book of abstracts and the CD of the proceedings.
More details about registration will be announced in January 2012.

Accommodation

All delegates should arrange their own accommodation during the symposium and there is a number of hotels and B&B's available in Pretoria. However, the University of Pretoria will make available a limited number of student residence accommodation at a reasonable rate (details will be posted on the Conference web page in January 2012).

For general queries please contact Mr Wandile Nomquphu at Tel: +27(0)12 3309069 or wandilen@wrc.org.za

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Editorial offices:
Water Research Commission, Private Bag X03, Gezina, 0031, Republic of South Africa.
Tel (012) 330-0340. **Fax** (012) 331-2565.
WRC Internet address:
http://www.wrc.org.za
Editor: Lani van Vuuren,
E-mail: laniv@wrc.org.za;
Editorial Secretary: Mmatsie Masekoa,
E-mail: mmatsiem@wrc.org.za;
Layout: Drinie van Rensburg,
E-mail: driniev@wrc.org.za

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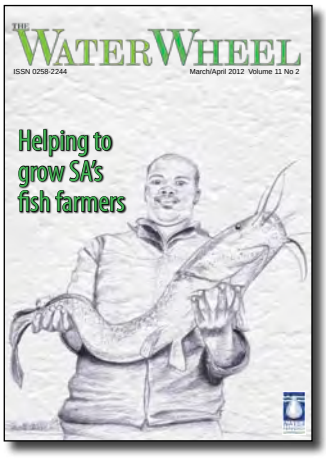
Cover illustration by Dee Janisch.



Seeking green off-grid solutions

Dhesigen Naidoo, CEO of the WRC

This year of the Dragon 2012 will be characterised by a range of interesting factors that intimately affect the world of water research and development (R&D). The first relates to the fact that 2012 is the year of Jhb+10 or Rio+20 to examine the sustainable development scorecard since the Rio Earth Summit (UN Conference on Environment and Development) of 1992 and the World Summit on Sustainable Development of 2002. The second is the continued global economic challenge with the recovery from economic crises adopting a much larger timeframe than initially hoped for. In this environment the need to maximise resource benefit on the one hand and extension of services on the other in particular to the rural and the poor, looks like a Herculean challenge. Add to this the need for Green solutions in a cash-strapped environment and this starts to describe the gordian knot we have to slice through.

To help address this, the Water Research Commission (WRC) and its partners have invested in a series of R&D projects for combined energy and water solutions – some of them completely outside the electricity grid and water networks. The idea in each of them is to maximise the possible concomitant water energy solution. The first example examines the possibility of utilising the potential energy stored in water tanks and reservoirs that have become landmarks in every South African city and many of its towns. A micro-hydropower solution has been developed and tested at the Queenswood Reservoir in the Tshwane Metropolitan District. The Queenswood demonstrator when extrapolated for ten reservoirs in Tshwane yields a yearly potential power generation of ten million kWh based on a range of assumptions – a key are being that power is generated for a maximum of six hours a day. If the pool is extended to include the Rand Water pipelines supplying the Tshwane Supply Area, then a further 1.2 million kWh could be generated. The technology has since been installed at the Pierre van Ryneveld reservoir in Tshwane.

A second example is a completely 'off-grid' combined water and energy solution for a livestock subsistence farming community in Okhombe in the Drakensberg area of rural KwaZulu-Natal in the Upper Thukela catchment. It is part of the Okhahlamba Local Municipality. The WRC project demonstrated a water solution through rainwater harvesting, and an energy solution using bio-digestor technology with the biogas feedstock coming from the livestock animals and water sourced from the rainwater harvesting to provide a viable energy from biogas solution. The project demonstrated that the integrated solution provided water and energy to meet both the domestic and agricultural needs in this community.

The final example I want to highlight is a wave energy solution. The southern African coastline has been identified as one of only six wave power rich areas in the world by the US Department of Energy (DoE). The estimate of wave power potential is very high with the US DoE calculating that in the Pacific North West coastline alone wave energy could produce some 40-70 kW per metre of coastline. The WRC project WEROP or Wave Energy Reverse Osmosis Pump is such a wave energy solution. In WEROP wave power is harvested to provide the energy to desalinate sea water in order to provide high quality freshwater for local community use just off Simonstown in Cape Town.

These three examples, all at demonstrator phase are providing models for innovative off-grid, sustainable water and energy combined solutions as part of the broader Green Economy efforts of South Africa.

The Pierre van Ryneveld reservoir where the WRC-funded micro-hydropower solution has been installed.

Peat discovered in Baviaanskloof

An inspection of the Baviaanskloof's wetlands has yielded some surprising results when members of Working for Wetlands came across peat – a rare and unique wetland type in South Africa.

Peatlands refer to those wetland ecosystems characterised by the accumulation of organic matter (or peat) derived from dead and decaying plant material under conditions of permanent water saturation. It is estimated that only about 10% of South Africa's wetlands contain peat.

The Baviaanskloof World Heritage Site is a relatively arid mountainous conservation area of over 200 000 ha located in the south-western part of the Eastern Cape. Human activities such as livestock and irrigation farming have impacted heavily on the area in recent years. Among others, this has resulted in the gradual deterioration of the Baviaanskloof River, with the river being incised by over 1,5 m in some areas.

During a recent wetland assessment field visit by members of Working for Wetlands a well defined black dried out peat layer was discovered of about 30 cm to 40 cm thick in the exposed incised riverbed, the International Mire Conservation Group reports in a newsletter. This is quite an unusual find in such a relatively dry climate. One possible explanation of this occurrence and formation of peat in this area is through the constant supply of groundwater from the nearby massive alluvial fan being fed with water from a large tributary. These alluvial fans act as major water storage areas and supply water to the main Baviaanskloof stream.

Peatlands have excellent water storage and filtering abilities. They also act as nature's carbon stores. Unfortunately, degradation and alteration of the Baviaanskloof River system has caused the peat layer here to dry out.

Working for Wetlands and Dutch non-governmental organisation Living Lands have since teamed up to restore some of the functioning of both the alluvial fans and the main Baviaanskloof River. Initial plans are for a three-year rehabilitation effort.

Source: www.imcg.net

SA pressure management project scoops international prize

South African engineering company, WRP, together with Emfuleni Local Municipality have won the prestigious International Water Association (IWA) 2011 Project Innovation Award – Development (PIA-D) in the Drinking Water category.

The awards were announced late last year at the second IWA Development Congress, held in Kuala Lumpur, Malaysia. The PIA-D Awards aim to celebrate excellence and innovation in water and sanitation projects in low

and middle income countries and are presented biennially.

According to WRP, the Drinking Water category was the most competitive category, drawing entries from around the world. "The fact that the Sebokeng pressure management project took the top award is a good reflection on South African expertise," the company said in a statement.

Originally commissioned in 2005, the Sebokeng pressure management project has scooped a number of awards over the years. Over five years the installation has saved around 50 million kℓ of water – representing financial savings to the municipality of more than R150-million.

Source: WRP

Quick response by City prevents vandalism disaster

The City of Cape Town has expressed its concern over what it calls the 'mindless acts of vandalism' against its water infrastructure.

This is after vandals attempted to remove the air valve on the 1,5 m-diameter bulk water supply pipeline which feeds the Blackheath-Kuilsrivier area. A member of the public reported the incident after spotting water spewing from the opening caused by the dislodged air valve.

A crew from the City Water and Sanitation department worked through the night to repair the damage. To affect the necessary repairs, a section of the bulk water supply had to be shut down and the water flow diverted via another line. While doing so, staff found that the closest isolation valve had also been rendered irreparable as a result of the vandalism.

Thanks to the member of the public who reported the incident and the quick reaction of the City potential disaster was averted. The leak was in an isolated area of the pipe and could have caused considerable damage and water loss.

"For small personal gain individuals who damage the water supply network inflict harm on entire communities. Repairing the damage is very expensive and places a severe burden on the City's already strained resource," said Councillor Shehaam Sims, Cape Town's Mayoral Committee Member for Community Services. "About 50 to 60 ℓ/s was lost in this particular instance, and if it was not dealt with so expeditiously the loss would have been considerably greater."

Novel chemical process to reclaim calcium carbonate from industrial waste

The CSIR has developed a novel process to reclaim high-quality precipitated calcium carbonate from calcium-rich industrial solid waste.

High-quality calcium carbonate is useful for various specialised industrial applications such as gastric acid treatment, tablet filling in pharmaceuticals, plastics, paint, adhesives and in pulp and paper-making. According to CSIR biochemical engineers Dr Mlawule Mashego and Jean Mulopo this technology, for which the CSIR has recent filed a patent application, can also be used as a waste management tool that creates new enterprises in the waste management sectors.

Calcium-rich waste streams are generated by a number of industries in South Africa, including the power and energy utilities, steel-making industry, bulk water-treatment utilities, and the pulp and paper making industry. These industries dispose of large volumes of waste/s streams to on-surface waste disposal sites or landfills which are rapidly filling up.

Furthermore, legislative requirements for landfill disposal methods, such as the National Environmental Management Waste Act (NEMWA) 59 of 2008, are expected to become more stringent in the future, resulting in the need to adopt alternative and innovative waste management approaches.

According to the researchers, the solid waste-producing industry, or new enterprises established to produce high-quality calcium carbonate, will be able to use such processes. "We also foresee an increase in demand for calcium carbonate for treating acid mine drainage," Dr Mashego adds.

Source: CSIR

We will get the funds to tackle AMD – Minister

The Department of Water Affairs (DWA) will secure the necessary funds to address current acid mine drainage issues on the Witwatersrand.

This is according to Minister of Water & Environmental Affairs, Edna Molewa.

Speaking at a media briefing at the opening of National Water Week in March, Molewa said she was confident that, with the right motivation and business plan, her department would eventually secure the estimated R924-million capital cost required to implement the planned solutions on the West, Central and Eastern basins. Another R385-million is required for operations and maintenance. To date, the department has managed to secure R433-million from Treasury for use in the short term.

At present, DWA is focusing its efforts on the Western Basin, where huge volumes of acid mine-water have been decanting since 2002. Implementing agent, TCTA, was moving ahead with plans to upgrade the current treatment plant at Rand Uranium along with the construction of a new high-density sludge plant. The aim of the short-term treatment plants is the neutralisation and metals removal from the acid mine drainage.

Molewa said she realised that neutralisation of mine-water was only a short-term solution, and that long-term management options were being investigated. "The short-term solutions will maintain underground mine-water levels in the East and Central Rand mining basins by protecting the environmental critical levels and also prevent surface decant of acid mine drainage to these basins. The water level in the Western Basin also needs to be drawn down to the environmental critical level. Meanwhile, the long-term feasibility study has begun. Among others, it will help us to determine which institutional model to use as well as the potential water users of the treated acid mine drainage."

Built environment professionals 'appalled' at government infrastructure underspend

In a joint industry statement the South African Federation of Civil Engineering Contractors (SAFCEC) and Consulting Engineers South Africa (CESA) stated that they were appalled by the recent announcement by government of the R12,4-billion underspend budgeted for municipal infrastructure projects.

"CESA considers this very disturbing as it has had a negative impact on communities struggling with service delivery issues and the construction industry which relies heavily on municipal expenditure in order to survive," stated Graham Pirie, CEO of CESA. "More importantly, infrastructure that we do have is not being adequately maintained."

SAFCEC Executive Director, Neville Gurry, called the underspend a 'tragedy', and said that one of the biggest reasons for this was the lack of capacity and expertise in government departments to both implement new projects and to maintain existing infrastructure.

Both associations through their affiliation with Business South Africa, were interacting with the stakeholders in government's New Growth Path initiative to create jobs through infrastructure spend. New delivery models were being considered which would assist with the implementation of numerous projects.

In other news, CESA has also expressed its full support to Economic Development Minister Ebrahim Patel's recent announcement of government's new 'integrity pact' to screen firms for big project deals. Companies wishing to win contracts from government's infrastructure development programme will need to sign this 'integrity pact' which commits them to ethical behaviour, including non-collusion with competitors and competitive pricing.

In commenting on the announcement, Pirie said: "CESA implemented a Business Integrity Management System early in 2009 and in 2011 all our member firms were constitutionally required to have such a system in place as a condition of membership of the organisation."

Tshwane river polluted

Tshwane residents were warned to stay clear of the Rietspruit, Hennops River, Crocodile River and Hartbeespoort Dam following the spillage of raw sewage into the water course.

Heavy flooding in the Midrand and Centurion areas on 21 February led to a pipe bridge over Rietspruit being swept away. The bridge carried a 900-mm diameter sewer pipe and a 200 mm-diameter water supply pipe. The Rietspruit flows into the Hennops River, which ultimately feeds into Hartbeespoort Dam and the Crocodile River.

At the time of writing a new sewer pipe was being reinstated.

Hundreds attend Limpopo wetlands event

Around 700 people gathered at Makuleke village, in Limpopo, on 2 February to celebrate World Wetlands Day.

This year's theme was 'Wetlands and Tourism – A great experience, enhancing community livelihoods.'

According to Deputy Minister of Water & Environmental Affairs, Rejoice Mabudafhasi, the Makulele wetland system, in particular, holds a significant reminder of the work that she and her department spearheaded years ago in ensuring that sites like this one remain healthy, provide benefits to surrounding communities and receive the recognition they deserve as valuable ecological resources.

The wetland, which was designated as a Ramsar Wetland of International Importance in 2007, was the first Ramsar site owned and co-managed by a community. The Makuleke community regained the land, situated in the north of the Kruger National Park, back in 1998 after a restitution of land rights process. The community then decided to retain the land as part of park to be co-managed by the Makuleke Community Property Association and South African National Parks.

"Wetlands are exceptionally high-value ecosystems that make up only a minute fraction of the country," noted Mabudafhasi. "Healthy wetlands such as the ones we visited today represent our endowment fund for immediate communities and those further afield – all of whom derive benefits."

"With their natural beauty and biodiversity wetlands are ideal locations for tourism," she continued. "The income can be significant and support livelihoods locally and nationally. Wetlands provide other 'services', too, such as water, food, water purification, erosion control ,etc., for the benefit of tourists and tourist accommodation. The income generated by tourism for national and local economies in and around wetlands can be substantial."

New CEO hopes to implement 'engineering with a heart'

Engineers focused on delivering expert service delivery 'with heart'. This is the main goal for new SSI Engineers and Environmental Consultants CEO, Nyami Mandindi.

Her desire is not only for her company to implement hard-core engineering, but to ensure that the execution of projects speaks to the dreams and aspiration of the people of South Africa. According to Mandindi, engineering excellence needs to address social and community needs if the challenge of increasing urbanisation is to be addressed intelligently.

"South Africa is undoubtedly an engineer's dream in terms of the massive opportunity in infrastructure design and build. However, infrastructure provision in developing countries requires a unique breed of engineers – the magic ingredient in our approach to infrastructure provision is innovation and creative thinking. Our engineers will step up to meet the challenge of SSI-led projects improving social equality and respecting the environment."

Source: SSI

'Deadly' chemical spill hits Ngagane River

The Department of Water Affairs (DWA) was called to swift action following what it described as a 'deadly' chemical spill into the Ngagane River, near Newcastle, KwaZulu-Natal.

The spillage of high concentrations of cyanide from a synthetic rubber manufacturing company allegedly polluted the nearby Karbochem spruit, a tributary of the Ngagane River. This led to the death of a number of cows drinking from the river.

During a site inspection, DWA officials discovered chlorine powder around sampling points which is believed to have been used to dry to drop the high concentration levels of cyanide in the stream.

At the time of writing, DWA was working with Newcastle water service authority, uThukela Water, and drinking water had not been affected. However, people were warned to keep themselves and their livestock away from the river for the time being.

The department warned that stern action would be taken against companies who broke the law and put people's lives at risk.

Source: BuaNews

Water diary

WATER INDUSTRY
MAY 6-10
The Biennial Congress and Exhibition of the Water Institute of Southern Africa will take place at the Cape Town International Convention Centre with the theme 'Water footprint'. *Enquiries: Conference Secretariat; Tel: (012) 914 2751 Fax: (021) 914 5493; Email: info@wisa12.org.za or Visit: http://www.wisa2012.org.za*

OXIDATION TECHNOLOGIES
MAY 7-9
The 6th IWA Specialist Conference on Oxidation Technologies for Water and Wastewater Treatment will take place in Goslar, Germany. This is the first ever joint conference of the International Water Association and the International Ozone Association aimed at the exchange and discussion of the latest information on advanced oxidation processes. *Enquiries: Prof Michael Sievers; Email: aop6@cutec.de; Visit: www.aop-conferences.de/*

GROUNDWATER
MAY 21-24
The International Conference on Groundwater in Fractured Rocks 2012 will take place in Prague, Czech Republic. *Email: gwfr2012@itctravel.cz; Visit: http://web.natur.cuni.cz/gefr2012/*

WATER, CLIMATE & ENERGY
MAY 13-18
The inaugural World Congress on Water, Climate and Energy will be held in Dublin, Ireland. The Congress will explore the topics of resilient and sustainable cities with a focus on climate change adaptation and mitigation. The challenges of climate change adaptation and incorporating uncertainty into the city vision and infrastructure will be discussed together with the impacts and responses of climate change on water resources. *Email: info@iwa-wcedublin.org or Visit: http://iwa-wcedublin.org/*

RAINWATER HARVESTING
MAY 20-24
The Third IWA Rainwater Harvesting Management International Conference will take place in Korea. The themes of this conference include the wisdom of old civilisation, scientific and engineering aspects of rainwater management, communication and education of rainwater and the environment, among others. *Enquiries: Mooyoung Han; Email: myhan@snu.ac.kr; Visit: www.3rwhm.org*

WETLANDS
JUNE 3-8
The 14th International Peat Congress will take place in Stockholm, Sweden with the theme 'Peatlands in balance'. At its core will be presentations and documentation of the latest research results on peat and peatlands in the broadest sense. The congress, which takes place every four years, also offers an excellent opportunity to stakeholders to meet and share new knowledge on all aspects of peat and peatlands. *Visit: www.ipc2012.se*

MUNICIPAL ENGINEERING
JUNE 4-11
The 2012 World Congress on Municipal Engineering will be held with the theme 'Sustainable Communities'. *Email: jyrki.vatto@hel.fi or Visit: www.ifme.com*

TECHNOLOGIES
JUNE 3-7
The 9th IWA Leading Edge Conference on Water and Wastewater Technologies will be held in Brisbane, Australia. The conference is focused specifically on advances and developments in water and wastewater technologies. Enquiries: LET-2012 Organising Committee; *Email: let2012@iwahq.org; Visit: www.let2012.org*

SUSTAINABLE DEVELOPMENT
JUNE 4-6
The Rio+20 United Nations Conference on Sustainable Development will take place in Brazil with the theme 'Making it happen'. The objective of the conference, which follows ten years after the Summit on Sustainable Development in Johannesburg, is to secure renewed political commitment for sustainable development, assess the progress to date and the remaining gaps in the implementation of the outcomes of the major summits on sustainable development. Visit: *www. http://www.uncsd2012.org/rio20/*

Diverse ecosystems are crucial to climate change buffer

Preserving diverse plant life will be crucial to buffer the negative effects of climate change and desertification in the world's drylands, according to a new landmark study.

The findings of the multi-author study, published in the journal *Science*, are based on samples of ecosystems in every continent except Antarctica. They confirm for the first time that the more diverse an ecosystem is the more ecological functions it performs. It also has implications for carbon sequestration and soil health.

"This is the most extensive study of the links between function and diversity ever undertaken," noted co-author Prof David Eldridge of the University of New South Wales' School of Biological Earth and Environmental Sciences.

