

THE WATER WHEEL

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Cover: The Klein estuary at Hermanus is one of a selection of estuaries for which estuary management plans have been drawn up. (See page 14).

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THE WATER WHEEL is a two-monthly magazine on water and water research published by the South African Water Research Commission (WRC), a statutory organisation established in 1971 by Act of Parliament. Subscription is free. Material in this publication does not necessarily reflect the considered opinions of the members of the WRC, and may be copied with acknowledgement of source.

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LETTERS TO THE EDITOR

South Africa's water crisis – interdisciplinary focus needed

Mike Muller (former Director-General of the Department of Water Affairs and Forestry and currently a Visiting Adjunct Professor at Wits University) has in various media and forums robustly criticised the now well-known political scientist Anthony Turton's contribution to the water sector.

In a *Business Day* article (2 December 2008) Muller stated that Anthony Turton is not a water expert and at a public debate at the University of Johannesburg argued that Turton knows nothing about water. This criticism stems from and is symptomatic of the academic phenomenon of the gulf between the engineering, natural and the social (i.e. interpretive) sciences.

I contend that there is no such thing as a water expert. There are discipline experts who are active and making significant contributions within the water sector (e.g. economists, engineers, natural scientists, social scientists, political scientists, legal specialists, etc.). The context and foci of their contributions will however differ. The challenges in water resource management in South Africa require contributions from all scientific fields but within a holistic, interdisciplinary and systems thinking approach.

Mike Muller suggests that Anthony Turton's history and background in the previous regime's military and secret service has had an influence on Turton's research focus on water as a political and security issue. Anthony Turton's background has indeed shaped his research which focuses on the governance of water resources and the political dimension of water. Turton's CSIR report (*Three Strategic Water Quality Challenges that Decision-Makers Need to Know About*) which caused a furore at the CSIR is certainly alarmist but sought to raise the profile and awareness of water as a strategic resource that if not managed properly and equitably supplied has the potential to spark grass-roots dispute and anger.

Linking water as a scarce resource that has the potential to spark dispute, anger and violence is a robust field of international study. For example, the acclaimed academic Prof. Thomas Homer-Dixon from the University of Toronto has a strong research focus on the causal role of environmental scarcity and conflict. In his CSIR paper, Turton makes a strong argument that South Africa's violent historical legacy is one of the three strategic drivers that decision-makers need to be cognisant of when trying to find viable solutions for the water scarcity crisis.

Turton's CSIR paper is in the format of a narrative which is built on analysis extracted from secondary sources and quantitative research from other scientists. He outlines a hypothesis based on

the observable phenomena of social conflict (as a result of the lack of municipal service delivery) and predicts that failure to supply good quality water at an acceptable level of assurance could in all probability lead to extreme violence.

The analytical manner in which Turton makes a causal link between water scarcity and social conflict is debatable, especially when one uses the rigidly orthodox scientific approach to research. Using the argument of causality is rooted in the Newtonian world of cause and effect. In the water sector, there has been a significant departure from this world view, where natural and social systems are recognised as being highly complex and stochastic and where things happen only with a certain probability and rarely turn out as originally intended.

The CSIR management's criticisms against the content of Anthony Turton's paper and presentation should be contextualised and understood within the scientism paradigm. This orthodoxy stresses hypothesis testing and replication of results that is modelled after the natural sciences. The scientific validity of Turton's method of analysis is a matter for the normal scientific peer review process to address. However, the challenges of assurance of water supply, water pollution and water treatment is not in dispute, as there is broad agreement about these challenges among professionals in the water sector.

All professionals, experts and activists within the water sector operate in the interface between law, policy, politics, advocacy and science (whether they recognise it or not). It is imperative that a pluralistic and interdisciplinary scientific approach should be utilised to address the challenges in the quality, management and supply of South Africa's water resources.

The technical and social challenges in the water sector are not intractable. What is required from professionals in the field is the recognition that methodological pluralism (including both quantitative and qualitative analysis) is necessary to provide the fundamental inputs to understanding the various contexts of the complex water system (e.g. environmental, economic, political, social, institutional and technological).

Nigel Rossouw, Centurion

Inventory of small dams

I refer to the interesting article on Small Farm Dams in the July/August 2009 edition of *The Water Wheel*.

The authors state that "It is not known how many small farm reservoirs there are in South Africa. ..." The South African National Committee on Large Dams (SANCOLD) has a Register of Large Dams in South Africa on its website www.sancold.org.za. The Register contains details of 1 082 dams. In addition reference is made to the Register of Dams of the former Department of Water Affairs and Forestry (DWAF) which contains details of 4 457 large and small dams with a safety risk. The DWAF Register can be downloaded from www.dwaf.gov.za by following the link to the Dam Safety Office (DSO) and publications. I trust that this information will assist the researchers in their study.

Paul Roberts, SANCOLD

Pollutants in groundwater – much already done in SA

With reference to the article, *WRC Studies Shed Light on Groundwater Polluting Chemicals*, in your July/August 2009 issue, it may be of interest to you that SRK Consulting and Heartland Leasing (AECI) have been actively involved with DNAPL pollution problems in this country for the past 10-15 years, both investigating, characterising and remediating.

In line with international practice we are currently using in situ bio-remediation as the best option and have thus far had some very positive results. The relevant authorities are all fully informed of the work and much of it has been presented internationally at the appropriate conferences.

One other comment regarding your list of top ten sources of possible DNAPL groundwater contamination: generally underground storage tanks at petrol stations are associated with LNAPL contamination.

Ian Cameron-Clarke, SRK Consulting

Department skills shortage not a crisis

Thank you for a most informative magazine. However, I would like to point out a serious factual error in the article "Partnerships the lifeboat over troubled waters" on page 10 of *The Water Wheel* July/August issue. I am incorrectly reported to claim that "... the seven-fold loss of engineers and technologies (sic) within the Department of Water & Environmental Affairs since 1994..". This seven-fold loss has been from the Local Authorities, not from the Department of Water and Environmental Affairs. The error has arisen from incorrectly stringing together phrases from different sentences to create a false statement. The word "technologies" is also incorrect. It is "technologists" who have been lost. The Department is indeed seriously under-staffed, but not nearly to the extent implied by the article.

Chris Herold, Umfula Wempilo Consulting

Groundwater: Pushing the limits

Throughout the country – and the rest of the continent – groundwater is used for irrigation, domestic water supply and also by industries. It is estimated that 75% of the African population is reliant on groundwater for its main drinking water source.

This hidden part of the hydrological cycle is playing an increasingly important role for water supply and as an ingredient in the local and regional economy. In many areas on the continent groundwater is the sole source of water supply for communities or small towns. Groundwater connections to surface water are now recognised as essential to maintain aquatic and riparian ecosystems.

The groundwater fraternity in South Africa includes world renowned specialists and academics that have committed their lives to the management and protection of groundwater. The number of challenges in terms of management and protection grows


daily and as adaptive management and integrated resources management are now accepted key approaches, the need for ongoing dialogue to discuss and share best practices, appropriate technologies and innovative solutions for growing concerns locally, are prioritised.

The biennial groundwater conference which will take place from 16-18 November 2009 at the Lord Charles Hotel in Somerset West near Cape Town, offers a perfect opportunity for groundwater professionals and students to share recent experiences, successes and mistakes or just to catch up with colleagues. This year's theme *Pushing the Limits* is challenging participants to view groundwater research challenges in a positive way.