According to the study, dryland ecosystems cover about 40% of the Earth's land surface, support 40% of its people, and are particularly vulnerable to environmental changes and desertification. "Our findings suggest that plant species richness may be particularly important for maintaining ecosystem functions linked to carbon and nitrogen cycling, which sustain carbon sequestration and soil fertility," reported Prof Eldridge. "And because land degradation is often accompanied by the loss of soil fertility, plant species richness may also promote ecosystem resistance to desertification."

It is generally accepted that the loss of biodiversity may impair how natural ecosystems function by reducing the quality of services they provide. These include provisioning services such as the availability of drinking water, food and energy; regulating services such as carbon sequestration and waste decomposition; and supporting services such as nutrient cycling and seed dispersal.

Ecosystems that provide multiple services – such as carbon storage, productivity, and the build-up of nutrient services – are described as multi-functional. However, the links between biodiversity and multi-functionality in dryland ecosystems have never been assessed globally.

In this study, a team of scientists from 14 countries evaluated how the diversity of perennial plants, and a range of climatic and landscape variables, were related to multi-functionality of 224 dryland systems. Researchers surveyed plots large enough to represent the main ecosystem features at each site and assessed 14 functions all related to the cycling and storage of carbon, nitrogen and phosphorus.

These functions were chosen because they deliver some of the fundamental supporting and regulating ecosystem services, and because they are used to identify the onset of desertification processes, explained Prof Eldridge. "Climate change will reduce the ability of dryland ecosystems to perform multiple functions related to the cycling of these elements. Changing climate is also likely to reduce plant richness and increase the areas affected by desertification."

World biodiversity crisis 'worse than climate change'

The challenge of conserving the world's biodiversity is perhaps even larger than mitigating the effects of global climate change.

This is the main conclusion from a discussion at the University of Copenhagen where researchers and policy experts gathered to discuss how to organise the future UN Intergovernmental Panel for Biodiversity and Ecosystem Services.

Species extinction and the degradation of ecosystems are proceeding rapidly and the pace is accelerating. The world is losing species at a rate that is 100 to 1 000 times faster than the natural extinction rate.

Mass extinctions of species have occurred five times previously in the history of the world – the last time was 65 million years ago when the dinosaurs and many other species disappeared. Previous periods of mass extinction and ecosystem change were driven by global changes in climate and in atmospheric chemistry, impacts by asteroids and volcanism. Now we are in the 6th mass extinction event, which is a result of a competition of resources between one species on the planet – humans – and all others.

"The biodiversity crisis – i.e. the rapid loss of species and the rapid degradation of ecosystems – is probably a greater threat than global climate change to the stability and prosperous future of mankind on Earth," said Prof Carsten Rahbek, Director for the Centre for Macroecology, Evolution and Climate at the University of Copenhagen. "There is a need for scientists, politicians and government authorities to closely collaborate if we are to solve this crisis."

The new planned Biodiversity panel is equivalent to the UN panel on climate change, which has resulted in enhanced policy awareness and changes around the world. Unfortunately the same cannot be said when it comes to reducing the threats to ecosystems and the loss of animal and plant species. "There is a need to produce future scenarios that are easily understood and, at the same time, bring together the best scientists in the field," noted Prof Rahbek.

Banana peel can purify water, say scientists

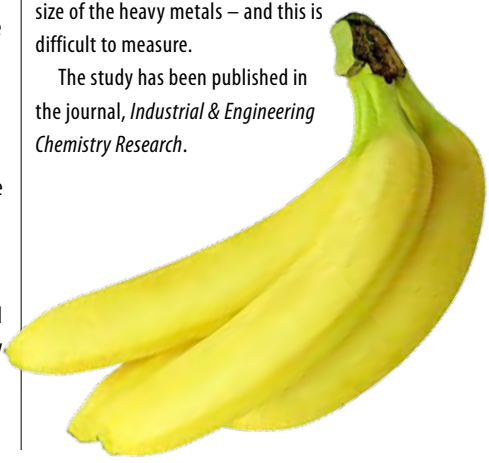
Banana peels can be used to purify water contaminated with toxic heavy metals such as copper and lead, according to Brazilian scientists.

Research from the Bioscience Institute at Botucatu, Brazil, reported that the skins can outperform even conventional purifiers such as aluminium oxide, cellulose and silica. The team's method follows previous work that showed that plant parts, such as apple and sugarcane wastes, coconut fibres and peanut shells, can remove toxins from water. These natural materials contain chemicals that have an affinity for metals.

Co-author of the study Gustavo Rocha de Castro explains that the peels were dried in the sun for a week, then ground and added to river water containing known concentrations of copper and lead. The researchers found that the peels absorbed 97% of the metals after only one hour.

Castro said that, although the peels were tested only on copper and lead, the material could also work on cadmium, nickel and zinc. However, he warned that this sort of filter is better suited to industrial purposes and cannot be used for water purification at home as the extraction capacity of banana peels depend on the particle size of the heavy metals – and this is difficult to measure.

The study has been published in the journal, *Industrial & Engineering Chemistry Research*.



New species of tiny frog is world's smallest vertebrate

Researchers have found two new frog species in New Guinea, one of which is the new smallest known vertebrate on Earth.

The discovery was made by a team of researchers led by Christopher Austin of Louisiana State University, in the US.

The new smallest vertebrate species is called *Paedophryne amauensis*, named after Amau village in Papua New Guinea, where it was found. The adult body size for these frogs ranges from just 7 to 8 mm.

According to Dr Austin, the discovery is "of considerable interest to biologists because little is understood about the functional constraints that come with extreme body size, whether large or small." The previous smallest vertebrate was a fish, called *Paedocypris progenetica*, with an adult size of 7,9 to 10,3 mm.

To read the scientific description of the species, Visit: **www.plosone.org/article/info:doi/10.1371/journal.pone.0029797**

Temperate freshwater wetlands are 'forgotten' carbon sinks

Results of a new study out of the US comparing the carbon-holding power of freshwater wetlands indicate that wetlands in temperate regions are more valuable as carbon sinks than current policies imply.

The study compared several wetlands at two wetlands sites in Ohio, US: one composed of mostly stagnant water and one characterised by water regularly flowing through it. The study showed that the stagnant wetland had an average carbon storage rate per year that is almost twice as high as the carbon storage rate of the flow-through wetland.

In addition, the scientists came up with measures of carbon storage in the stagnant wetland that exceed carbon measurements recorded in recent years in various types of wetlands, suggesting to the researchers that temperate freshwater wetlands may have a significant role in worldwide strategies to offset greenhouse gas emissions.

All types of wetlands deserve more credit than they receive as carbon sequestering systems in global carbon budgets, the researchers say. However, they also say that boreal peatlands – wetlands containing deep layers of organic matter in subarctic regions – should not be the only wetlands favoured in policy considerations.

"These numbers are a lot higher than those often used to determine policy about wetlands. All of our numbers are, in general, considerably higher than the average rates of carbon sequestration for boreal peatlands, but the boreal peatland numbers rule the roost in climate change," said William Mitsch, senior author of the study and environmental and natural resources professor at Ohio State University. "Wetlands make up 6% to 8% of the landscape, but they hold much more than 6% to 8% of the world's carbon. They are the forgotten carbon sink."

Disease-causing fungi prevalent in sink drains, study finds

A study examining the prevalence of the fungus *Fusarium* in bathroom sink drains suggests that plumbing systems may be a common source of human infections.

US researchers from Penn State's College of Agricultural Sciences sampled nearly 500 sink drains from 131 buildings – businesses, homes, university dormitories and public facilities. They analysed fungal DNA to compare the spectrum of *Fusarium* species and sequence types found in drains with those recovered from human infections.

The study identified at least one *Fusarium* isolate in 66% of the drains and in 82% of the buildings. About 70% of those isolates came from the six sequence types of *Fusarium* most frequently associated with human infections.

"With about two thirds of sinks found to harbour *Fusarium*, it is clear that those buildings' inhabitants are exposed to fungi on a regular basis," noted lead investigator Dylan Short, who recently completed his doctorate in plant pathology. "This strongly supports the hypothesis that plumbing-surface biofilms serve as reservoirs for human pathogenic fusaria."

Some species of *Fusarium* cause opportunistic and sometimes fatal infections in humans, typically entering the body through wounds or trauma, via catheters and intravenous devices or by introduction of a biofilm to the eye. While relatively rare, *Fusarium* infections can be difficult to treat because of the organism's resistance to many antifungal drugs. Those most at risk are individuals with weak or compromised immune systems.

Short explained that biofilms on plumbing surfaces are known to comprise a diverse spectrum of fungi and other microbes. "Based on its very high frequency, it is clear that *Fusarium* is a ubiquitous component of biofilm microbial communities in plumbing systems. The adaptations that make *Fusarium* biofilm growth possible also may facilitate infection of humans."

The study results have been published in the *Journal of Clinical Microbiology*.

Water on the Web

www.dwa.gov.za/DSO/
This is the official website of the Department of Water Affairs' Dam Safety Office. Legislative and guidelines documents and forms pertaining to dam safety can be found at this site.

www.reservoir.co.za
This website, developed by Rand Water, is an information centre for the Upper Vaal Water Management Area (WMA). It has been developed to facilitate communication of information between stakeholders and role-players participating within all catchment forums and associated management structures of the Upper Vaal WMA. Water quality information and reports for both river and drinking water are provided.

www.worldfishcenter.org/
The WorldFish Centre is an international, non-profit research organisation dedicated to reducing poverty and hunger by improving fisheries and aquaculture. WorldFish is one of the 15 members of the CGIAR Consortium. The site offers interesting information regarding aquaculture and its role in poverty and hunger alleviation, especially in developing countries.

New Zealand river is top satellite image of 2011

An image of New Zealand's Rakaia River has come out tops in global commercial satellite imagery company, DigitalGlobe's, top satellite image contest.

The Rakaia River is located in the Canterbury Plains in New Zealand's South Island. It rises in the Southern Alps, travelling 150 km in a generally easterly or southeasterly direction before entering the Pacific Ocean 50 km south of Christchurch. It is one of the country's largest braided rivers.

The satellite imagery company placed images, ranging from natural disasters to natural wonders, on its Facebook page, asking viewers to vote for their favourite.

Artificial wetlands can provide long-term benefits over the long haul

Wetlands created to replace those lost to environmental degradation or development take up carbon from the atmosphere and so potentially reduce greenhouse warming, a unique 15-year study suggests.

Such artificial wetlands caused emissions of methane, which may contribute to warming, smaller than those from natural wetlands.

William J Mitsch, of the University of Florida Gulf Coast University in Naples and his colleagues, describe the development of two one-hectare wetlands in Ohio created by pumping water from the nearby Olentangy river, starting in 1994. One was manually planted with vegetation, and the other was left to develop naturally.

The results, reported in the March issue of *BioScience*, show that over time the manually planted and the unplanted wetlands differed principally in the variety of plants present and in how much gas they exchanged with the atmosphere. The manually planted wetland showed more variety, but the unplanted one took up more carbon from the atmosphere. Methane emissions from the unplanted wetland, unlike the planted one, meant that it was estimated to contribute slightly to net greenhouse warming. Both created wetlands, however, removed large amounts of nitrogen and phosphorus from the incoming river water. Emissions of nitrous oxide, which can also increase warming, were small.

This study may prove useful as a model for future wetland reclamation or replacement projects and for determining the amount of human intervention that is necessary for these projects to be successful.

Scientists measure human water footprint

The average person consumes 4 000 ℓ/day of water – including water for food and other products. This is the main finding of a recent study into the global water footprint published by researchers at the University of Twente.

The 'Water Footprint of Humanity' study, published in the 13 February *Proceedings of the National Academy of Sciences*, looks at the use of rainwater, groundwater and surface water, as well as contaminated water. Water used by the agricultural sector accounts for nearly 92% of annual global freshwater consumption, the largest proportion which is 'green' water (74%).

In the period between 1996 and 2005, the average consumer used an annual total of 1 385 m^3. However, on examining the statistics per country, startling differences emerge: one American consumes more than double the average global amount, while the inhabitants of China and India consume little more than 1 000 m^3. The water footprint of the average consumer is determined mainly by the consumption of cereals (27%), meat (22%) and dairy products (7%).

The study also shows the virtual import and export of water through trade in resources and products. Some countries, such as China and the US, are both large importers and exporters of water. Research shows that water-rich countries in northern Europe often rely on water imports from areas struggling with severe water scarcity.

The researchers also expect to see a drastic change in consumption in China as it relies increasingly on farmland in, for example, Africa. This will lead to much greater water imports. "These are all indicators that water scarcity is not a local problem but must be seen from a global perspective," the researchers said in a statement. They are therefore questioning whether the continued use of the limited blue water footprint approach for export is sustainable.

Source: University of Twente

Water by numbers

- **350** – The number of people who had to be evacuated or airlifted to safety following heavy flooding in the Hoedspruit area, in Limpopo, earlier this year. The floods, caused by Cyclone Dando when it moved inland from the coast of Mozambique, struck the hardest in Mpumalanga's Nkomazi area south of Malelane, Hoedspruit and the Kruger National Park.
- **R2-billion** – The potential shortfall faced by the Limpopo Province at the end of this financial year. According to a statement by Treasury, the province's finances would be restructured in order to find savings to cover the shortfall. The province's large, accumulated unauthorised expenditure (R2,7-billion in 2011) has been given as the main reason for the shortfall.
- **102 –** The number of families in Makana Municipality, in Grahamstown, Eastern Cape, which still make use of the bucket toilet system. The municipality aims to spend around R3-million to eradicate the buckets by May, BuaNews reported.
- **2013** – The expected completion date of the new Spring Grove Dam, which is currently under construction near Rosetta in the KwaZulu-Natal midlands. The dam will increase the yield of the uMgeni system, which supplies water to Durban, Pietermaritzburg and surrounds, to 394-million m^3/year. The dam will be about 42 m high, with a gross storage capacity of 142,5-million m^3.
- **10%** – The percentage of Rand Water's 3 500 km pipeline network which is constructed out of concrete. The remainder of the network is made up of steel pipelines.
- **46** – The number of new species discovered by scientists during a recent expedition to the pristine tropical forests of Suriname, BBC Nature reports. A total of 1 300 species were recorded, with frogs, crickets and catfish being counted among the new finds.

Millennium Development Goals – Drinking water target in site

According to the latest report by UNICEF and the World Health Organisation (WHO), the world is well on its way to meeting the Millennium Development Goal (MDG) of improving access to safe drinking water by 2015. However, soaring population growth is hampering progress in some areas.

"The good news is that almost 1,8 billion more people now have access to drinking water compared to the start of the 1990s," reports Sanjay Wijsekera, UNICEF Associate Director. "The bad news is that the poorest and most marginalised are being left behind."

The report, *Drinking Water Equity, Safety and Sustainability*, says that between 1990 and 2008, the proportion of the world's population with access to improved drinking water sources increased from 77% to 87%. Despite this progress, however, there were still 884 million people that did not use improved drinking water sources.

At the current rate of progress, 672 million people will not use improved drinking water sources in 2015. It is likely that many hundreds of millions more will still lack sustainable access to safe drinking water.

The report stresses that, even though good progress has been made in some regions, others are still not on track to meet the target. Of the millions of people without access to improved sources of drinking water in 2008, 37% live in sub-Saharan Africa, 25% in Southern Asia, 17% in Eastern Asia and 9% in South-Eastern Asia.

Pierre Holtz/UNICEF

Today, at least 1,8 million more people have access to safe water.

In sub-Saharan Africa, for example, total access has significantly increased since 1990, jumping from 49% to 60%, and reaching an additional 126 million people in urban and 111 million in rural areas. However, population growth has outstripped the progress to the extent that the actual number of people without access was greater in 2008 than it was in 1990.

Of particular concern among those people without access to improved drinking water sources are those who rely on surface water sources. Such sources include rivers, dams, lakes, ponds, and canals, and are often the most susceptible to pollution and most likely to have poor water quality. Since 1990, use of surface water sources has decreased significantly and accounts for only a small proportion of drinking water sources in most regions, however, in sub-Saharan Africa 20% of the population is still dependent on these water sources.

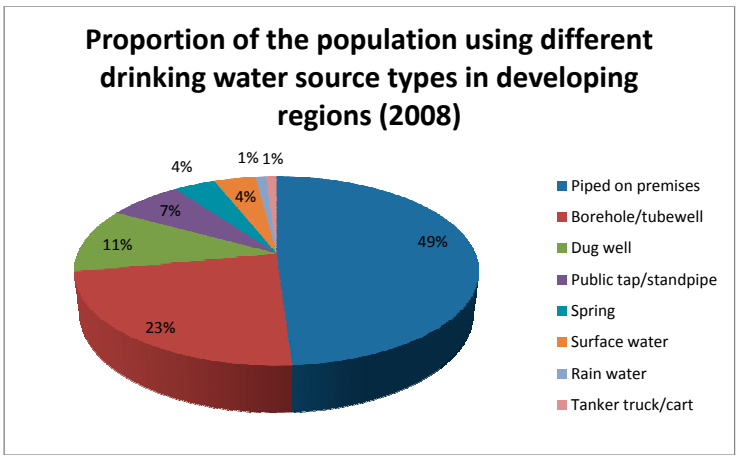
Furthermore, the report found that the richest 20% in sub-Saharan African countries are more than twice as likely to use an improved drinking water source as the poorest 20%. In addition, poor people in rural areas have the lowest access to safe drinking water, with the greatest burden in collecting water falling to women and girls.

Globally, more than eight out of ten persons without an improved drinking water source live in rural areas. However, the proportion of the rural population in developing regions using piped drinking water on premises (considered the optimal service level) was still only 31% in 2008, up from 21% in 1990. In urban areas it went from 71% to 73% during the same period. This proves, according to the report, that investment in water and sanitation is not being optimised – almost two thirds of total official development assistance for drinking water and sanitation goes to the development of large urban systems.

The report adds that even where there is access to water, it is often not safe for drinking. Water quality surveys show that many improved drinking water sources – such as piped supplies, boreholes and protected wells – do not conform to WHO guidelines. On average, half of all protected dug wells may be contaminated, along with one-third of protected springs and boreholes.

Climate change also poses threats to water infrastructure. The increasing frequency of droughts and floods could lead to loss of functioning which would set back progress in drinking water supply, and affect other MDG targets. Investments should, therefore, be aimed at making systems and services more resilient in the face of extreme weather conditions.

To access the report, *Drinking Water Equity, Safety and Sustainability*, Visit: www.unicef.org/media/files/JMP_Report_DrinkingWater_2011.pdf



Source: Drinking Water Equity, Safety and Sustainability

New from the WRC

Report No: TT 505/11

The long-term impact of Acacia mearnsii *trees on evaporation, streamflow and groundwater resources (AD Clulow; CS Everson & MB Gush)*

Good estimates of tree water-use and the impacts thereof are critical to the forestry industry and equitable water supply to all South Africans. In this study, state-of-the-art technology was applied to assess whether there was a potential long-term impact on water resources. The specific objectives of the project were to quantify the long-term effects of commercial forestry species on deep soil water profiles, streamflow and evaporation; describe the controlling environment and soil water processes which allow for total evaporation to exceed the annual rainfall; provide a modelling framework for the catchment water balance to improve streamflow predictions; and extend the hydrological record of the Two Streams catchment to provide a long-term database of the catchment hydrological variables for future modelling studies.

Report No: 1653/1/11

Impact of a ceramic pot point-of-use water treatment device on rural people living with HIV and AIDS (N Potgieter; TG Barnard; J Brown & MD Sobsey)

The consumption of contaminated water can result in increased incidence of waterborne diarrhoea, a leading cause of morbidity as well as mortality worldwide. Immunocompromised people (such as those suffering from HIV/AIDS) exposed to microbial contaminated water are more likely to experience adverse health effects. The current situation in rural households of South Africa is that clean water supplied at taps is being microbiologically contaminated at the point-of-use, usually or directly around the home. The reason for this is most often the unclean containers used to fetch and store water, as well as unclean hands involved in handling the water at home. Home water treatment devices, such as the ceramic pot filter, are frequently reported to improve the microbial water quality of water and reduce incidence of disease. This study investigated whether improved household drinking water at the point-of-use using ceramic pot filtration will improve the water quality and well-being of people living with HIV and AIDS.

Report No: 1465/1/11

Sustainable techniques and practices for water harvesting and conservation and their effective application in resource-poor agricultural production through participatory adaptive research (C Everson; TM Everson; AT Modi; D Csiwila; M Fanadzo; V Naiken; RMB Auerbach; M Moodley; SM Mtshali & R Dladla)

Rainwater harvesting is already widely used throughout the world as a method of using rainwater for domestic and agricultural use. Although it has wide application for the provision of drinking water, water for livestock and water for irrigation, the percentage of households using rainwater harvesting in rural areas of South Africa is low. One of the areas where this potential can be realised is the Umlazi River catchment, in the eastern region of KwaZulu-Natal. There is no piped water in this area and the rural communities are entirely dependent on rainwater. The aim of the project was to select and implement rainwater harvesting and conservation techniques that would assist the communities in this catchment area to improve their livelihoods by increasing their food production.

Report No: 1902/1/11

Rapid enzymatic detection of organophosphorus and carbamate pesticides in water (BI Pletschke; M Mwila; MC van Zijl; NH Aneck-Hahn; JS van Dyk; M Burton)

Pesticides are important for growth of commercial crops, and this is especially noteworthy considering the number of crops of commercial value grown in South Africa. However, due to runoff they often contaminate water sources which may function as drinking water for humans and animals. When ingested, organophosphate and carbamate pesticides may inhibit the enzyme, acetylcholinesterase (AChE). As a result of their toxic effects, contamination of water by these pesticides must be monitored to prevent adverse effects in humans and animals. Due to the cost and complexity of traditional analysis methods, alternative screening methods of water for pesticide contamination has to be identified. As AChE is the intended target for organophosphate and carbamate pesticides, it has been identified as a suitable method for detection of these pesticides with the concentration of the pesticide having a linear correlation to the inhibition of the enzyme. Using AChE as a detection mechanism has the advantages of being cheaper than most methods and allows for high initial throughput screening. In addition, its sensitivity allows for testing at toxicity levels below stipulated legal limits.

Report No: KV 276/11

Implementation of ecological hazard assessment of industrial waste discharge: A comparison of toxicity test methods (NJ Griffin; WJ Muller & AK Gordon)

The National Water Act provides for water in sufficient quantity and in sufficient quality for basic human needs and for maintenance of aquatic ecosystem function. In order to achieve this, discharge of effluents into water bodies needs to be managed so as not to compromise water quality. In the past, the main method for assessing whether effluents could be discharged was based on discharge criteria structured around substance-specific guidelines. Although useful in management of effluent discharge, these were found to have flaws as a result of the difficulty in predicting toxicity. An approach known as Direct Estimation of Ecological Effect Potential (DEEEP) was proposed as a means of circumventing the shortcomings of direct toxicant monitoring. DEEEP proposes a battery of tests to directly assess effluent oxygen demand, lethal (acute) and sublethal (chronic) toxicity, bioaccumulation, mutagenicity, and persistence potential of effluents, using test organisms from a range of trophic levels. When proposed, it was recognised that implementation of widespread toxicological testing in South Africa may be limited by the base of skills and facilities for toxicological testing. One possible route to simplify adoption of testing may be the use of commercial toxicity test kits that can be used to undertake many of the tests proposed under DEEEP. The kits require relatively little labour to undertake and remove the necessity of maintaining cultures of test organisms. This project examines the suitability of commercial toxicity test kits for use under DEEEP in South Africa.

Report No: 1854/1/11

Development of an indicator methodology to estimate the relative exposure and risk of pesticides in South African surface waters (JM Dabrowski; K Schachtschneider; TA Ross; S Bollmohr & M Thwala)

A number of studies performed in South Africa illustrate that pesticides are frequently detected in surface waters across a variety of agricultural settings. Despite these findings, the potential impact of pesticides in South African surface waters has generally been a low priority and, as such, has generally not been considered in aspects of water resource management. Although intensive monitoring and sampling can identify pesticide impacts, the cost of sampling and analysis makes this a highly costly exercise. As a result there is a need to develop cost-effective methods of predicting the environmental risks of pesticide use on a catchment specific basis. This study examined the application of pesticide risk indicators as a meaningful tool to predict the relative impacts of pesticides on water quality through integrating pesticide use, toxicity and physico-chemical data of pesticides

with site-specific geographic and climatic characteristics. It is anticipated that the developed methodology will allow users to assess and rank pesticides in terms of their risk (i.e. from low to high) to the aquatic environment, thereby encouraging informed and responsible decision-making with respect to management, monitoring and mitigation of pesticides in agricultural catchments.

Report No: 1853/1/11

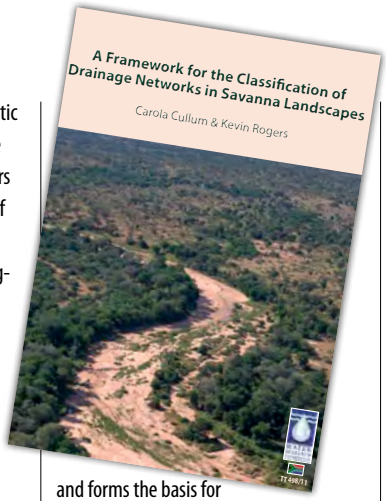
Aquatic toxicity testing in South Africa: Status of aquatic toxicity testing in South Africa (AA Chapman; EA Venter & H Pearson)

Standardised toxicity test protocols and the application of these tests in the assessment of complex industrial wastes have led to routine toxicity testing in many countries for compliance and regulatory monitoring. Toxicity limits are set by the regulatory authority and are used in the same manner that chemical limits are used. The aims of this project were to compile a quality assurance manual to guide South African aquatic toxicity testing laboratories; to develop an implementation plan for the Department of Water Affairs for routine toxicity testing; and to develop a guideline to promote a sustainable network between toxicity testing laboratories.

Report No: TT 498/11

A framework for the classification of drainage networks in savanna landscapes (C Cullum & K Rogers)

The intertwined landscape patterns of water, soil, vegetation and topography are not easy to disentangle, since they occur across many scales and are influenced by the local characteristics of each factor as well as by the climate, geology and relief of the setting in which they occur. However, despite this landscape complexity, in semi-arid environments the distributions of vegetation and soils are often spatially aligned and occur in patterns that are both cause and consequence of topographically controlled water fluxes. Although the coupling of soils, vegetation, hydrology and topography has long been recognised



and forms the basis for the mapping of both soils and ecological regions, there is no standardised approach to such tasks. Indeed, many of these efforts struggle to find appropriate scales and variables to describe landscape patterns and the processes that give rise to them. The framework presented in this report aims to resolve these issues by introducing a hierarchical approach that facilitates the synthesis of knowledge across many disciplines.

Report No: 1848/1/11

Nitrate removal for groundwater supply to rural communities (S Israel; G Tredoux; A Maherry; P Engelbrecht; J Wilsenacht; J Germanis & N Jovanovic)

This report documents a three-year study regarding nitrate in groundwater in South Africa. Funded partly by the WRC and partly by the CSIR, it undertook to evaluate nitrate distribution and priority area identification for remediation; review nitrate removal technologies worldwide; construct and monitor operational field-scale units for demonstration of nitrate removal for safe water supply & develop guidelines for technology transfer of groundwater treatment techniques for nitrate removal for designated purposes. This project successfully tested denitrification processes for treatment of water for potable and other purposes in both the laboratory and field settings. It was found that nitrate levels were halved in the laboratory, and reduced to well within the maximum guideline values for the field where tested with in-situ treatment with a carbon barrier.

Report No: 1828/1/11

Sewer system planning made simple – for small communities (HE Jacobs; K Fair; AH de Klerk & B Bester)

Over the last decade in South Africa there has been a government drive to provide basic services to all residents. This resulted in considerable development in certain areas of the country and particularly in providing new sewer systems. South African sewer systems and storm drainage systems are designed as separate systems, while the sewer system is commonly waterborne. This research project focused exclusively on separate sewer systems and specifically on the planning of waterborne sewer systems. The key objective was to address the need for simple tools to assist staff at all levels of local and regional authorities to complete a basic assessment of their sewer systems through compilation of basic inputs and generation of useful outputs. This research also gives structure to the sewer system planning process (often termed 'master planning') and provides a methodology for compiling a sewer system plan.

Report No: TT 460/11

Water related microbial disease guidelines Volume 5: What we and our children need to know – Health and hygiene awareness (Natasha Potgieter)

This guidelines document presents the fifth in a five-volume series aimed at addressing the question of how best South Africans can protect themselves from water-related microbial diseases. It provides practical guidelines and awareness of hygiene and sanitation practices at the household level from the point of view of the family and the range of actions which family members need to undertake in order to protect themselves from infectious and emerging diseases. The primary target audience for this guideline includes mothers, grandmothers, caretakers of children and males (where appropriate) who have responsibility for improving hygiene standards at the household level, community workers and teachers.

Report No TT 504/11

Aquatic toxicity testing in South Africa: Guideline for the accreditation of routine aquatic toxicity testing laboratories (AA Chapman, EA Venter & H Pearson)

This short document provides an overview of the procedure for applying for accreditation in South Africa. It also describes a four-tier quality management system and related documents. The accompanying DVD contains these latter documents (about 200). The guideline forms part of a larger project which aimed to compile a quality assurance manual to guide South African aquatic toxicity testing laboratories; to develop an implementation plan for the Department of Water Affairs for routine toxicity testing; and to develop a guideline to promote a sustainable network between toxicity testing laboratories.

Report No TT 394/10

Water quality data and information: A communicator's manual (K Murray; K Dabrowski; L Hill; M du Preez; M Kadiaka & W Strydom)

This manual rose out of a perceived need to provide recommendations for the way in which data and information relating to water quality can best be communicated to various target audiences. Improving this communication allows the full value to be realised of the generally considerable investment in data acquisition. This manual is aimed primarily at people responsible for such communication both in the public and private sectors. The manual is introductory, not exhaustive. A wide variety of situations are covered. Accordingly, a number of mechanisms are provided for finding information in the manual.

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Aquaculture in South Africa: FROM FINGERLING TO PRIZE CATCH

A recently completed project initiated and funded by the Water Research Commission (WRC) has done much to raise the profile of aquaculture in South Africa. Article by Lani van Vuuren.

Today, the farming of aquatic organisms, or aquaculture, is the fastest growing animal food producing sector in the world. According to the Food and Agriculture Organisation of the United Nations (FAO), farmed fish now accounts for nearly half of the world's total food fish consumption. In 2008 (the latest figures available), global production of fish from aquaculture reached 52,5 million tons. The sector is dominated by the Asia-Pacific region, which is responsible for nearly 90% of global farmed fish production.

The accelerated growth of the sector has mainly been ascribed to concerns around wild fisheries and threats of overfishing to world fish populations; increases in the demand for fish due to population growth and awareness of health benefits of fish; an increase in the real price of fish as well as the development in fish farming technology, resulting in a significant rise in the number of new species being farmed.

The sector has been slower to take off in sub-Saharan Africa, and only 0,5% of the world's farmed fish comes from this region, however, the last decade has seen the sector taking off in many African countries as governments have realised the importance of fish as a high-protein food source and seen the potential of aquaculture to relieve hunger and improve livelihoods. The bulk of aquaculture production in sub-Saharan Africa is from freshwater, predominantly of the indigenous and ubiquitous species of tilapias and African catfishes.

AQUACULTURE IN SOUTH AFRICA

The aquaculture sector in South Africa remains low in regional and world terms. The sector has a complex history in South Africa. Various government agencies promoted freshwater aquaculture here during the late 1960s to 1980s, and several well-equipped hatcheries were constructed mainly in the

former 'homeland' areas to supply fingerlings to private and government projects. However, of the 13 government hatcheries then existing, only three are still operational but at reduced capacity and efficiency. Some commercial aquaculture enterprises have been established successfully since 1994, the most successful being focused around high value fish (like trout for restaurants) and shellfish (like abalone).

The potential of freshwater aquaculture in South Africa is said to be partly constrained by the natural environment. Firstly, water is a scarce resource, while the country is subjected to extreme seasonal temperature fluctuations over much of the interior. For example, winters over large parts of the interior are too cold for economically viable production of many warm-water aquaculture species, yet the summers in the same areas are too warm for cold water fishes.

However, despite these constraints, it is believed that aquaculture can make a valuable contribution in alleviating hunger and improving rural livelihoods. "In recent years government has, through initiatives such as the Zero Hunger Programme, encouraged rural communities to not only become self sufficient in food production, but also to produce enough to sell. Aquaculture can certainly add to these efforts," says Qurban Rouhani, WRC project leader and Progamme Manager of the Rural Fisheries Programme at Rhodes University. "We are also seeing a local increase in the demand for fish from both the urban and rural sectors linked to its health benefits, although the connection to aquaculture as a method of meeting this demand for fish has not sufficiently been made."

AQUACULTURE AND THE WRC

Over the last decade, the WRC has initiated and invested in a number of research projects on aquaculture. The first was a baseline study on the contribution of aquaculture to rural livelihoods in South Africa. In this report, published early in 2004, a number of priorities for further research were identified. (For more on this study see 'Aquaculture gets a second chance in South Africa' in *the Water Wheel,* May/June 2005).

Courtesy Rhodes University

Courtesy Rhodes University

Top: *Fish being sold along the roadside in Limpopo. Farmers can establish a considerable number of customers by selling fish informally.*

Above: *Stocking a dam with trout fingerlings in the Western Cape Province, as part of a project to develop emerging farmers.*

Courtesy Rhodes University

Courtesy Rhodes University

Top: *Extension officers from the Limpopo Department of Agriculture visiting a rural fish farmer.*

Above: *An emerging farmer with fish from a dam in the Eastern Cape.*

"All of our counterparts in the various provincial departments expressed a need for the technical support this project brought them, and were genuinely engaged with the team."

In cooperation with Rhodes University, widely-based consultation with provincial departments of agriculture followed. Given the support that was expressed, a participatory action research project was consequently undertaken to evaluate the role of State hatcheries. This finally led to the latest report from Rouhani and colleague, Prof Peter Britz of the Department of Ichthyology and Fisheries Science, namely *Participatory Development of Provincial Aquaculture Programmes for Improved Rural Food Security and Fisheries Science*, published late last year.

WRC Director: Water Utilisation in Agriculture, Dr Gerhard Backeberg, explains that this research work coincided with the evolvement of a national policy on aquaculture, driven by the Department of Agriculture, Forestry & Fisheries (DAFF), who also co-funded the WRC solicited research projects. "This makes the implementation of policy through provincial aquaculture strategies possible."

PROVINCIAL AQUACULTURE STRATEGIES

One of the outputs of this project was the formulation of aquaculture strategies in participation with department of agriculture personnel in most provinces. According to Rouhani there was significant support from the various provinces for this project. "All of our counterparts in the various provincial departments expressed a need for the technical support this project brought them, and were genuinely engaged with the team."

Interestingly, for many provincial department officials, it was their first involvement with aquaculture. Unfortunately, the project exposed the often severe organisational and capacity challenges faced by the provincial departments. "In evaluating the project it is clear that some of the

project goals were not achieved due to organisational constraints within the provincial departments," it is stated in the final report. "Of particular concern is that farmers were not effectively engaged with or support provided. Aquaculture capacity building within the department is a long-term process that will require national guidance and coordination."

A key requirement for successful aquaculture programmes is that provincial departments are well organised, notes Dr Backeberg. "It requires recognition of a separate function for aquaculture with trained and dedicated staff and coordination of technical services at hatcheries as well as extension services to farmers. Continuity of personnel is essential for achieving service delivery to establishing viable aquaculture enterprises in rural areas."

This raises the question of whether the provincial departments are the most appropriate public sector organisation for establishing a new sector such as aquaculture. However, it is believed that some form of State intervention will always be required, especially for emerging farmers.

"Aquaculture will only be viable if it is profitable and attractive for investment by private sector commercial interests," adds Dr Backeberg. "This means that aquaculture development has to be market led, meeting consumer demands at lowest possible cost, but also requiring government support."

Specific attention has to be given to establishing new, emerging small business farming enterprises with opportunities for employment creation in rural areas. "This purpose can be achieved with public-private partnerships in which State hatcheries are operated by competent technical personnel producing fingerlings for profitable enterprise by farmers with extension services linked to these development nodes," adds Dr Backeberg.

An important first step in the development of rural aquaculture has been the development of draft provincial aquaculture strategies in participative workshops for the Limpopo, Mpumalanga, KwaZulu-Natal, Free State, Northern Cape and North West provinces. The strategies provide a valuable 'road map' for the provincial agriculture departments to plan and develop aquaculture in the provinces.

Courtesy Rhodes University

Left: *Aquaculture is not just about producing food. Here a farmer in KwaZulu-Natal is sorting fish for the ornamental fish trade.*

Below: *The African aquaculture sector has grown drastically in the past decade.*

REVITALISATION OF STATE HATCHERIES

In addition, the project undertook the revitalisation of selected existing provincial hatcheries to act as development hubs for emerging farmers, from which to provide services such as advice, training and fingerlings. The facilities were found to be in a general state of disrepair, operating on low budgets and with few skilled staff, and were not performing. A critical aspect was that the operation of these provincial facilities had no guiding policy and their existence seemed to be dislocated to the needs of the province. The project team was able to provide technical support not only in the training of staff at various provincial hatcheries, but also to develop strategic plans on the revitalisation and operation of these hatcheries in close cooperation with the provincial agriculture departments.

One of the hatcheries to receive a makeover was Turfloop hatchery near Polokwane, in Limpopo, which was originally established in 1982 as a catfish production and research facility under the former Lebowa homeland. The facility, which ceased operation in the early 1990s, began operating again following investment of the provincial agriculture department and support by the WRC project team.

Niall Crotty/Wikipedia

In 2008, catfish were spawned again on the site for the first time in ten years. By 2009, Turfloop was producing its first male tilapia with technical assistance from Limpopo University's aquaculture unit. Although there is still much work to be done a valuable and substantial aquaculture facility is once again in operation.

According to Rouhani, the most valuable lesson learnt during this project is that emerging farmers are not looking for handouts. "Emerging aquaculture farmers need practical advice on how to produce more efficiently and assistance to compete with commercial farmers in the market on a more equal level. While we can provide the technical assistance, it is up to government to create an enabling environment for emerging farmers to become successful."