Themes for the conference show the unlimited links between groundwater and society, the economy, land use activities and the environment:

- ◆ The brain drain
- ◆ Pollution and remediation
- ◆ Awareness and publicity
- ◆ Groundwater and the environment
- ◆ Sustainable development
- ◆ Hydrogeochemistry and isotopes.

Case studies not only cover the entire country, but also include lessons from as far afield as Mozambique, Nigeria, Botswana and Namibia and even the United Kingdom. Apart from scientific research results, groundwater practitioners will challenge some limits but also share some practical, local solutions. A poster session also provides for experience sharing. Various exhibitors will showcase their products, services and technologies related to the groundwater industry.

For more information, contact Kruger & Associates at +27 28 3162905 ; E-mail: kruger@kruger-associates.com or visit: www.groundwaterconference.com 

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WATER DIARY

MINE-WATER**OCTOBER 19-23**

An International Conference on Mine-Water will be held at the CSIR Convention Centre, in Pretoria. *Enquiries: Conference Secretariat; Tel: (012) 667-3681; Fax: (012) 667-3680; E-mail: minewater2009@wisa.org.za; Visit: www.wisa.org.za/minewater2009*

IWRM**OCTOBER 28-30**

The WaterNet/WARFSA/GWP-SA Symposium will be held in Entebbe, Uganda, this year, with a focus on integrated water resource management within the context of environmental sustainability, climate change and livelihoods. *Enquiries: E-mail: symposium10@waternetonline.org*

SANITATION & HYGIENE**NOVEMBER 10-12**

The West Africa Regional Sanitation and Hygiene Symposium will take place in Accra, Ghana. The symposium is jointly organised by RCN Ghana, UNICEF, West Africa Water Initiative, WaterAid and IRC International Water and Sanitation Centre. *Visit: www.irc.nl/page/48900*

DAMS**NOVEMBER 4-6**

The biannual South African National Committee on

Large Dams (SANCOLD) conference with the theme 'Sustainable development of dams in Southern Africa' will be held at the Alpine Health Resort, Drakensberg. *Enquiries: Mrs Leana du Preez/ Marechia Basson; Tel: (021) 808-2100; E-mail: ldpreez@sun.ac.za or msb@aspt.co.za; Visit: www.sancold.org.za*

ORANGE RIVER BASIN**NOVEMBER 11-12**

The Second Orange River Basin Symposium will be held at the University of the Free State with the theme 'The Orange River Basin – The Challenge'. *Enquiries: Sanet Neethling; Tel: (051) 401-2863; Fax: (051) 401-2629; Web: www.ufs.ac.za/orangeriver*

GROUNDWATER**NOVEMBER 16-18**

The Groundwater 2009 Conference, organised by the Groundwater Division – Western Cape with the Geological Society of South Africa, the Water Research Commission and the International Association of Hydrogeologists, will be held in Somerset West, in the Western Cape. The theme for this year's conference is 'Pushing the Limits'. *Enquiries: Kruger & Associates; Tel: (028) 316-2905; E-mail: kruger@kruger-associates.com; Visit: www.kruger-associates.com/groundwaterconference2009/home/default.asp*

Conference for young professionals to see and be seen

The First Regional Conference of the Southern African Young Water Professionals, to be held on 19 and 20 January at the CSIR International Convention Centre in Pretoria, promises to be a valuable platform for newcomers to the water sector to meet their peers and advance their careers.

The conference, which is organised by the Southern African Young Professionals Programme under the auspices of the International Water Association and the Water Institute of Southern Africa, has already attracted significant attention from potential presenters and sponsors alike, with sponsorship from Rhodes University, the University of Johannesburg and Rand Water confirmed at the time of writing.

This event will provide a forum for young researchers and professionals in water and wastewater science, research, engineering, technology, management and other areas of the water sector to network with both peers and prospective employers. Young professionals are regarded as those under the age of 35 or who received their qualifications less than five years ago.

"The first of its kind in South Africa this conference will provide a friendly platform for young professionals to present their work while offering them the opportunity to obtain career advice from distinguished water professionals, who will also be present," reports Young Professionals President Dr Jo Burgess. "We have also found a mismatch between institutions trying to recruit new staff and graduates who want employment – this event aims to breach this communication gap and bring the two parties together under one roof."

The best presenter at this regional conference will go on to represent South Africa at the Fifth Biennial IWA Young Water Professionals Conference in Sydney, Brisbane, from 5 to 7 July 2010.

The organisers hope that the conference will become a regular occurrence. "We eventually hope to have a young professionals event at least every two years," notes Dr Burgess.

For more information about the conference contact Cilla Taylor at Tel: (012) 667-3681 or E-mail: confplan@iafrica.com or Visit: www.wisa.org.za/YWP2010.htm

Recession 'good news' for water reuse technologies

The global economic slowdown has created huge opportunities for sustainable water and wastewater treatment technology, according to a report by international firm Frost & Sullivan.

These opportunities can be found in key areas such as energy efficiency, waste reduction, resource recovery as well as water reuse and recycling. The market is growing daily and promises to become a fully mainstream feature of the water market in years to come.

Frost & Sullivan Research Manager Frederick Harry Royan has no doubts that water is becoming the oil of the 21st century and sustainability will be a defining factor. "Sustainable water and wastewater treatment technologies and services are proving to be the 'green shoots' of strong growth for the global water market in 2009. These technologies have benefited hugely from the fact that the global

financial meltdown has led to the drying up of funds for large water and wastewater treatment infrastructure projects. As a result, sustainable water and wastewater treatment technologies with strong green credentials are increasingly finding favour on account of key tangible benefits: higher levels of energy and treatment efficiency, protecting sensitive ecological habitats and wildlife, generating renewable energy and/or reducing the carbon footprint of treatment facilities."

There are some challenges that may hamper the market expansion, however. The biggest of these is cost. "The price of some sustainable solutions is still beyond the reach of a large section of the market," reports Royan. "Financing of large sustainable projects is one of the main issues that need to be considered."

Vandalism, theft, diminish CT's upliftment efforts

The City of Cape Town has spent more than R80-million over the past year on repairing or replacing stolen or vandalised basic services in informal settlements.

"For every R3 that the City spends of its R125-million annual budget for water and sanitation facilities in informal settlements, R2 is spent on repairs and replacements," reports Alderman Clive Justus, Mayoral Committee Member for Utility Services. Addressing the annual convention of the SA Revenue Protection Association in Cape Town, Justus said that in the past financial year, the municipality had installed 422 water standpipes, but had to effect 5 482 repairs to sabotaged or stolen pipes and taps. In the same year, 2 458 toilets were installed, but 4 302 repairs were made to cisterns, pans, pipes and ablutions.

"This has continued in the current financial year. Although we have installed 2 840 toilets halfway through the year – nearly 400 more than the previous year – we have had to effect 1 028 repairs due to theft and vandalism. While we have installed 186 water stand pipes, we have had to repair 1 942," reported Justus. "For two years the City has been systematically upgrading all 222 informal settlements

across the metro. We would be able to proceed at three times our current rate without this lawlessness."

To address the theft of copper cabling, brass valves, lead batteries, manhole covers and water meters, the municipality is now using only plastic or steel pipes and concrete for toilets. Underground electricity cables are now covered with concrete so that they cannot be dug out. Padlocks and chains are provided to community leaders to keep facilities secure at night and there have been crackdowns on dealers of stolen scrap metal. All kinds of materials are removed from blocked sewer drains, including car tyres, animal carcasses, suitcases and even substantial blocks of concrete.