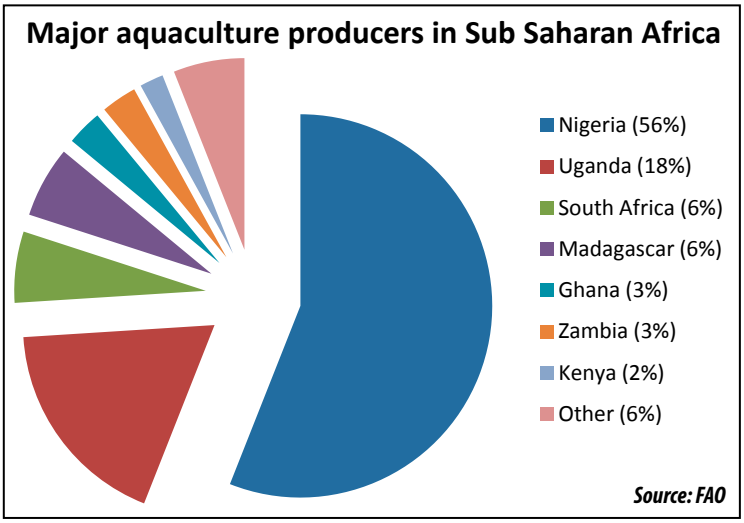
VIABLE FUTURE

Arguably, the most important contribution of the WRC project was to increase the profile of aquaculture in the eyes of the government. "Through our constant communication and interaction with various agriculture department personnel and stakeholders, aquaculture has been placed firmly on the agenda where before it had a very low priority," notes Rouhani. "We have now reached a point of no return with regards to the role of government in aquaculture development. This project has played a role in the process."

A highlight for Dr Backeberg has been the publication of a manual for rural freshwater aquaculture as part of this project, which was guided through the various stages of testing by the Rural Fisheries Programme. "This manual is a most useful practical guide for both farmers and extension officers." The manual covers everything from basic fish biology to setting up ponds, production and shipping, to feeding, health and disease issues. It is envisaged that the manual will continue to be modified and reviewed as aquaculture in South Africa grows.

The WRC is continuing its investment into aquaculture-related research, with a current project aiming to determine the potential of small and large storage dams in South Africa for recreational, subsistence and commercial fishing and the related contribution to rural livelihoods. "If the revitalisation of State hatcheries can be continued successfully, there is a link between freshwater aquaculture and inland fisheries, which as a whole can open up many new opportunities to establish small businesses, create employment, reduce poverty and improve household food security in rural areas," says Dr Backeberg.

Rouhani believes strongly that there is a future for aquaculture in South Africa. "What we lack in climatic conditions for aquaculture production, we make up for in research, technology and innovation. If as a country we can bring all the elements together, such as technical support for emerging farmers and a more level playing field in the market, aquaculture can become a viable, established sector in South Africa."



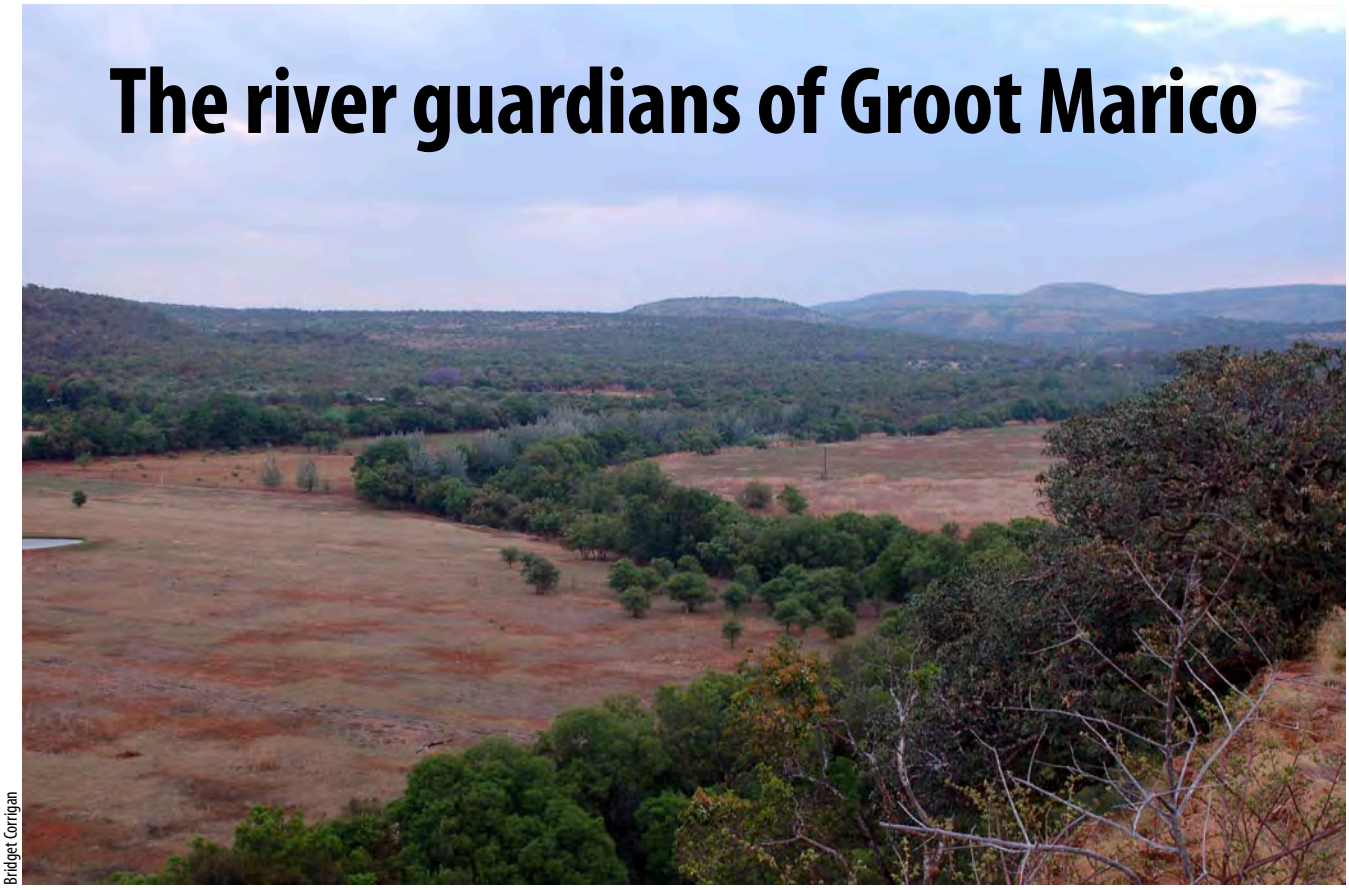
MAIN RECOMMENDATIONS FROM THE WRC AQUACULTURE PROJECT

- Aquaculture development strategies should be market-driven and appropriate State-supported special purpose vehicles, such as public-private partnerships or provincial aquaculture project promotion agencies should be established to drive public and private sector investment projects.
- In terms of hatchery revitalisation, it is recommended that suitable non-governmental organisations, university or economy development agencies facilitate this process in partnership with the provincial departments of agriculture to create viable, market-driven service hubs which address the needs of rural farmers.
- The training of provincial department staff in aquaculture needs to continue at all levels.

Source: FAO

- To access the reports, *Participatory Development of Provincial Aquaculture Programmes for Improved Rural Food Security and Livelihood Alternatives* (**Report No: TT 502/11**) and a *Manual for Rural Freshwater Aquaculture* (**Report No: TT 463/P/10**) contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; Email: orders@wrc.org.za or Visit: www.wrc.org.za to download an electronic copy.

The river guardians of Groot Marico



Bridget Corrigan

Landowners and community members are taking a stand for the conservation of the Groot Marico River, one of the last remaining free-flowing rivers in the country. Article by Petro Kotzé.

The Crocodile (West)-Marico is one of the most developed and economically active water management areas (WMA) in South Africa. Mostly located in the North West Province, parts of it fall in the northern regions of Gauteng and the south-western corner of the Limpopo province, and include the urban areas of northern Johannesburg, Midrand and Tshwane. This WMA is the single largest contributor to our national wealth (25% of the gross domestic product).

The Crocodile and Marico rivers are the two main rivers in this WMA, which at their confluence form the Limpopo River that flows eastwards to the Indian Ocean. The latter, again, is an international river that is shared by Botswana, Zimbabwe and Mozambique. The headwaters of the west flowing Molopo River, a tributary of the Orange River, also forms part of the WMA. Moreover, the area boasts a number of unique features, including the Cradle of Humankind, Pilanesberg Nature Reserve and dolomitic eye system at the source of the Molopo, Molemane and Marico rivers.

Intensive development for economic purposes has come with a hefty price tag. Approximately 30% of the North West province has been transformed to other non-natural land uses and it is rapidly approaching a critical threshold in its state of biodiversity (60% natural habitat remaining). The major driver of this change has been agriculture (73%), while urban expansion (24%) and mining (3%) contribute further. At the current rate of habitat loss, there will be no natural habitat left in the province in 60 years' time. It is estimated that about 40% of the province's ecosystems are under severe pressure, while 11 of the 61 vegetation types and 14 of the 18 river types in the province have been classified as threatened in terms of their ecosystem status.

This state of affairs has not gone unnoticed. Following their relatively recent entry into the arena of freshwater conservation, the Endangered Wildlife Trust (EWT) has launched the Crocodile-Marico Catchment Conservation Project, funded in part by the Elizabeth Wakeman Henderson Charitable Trust and, more recently, Rand Merchant Bank. Activities are guided by the National Freshwater Ecosystem Priorities Areas (NFEPA) project, which identifies a national network of freshwater ecosystems that should be priority conservation areas.

The EWT pilot project is taking place together with the local Marico Catchment Conservation Association (MCCA), a group of community members and landowners situated

Bridget Corrigan

A tufa waterfall on a private farm located in the area surrounding the headwaters of the Groot Marico River is one of the area's many special features. It is formed when water runs over dolomite rock, absorbs calcium and deposits rock formations quicker than it erodes the surrounding rock.

around the headwaters of the last remaining free-flowing river in the semi-arid north-western region of the country, the Groot Marico. The area has rural characteristics and comprises limited dryland farming, vegetable production and grazing and much of the unique dolomitic eyes characterising the unique biodiversity of the Marico system are located here.

If the programme is successful, it can be applied to other areas in the WMA to improve the province's significantly under-representative Protected Areas (PA) network, under which only 2,84% of the province was classified in 2008.

The initiative calls for landowners in the specific FEPA to have their property declared as Protected Environments or Nature Reserves and to sign Biodiversity Stewardship Agreements. "As the principal stakeholders, the community must ultimately take ownership of their catchment," says Bridget Corrigan, Healthy Rivers Project Executant of the Source to Sea Programme at EWT.

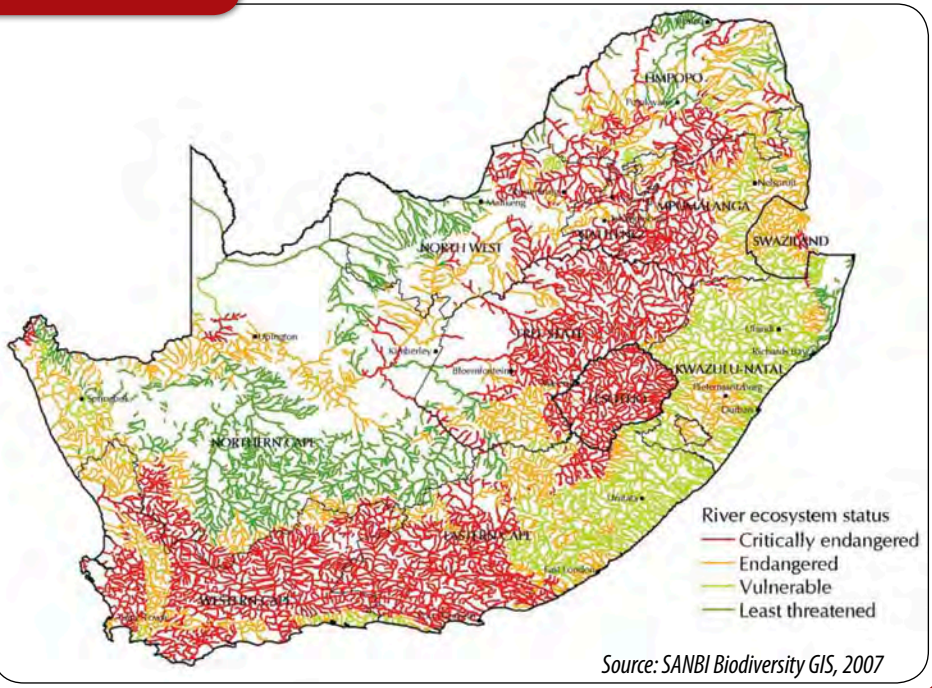
CONSERVATION FROM THE GROUND

Biodiversity Stewardship recognises landowners or users as custodians of their land, including the biodiversity and natural resources. It entails voluntary, legal agreements which promote the wise use and management of these resources and the services it provides; in other words, sustainable use of their properties. These sites can then contribute to the protected areas and biodiversity targets that need to be met by provincial departments.

An initiative of the national department of Environmental Affairs in partnership with key conservation organisations, the Biodiversity

THREATENED RIVERS MAP OF SOUTH AFRICA

Only 22% of South Africa's river length has been identified as FEPAs. By treating less than a quarter of our rivers as priority areas and ensuring they are minimally used, South Africa will be able to conserve natural examples of its diverse freshwater ecosystems while contributing to sustainable development of water resources in the country. Throughout South Africa, freshwater ecosystems are under severe pressure with more than 80% of our rivers being threatened. Where rivers fall within protected areas, they often form the boundary of that area, and not the focus, which is usually terrestrial. Nature reserves or conservation agreements only protect 7% of the total river length in South Africa (not including privately owned areas) and about one third of South Africa's main rivers define the boundaries of protected areas rather than occur within them, and therefore cannot be considered sufficiently protected.



Source: SANBI Biodiversity GIS, 2007

THE BIOSPHERE RESERVE

A Biosphere Reserve is a representative ecological area with three mutually reinforcing functions: conservation, sustainable development and logistic support for scientific research and education. Collectively, all biosphere reserves form a world network linked by exchanges of experience and knowledge. They are part of a UNESCO Scientific Programme, governed by a "soft" law, the Statutory Framework for Biosphere Reserves, adopted by the UNESCO General Conference and which all countries are committed to apply.

In the case of a perceived problem, like plans to construct a mine within the site, the Biosphere Reserve status should be used as a platform for dialogue to arrive at an optimal solution. Examples in South Africa include the Cape West-Coast-, Kogelberg-, Waterberg- and Kruger to Canyon-Biosphere Reserves.

Source: ***www.unesco.org***

Stewardship South Africa (BSSA) programme was originally pioneered in the Western Cape by the Botanical Society of South Africa and Cape Nature, but has since found its way to KwaZulu-Natal, Mpumalanga, the Eastern Cape, Gauteng and the Northern Cape.

There are a range of stewardship options, all of which are voluntary and can be tailored to the specific needs of the landowners. The higher categories offer more incentives (benefits) and support by the relevant department but they also offer more restrictions and require greater commitments from the landowners. In essence, says Corrigan, you have to understand what people need from their land. If they need, for example, to have a large area for cattle grazing you would rather go for a more flexible option.

Properties can be secured through Conservation Areas, Biodiversity Agreements, Protected Environments or Nature Reserves (listed from lowest to highest protection offered). Conservation Area status, for example is suitable for any land, requires no defined period of commitment and entails few land-use limitations. At the other end of the spectrum, Nature Reserve status is suitable for priority areas adjacent to statutory reserves and which contain critically important species, habitats and self-contained sites. Landowners have to commit for a minimum of 30 years while no further development or land-use rights will be allowed. Owners retain the title, and access and resident rights are unrestricted (see table). In return, owners could receive (depending on the provincial agreement) sustainable assistance with biodiversity services and other benefits.

"The aim," says Daan van der Merwe, MCCA chairperson, "is to make your land available for conservation while still being able to use it." He adds that in the Marico area reaction from landowners has, in general, been positive. About 80 landowners have become members of the MCCA and have pledged their land as part of the initiative, covering an area of approximately 25 000 ha in the Groot Marico district. A provisional agreement has also been reached between the MCCA and the local kgosi's to include the 350 000 ha of communal land in the application. An application to have the properties declared as either Protected Environments or Nature Reserves has been handed in to the MEC of the North-West Department of Economic Development, Environment, Conservation and Tourism (NWDEDECT). "Ideally you want this entire FEPA declared a Nature Reserve, but it will depend on the willingness of the landowners and the balance between conservation and economic needs," says Corrigan.

The draft proposal must still be made available for public comment, after which it will be gazetted. Corrigan says that the Biodiversity Stewardship site will then be secure, and a management plan can be put in place. Elements that can be built into such a plan include the rehabilitation of degraded sites and riparian zones and the removal of alien vegetation.

Once the area has been proclaimed, development in the relatively pristine headwaters of the Groot Marico would be severely limited. Indeed, it was the prospect of mining activity in the Marico area in 2010 that spurred community members into action, and saw the formation of the MCCA. Due to massive community opposition, African Nickel retracted most of their prospecting rights applications in respect to certain minerals (nickel ore, copper, cobalt, chrome, ore, platinum group metals and gold) on farms on and around Groot Marico.

"We believe that a healthy environment makes for happy people," says van der Merwe. He adds that the area is very special, not only from a biodiversity point of view but also because it is still relatively

The Groot Marico is the last remaining free-flowing river in the semi-arid north-western regions of the country.

Bridget Corrigan

Giela Jonker

Above: *The project will also focus on the conservation of endangered aquatic species, such as the Marico Barb (*Barbus motebensis*) and it is envisaged that the protected areas will serve as fish sanctuaries.*

Below: *The Crocodile (West) and Marico WMA and the area's Freshwater Ecosystem Priorities Areas.*

undeveloped and the head-water is still pure. Peter Phefo, traditional councillor agrees that what makes the river special is that it is so clean. Many of the Koffiekraal community members, where Phefo stays, rely on using water directly from the river. "We need to proclaim it a protected area to sustain the people of the area," he says. He adds that the river, that used to be known as Madikwena, or the 'Mother of Crocodiles', also has significant cultural value for the communities dependent on it.

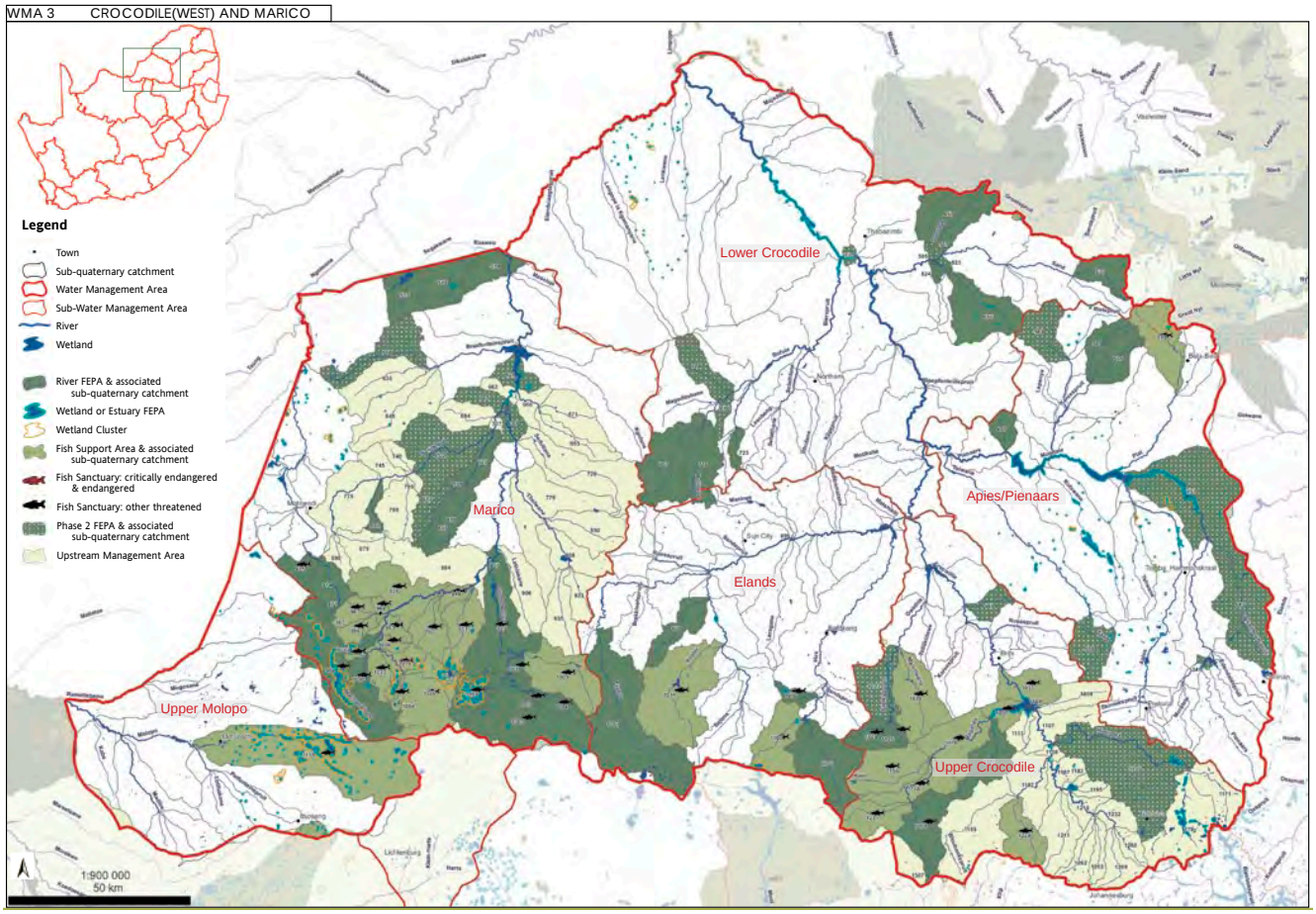
"There isn't another way to do it," says property owner and part-time olive farmer, Danie Steyn, "at the end of the day the responsibility rests with the landowner." Steyn, whose property is located downstream of Marico town tells that they are experiencing "many" problems with water quality. "It used to always be clean and we could swim and drink from it, but today things are different," he says. Even though the headwater of the river is still clean, the water downstream for the town is polluted by, among others, sewage.

WHAT LIES AHEAD?

The expected outcomes of the project include the protection of river segments in Biodiversity Stewardship agreements with a joint management plan in place, the reestablishment and protection of various red data fish species though the development of fish sanctuaries and the development of sustainable use options with the relevant stakeholders to ensure long-term protection of the system.

"At the moment," says Corrigan, "there is no formal Biodiversity Stewardship Programme in the North West Province." She adds that, although it will not prevent the proclamation of Nature Reserves or Protected Areas, having a formal Stewardship Unit in the North West would streamline future applications in the province and would assist the province to reach their Protected Areas Expansion targets for 2013.

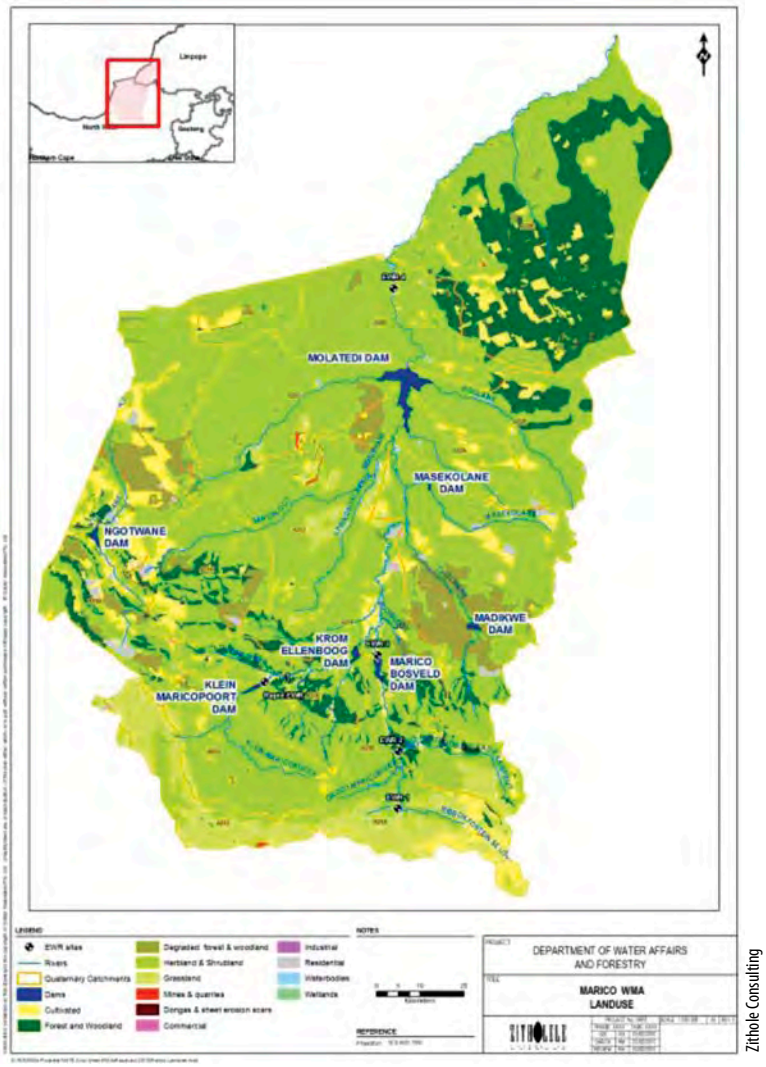
It is thus hoped that a major outcome of the project is the establishment of a formal house for the stewardship programme with a clear understanding of the roles and responsibilities of all relevant people. It is envisaged that NWDEDECT will champion the development of the Biodiversity Stewardship concept in



the North West, using the National Standards developed through Biodiversity Stewardship South Africa (BSSA). This will be done in collaboration with the North West Parks and Tourism Board and MCCA.

The declaration of the protected areas at the headwaters of the Groot Marico River will also serve as the foundation for the establishment of a UNESCO Biosphere Reserve (see sidebar) and, if successful, the Biodiversity Stewardship initiative can be applied in other areas. Two sites have already been earmarked. These are the Sondagsrivier/Vaalwaterspruit FEPA in Limpopo province (situated at the northeast border of the Crocodile-Marico WMA) and the Hex River/Sterkstroom FEPA in Gauteng. "In these areas we would try and establish or support land-owners associations first, and then take it from there," says Corrigan.

"We will never be done," she adds. The EWT will always be providing support to the Marico Protected areas and the communities as they need it as it will remain one of our key sites. The EWT will, however, aim to empower the landowners, as main stakeholders of the area, to carry the main responsibility for the conservation of the natural area that they are dependent on. ❑



Land use in the Marico system.

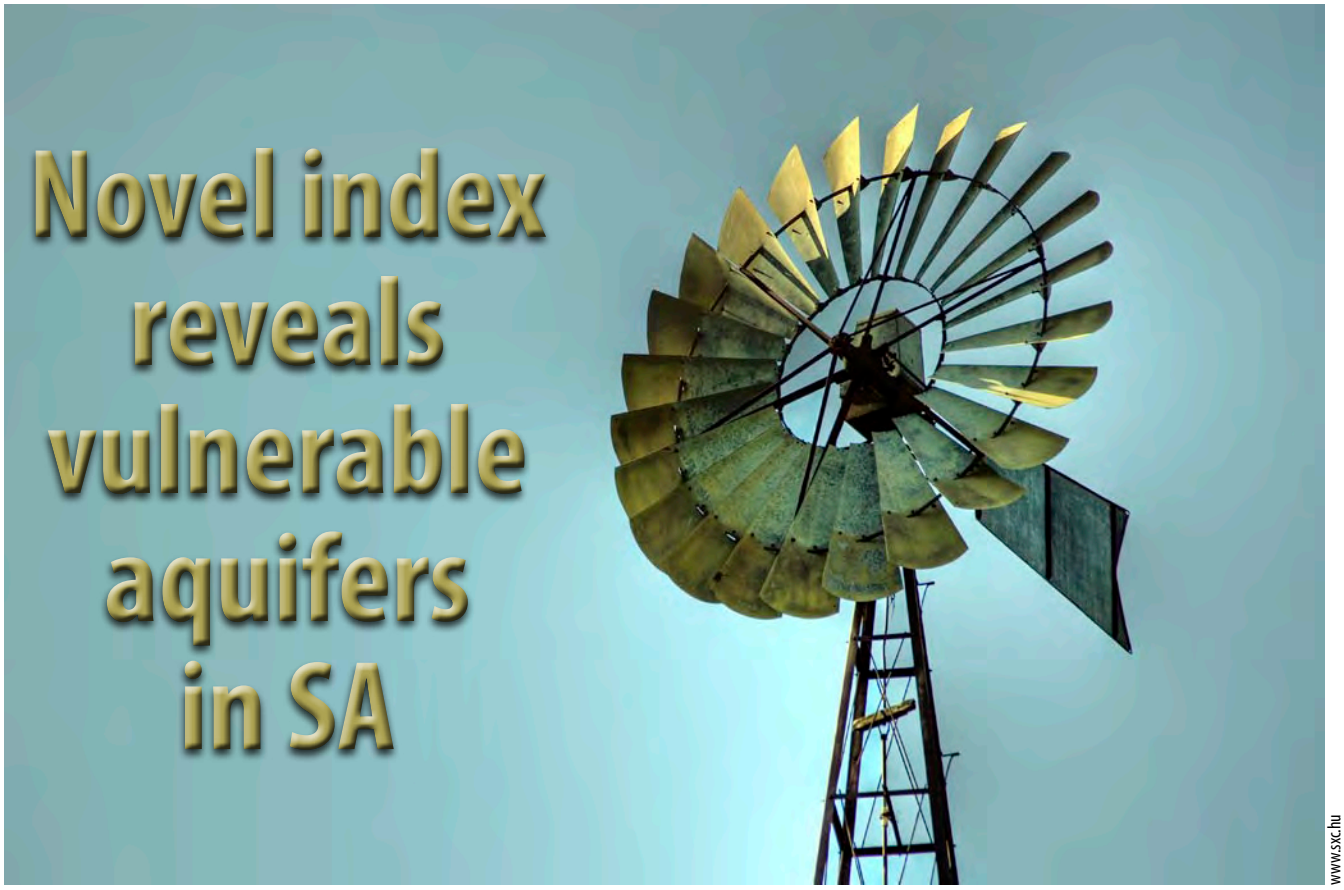
Zithole Consulting

Stewardship options

Option	Level 1: Conservation Area	Level 2: Biodiversity Agreements	Level 3: Protected Environment	Level 4: Nature Reserves
Which option applies to your land?	• Any natural land is suitable • If rare or endangered habitats, rather progress to higher level of conservation security	• Suitable for any conservation-worthy land • Not excluding small and isolated fragments	• Large landscapes requiring some form of conservation management, but unsuitable to restrict other forms of land use. • Buffers to statutory PAs	• Priority areas adjacent to statutory reserves or sufficiently large to be self-contained ecosystems • Containing critically important species, habitats
Legal status / duration	• Flexible option with no defined period of commitment	• Minimum period of 5 - 10 years suggested, but may be in perpetuity if so requested	• Legal declaration under the PA act • The duration is not prescribed	• Minimum of 30 years to in perpetuity
Possible land use limitations	• Very few, but the area needs to maintain its natural character	• Land must be managed in a way that will support natural processes	• No limitation on activities other than those listed in the gazetting notice	• No further development or land use rights • Access and resident rights unrestricted • Owners retain title
Benefits to the landowners	• Advice and support through basic extension services • Assistance with management plans and farm maps	• Specific agreements for fire, alien, plant and animal management • Advanced extension services (e.g. alien clearing planning)	• Specific agreements for fire, alien, plant and animal management • Advanced extension services (e.g. alien clearing planning)	• Sustainable assistance with habitat management • Recognition and marketing exposure • Lobbying on your behalf for incentives e.g. rates exemptions

Source: Information as supplied by Ezemvelo KZN Wildlife. Other provinces may differ.

Novel index reveals vulnerable aquifers in SA



www.sxc.hu

The potential impact of climate change still leaves more questions than answers. One area of research that is only now being explored is the potential effect of a changing climate on South Africa's groundwater resources. Article by Lani van Vuuren.

The recent United Nations Conference on Climate Change or COP17, held in Durban during December 2011, again emphasised the challenges South Africa faces in adapting and mitigating against the potential effects of climate change. South Africa already is a water scarce country and, while the exact nature of our future climate remains uncertain, further changes in respect of water availability as a result of changing rainfall patterns, extreme weather events and increased evaporation are predicted.

The potential impacts of climate change on water resources and hydrology in southern Africa have received considerable attention from hydrologists during the past decades. In areas such as the western parts of the country, where rivers are expected to become potentially drier in future, alternative sources such as groundwater have been put forward to keep up with future water demand. Yet, while groundwater forms an inextricable part of the hydrological cycle and is bound to be potentially impacted by shifting climate patterns in the same way as surface water resources, hardly any research has been done on the subject to date.

"The question of the likely impact of climate change on renewable groundwater resources is highly relevant," explains Dr Rainier Dennis of the Centre for Water Sciences and Management at North West University. "Climate change can potentially affect groundwater levels, recharge and groundwater contribution to the baseflow of rivers."

One possible reason for the dearth of knowledge regarding the potential impact of climate change on groundwater is that such studies normally require extensive time series records. "Traditionally, hydrological records are more easily available due to the fact that the resource is visible as opposed to groundwater," explains Dr Dennis. "The longest South African time series record with respect to groundwater levels does not exhibit any behaviour that can conclusively be attributed to any form of climate change."

REGIONAL INDICATOR

Dr Dennis and his research team have now successfully developed a regional screening tool with funding from the Water Research

Commission (WRC). This is seen as a first step in assessing the impact of climate change on South Africa's aquifers on a regional scale. "Aquifer recharge and groundwater levels interact, and depend on climate and groundwater use," explains Dr Dennis. "Each aquifer has different properties and requires detailed characterisation and eventually quantification."

The so-called DART methodology uses different parameters (**D**epth to water level; **A**quifer type (storativity), **R**echarge and **T**ransmissivity) to come up with an index that serves as a regional indicator of areas that are potentially vulnerable to the effects of climate change with respect to groundwater. Datasets of each parameter are generated over the whole of South Africa for the generation of this index for every month of the year for a certain climate change scenario.

The team considered two scenarios – one current and one future. The current scenario is representative of present precipitation patterns while the future scenario is representative of the predicted scenario based on a selected global circulation model (GCM). The future scenario selected assumes a moderate to high growth in greenhouse gas concentrations. GCMs are the primary tools for the projection of climate change from which data is downscaled for specific regions. The downscaled datasets for this project were made available by the Climate System Analysis Group at the University of Cape Town.

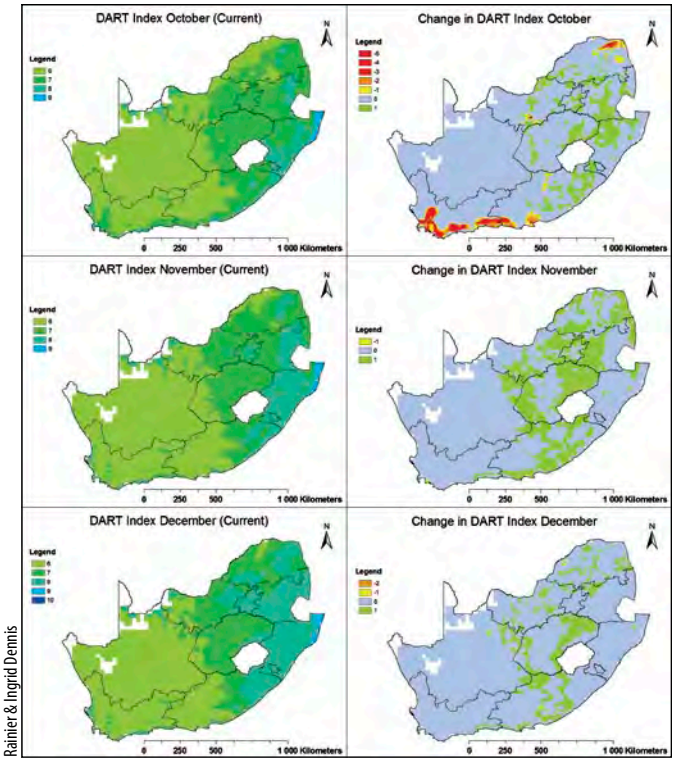
At first, it does not seem as if the country's aquifers will be that vulnerable to the potential effects of climate change. However, a closer look at the index reveals a different tale. "If the annual average change in the DART index is calculated then we do not see such a big variation in figures," notes Dr Dennis. "However, the index does show a substantial change for certain areas if one examines the results per month for the scenario tested. This implies that groundwater in affected areas will be more vulnerable in certain months than in others. Detailed studies on local scale will have to be performed, however, to verify that vulnerability can be managed."

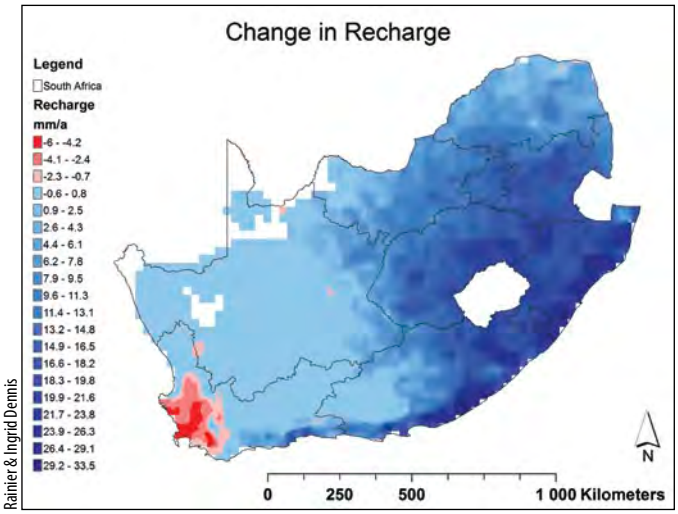
By far the greatest challenge of the project was the lack of available groundwater data. The availability of regional data to support the DART index was a major consideration in the selection of parameters. "Initially the index calculation required more parameters than the current four that are being used, but in the end we had to simplify the calculation based on the dearth of available data," Dr Dennis tells *the Water Wheel*.

SUSTAINABLE MANAGEMENT

Regardless of the future climate scenario, for groundwater to remain a reliable resource it has to be sustainably used and managed. "Sustainable management, in turn, is based on sound monitoring of the resource," says Dr Dennis. "It is quite simple to verify if a borehole is being used in a sustainable manner if long-term water level measurements are available. Therefore we encourage all groundwater users to undertake regular water level monitoring as a general rule of thumb."

More research is required to say for sure if and how South Africa's groundwater resources will be affected by climate change. Due to the current lack of groundwater monitoring records, present research is dependent on the output of climate change models to produce possible future scenarios. There are quite a number of climate models available, each with its own suite of potential climate change scenarios. To complicate things further the output of these models are downscaled to the area of interest. This introduces a whole lot of uncertainty with respect to which model and which scenario to use. "Methodologies developed around climate change can be tested with various scenarios but we need more certainty as to which scenario we can expect for us to appropriately react to the expected changes," notes Dr Dennis.