Despite these measures vandalism continues. "A new pattern is emerging whereby plastic pipes are stolen despite their minimal re-sale value, concrete toilets are smashed with axes and even padlocks are taken," noted Justus. "In some cases concrete wall panels, wood and steel doors, and roofing from ablution and toilet blocks are stolen for use by residents to build their own structures. Most worrying of all are reports that residents purposefully vandalise facilities to secure more jobs in the subsequent repair programmes."

"The City does not have a bottomless pit of resources. We appeal to communities to assist us by reporting all incidents of theft and vandalism. If our request for cooperation from communities fails to improve matters, we may be forced to suspend service delivery programmes until communities take responsibility to protect these facilities," Justus said.



Technology Collaboration Partner Biological mine water treatment technology

Technology description:

Treatment of acid mine water is a growing concern in South Africa and elsewhere in the world, and there is growing demand for the construction and operation of effective treatment plants.

The CSIR has over the past 10 years, developed a number of patented demonstration, pilot and full-scale acid mine water treatment plants, operating in Southern Africa and abroad. The Waste Treatment and Utilisation Research Group works closely with external technology and commercialisation partners to develop and implement pilot and full-scale treatment facilities.

The CSIR (Council for Scientific and Industrial Research) is one of the leading research and development, technology and innovation institutions in Africa. With a track record spanning more than 60 years, the CSIR is committed to serving the development objectives of South Africa and the region through top skills and by performing research that is relevant and has impact. With an emphasis on building and transforming human capital, the CSIR plays a key role in ensuring the science and technology competence to address challenges of the future.

The group is currently undertaking research at the laboratory and pilot scale on a new biological treatment process for the treatment of acid mine waters, with the potential to recover by-products of economic value.

The CSIR is looking for technology collaboration partners interested in further development of this innovative technology as part of possible technology implementation projects in Southern Africa and ultimately abroad.

Technology partner expertise sought:

Organisations are requested to submit an expression of interest (EOI) which should include:

- Company profile and full contact details (applicants must demonstrate their capabilities to implement technology solutions within the water or mining sectors).

EXPRESSION OF INTEREST

- Experience in technology development. Previous experience in mine water treatment technology implementation (e.g. ability to upscale, process engineering capacity, due diligence, engineering drawings design, etc) would be advantageous.
- Potential offerings the company can provide to the CSIR in ensuring technology transfer and uptake as part of a future commercialization strategy (e.g. techno-economic feasibility; up scaling; developing a marketing strategy, etc).

Short listed organisations submitting an EOI that meets the CSIR's criteria will be requested to submit a full proposal following the successful signing of a non-disclosure agreement between the parties involved.

EOIs should be submitted electronically to Ms Sunita Kalan, R&D Outcomes Manager (SKalan@csir.co.za) by the 30 October 2009.

Encapsulating local knowledge

Indigenous rainwater harvesting and conservation practices are the product of accumulated knowledge, practices and traditions which have evolved over many generations of experimentation and adaptation. These practices have an inherent sustainability and present a sound platform on which to develop new practices aimed at maximising the benefits of 'runoff farming'.

A WRC-funded study documented and captured ten such practices in detail, both in a written format and on a DVD. The techniques that were documented covered scales varying from tens of thousands of hectares to micro-catchments of a few square metres in size.

The first technique covered is the practice of 'gelesha', which entails hoeing or tilling the soil after a crop harvest. The intention of the practice is to ensure that any falling rain or dew infiltrates the tilled soil. Historically, this practice was undertaken when a 'digging star' (the Orion constellation) *Isilimela* appeared in late autumn during and after the harvesting of the summer crops.

Stone terracing or the enclosure of specific



portions of lands by boulders and stones is a historical practice that was largely geared towards water-flow management and soil preservation. The practice is still undertaken in some

parts of South Africa, for example, Gogela Village in KwaZulu-Natal.

Saaidamme or 'planting dams' as well as contouring and homestead ponds are some of the other indigenous rainwater harvesting and conservation methods investigated. These practices have demonstrated the value of rainwater harvesting and conservation across the socio-economic and cultural spectrum of South Africa, including both emerging and commercial farmers.

To order the report and DVD, *Indigenous Water Harvesting and Conservation Practices: Historical Context, Cases and Implications* (WRC No: TT 392/09), contact Publications at Tel: (012) 330-0340 or E-mail: orders@wrc.org.za.

Also turn to page 28 for more on historical agricultural practices.

WATER ON THE WEB

www.c4w.org.za

The Climate for Water website was established as part of a Water Research Commission funded project and is a resource for climate and weather information available on the Internet. Users will be able to view Frequently Asked Questions on weather- and climate-related issues. The toolkit also provides valuable and easily searchable links for a number of weather- and climate-related resources available on the internet.

www.circleofblue.org

Circle of Blue is an international network of leading journalists, scientists and communications design experts that reports and presents information to respond to global freshwater challenges. It is a non-profit affiliate of the internationally recognised water, climate and policy think tank, the Pacific Institute.

www.1h20.org

This is a media website aimed at generating worldwide awareness about the provision of safe potable water. It enables journalists from around the world to tell stories about the challenges relating to water.

11th International Symposium on River Sedimentation (ISRS)
6 to 9 September 2010, Stellenbosch, SOUTH AFRICA

Sedimentation and Sustainable Use of River Systems



Organiser: University of Stellenbosch

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Secretariat: University of Stellenbosch
Permanent Secretariat: IRTCES

Visit the symposium website: www.civeng.sun.ac.za/isrs
Deadline for abstracts: 30 November 2009

Water wins at consulting engineering awards

A number of water-related projects were winners at this year's Consulting Engineers South Africa (CESA) Glenrand MIB Engineering Excellence Awards.

The Awards is a celebration of innovation, quality, outstanding workmanship and professionalism. While WSP Africa Coastal Engineers received a commendation for the Dense Effluent Marine Outfall at Richards Bay in the category for projects valued at more than R100-million, Knight Piésold Consulting won the prize for the Ntimbale Dam project under-

taken for the Botswana government in the category for projects valued at between R10-million and R100-million. SSI Engineers and Environmental Consulting received a commendation for the Nereda Wastewater Treatment works in Gansbaai in the same category.

In the category of Engineering Excellence with a value less than R10-million, Bosch Projects won the award for the Durban Harbour Tunnel Trolley System while Kwezi V3 Engineers scooped the commendation for the George Garden Route Dam project.



Winners pose at the CESA Glenrand MIB Engineering Excellence Awards 2009

Clearing the way for dirty water reuse

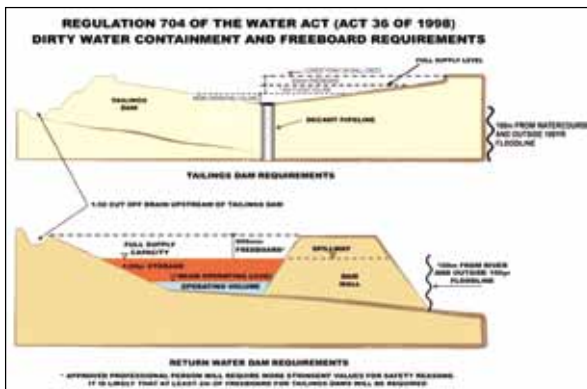
A dramatic change of attitude by mining bosses in African countries is smoothing the way to more sophisticated water management procedures being initiated that will lead to improved production and protection of the environment.

Five years ago, the mining industry balked at the treatment and reuse of mine-water. Today, the industry can save up to 40% of its daily freshwater intake by reusing processed mine and sewage water, says Peter Shepherd, principal hydrologist and a partner in the Johannesburg office of SRK Consulting. He reports that the water unit of the consulting firm is currently busy with some 75 projects on mines, some as far north

as Senegal, where the implementation of the latest techniques in water management is required.

Shepherd explains that in water-short areas water authorities limit the daily supply of freshwater to the mining industry, which could limit production. However, in some instances, this challenge is overcome and production is improved by treating and reusing sewage water and other used water in mining processes. "Management now understands what qualities of water may be reused within the various elements of a minerals recovery plant. Since there is no need to treat water to produce potable-quality water for reuse purposes, costs are reduced."

Considerable research has been done to find ways to reuse water with a minimal amount of treatment, and further research should be done to lessen industry's strain on the environment, maintains Shepherd. "There is a definite drive today, both from government and mining's side, to increase the reuse of water so as to reduce pressure on scarce water resources."



Illustrating Regulation 704 of the National Water Act regarding dirty water containment and freeboard requirements.

Power station water plants refurbished

VWS Envig has completed the refurbishment of the potable and demineralisation plants for Eskom's Grootvlei Power Station.

The power station falls under the power generator's return-to-service initiative to increase its reserve margin, and will once again see production after almost two decades of inactivity.

The contract, valued at R24-million, included a pre-treatment plant situated at the Vaal Dam, where water is put through coagulant pre-treatment processes, as well as a clarifying system. Treated water is then pumped to the Grootvlei Power Station where it is stored in terminal reservoirs. Once the water leaves the terminal reservoirs it is treated in a flocculation chamber to remove suspended solids.

The water is then put through two clarifying systems and rapid sand filters. From here the water is split into two separate streams: one destined for drinking water, which is chlorinated and disinfected; and the other for the demineralisation plant. Demineralised water will be used to produce super heated steam to drive the station turbines.

VWS Envig ran the plant for three months in collaboration with Eskom to ensure that plant personnel are adequately trained before the plant is handed over. "Each brownfield project has its own unique set of challenges which require unique solutions. The greatest challenge on the Grootvlei project has been adapting old technology commissioned in 1968 to meet modern standards," reported VWS Envig Project Engineer Julius Pistorius.

Among other important services being sought by the mining sector is flood prevention, which involves the design of infrastructure so that mine workings, either underground or openpit operations, are not flooded. The objective of this is to keep clean water clean and to prevent dirty water from leaving the mine. Dirty water is kept in stormwater control dams and reused.

"In the past 15 years there has been a change in the thinking of mining companies. Initially, it was more compliance driven, but today management realises that they have to clean up their mess anyway because each mining operation has a mine plan in places that includes a procedure for eventual mine closure," notes Shepherd.



Peer pressure helps people to stay green

People are more likely to participate in conservation programmes if their neighbours do – a tendency that should be exploited when it comes to protecting the environment, according to a study from Michigan State University (MSU), in the US.

The research is believed to be the first to focus on the phenomenon of social norms in the context of China's conservation efforts, said Jianguo Liu, University Distinguished Professor and study co-author. The study focused on a mammoth government initiative called Grain to Green that pays Chinese farmers to convert cropland back to forest. While money is a key factor in whether people sign up for the voluntary programme, peer pressure also plays a surprisingly large role.

"That is the power of social norms," noted Liu. "It is like recycling. If you see your neighbours doing

it, you are more likely to do it."

Xiaodong Chen, MSU doctoral student and lead author of the study, believed that government officials should leverage these social norms along with economic and demographic trends when deciding how to support conservation programmes. "We found that, without considering the social norm factor, the conservation payments may not be used efficiently. But if the government considers social norms as they decide where to invest money, they could possibly obtain more environmental benefits in communities that are more supportive of these programmes rather than those who are not."

UN report promotes rainwater harvesting

A joint report from the Stockholm Environment Institute (SEI) and the United Nations Environment Programme (UNEP) outlines the advantages of investing in rainwater harvesting.

The publication, *Rainwater Harvesting: a Lifeline for Human Well-being*, highlights the potential of rainwater harvesting as a way to create synergies in landscape management and human well-being. The report explains how rainwater harvesting can serve as an opportunity to enhance ecosystem productivity, thereby improving livelihoods, human well-being and economies.

"Rainwater harvesting has often been a neglected opportunity in water resource management because only liquid water in surface and groundwater sources is usually considered. If we develop better ways of managing rainwater, we can improve water supply, enhance agricultural production and even sustain the ecosystem services we rely upon," reports SEI researcher Jennie Barron.

Rainwater harvesting is the collective term for a wide variety of ways of collecting and storing rainfall, be it soil as storage, man-made dams, tanks or containers. The intention is to improve water management for multiple purposes.

With farms being the most important ecosystem for human welfare, rainfed agriculture provides nearly 60% of global food value. Needless to say, rainfall variability constitutes a challenge to such agricultural systems.

"Low agricultural productivity often aggravates a negative spiral in landscape productivity, with degradation of ecosystem services through soil erosion, reduced vegetation cover and species decline," notes Barron.

She says that rainwater harvesting deserves serious consideration, as it is economic and reduces pressure to withdraw water from existing groundwater and/or surface water sources which could negatively impact ecosystem habitats and services.

"Rainwater harvesting is not a magic bullet but it can be effective as a complementary and viable alternative to large-scale water withdrawals, and as a way of reducing the negative impacts on ecosystem services, not least in emerging water-stressed basins," Barron concludes.

To access the report, Visit: www.unep.org/Themes/Freshwater/PDF/Rainwater_Harvesting_090310b.pdf

Permafrost melt poses major climate change threat

New research shows that the amount of carbon stored in frozen soils at high latitudes is double previous estimates and could, if emitted as carbon dioxide and methane, lead to a significant increase in global temperatures by the end of this century.

"Massive amounts of carbon stored in frozen soils at high latitudes are increasingly vulnerable

to exposure to the atmosphere," says Executive Director of the Global Carbon Project at CSIRO, Dr Pep Canadell. "The research shows that the amount of carbon stored in soils surrounding the North Pole has been hugely underestimated."

According to Dr Canadell, frozen high-latitude soils have the potential to release vast quantities of carbon and methane into the atmosphere and subsequently influence carbon-climate feedbacks. "Warmer temperatures at high latitudes are already resulting in unprecedented permafrost degradation," he reports. "Projections show that almost all near-surface permafrost will disappear by the end



of this century exposing large carbon stores to decomposition and release of greenhouse gases."

Models developed in collaboration with Dr Canadell show that global warming could trigger an irreversible process of thawing. A number of feedbacks increase the vulnerability of these soils. For

example, heat generated from increased microbial activity could lead to sustained and long-term chronic emissions of carbon dioxide and methane. In addition, 'thermofrost lakes' formed as permafrost thaws, would draw heat to deeper layers and bring methane to the surface. Increased fire frequency will also trigger permafrost degradation and thermokast collapse.

"Using the new carbon pool estimates from this research, permafrost degradation could account for the entire upper range of carbon-climate feedbacks currently estimated by climate models," notes Dr Canadell.