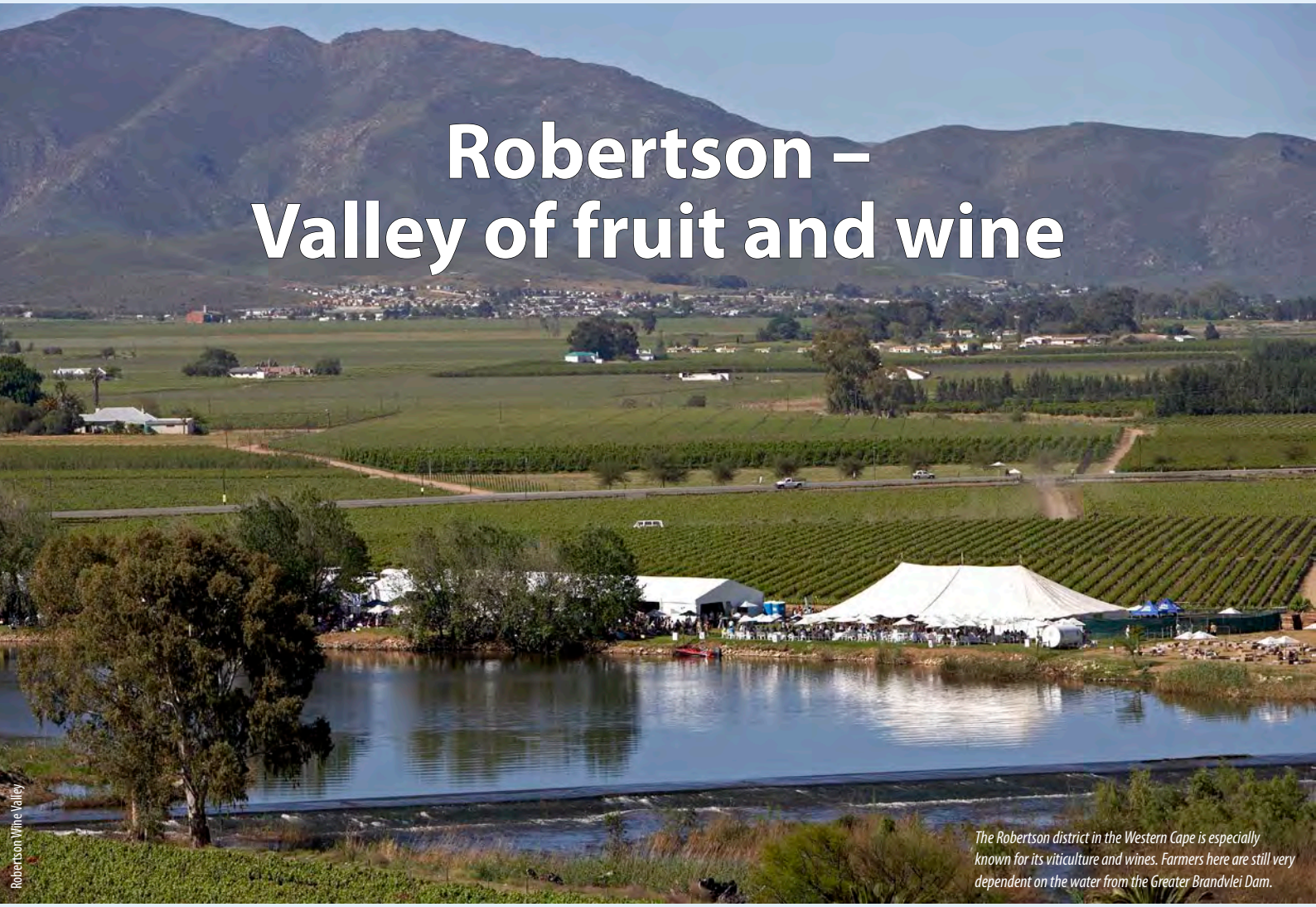


Top: *The DART index showing the expected change between current and future climate scenarios for the period October to December.*

Above: *The projected change in annual recharge between current and future climate change scenario.*

It is expected that the knowledge generated by this study will contribute greatly to South Africa's adaptation to climate change, particularly the management of the country's water resources. The methodology is already being used in another WRC-funded study looking at adaptation to climate change. It is hoped that in the end, South Africa will be prepared whatever the scenario. ❑

Robertson – Valley of fruit and wine



Robertson Wine Valley

The Robertson district in the Western Cape is especially known for its viticulture and wines. Farmers here are still very dependent on the water from the Greater Brandvlei Dam.

In the area of Robertson, in the Western Cape, lies one of the oldest irrigation districts in South Africa. Article by Lani van Vuuren.

With a total catchment area of 12 600 km^2 the Breede River (also called Breë, meaning 'broad') is one of the largest rivers in the Western Cape. The river lies on the East Coast of the Western Cape and originates in the Ceres valley, from where it drains in a south-easterly direction, cutting through Mitchell's Pass and meeting the Indian Ocean at Witsand (Sebastian Bay). The river supports a key agriculture region, known for its wines, fruits and vegetables.

White farmers had settled most of the Breede River valley by the beginning of the 18th century, although large-scale development only took place following the cutting of passes through the mountains a century later. The valley was one of the first areas of South Africa where modern irrigation practices were applied – the earliest known irrigation works on the Breede River date back to the 1860s.

ROBERTSON IRRIGATION SCHEME

One of the oldest State-supported irrigation schemes in the country is situated at Robertson, in the Western Cape. From about 1860, the possibility of irrigating the rich soils along the north bank of the Breede River, reaching from the Vink River to the Kogmanskloof River was discussed among farmers and in Parliament. As far back as 1862, Civil Commissioner of the Robertson District, Mr Le Brun, requested State assistance to establish an irrigation scheme in this area.

Between 1865 and 1875 some minor attempts to use the river for irrigation were made with a certain degree of success. But it was not until 1896, backed by the Cape Irrigation Act, that concrete moves were made to establish irrigation in the area on a large scale. Between 1896 and 1897, at the request of the landowners, surveys were made by the Cape Public

Irrigation Board to undertake the scheme on their behalf. Parliament approved a loan of £23 500 (later increased to £33 000). The period for repayment was fixed at 40 years at an interest rate of three-and-a-half percent. Tenders were called for the work, but the Irrigation Department disapproved of all the submissions received and decided to construct the work on behalf of the Irrigation Board.

Construction of the scheme started in February 1900. Work comprised a diversion weir across the Breede River, about 8 km outside the town of Robertson. Government engineer TE Scaife was appointed Resident Engineer and work was carried out through small contracts and by day labour. The weir was described to be of 'singularly bold design', consisting as it did of a thin concrete wall some 2 m high and up to 0,9 m thick, flanked on both sides by steep slopes of loose rubble without mortar of any kind or other means of securing cohesion. In addition, the base of the wall was not founded on rock, but on gravel about 2,4 m below the riverbed. It was 366 m long.

Construction was interrupted by the South African War and further delayed by the river being in flood. The scheme was not completed until 1904. In 1902, considerable damage was caused to the unfinished weir by high floods in tributaries of the main river where they cross the line of the canal. Surprisingly, this unusual structure withstood the test of time and floods. In 1923, Cape Town Circle Engineer W Farrant notes: "A very small amount of maintenance has been necessary during the last 20 years. It is only recently that some of the loose stone on the downstream slope has been washed out. Floods have risen over 9 feet [2,7 m] in depth on the crest of the weir."

At the time the main crops produced through irrigation from the scheme were grain, lucerne, wine and fruit.

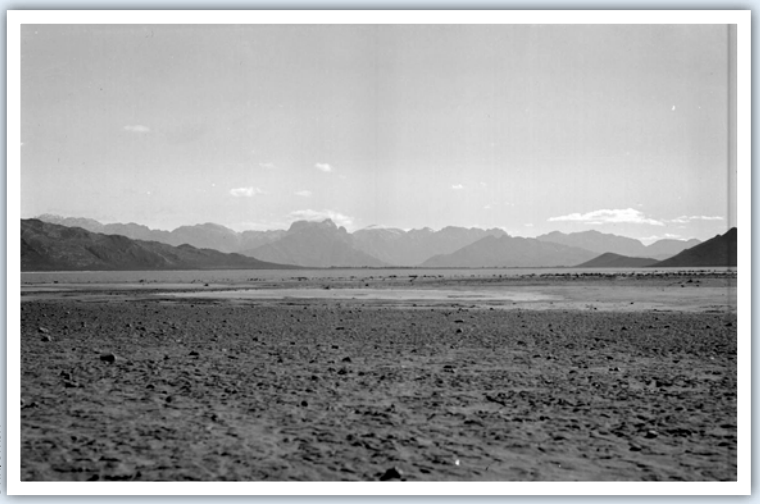
By 1918, several irrigation boards had been proclaimed in addition to Robertson. These included Zanddrift Irrigation Board (proclaimed in 1909), Le Chasseur and Goree Irrigation Board (1910), and Angora Irrigation Board (1917). By the end of the second decade of the 1900s several small weirs and canal schemes had been constructed to abstract water from the river at various points.

Farmers frequently found themselves without adequate water supplies, especially during the dry summer months (the region being dependent on winter rainfall). As far back as 1906 proposals were put forward for the construction of a storage dam at Gerberspoort near Wolseley, together with a high-level canal known as the Ashton Scheme. The scheme appears in various reports of the Cape Irrigation Department until 1909, after which it seems to have fallen off the radar, mainly due to the difficulty in obtaining suitable foundations for a dam.

BRANDVLEI DAM

Following the establishment of the Union Irrigation Department in 1912, the development of water storage works in the Breede River valley again came to the fore. At this time about 7 710 ha of land lie under irrigation in the valley. The department investigated several possible locations along the river and eventually settled for a site situated about 10 km from the town of Worcester.

Here the surveyors found a natural vlei (*Brandvlei*, meaning 'burning

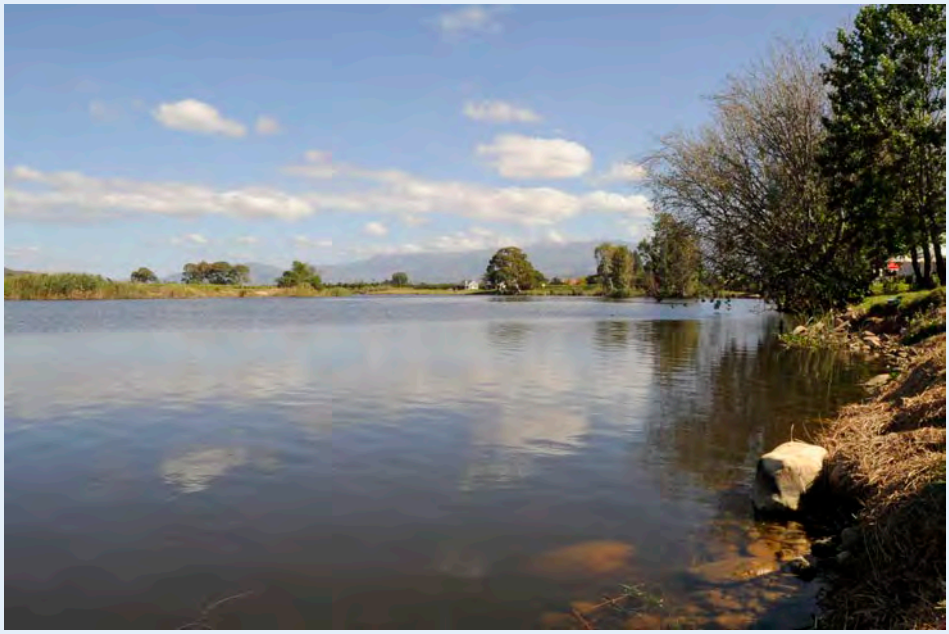


DWA/eWISA

DWA/eWISA

Top left: *A dry Brandvlei Dam, also known as Lake Marais, during the drought of the 1930s.*

Bottom left: *Brandvlei Dam in 1955, prior to its augmentation.*



DWA/eWISA

Above: *The Breede River is one of the larger rivers in the Western Cape.*

Right: *Completed in 1981, Greater Brandvlei Dam is still a major water supplier to agricultural activities in the Robertson area.*

wetland') about 10 km in extent and fed by natural hot springs. The vlei was located close to the Breede River. At times of flood the Breede River backed up into Brandvlei through a gap 550 m in width between the hills flanking the river and formed a large expanse of water. As the river fell, this water receded back through the gap. The department's engineers conceived the idea whereby a dam would be placed across this gap, and filling the reservoir thus formed from the Holsloot River, a tributary of the Breede.

The original design was for a concrete dam, however, test borings revealed layers of sandy clay, sand and gravel, rock bottom being reached only at a depth of about 25 m, in the centre of the gap. Since this would make the cost of a concrete dam prohibitive, the designers instead opted for an earthen embankment without a core wall. A puddle clay apron was to be constructed on the upstream face. This apron extended to a width of 34 m opposite the highest part of the embankment, decreasing in width as it approached the flanks. The original storage capacity of the dam was 45,8 million m^3 and the area of water surface extended 15,5 km^2 (at full supply level).

The Breede River Conservation Board was proclaimed in 1918 to take ownership of the project, and Edmund Burrows was appointed Resident Engineer. Work started in March 1920 under contract with Messrs JW Wilson and Company from Johannesburg. The embankment was pitched on the downstream side as well as upstream to protect it from Breede River floods. In addition, five (hand-operated) regulating sluices, 1,8 m by 0,9 m, with steel gates were installed for the dual purpose of discharging the required water into the river for the numerous irrigation works downstream, and of allowing through floodwater. The total length of the dam wall was 990 m and it had a maximum height of 7 m.

Since the dam would submerge the old road from Worcester to Villiersdorp, it had to be diverted to pass along the crest of the dam, which was built wide enough to accommodate a 6 m roadway. Along the upstream edge of the crest, a metre high masonry wall was built to protect the surface of the roadway and the travelling public from the north-westerly gales which prevailed during winter months. These winds caused a great deal of inconvenience to the construction team.

Halfway through the project severe floods caused serious damage to the works, however, the work was eventually completed in 1922. The total amount of material in the structure of the dam, including apron, pitching and masonry amounted to 172 025 m^3, and the total cost of the project (including roads) was £47 570.

GREATER BRANDVLEI DAM

Like many other dams in South Africa, Brandvlei Dam is

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- Thanks to eWISA and Robertson Wine Valley for photographs

DWA/eWISA

DWA/eWISA

Above and left: *In the 1980s the Greater Brandvlei Dam was created by the concurrent raising of the Brandvlei and adjacent Kwaggaskloof dams.*

plagued by sedimentation, and in 1950 it became necessary to increase the capacity of the dam to 84 million m^3. By 1972, this capacity had diminished to 76 million m^3. During that time the Department of Water Affairs began investigations into suitable off-channel storage sites for a dam to control the runoff of the Breede River. At first it appeared that a dam at the northern exit of the Slanghoek Valley would be most suitable.

The department's engineers had reservations about constructing a major high dam at Brandvlei, mainly on account of the difficulties and high cost expected in the sealing of the pervious foundations at the sight. However, a technology had been developed overseas involving the excavation of a deep and narrow cut-off trench and then filling it with impervious slurry material. Engineers were confident that the method could be replicated successfully at the Brandvlei site.

So, instead the Brandvlei-Kwaggaskloof basin was selected as the site of the new main storage unit in place of the Slanghoek Valley. The project consisted of raising Brandvlei Dam together with the corresponding raising of the adjacent Kwaggaskloof Dam, which was under construction at the time. Several embankments were also built between some of the surrounding hills. These two storage units then became an integrated off-channel storage unit. The original storage capacity of the combined rolled earthfill dam, completed in 1981, was 460 million m^3. Today, the Greater Brandvlei Dam as it is known is still a major water supplier to agricultural activities in the area, specifically the wine farms around Robertson.

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Research project helping to tackle malnutrition in South Africa

A group of researchers led by the University of Pretoria are currently working towards increasing the ability of vulnerable people in South Africa to meet their daily requirements for adequate nutrition. Article by Friede Wenhold, John Annandale, and Mieke Faber.

Malnutrition – in particular under-nutrition amongst children – is rife in South Africa. Numerous studies have shown that it disproportionately affects the rural poor. For this segment of the South African population home production of food may very well be a means of improving the households' food security and the nutritional status of their members.

In water-limiting environments, such as most parts of rural South Africa, it is of utmost importance to focus the promotion of home production of foods not only on those crops and livestock that have the potential to address nutritional deficiencies, but also on food products that are simultaneously water productive. Combining human nutrition needs with water productivity has resulted in a new concept amongst researchers, namely 'nutritional water productivity.'

This is the focus of a scoping study initiated, managed and funded by the Water Research Commission (**Project No: 1954**). The project is being led by the Department of Human Nutrition at the University of Pretoria (UP), supported by the UP Department of Plant Production and Soil Sciences and the Nutritional Intervention Research Unit of the South African Medical Research Council.

ADDRESSING THE NUTRITIONAL PROBLEMS OF THE RURAL POOR

Multiple nutritional deficiencies occur in South Africa. One of the major nutritional problems is vitamin A deficiency, but inadequate iron, zinc and protein status is also common, often in combination.

Vitamin A in the diet is needed for healthy eyes and to boost the immune system. Children who are vitamin A deficient have a lower resistance against childhood illnesses, such as measles, diarrhoea and respiratory infections, and therefore get sick more often. Foods of animal origin are the best sources of vitamin A as they contain preformed vitamin A, but for a large section of the population affordability is a barrier to regular intake.

Dark yellow and orange vegetables and fruits (for example, butternut, pumpkin, carrots, orange sweetpotato, apricots, mangoes, papaya) and also dark green leafy vegetables (for example wild and cultivated leaves such as amaranth or spinach) contain β-carotene. This is a pro-vitamin that is converted in the human body to vitamin A.

Iron in the diet is needed for transferring oxygen from the lungs to tissues, and for electron and enzyme transport. Children and women of child-bearing age are particularly vulnerable to iron deficiency. Iron deficiency leads to anaemia, with fatigue and weakness being common symptoms. In children it is associated with poor cognitive performance. As for vitamin A, foods of animal origin are the best sources of iron. Plant foods, particularly dark green leafy vegetables, also contain considerable amounts of iron, but dietary iron from plant sources is less easily absorbed by the human body.

Zinc in the diet is needed for the body's immune system, for the healing of wounds, for the senses of smell and taste, and for normal child growth. Again, foods or animal origin are good sources of zinc. Other good sources of zinc are nuts, whole grains and legumes. Vegetables and fruit are not good sources of zinc.

Because of the high β-carotene content in dark yellow and orange vegetables and fruits and dark green leafy vegetables, the focus of home production for improved nutrition is often on vitamin A. The production of β-carotene rich vegetables and fruit is affected by numerous environmental factors, including available water.

WHAT IS WATER PRODUCTIVITY?

Water is essential for the agricultural production of plant and animal-source foods. In the case of plants, water productivity considers the yield of a crop relative to the water used to produce it – be it from rainfall, irrigation or groundwater and taking into account productive and unproductive water losses. It is typically expressed as kilograms of crop per cubic metre water. This basic concept of efficiency is deceivingly simple: optimisation of dry matter or "food" production relative to water input. Practical management and measurement is, however, not trivial.

Broadly speaking, a general ranking of water use efficiency of food crops from most to least efficient, would be from vegetables to fruits, then to cereals, oil crops and lastly legumes. One has to consider, however, that vegetables are largely composed of water and a major part of the plant is harvested. On the other hand, legumes are harvested dry and contain significant amounts of protein.

In the case of animal-source foods, some water is used by livestock for drinking, but by far the most is used in the production of feed (and hence the above considerations about plant water productivity again apply), but the processing of carcasses into meat and other (edible) outputs also depletes water. Overall, animal-source products are less water efficient than crops. Amongst the animal source foods a ranking from highest to lowest water productivity would be from milk and eggs, to chicken and pork, to small stock (sheep and goats) and lastly to beef.