Disaster risk on the rise – report

The world's disaster risk is increasing, according to the first *Global Assessment Report on Disaster Risk Reduction*, published by UNESCO.

Disaster risk is concentrated in a very small portion of the Earth's surface and is unevenly distributed, the report finds. A mere handful of countries have been struck by more than one mega-disaster in the past 30 years: Bangladesh, China, India, Indonesia, Japan and the USA.

Although mega-disasters remain rare, half of the 14 costliest disasters since 1976 occurred in the past five years. These include the Sichuan earthquake in May 2008, which killed at least 87 566 Chinese and affected more than 60 million.

The report argues for a radical shift in development practices and a fresh emphasis on resilience and disaster planning, especially in poorer countries which are more at risk. Addressing the underlying drivers of risk such as the lack of access to social protection requires specific attention.

The report observes that 'economic growth per se does not lead to reduced disaster risk: as economies grow, exposure tends to increase at a faster rate than vulnerability can decrease. Greater social equity can not only reduce vulnerability by also alleviate poverty.'

To read the report visit: www.preventionweb.net/english/hyogo/gar/report/

Bio-fuel thirstier than conventional power

Production of bioethanol – often regarded as the clean-burning energy source of the future – may consume up to three times more water than previously thought.

This according to a study of scientists from the University of Minnesota, in the US, published in *Environmental Science & Technology*.

Sangwon Suh and colleagues point out in the study that annual bioethanol production in the US is currently about 34 000 Mℓ and note that experts expect it to increase in the near future. The growing demand for bioethanol, particularly maize-based ethanol, has sparked significant concerns among researchers about its impact on water availability. Previous studies estimated that a gallon (3,8 ℓ) of maize-based bioethanol requires at least 263 gallons (996 ℓ) of water from the farm to the fuel pump. But these estimates failed to account for widely varied



regional irrigation practices, the scientists say.

The scientists made a new estimate of bioethanol's impact on the water supply using detailed irrigation data from 41 US states. They found that bioethanol's water requirements can be as high as 861 gallons (3 259 ℓ) of water from the field to the fuel pump.

To read the full article visit <http://pubs.acs.org/stoken/presspac/presspac/full/10.1021/es8031067>

Virtual farm modelling helps Aussie farmers grow profit

CSIRO, Queensland Primary Industries and Fisheries and the University of Queensland have joined forces to develop new agriculture modelling technologies to help farmers improve crop risk management and profitability.

The joint venture has been formed to further develop the Agricultural Production Systems Simulator (APSIM) – a computer simulation model which takes into account many of the factors affecting a farm's success, including different plant, soil and management approaches, to inform on-farm management decisions.

APSIM has a range of applications, including farming system design, assessment of seasonal

climate forecasting, supply-chain planning, development of waste management guidelines, risk assessment for government policy making, as well as guiding research and educational activities.

Director of CSIRO's Sustainable Agriculture Flagship, Dr Brian Keating, says the initiative will help Australian agriculture respond to the critical challenges of increasing productivity while reducing its environmental footprint. "The research team is well placed to build on its past achievements and achieve new innovations in knowledge-based systems to support the productivity gains and enhanced management practices needed for the future prosperity of Australian agriculture."

Fellowships announced for African women in agriculture

International organisation African Women in Agricultural Research and Development (AWARD) announced its selection of 61 women scientists who will receive the AWARD Fellowship designed to boost the female talent pool for African agriculture.

Chosen from nearly 500 applicants these women bring with them scientific and development expertise that has great potential to tackle the food crisis and climate change while improving the daily lives of small-scale farmers. The winners represent ten African countries, including Ethiopia, Ghana, Kenya, Malawi, Mozambique, Nigeria, Rwanda, Tanzania, Uganda and Zambia.

An estimated 80% of Africa's farmers are women, while between 60% and 80% of Africa's food is produced by women. "Yet, only 5% of agricultural extension and 10% of rural credit reaches women," notes AWARD Director Vicki Wilde.

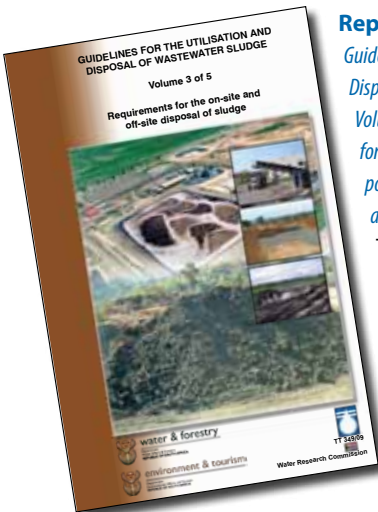
"Part of the reason for this is that women comprise only 25% of the agricultural research and development (R&D) pool and very few hold positions of leadership."

According to Wilde this means that there are not enough African women in a position to influence the priorities for agricultural R&D. "Much more needs to be done to ensure rural women's voices and needs are brought into laboratories and field projects."

AWARD is supported by the Bill & Melinda Gates Foundation and the US Agency for International Development.



New from the WRC



Report No: TT 349/09
Guidelines for the Utilisation and Disposal of Wastewater Sludge, Volume 3 of 5: Requirements for the on-site and off-site disposal of sludge (JE Herselman and HG Snyman)

The Water Research Commission, with the Department of Water & Environmental Affairs developed a series of guidelines to encourage the beneficial use of wastewater sludge where possible. This

volume deals with the management, technical and legislative aspects associated with on-site and off-site disposal of sludge as well as the characterisation and monitoring requirements for each disposal option.

Report No: KV 219/09

Assessment of Gender Equity in Water User Associations (N Mjoli; R Nenzhelele and E Njira)

The overall objective of the study was to assess gender equity within the management committees of Water User Associations (WUAs) and to make recommendations for ensuring that participation of women in WUAs contributes to their social and economic empowerment. Gender equity was assessed in six WUAs in Limpopo and KwaZulu-Natal. The findings of the study supported the hypothesis that gender quotas alone were not enough to bring about gender equity and poverty reduction in WUAs because the required enabling environment for the empowerment of rural women was not created. Although the water and gender equality policy and legislative framework clearly outlined steps that must be taken to redress past gender imbalances, the decision-makers have focused on increasing the representation of women in management structures without implementing the necessary programmes for empowerment of women. The study showed that women were not getting any benefits from their involvement in WUAs because they did not own land and water rights in their individual capacity.

Report No: 1490/1/09

Design and Development of a Hydrological Decision Support Framework (DJ Clark; JC Smithers; DA Hughes; KB Meier; MJ Summerton and AJE Butler)

The National Water Act calls for the equitable and sustainable allocation of water resources. This will require decision support at temporal and spatial scales appropriate to the demands of the Act and which utilises state-of-the-art hydrology, in addition to social economic and environmental needs which have to be considered. A process-based hydrological model, which can have meaningful links with socio-economic models, is a logical framework on which to build the decision support system. The primary objective of this project was the development of such a hydrological decision support framework which can incorporate relevant and appropriate simulation models linked by a common flexible and extensible database and integrated with a GIS for use at a planning and operational level by catchment management agencies at spatial scales ranging from point of use to the entire water management areas and at temporal time scales of one day.

Report No: 1688/1/08

The Role of Local Government in Integrated Water Resources Management Linked to Water Service Delivery (EH Haigh; H Fox; H Davies-Coleman; D Hughes; D Atkinson and M McCann)

This project investigated the legislation for, and the support available to water services authorities (WSAs) to engage in integrated water resource management, planning and implementation, using Makana Local Municipality as a case study. Among others, the study found that one of the critical gaps in local government was a lack of understanding of the full scope and value of the water services delivery plan and integrated waste management plan. Members of staff are unable to complete these plans independently. A water services authority such as Makana should also incorporate water resource protection into their planning, development and service provision. The ability of municipal officials to engage in these activities were found wanting. Cooperative governance at local government level which is at the base of all integrated resource management is generally not practiced in municipalities, the project found.

Report No: 1566/1/09

Using Enhanced Knowledge of Climate Variability for the Benefit of Water Resource Management (G Ziervogel; P Johnston; R Walawege; M Matthew and P Mukheibir)

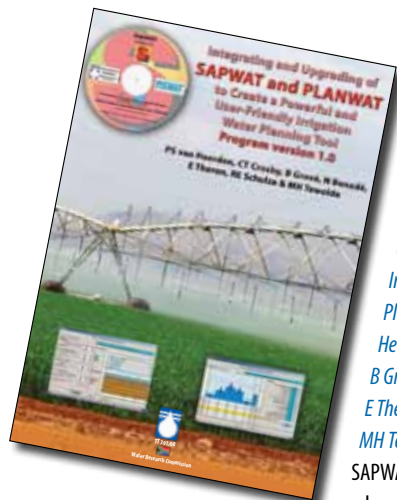
Seasonal climate forecasts are available in South Africa, yet they are of little value to the water management sector if they are not accessible and understood. Currently, these products, that address annual climate variability, do not yet appear to meet the needs and expectations of water resource managers. This project sought to identify processes and products that might facilitate increased uptake of all types of useful weather and climate information, and especially seasonal climate forecast, among water resource managers. All the collected data has been analysed and the information used to develop a toolkit for guiding water resource managers (and others) towards the most applicable information. This online toolkit (www.c4w.org.za) will help to guide water resource managers through a process of selecting useful and applicable weather and climate information in line with their specific needs. It will also be useful for educating other stakeholders (such as farmers and local authorities) about climate variability information and its potential applications and limitations.

Report No: KV 221/09

Application of the Guide for Farmer Trainers and Facilitators on the Revitalisation of Smallholder Rainfed and Irrigated Agriculture (ME Botha)

During a previous WRC-funded project, attention was given to the development of a training package that can be given to prospective trainers or facilitators to use in the field when presenting training to smallholder farmers. The aim of this project was the development of a training material package for use by trainers/facilitators to try and increase the accessibility of meaningful training and capacity building where small-scale irrigation forms part of integrated sustainable rural development initiatives. The training package includes information such as the actual technical training content in Outcomes Based Education format, the expected outcomes of the training as well as notes to trainers regarding important issues to consider throughout the training process itself.

To order any of these reports, contact Publications at Tel: (012) 330-0340; Fax (012) 331-2565; E-mail: orders@wrc.org.za or visit: www.wrc.org.za

**TT 391/08**

Integrating and Upgrading of SAPWAT and PLANWAT to Create a Powerful and User-Friendly Irrigation Water Planning Tool (PS van Heerden; CT Crosby; B Grové; N Benadé; E Theron; RE Schulze and MH Tewolde)

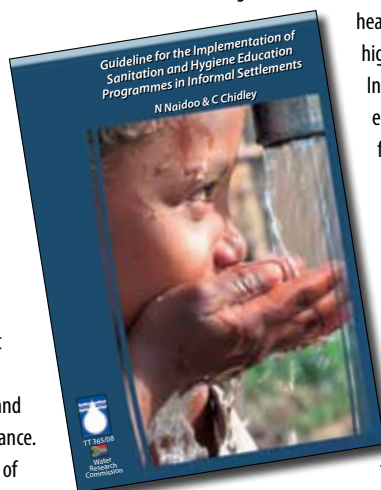
SAPWAT3 is essentially an enhanced and improved

version of SAPWAT, the program that is extensively applied in South Africa and developed to establish a decision-making procedure for the estimation of crop irrigation requirements by irrigation engineers, planners and agriculturalists. The irrigation requirement of crops is dominated by weather, particularly in the yearly and seasonal variation in the evaporative demand of the atmosphere as well as precipitation. SAPWAT3 has included in its installed database comprehensive weather data that is immediately available to the user. Moreover, the program can be used to estimate the irrigation requirement for a single crop, for a field with multiple cropping, for a single farm, for a group of farms, or water user association (WUAs), for a group of WUAs, for a water management area or even a river basin.

Report No: 1483/1/09

The Influence of Hydraulics, Hydrology and Temperature on the Distribution, Habitat Use and Recruitment of Threatened Cyprinids in a Western Cape River, South Africa (BR Paxton and JM King)

The Olifants-Doring River system in the south-western Cape is a hotspot of freshwater fish diversity in South Africa and a catchment of national and international biogeographic importance. A substantial decline in the number of indigenous fish in this system has been reported. This study reports on research undertaken on a tributary of the Doring River (the Driehoeks River) that supported populations of Clanwilliam yellowfish and sawfin. The primary aim of this study was to assess the movement, flow and habitat requirements of the Clanwilliam yellowfish and sawfin and recommend water management strategies to ensure the persistence of remaining populations.

**Report No: 1340/1/09**

Research on Activated Sludge Settling Behaviour Based on Short-term Temperature Variations (WH Rössle; W van der Merwe; A Chapman; LS Chueu and WA Pretorius)

Settling properties of activated sludge or mixed liquor suspended solids (MLSS) have been studied for more than 75 years at wastewater treatment plants. Temperature, together with MLSS concentration, has been acknowledged as important contributors to MLSS settling variations. These settling variations can be detected over short term, from minutes up to diurnal periods, or over long term, from weeks up to annual periods based on seasonal meteorological changes. This research project evaluates the effects of short-term temperature variations on MLSS settling parameters. The extent of typical plant temperature variations is demonstrated by short- and long-term reactor temperature observations.

Report No: TT 365/08

Guideline for the Implementation of Sanitation and Hygiene Education Programmes in Informal Settlements (N Naidoo and C Chidley)

A detailed assessment of the requirements for the successful implementation of hygiene education programmes in informal settlements found that municipalities do not generally address issues of hygiene education in informal areas in a meaningful and sustainable manner. Hygiene education programmes are among the most cost-effective ways of lowering

health costs, especially in high-density settlements. In addition, hygiene education creates the foundation for other water- and sanitation-related education, such as education on the proper use and maintenance of the facility, water conservation education, using water for productive purposes etc. This

guideline aims to develop a new and internationally accepted approach to providing hygiene education in informal settlements; providing step-by-step assistance in planning, designing, implementing and monitoring and evaluating hygiene education programmes in informal settlements; and illustrating how hygiene education programmes can become the foundation for broader education programmes around water and sanitation issues.