NUTRITIONAL WATER PRODUCTIVITY

The nutrients – macronutrients (for example protein) and micronutrients (for example vitamin A) – within the edible output or harvest of crops or animal-source foods are of interest to nutritionists in the food-based prevention of malnutrition. *Nutritional water productivity* combines knowledge of the composition of food products in terms of nutrients (for example the protein or vitamin A content of a food) with knowledge of the water productivity of that food product.

Nickey Wenhold

"Nutritional water productivity combines knowledge of the composition of food products in terms of nutrients with knowledge of the water productivity of that food product."

The result is an index for a given food product which includes nutrient-based output per unit water use, for example micrograms of β-carotene in 100 g raw spinach per cubic metre of water used to produce the food. This knowledge can be used to promote the production of those food products that may contribute to closing the nutrient gaps in vulnerable communities while, simultaneously, leaving a sustainable water footprint.

Water and nutritional health of people are intricately linked: On the one hand enough clean water is an essential part of a healthy environment and water has been called a "neglected nutrient" in human nutrition. On the other hand, *nutritional water productivity* shows that collaboration between agriculture and human nutrition poses yet another prerequisite and challenge for improving food security and nutrition amongst the rural poor in South Africa.

- To read more about the WRC project, 'Baseline and scoping study on water use and nutrient content of crop and animal food products for improved household food security', see page 168 of the *WRC Knowledge Review 2010/2011*, available at: http://wrcwww/Knowledge%20Hub%20Documents/Knowledge%20Reviews/WRC%20Knowledge%20Review%202010-11.pdf

Conserving wetland biodiversity in a concrete jungle

Among crowd-pleasing lions and leopards, the Johannesburg Zoo is also taking care of the survival of a number of South Africa's critically endangered species. Petro Kotzé paid them a visit.

Petro Kotzé

The role of zoos has changed considerably over the years. The Johannesburg Zoo for example, covering 56 ha and founded in 1904, was initially donated to the public for recreational use by the firm of the late Hermann Ekstein. Today, part of its core business strategy is the preservation and management of biodiversity through direct conservation action, education, research and recreation. Reputable zoos such as this one are described as respected scientific institutions that work cooperatively towards attaining serious conservation goals.

The Johannesburg Zoo is guided by the World Zoo and Aquarium Conservation Strategy, published in 2005 by the World Association of Zoos and Aquaria (WAZA). According to this strategy, zoos must strive to integrate all aspects of their work with conservation activities and promote fundamental values of sustainability and social and environmental responsibility. From first charging a visitor over 16 entrance fees in 1961, they now also generate thousands of Rand for direct funding of conservation projects and protection of habitats in the wild.

In February, the zoo, like the rest of the country, celebrated World Wetlands Day. Apart from the official proceedings, the institution also runs two specific programmes dedicated to the conservation of two of South Africa's critically endangered wetland species. While the flagship programme is the Wattled Crane Recovery Programme (WCRP), the Amphibian Conservation Project is also ongoing, and reached an important milestone earlier this year.

In both these cases, the zoo keeps captive populations of endangered species to act as genetic reservoirs or assurance populations and for potential reintroduction to the wild. The WCRP was formed in 2000, when concern over the decline of the Wattled Crane in South Africa led to

Above: *The Wattled Crane enclosure at the Johannesburg Zoo, open for the public to view.*

Below: *Wattled Cranes typically lay a clutch of one or two eggs. One is taken from the nest to a participating facility where they are incubated and hatched.*

Johannesburg Zoo

a Population and Habitat Viability Assessment (PHVA) workshop.

CREATING A VIABLE WATTLED CRANE POPULATION

The Wattled Crane (*Bugeranus carunculatus*) is one of only three crane species indigenous to South Africa and is the most critically endangered crane species on the African continent (the South African Wattled Cranes are also genetically unique from other African populations). Due to habitat loss and renowned poor reproductive success there has been a 35% decline in the South African Wattled Crane population over the last two decades. By 2004, the *in situ* population in South Africa was estimated to be a mere 235 birds. The remaining birds, says Louise Matschke, Johannesburg Zoo curriculum specialist, occur in the Southern Free State and the midlands of KwaZulu-Natal.

Johannesburg Zoo

One of the outcomes of the mentioned PHVA workshop was the recognition of the need for a captive propagation and release programme to ensure species survival by creating a viable genetic reservoir. The South African Crane Working Group of the Endangered Wildlife Trust (EWT) that was involved with the conservation of the Wattled Crane in its natural habitat, partnered with the African Association of Zoos and Aquaria (PAAZAB) and private avicultural institutions to create the WCRP.

This programme aims to firstly, maintain a captive breeding flock to serve as a genetic reservoir in the case of catastrophic extinction of the species in the wild. A second aim is the supplementation of the wild population through the release of captive-reared fledglings into existing wild populations. In 2006, the Johannesburg Zoo took over the management and coordination of the WCRP.

The existing captive flock consists of 30 birds, housed at the

Above: *The zoo's conservation farm in KwaZulu-Natal, showing the Wattled Crane encampments. These birds are monogamous, and the set-up allows the birds to 'check out' potential partners.*

Below: Ex-situ *bred chicks released into the wild will initially be fed with puppets accordingly to a similar successful method applied in the US.*

Johannesburg Zoo

Johannesburg Zoo

Thoko Masina, or 'Mama Thoko", takes care of the Wattled Crane chicks.

Johannesburg Zoo as well as their conservation farm in KwaZulu-Natal. "The ideal is to build up a viable flock of 40 individuals, consisting of 20 males and 20 females," says Matschke. As the Wattled Crane has the lowest reproductive rate (*in situ* and *ex situ*) of all the crane species, this is an ideal which is easier said than done.

Wattled Cranes are monogamous by nature, and typically lay a clutch of one or two eggs. Only one chick is reared and the second egg is abandoned. The department of Nature Conservation in KwaZulu-Natal allows for the removal of second eggs which are incubated, hatched and the chicks taken to the chick-rearing facility at the Johannesburg Zoo.

The hatchlings are hand reared and bird keepers use hand-puppets to walk and feed them in order to ensure natural imprinting. Minah Mabitsela, a bird keeper at the zoo, explains that it is a very labour intensive process. The birds have to be watched very closely, she says, weighed regularly and fed and walked every two hours. "For the past five years they have received about six chicks per year," says Matschke. Once the breeding flock is big enough, the *ex-situ* bred chicks from the zoo's breeding flock will be released into the wild. At the moment, says Matschke, the zoo practises artificial insemination on certain birds to increase the reproductive output. "Artificial insemination is used as we have more females than males", she says, "but in the future we hope they will breed naturally in a captive situation." She says that it's hoped that the first birds will be released into the wild in KwaZulu-Natal within the next year or two.

THE ZOO'S WETLAND PURIFICATION SYSTEM

Braamfontein Spruit runs through Johannesburg, enters the zoo through two storm-drain pipes and is eventually deposited into man-made dams, just opposite Jan Smuts Avenue. The stream picks up a number of pollutants on its way, including littler, human waste, plant matter and discharges from some of the animal-enclosures. This used to be deposited in Zoo Lake.

The lake bore the brunt of the damage, and public outcry over the state of the public open space demanded rectification. Consequently, the zoo constructed a ± 1 ha wetland purification system in 2002. Water that enters the zoo from the two stormwater channels enters the primary sieve tank, where large objects such as bottles and tins are removed. From here the water flows into a large catchment tank, and then into a sludge settlement tank where solid waste is removed (solids suspended in the water settles at the bottom of the tank and is pumped into the city's sewer line, while some is also used for compost). The biological purification system involves the water flowing through a channel, and into the first of three reed-beds planted in a zigzag pattern, allowing the plants and indigenous fauna time to remove impurities.

The water then exits the wetland system, moves under Jan Smuts Avenue, and then enters Zoo Lake. In March 2002 the faecal coliform count for bacteria in the water entering the zoo was 75 000, reduced to 0 by May of the same year. Some of the water is also channelled back into the zoo for their own use, explains Matschke.

ONE MORE STEP TOWARDS ENDANGERED AMPHIBIAN CONSERVATION

In response to the call for action from the WAZA to respond to the amphibian extinction crises, the Johannesburg Zoo established the Johannesburg Zoo Amphibian Conservation Centre for the captive propagation of South African wildlife amphibians.

The project started in March 2006, with the aim to initially keep and breed common species of indigenous amphibians in captivity. If done successfully, the keeping and breeding of endangered analogue species of indigenous amphibians

could be tackled. Furthermore, the programme aims to compile husbandry guidelines and protocols on how to keep and breed the species being kept in the collection, to successfully breed each species of frog to an F3 generation and to conduct research on the breeding, enclosure design and husbandry of each species of amphibian. Timothy Netsianda, amphibian and reptile keeper at the zoo says they also aim to establish and implement a frog collection protocol with special emphasis on the prevention of disease transmission.

The first, common species chosen for the collection, says Netsianda, are the Painted Reed Frog (*Hyperolius marmoratus*), Guttural Toad (*Amietophrynus gutturalis*), Bushveld Rain Frog (*Breviceps adspersus*) and Cascade Frog (*Hadromophryne natalensis*).

Above: Education is an important part of the zoo's Amphibian Conservation Centre.

Below: Common species of frogs are kept at the zoo for public viewing.

Petro Kotzé

Petro Kotzé

To date, the Painted Reed Frogs and Guttural Toads have been successfully bred, and it was found that the breeding pattern of the first was similar to that of the critically endangered Pickersgill's reed frog (*Hyperolius pickersgilli*). This frog occurs in only 11 currently known locations from Kingsburgh in the south coast of KwaZulu Natal to iSimangaliso Wetland Park in the north. In January, the zoo received their first 30 individuals of the species.

The project could last as long as 25 years, during which frogs will be collected in the wild in order to establish an assurance population. These will be divided between the zoo and Seaworld at UShaka Marineworld. It is foreseen that the captive breeding programme will eventually result in endangered individuals that can be released back into the wild once suitable habitats have been restored or created. This part of the project is done in conjunction with the South Africa Association of Marina Biological Research, North-West University and Ezemvelo KZN Wildlife.

Netsianda says that what makes the zoo special is that it not only provides the opportunity for research, but to educate ordinary people. In fact, the zoo places particular importance on education, especially of the thousands of children that visit annually. In this way, even though the species inside the zoo are far away from home, the people that learn about them will take home knowledge about the natural environments that they came from, and the importance of their survival. ❑

THE ANIMALS IN THE ZOO

The original animal collection at the Johannesburg Zoo consisted of one lion, one leopard, one giraffe, two Sable antelope bulls, one baboon, and one genet, one pair of Rhesus monkeys, one pair of porcupines and one Golden eagle. Today the zoo houses over 320 species of animals, totalling about 2 000 animals. These include at least 10 endangered species, five critically endangered species and the Scimitar Horned Oryx which is considered extinct in the wild.

Wikipedia

Water research – LOOKING AT THE NEXT 40 YEARS

As the Water Research Commission (WRC) enters is 41st year, independent consultant Barbara Schreiner looks at the challenges facing the Commission – and the wider South African water community – in the coming decades.

The WRC has been commissioning research to serve the needs of the water sector for 40 years – since it came into being in 1971. That body of knowledge has served to bring the sector to where it is today, and has served to keep South Africa at the cutting edge of water management.

With the WRC having celebrated its 40-year existence through a special conference, one can ask what can be said about research in the next 40 years, and what some of the key challenges of the next 40 years might be. In looking forward, we can best start with where we are now, and what we know now.

Over the last decade, there have been major changes in the water sector globally, driven, amongst other things, by the global recognition of the impacts of climate change on water, and the need to take an adaptation focus in the water sector, rather than the mitigation focus of the energy sector. At the same time, increased water scarcity and heightened public awareness of the value of water at all levels in society have meant that large corporate business has recognised the significant water risks that they face. As a result, they have stepped into the water arena to address the risks they are facing, with impacts on how water is viewed and managed in the corporate sector.

In South Africa, heightened public awareness around water issues has resulted in unions threatening to strike around water resource management issues, and the Minister of Water Affairs being charged with failure to protect water security and failure to effectively implement the National Water Act. Within the water research arena in South Africa, we have both remarkable opportunities and significant challenges.

Firstly, we have a strong WRC, envied by many in the rest of the world. We have decades of excellent research, and some world-class researchers. Nonetheless, we also face massive challenges in implementation despite the years of excellent research. The country faces, as everyone in the water sector knows, limited water resources, deteriorating water quality, major water service delivery achievements but poor quality construction, operation and maintenance and revenue generation.

These water sector challenges are compounded by the broader challenges of high levels of joblessness, poverty and inequality, jobless growth and the impacts of a global economic downturn. All this could make one despair or panic – or, alternatively, see it as a challenge to the considerable innovative intellectual capacity in South Africa to find new ways to address our water challenges – an opportunity for us to shine, to do things differently, to show the world the way forward.

Looking at it as a challenge in this way, one must ask the question: How does one take the good that currently exists in the water research sector and make it great, so that it really serves the people of South Africa, and the world more broadly. If we look forward over the next few decades, there is much that we cannot foresee, but some things are extremely likely. We are almost certain to see increasing complexity, increasing pressure on our limited water resources in relation to both quality and quantity, a changing availability of resources due to climate change, changes in the skills needed and the skills available, an increasing population and an increasingly urbanised population, increasing regional economic integration, an increasing rate of change, an increase in the proportion of the population classed as middle class with increased consumption patterns and resource use, and economic growth and diversification, possibly into areas that we can hardly imagine now.

What does this mean for the water sector? Limited resources will have to go further, services will have to be provided in a more sustainable way, and the water sector, including the research community, will have to work much, much smarter!

What then are the implications for water research as we move forward?

Some things will stay the same, such as the need for good science, based on good data. Maintaining and obtaining good data in South Africa is a challenge. Relative to many of our SADC counterparts, our data is good, but is it as good as we can make it? Is it getting better, or is it getting poorer?

Papers presented at the WRC 40-year celebratory conference show how the monitoring network is deteriorating, rather than improving. We will need to find effective, innovative and reliable ways to obtain good data to underpin research and decision making. This is an area that requires improvements in management, funding, and technology.

There is a call for stronger and more innovative partnerships between researchers and government, and we need to bring civil society and the private sector into these partnerships as well. We will need to combine the intellectual capability of all of these sectors into finding innovative and appropriate solutions to our challenges. There is also a need for stronger alignment between water research, research in the broader science community and research in the economic development field, so that our research can be integrated into the economic development challenges and solutions for the country.

Systems thinking, finding ways to solve 'wicked' problems, interdisciplinary and transdisciplinary research will continue to develop in importance in water research, bringing together social scientists, bio-physical scientists, economists, grassroots researchers, and indigenous knowledge to find answers.

Of great importance is that the water sector moves beyond a focus on methodologies to a focus on supporting implementation, but not to the exclusion of long-term and blue-sky thinking. We need able minds that are looking at how to fix the problems of today and next week, but we also need able minds to be looking down the line at how to respond to issues that we have not even identified yet. We must encourage a structured scanning of the environment to pick up new challenges while they are still far away, on the horizon, not already burning on our laps.

The focus on implementation and the huge challenges on the ground mean that we must increase action research, research that creates change through the process of research. The increasing need for adaptability and the ability to manage and understand complexity and change require that the very way we do research, the type of research and the results of the research heighten our adaptive capacity as a country, whether as decision makers or household gardeners. The other side of this coin is the need for a much greater understanding of risk and how to manage risk in a context of increasing uncertainty.

We will want to see more effort going into the development of innovative technologies, ones that might be able to create jobs and bring in foreign exchange, while helping to manage our increasing water challenges. Finally, the water sector needs to support long-term research that spans decades, in order to provide the necessary knowledge and understanding of hydrological, social, ecological and other processes that operate over long-term horizons.

Looking at the future of water research in this manner raises the question of who the research serves, and how to get the results of the research to them. The purpose of research is to change the world, and to do so it must be channelled out into the world where it can be applied, by public officials, water users, stakeholders, and members of the public.

The next 40 years will bring unimaginable opportunities for using communication technology to get information to people who need it. If regimes can be overthrown through the use of social-networking technology, surely the water sector can be revolutionised in this manner as well?

Finally, there is a need for the ongoing transformation of the research community to represent the demographics of South Africa. The challenges that the country faces in relation to science and maths education in particular, but education more generally, raise questions about how the water research community engages with these education challenges, not just at the tertiary level but at all levels, to ensure that we are breeding the young scientists that we need.

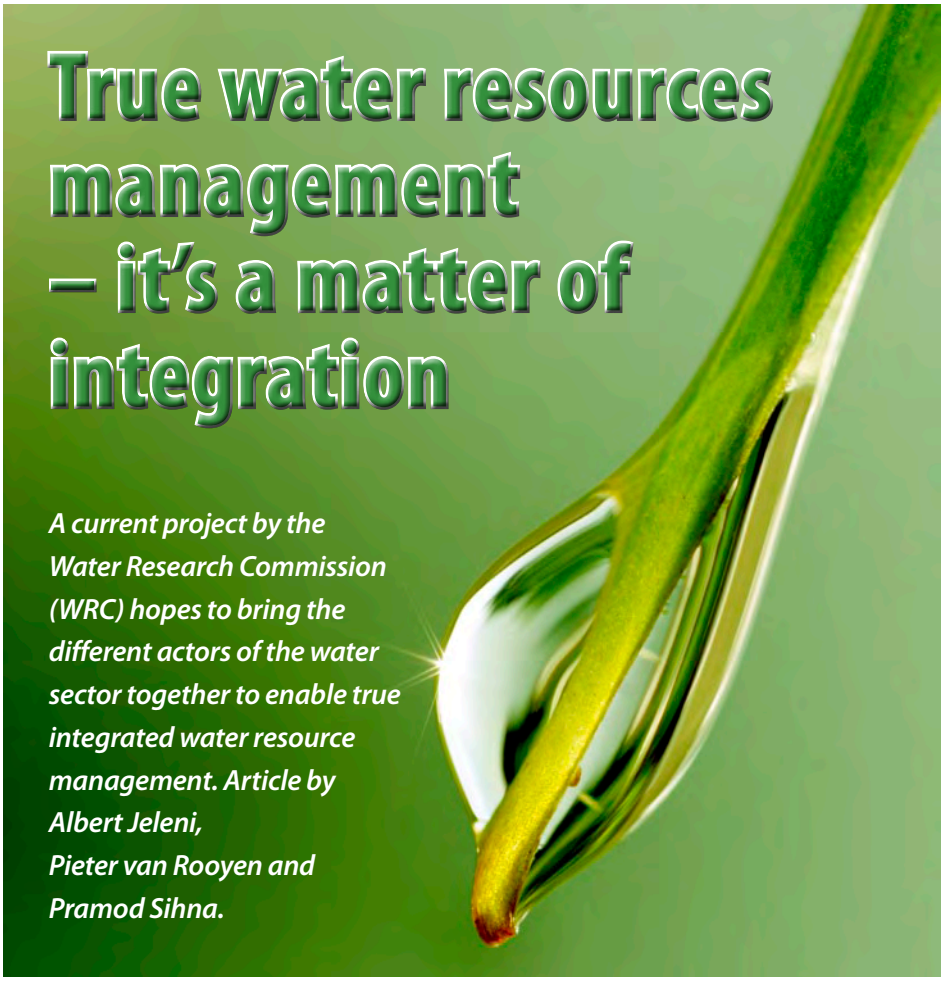
In closing, we must note that water research takes place in a broader context, both the current context, and a planned future context. In the New Growth Path, the government has identified the creation of jobs as critical, and they have identified the following sectors of the economy for job creation: infrastructure, the agricultural value chain, the mining value chain, the green economy, certain manufacturing sectors, and tourism and certain high-level services.

All of these require water and have water-related implications, and research needs to support these national objectives, within the context of the Constitution that calls for socially justifiable economic development, but also calls for the protection of the environment. In doing so, we must put people at the centre of the research agenda. Let us remember that there are no people without water; there would be no water problems without people; there can be no knowledge without people; and there can only be solutions to human-induced water problems, through people.

We need to continually get people together, virtually or face-to-face, to create new knowledge and new ideas. Bringing together these things, we may be able to achieve well-researched knowledge to inform our endeavours so that we can envision who we are, what we can be, and how to get there.

- This editorial first appeared in the WRC 40-Year Celebration Special Edition 2011 of *Water SA* Vol 37, No 5. ❑

True water resources management – it's a matter of integration



A current project by the Water Research Commission (WRC) hopes to bring the different actors of the water sector together to enable true integrated water resource management. Article by Albert Jeleni, Pieter van Rooyen and Pramod Sihna.

In the past, water management was characterised by clearly defined problems that society wanted to be solved. These problems were dealt with in isolation based on scientific concepts and tools mainly concentrated on the supply or resource side. The use side, or rather the human dimension side, was taken into account as an 'external' boundary condition.

Further, over years in the natural science community a tool typically was understood as a stand-alone computer software product describing mainly one topic, for example groundwater flow. This has led to practitioners developing tools reflective of their training and the challenges posed by modelling particular aspects (silos) of water management.

When the need for integrated water management was recognised by practitioners, technological solutions were sought after, and this to the detriment of the water sector. This quest to solve the integration problem using sophisticated technological systems has led many to forsake basic scientific concepts, and create even more silos in cyberspace, forgetting that tools are only as useful as their users.

While scientific concepts form the necessary basis for developing appropriate management approaches for water systems, such concepts must eventually provide the framework that allows for the integration of tools, and consequent 'breaking down' of silos. Importantly, however, these silos need to disappear without dumbing down the expertise within each segment. Therefore, doing away with silos does not mean doing away with specialisation.

In a South African context, the National Water Act (NWA) makes it clear that tools (i.e. for conservation, pricing, conflict resolution etc) as required by integrated water resource management (IWRM), should be put in place. IWRM requires that the tools for each domain be integrated and that scientific experts, water management and stakeholders collaborate in the holistic assessment and management of water.

Integration is being pursued within the different domains/silos in the South African water sector (i.e. within water services, water resources information programmes, integrated water resource planning, resource directed measures, catchment management agencies, WRC etc), however, very little has been done to bring the tools of these domains together. There, while the NWA is hailed across the world for getting the right mix between economic growth, social equity and environmental sustainability, the ultimate test is in its implementation, and consequently the sector's ability to develop and integrate the required tools.

Despite the major advances in science and technology in water management that have taken place over the past two decades, a need remains to establish a unifying framework that will lead to appropriate tools for sustainable water management. In recognising the importance of an integrated approach in water management, the WRC has initiated and funded a project with the aim of adding value to the process of looking into requirements for a multidisciplinary approach to IWRM.

The project focused on the integration of tools in general, including mobilisation of social, economic, institutional, legal, environmental and technical expertise, in an effort to address water resources and water uses in an integrated manner. In the project, a 'tool' was defined as something (either tangible or intangible) used to support operational and strategic actions in performing IWRM. This means that a tool can be a guideline, a procedure or protocol, a method or technique, a device, an

apparatus and a software program dealing with all levels in relation to transition to IWRM or a subset of levels and approaches.

"The quest to solve the integration problem using sophisticated technological systems has led many to forsake basic scientific concepts, and create even more silos in cyberspace, forgetting that tools are only as useful as their users."

The project has developed a generic integrated conceptual framework (GICF) that can be applied in a consistent and coherent manner to a wide range of water management issues in an integrated manner. The key to building systems that provide a high level of flexibility is to use a component-based design that meets current requirements, and is flexible enough to meet future needs. This requires a dynamic architecture that allows for easy modifications of existing functionalities and easy adoption of new ones.

Hence, in developing the GICF it was necessary to build an understanding of the water management process evolution over the years, the circumstances driving the evolution, the water sector building blocks, as well as the different water management philosophies that shaped the water sector. The framework has, therefore, been developed around the principles of extensibility with four basic characteristics: a) plug and play, b) evolutionality, c) representativity of the problem and d) adaptive water management.

The project has shown that water sector integration should be pursued from a water business perspective instead of the technology perspective. However, technology should be used to support integration efforts where necessary, taking into consideration country needs and skills levels. Essentially, the new framework seeks to achieve integration from the business perspective, and allows users to link their tools to the mandate and objectives, to the reporting requirements, to the information value chain, and to the required resources in assessing trade-offs.

More importantly, the GICF allows for decision-making and reporting to in a single platform linking the water managers, users and other stakeholders to the national government objectives. The application procedure to guide the use of the GICF consists of nine steps:

- **Step 1** – Identify the high-level mandate of an entity;
- **Step 2** – Identify actors and their objectives;
- **Step 3** – Identify the decision process and performance indicators;
- **Step 4** – Identify required tools and assess their maturity;
- **Step 5** – Identify the required data;
- **Step 6** – Identify the data sources and point of contact on the value chain;
- **Step 7** – Bring the actors with their objectives and data requirements to the unifying platform using the appropriate Level II frameworks;
- **Step 8** – Identify overlaps and gaps on objectives, tools and data; and
- **Step 9** – Streamline the processes accordingly.

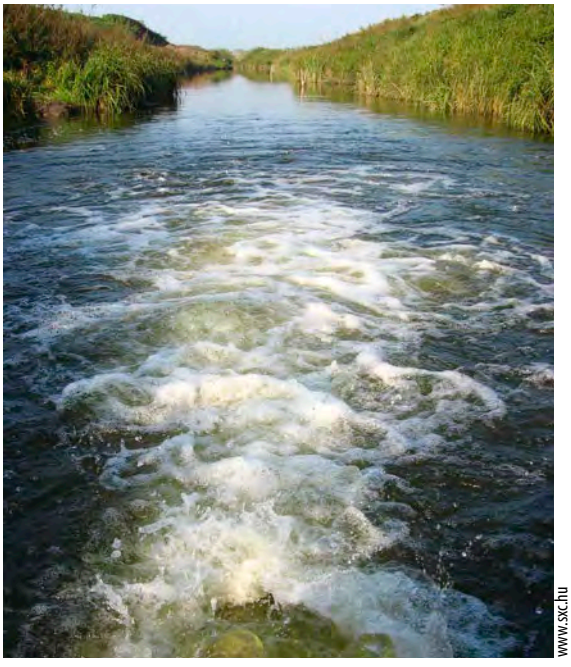
The project has identified data and/or information as a medium through which integration takes place and emphasises the importance of information systems to 'support' integration efforts. Three levels of integration hierarchy have been identified and adopted for use in the project, i.e. Level I Frameworks (integrated tools), Level II Frameworks (integrated frameworks) and Level III Frameworks (generic integrated frameworks).

From the outcome of this project it is concluded that many of the water management tools in the South African water sector support the principles of IWRM within their respective domains. However, it is also concluded that the tools, as a collective, do not embrace the principles of IWRM, and to enable a transition to IWRM, a unifying framework (such as the GICF) is required.

The project has also identified that many of the domain specific Level II Frameworks have reached their maturity level, and that efforts are being made to integrated other Level II Frameworks on an ad-hoc basis, this could result in systems procured and developed to solve a specific problem, characterised by a limited focus and functionality, and containing data that cannot be easily shared with other systems.

The GICF provides a long-term high-level process that frames major integration issues and provides strategies and recommendations for addressing those issues. The GICF represents a means to an end, rather than an end in itself, and what is ultimately required is for all the actors in the water sector to align with the GICF's optimal direction leading to complete integration. ❑

The project has shown that water sector integration should be pursued from a water business perspective instead of the technology perspective.



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WATER Kidz

Wetlands – Places to play and learn

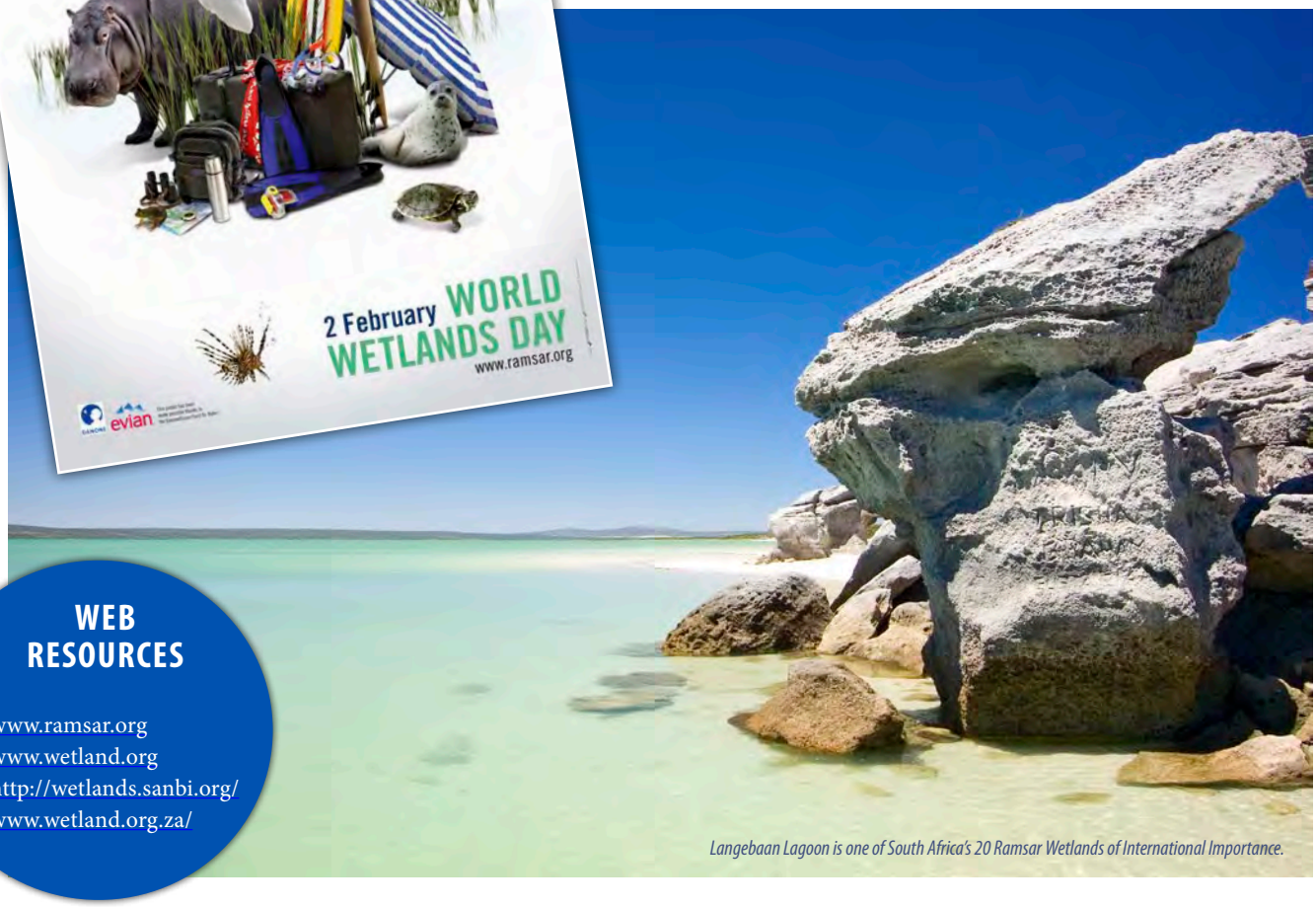
Every year World Wetlands Day is celebrated on 2 February on the anniversary of the signing in 1971 of the Ramsar Convention on Wetlands. This year, the special day focused on the relationship between wetlands and tourism.

Tourism is a growing business, with around a billion international tourists visiting destinations across the world every year. With half of international tourists travelling to wetlands, the tourism expenditure linked to these special water ecosystems is estimated at around US$925-billion a year. This does not even include domestic tourism and recreational day trips. Truly the economic value generated by tourism to wetlands is enormous.

Wetlands, with their natural beauty and abundance of plant and wildlife offer much in terms of recreation and tourism. In South Africa, as in other parts of the world, many of these wetlands have been declared national parks or protected areas. It is easy to see why our wetlands are so popular with domestic and international travellers. Arguably South Africa's most famous wetlands area, iSimangaliso Wetland Park, for example, contains three major lake systems and is home to Africa's largest estuarine system, 526 bird species, 1 200 species of fish, and several large animals, including crocodile and hippo.

Another well known wetlands tourist destination is Nylsvley Nature Reserve in Limpopo. The reserve provides protection for about 700 ha of wetland, and is home to hundreds of animals and birds. In the North West, Barberspan Bird Sanctuary is one of the largest waterfowl sanctuaries in South Africa, with over 320 recorded species and bird counts in excess of 12 000 individuals.

Well managed tourism in and around wetlands can bring significant benefits. Recreational activities around wetlands



Langebaan Lagoon is one of South Africa's 20 Ramsar Wetlands of International Importance.

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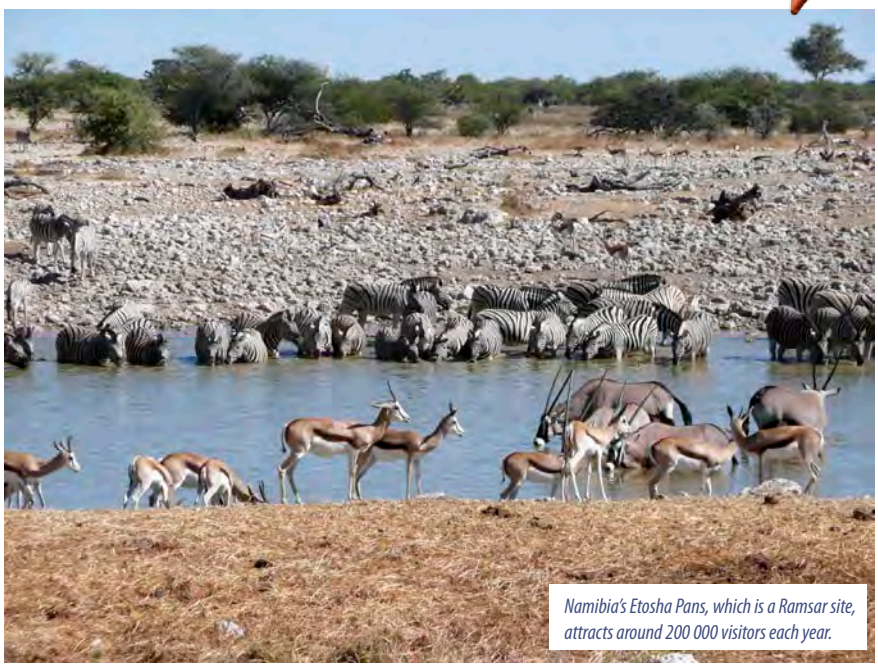
WEB RESOURCES

www.ramsar.org
www.wetland.org
http://wetlands.sanbi.org/
www.wetland.org.za/

What is the Ramsar Convention?

The Convention on Wetlands of International Importance, or Ramsar Convention in short, is an international treaty for the conservation and sustainable use of wetlands. It is named after the town of Ramsar in Iran where it was originally signed in 1971. To date, 160 parties have signed the Convention, and close to 2 000 wetlands have been listed as Wetlands of International Importance. South Africa was one of the first signatories of the Convention.



Namibia's Etosha Pans, which is a Ramsar site, attracts around 200 000 visitors each year.

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can generate welcome income that can be ploughed back into conservation. These activities range from boating, snorkelling and other water sports to watching wildlife and even fishing. Many areas also charge entry and user fees, which can be used to conserve wetlands and the species and services they support. Tourism can also benefit local communities in terms of income and employment.

It is worth noting that tourism is only one of the ecosystem services that wetlands provide, and ensuring the sustainability of tourism in and around wetlands contributes to the health of the wetlands so that other services can be sustained. Unfortunately, poor tourism practices have resulted in the pollution and degradation of wetlands in many areas.

The continuous rapid growth of tourism puts enormous pressure on the places – and their natural and cultural attractions – that tourists want to visit. The downside of uncontrolled tourism includes, for example, trampling effects of uncontrolled visit rates in sensitive habitats, such as peatlands; excessive disturbance of breeding bird populations; overharvesting of fish and shellfish to supply hotels and restaurants; as well as poor disposal of waste.

It is up to all of us to ensure that we enjoy our wetlands responsibly. Take some time to learn about the wonder of the wetlands you visit and share this information with others. Take only photographs and leave only footprints. In this way generations of people will still be able to marvel at our wetlands in years to come. ❑

Some wetlands are home to a myriad of plants and animals, making them ideal tourist attractions.

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White-faced and Comb Ducks at Nylsvley.

Drinie van Rensburg

Courtesy Ramsar

Limpopo-Mpumalanga mop up following floods

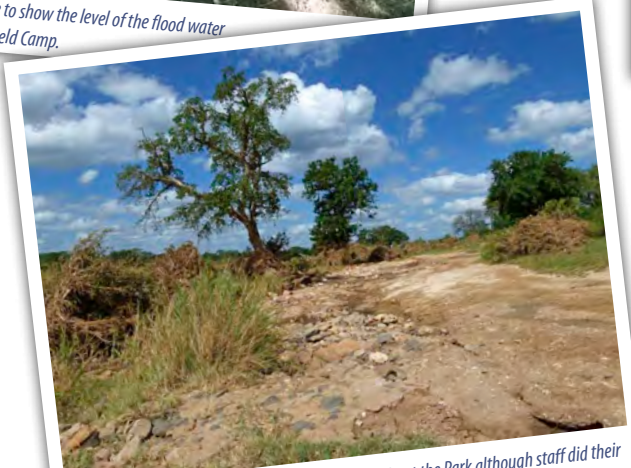
South Africa again showed why it is a land of extremes when parts of Limpopo and the Mpumalanga Lowveld flooded in January. The flooding followed unusually heavy rains caused by Tropical Cyclone Dando off the Mozambican coast. The town of Hoedspruit, for example, recorded as much as 400 mm of rain in a few days – almost its entire average annual rainfall. Scenes of raging rivers overtopping bridges and roads as well as dramatic rescue attempts made national news headlines. The Hoedspruit area as well as five municipalities in Ehlanzeni district, in Mpumalanga were declared disaster areas, with damage to road, water and agricultural-related infrastructure estimated at hundreds of millions of Rands. Around 80 people, mostly tourists, had to be evacuated by helicopter from the Kruger National Park (KNP) after camps and roads became inaccessible. Several large rivers, including the Olifants, Crocodile, and Blyde burst their banks, with normally dry streams turning into wild torrents of water. Drinie Janse van Rensburg of the WRC visited the KNP shortly after the floods.

Damage to a causeway on a gravel road near Orpen Dam.

The steel railings of the high water bridge near Lower Sabie were badly damaged.

Debris against the fence to show the level of the flood water through Talamati Bushveld Camp.

Flood water went through the Tshokwane picnic area at a height of more than 2 metres. This popular picnic area will be closed for a few months for repair.



Extensive damage to gravel roads was seen throughout the Park although staff did their utmost best to repair and open roads as soon as possible for the public.

The causeway over the Olifant River at Balule.

THE WATER WHEEL

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