WATER BY NUMBERS

- ◆ **1,4 million** – The number of people living in informal settlements who will receive access to safe water and sanitation by 2012 through eThekweni Municipality's new water and sanitation project. About R175-million is being spent over three years and the project is expected to generate about 3 000 job opportunities.
- ◆ **16 000** – The estimated number of people in Ilembe District Municipality who will benefit from the Ngcebo/KwaDukuza Bulk Water Supply Scheme, currently being undertaken by Umgeni Water.
- ◆ **0,67 kg** – The amount of carbon dioxide emitted for every kilolitre of drinking water produced.
- ◆ **R30-billion** – The funds to be spent by the Department of Water & Environmental Affairs (DWEA) over the next five to eight years on the construction of mega water resource infrastructure. According to Deputy Minister Rejoice Mabudafhasi feasibility studies are continuing for 12 dams.
- ◆ **60** – The number of crest gates on the Vaal Dam. The dam has a flood storage capacity of 25% above the 100% full supply level. The highest peak inflow ever recorded was in February 1996 at 4 800 m³/s.
- ◆ **575 ℓ** – The volume of water the average American uses every day. The average European uses 250 ℓ of water per day. The estimated 1,1 billion people who lack adequate water access use an average of 19 ℓ of water per day.
- ◆ **32 ℓ** – The volume of water it takes to produce 1 microchip.
- ◆ **1** – The drops of oil it takes to make 25 ℓ of water undrinkable.
- ◆ **4 000** – The number of people who have fallen ill in the city of Chifeng in China's Inner Mongolia region after the potable water supply was contaminated following heavy rainfall. Tests of water samples in the city indicate a high number of bacteria, including coliform and salmonella.
- ◆ **500** – The estimated number of fish species in Lake Malawi, more than any other lake in the world.



Sue Matthews

An angler heads for her fishing spot at the Gamtoos River estuary.

Estuaries Management – TURNING A CONSERVATION VISION INTO REALITY

The development and review of a set of estuary management plans for Western Cape estuaries are the first steps in ensuring the conservation of these unique ecosystems for future generations. Sue Matthews reports.

The departmental restructuring announced with the appointment of President Jacob Zuma's cabinet - which saw components of the Department of Water Affairs & Forestry (DWAF) and Department of Environmental Affairs & Tourism merge into a new Department of Water and Environmental Affairs (DWEA) – was a

positive step for South Africa's estuaries, given their dependence on riverine input. This was the general consensus among estuary scientists and managers attending a workshop in June to review the estuary management plans (EMPs) developed for six pilot estuaries as part of the CAPE Estuaries Programme.

CAPE – the Cape Action Plan for People and the Environment – is a partnership programme that aims to conserve and restore the biodiversity of the Cape Floristic Region's terrestrial, freshwater and marine environments, while delivering significant benefits to the people of the region. The programme is hosted by the South African National Biodiversity

Institute (SANBI) at Kirstenbosch in Cape Town, but much of its funding over the past five years has come from two grants from the World Bank and UNDP – via the Global Environment Facility (GEF) – totalling US\$14-million.

As one of CAPE's 23 signatory partners, the provincial conservation authority, CapeNature, took responsibility for the Estuaries Programme, overseen by programme coordinator Pierre de Villiers. The first phase of the programme has come to an end, marked by the review workshop and the cessation of GEF funding. One of the first outputs during this phase was a regional conservation plan prepared by Anchor Environmental Consultants, which rated temperate South African estuaries on the basis of biodiversity importance, ecosystem health, and economic costs and benefits. At the same time, a Generic Framework for Estuarine Management Plans was compiled by the CSIR, as well as nine supporting Guideline documents by various authors.

These were developed in accordance with the proposed National Estuarine Management Protocol outlined in the new National Environmental Management: Integrated Coastal Management Act, which identifies the need for EMPs to coordinate estuary management at a local level. The Act has been more than a decade in the making, its Green Paper having been published in 1998 and the Act finally only gazetted in February of this year – with a date for its implementation yet to be announced.

“Estuary management is a practical process, with no right or wrong. It’s about coming up with a vision that is acceptable to all stakeholders, finding ways of achieving that vision and implementing them.”

“When the CAPE Estuaries Programme was designed, it was presumed that the Act would be in force by the time the EMP development process began,” says De Villiers. “What has happened is that we’ve essentially ended up testing the implementation of the processes that will be necessary to develop EMPs, and our Generic Framework and Guideline documents can now assist with the drafting of the National Estuarine Management Protocol.”

The usefulness of the Generic Framework was gauged by applying it in the development of EMPs for six pilot estuaries in the Cape Floristic Region – those of the Olifants, Klein, Heuningnes, Breede, Knysna and Gamtoos rivers. For each estuary, the EMP development process was initiated with a desktop situation assessment, covering aspects such as the biophysical and socio-economic environment, the exploitation of living resources, water quality and quantity issues (resource directed measures), legal requirements and institutional structures. Apart from providing

the necessary background information, the situation assessment will be a useful baseline document for five-yearly State of the Estuary reports.

Six different consultancy teams conducted the situation assessments, and then organised workshops with stakeholders to launch the development of the EMP. Each process began by defining a vision of how stakeholders saw the estuary, both now and in the future. The vision needed to be inspirational, but at the same time realistic and achievable, and was designed to ensure that the strategic objectives and management actions subsequently identified for the EMP would help to reach the common goal. It also needed to be in line with the overall vision set for the CAPE Estuaries Programme, which states that: “The estuaries of the Cape Floristic Region will continue to function as viable systems which are beautiful, rich in plants and animals, attract visitors, sustain our livelihoods and uplift our spirits”.

An Estuarine Zonation Plan – a map of the estuary showing its geographical boundaries, important biophysical features, and zones identified for conservation, recreation and development – was ultimately drawn up as a tangible product of the EMP. In addition, an estuarine management forum was set up for each estuary to oversee the implementation of the EMP. The forums are made up of representatives of all relevant government authorities at the national, provincial and local level, as well as stakeholder groups.



A channel cuts through a saltmarsh at the Olifants River estuary on the West Coast.

The Pilot Estuaries Management Programme

The six pilot estuaries have a range of different management issues that need to be addressed, but the process of doing so is guided by the Generic Framework, which provides a consistent format for the Estuary Management Plan. Contentious issues or encouraging aspects in each estuary are highlighted here.

The **Olifants estuary** on the West Coast ranks among the country's top five estuaries in terms of conservation importance. The consultants therefore recommended establishing a marine protected area in the estuary, with zones allowing for different activities. Gill-netting, which targets haarders (mullet) but has a high bycatch of juvenile line-fish, would be banned from the mouth to 12 km upstream. Marine & Coastal Management had earlier indicated that gill-net fishing would be phased out in all estuaries countrywide, but the consultants had brokered a compromise to allow activity to continue in the upper reaches of the estuary, in light of the fishery's importance here. However, the local fishing community has objected to the proposal.

The **Klein estuary** at Hermanus is popular for recreational activities such as dinghy sailing, windsurfing, canoeing and waterskiing, but swimming has been banned due to faecal pollution from leaking sewers. In addition, artificial breaching takes place to protect the adjacent low-lying properties from flooding. To avoid compounding these

problems, the spatial implications of the EMP have been integrated into the local municipality's Spatial Development Framework in the 2011 review. The interest generated in the EMP development process, together with the municipality's commitment, has encouraged the environmental NGO WWF to fund a newly created position for an estuary manager to oversee this and the neighbouring Bot and Onrus estuaries.

The **Heuningnes estuary** near Cape Agulhas – the continent's southern tip – is the smallest of the six estuaries. Its mouth is kept open artificially by Cape Nature, which manages the De Mond Nature Reserve encompassing the lower part of the estuary. This management strategy is in line with a long-standing agreement with local farmers, whose land was flooded in the past when the mouth closed during periods of low flow due to shifting sand. Sensitive wetland habitat occurs on these farmlands, where it is threatened by grazing and other agricultural activity. A more holistic approach to estuary management is therefore needed.

The **Breede estuary** benefits from well-established stakeholder involvement through the Lower Breede River Conservancy, which employs a team of law enforcement officers to oversee compliance with the Marine Living Resources Act and local bylaws passed by the Swellendam Municipality. In addition, various monitoring studies are being conducted by the CSIR, MCM and

DWEA. It is anticipated that these initiatives will facilitate implementation of the EMP, which includes measures to protect sensitive habitats and rehabilitate degraded areas.

The **Knysna estuary**, better known as Knysna Lagoon, is managed by SANParks, so the EMP has been drafted as a Low-level Operational Plan according to the planning format used by SANParks for protected areas. As such, the EMP covers the water area only, and does not address highly sensitive saltmarshes away from the main water body. Although SANParks has provided input to Knysna's recently revised Spatial Development Framework, proper integration with the EMP is required if the estuary is to be protected from further development impacts.

The **Gamtoos estuary**, close to Jeffrey's Bay in the Eastern Cape, is renowned as a prime location for catching large dusky kob – a species so overfished that its population is now less than 5% of its historical breeding stock. A proposal to limit kob angling to a catch-and-release fishery met with opposition from local angling clubs, so it was agreed that effort would instead focus on better enforcement of the existing legislation, which stipulates a bag limit of one kob per day when caught in estuaries and from the shore east of Cape Agulhas. The interest generated by this issue meant that the Gamtoos Estuarine Management Forum was the first to be established.



“We need to build capacity to develop estuary management plans and implement them, both on the ground, at local level, and in the provincial and national departments that need to play a part.”

“In any one estuary, there’s probably four or five government bodies, each with very specific roles to play,” says De Villiers. “It may be appropriate for the local authority to chair the forum and drive the EMP, but representatives of provincial and national government departments must attend to ensure their particular mandates are fulfilled.”

Stakeholder involvement is also considered crucial for the successful implementation of the EMP. “Estuary management is a practical process, with no right or wrong. It’s about coming up with a vision that is acceptable to all stakeholders, finding ways of achieving that vision and implementing them. And you can adapt as you go if necessary – the idea is that the EMP is a living document, which must not be confused with a scientific one. You need science to tell you what has to be managed, you need the stakeholders to agree on a common vision, and you need the legislation to tie it all together. If you focus on any one, it’s not going to work. That’s what happened with previous initiatives, like the Eastern Cape Estuaries Programme. It was great science, but the other two aspects were missing, so there’s been very little implementation.”

Initiated in 1998, the Eastern Cape Estuaries Programme was led by the Pietermaritzburg-based Institute of Natural Resources and funded largely by the Water Research Commission (WRC). It spawned a number of research reports and popular publications, including the guideline document *Managing Estuaries in South Africa: a Step by Step Guide (WRC Report No TT 243/04)*. Although the recommendations have generally



Lani van Vuuren

The Klein estuary at Hermanus is popular for recreational activities such as dinghy sailing, windsurfing, canoeing and waterskiing.

not been put into practice, this is not to say that the research effort was wasted.

“The strategic adaptive management approach was developed and tested for estuaries on the Eastern Cape Estuaries Programme, and the same principles are now being applied in these EMPs,” says Prof Janine Adams, Chair of the WRC Board and a member of the CAPE Estuaries Programme technical working group. “In addition, a number of WRC-funded research programmes have contributed to the understanding of environmental water requirements of estuaries, and our recent review of the six completed EMPs clearly indicated that where a DWAF

environmental water requirement study had been completed on an estuary, the available information provided valuable input to the EMP. Many postgraduate students were involved with this research, so training and capacity-building has been an important aspect.”


De Villiers agrees that scientific training is vitally important, but highlights the need to train and employ estuary managers countrywide. “We need to build capacity to develop EMPs and implement them, both on the ground, at local level, and in the provincial and national departments that need to play a part,” he says. “We’ve used consultants for the

CAPE Estuaries Programme because we had to get the pilot EMPs up and running quite quickly. Since then we've already started developing another five EMPs – for the Berg, Verlorenvlei, Diep, Bot and Gouritz estuaries – and will soon be advertising another five."

"Beyond the Cape Floristic Region, however, we've liaised with colleagues at the KwaZulu-Natal and Eastern Cape parks boards, and they're now applying our Terms of Reference and the Generic Framework – which covers everything that a manager should need to develop an EMP – to their own estuaries. The main aim was to test the EMP development process to see if it works country-wide, but at the same time the managers are gaining practical experience, while

government officials and stakeholders are learning more about estuaries – and they're all talking to one another."

"So through the CAPE Estuaries Programme, we've created a massive

amount of energy and support out there at a local level. But we're at a crucial stage now, because developing an EMP is just the first step – the actual implementation is the huge task ahead!" 



The Knysna lagoon remains one of the top tourist attractions in South Africa.

SA Tourism

ESTUARIES IN SOUTH AFRICA

Estuaries are generally recognised as being partially enclosed, coastal bodies of water which are either permanently or periodically open to the sea and within which there is a measurable variation of salinity due to the mixture of sea water with freshwater derived from land drainage. These water bodies are therefore linked to a river, stream or other freshwater input on the one side and to the sea at the other.

The southern African coastline from Mozambique in the east to Angola in the west is uniquely characterised amongst Southern Hemisphere coastlines by the combination of few near shore islands, strong wave action, especially in the southern Cape, and the very small number of sheltered bays. Therefore, South Africa's estuaries are virtually the only protected coastal habitats which are able to provide an environment which combines predominantly marine or near marine salinities, shelter from wave action and relatively fine sediments. This combination is preferred by a variety of animal and plant species.



Estuaries are dynamic systems and virtually any physical or chemical feature associated with them is subject to rapid and sometimes extreme changes. The mouths of South African estuaries, unless pinned by some rocky feature, tend to meander under the influence of currents, wind and wave action and sediment movement. Under flood conditions major mouth changes involving thousands if not millions of cubic meters of sand may occur in a few hours.

The fauna and flora of estuaries are typically capable of tolerating the constant change within estuaries. Those that can tolerate the estuarine environment are often very successful and abundant in their chosen environment, e.g. sand prawns

(*Callinassa kraussi*) and mud-prawns (*Upogebia africana*), mullet and fish that feed on the bottom or eat plankton.

A feature of the life styles of a variety of estuarine species is migration. Most of the larger fish species as well as invertebrates such as the estuarine swimming prawns and the mangrove crab (*Scylla serrata*) breed at sea where salinity, temperature and oxygen availability are much more constant than in an estuary. This favours the sensitive larval stages which then, at a later stage of development, move to the estuarine nursery grounds for a time to grow and develop into mature animals before migrating back to the sea. In invertebrates such as the swimming prawns or fish like the Cape stumpnose (*Rhabdosargus holubi*) there is no return migration. Fish like grunter (*Pomadasys commersonii*) may move repeatedly between marine spawning grounds and estuarine nursery or feeding grounds as at St Lucia.

Source: www.upe.ac.za/cerm/

THE ORANGE RIVER BASIN SYMPOSIUM- **THE CHALLENGE**

Presented by THE UNIVERSITY OF THE FREE STATE, BLOEMFONTEIN

11-12 NOVEMBER 2009



THE FOCAL AREAS FOR THE SYMPOSIUM ARE

Governance and Planning
Climate Change
Environmental Management
Water Quantity
Water Quality
Human Health
Operations and Processes
Securing the resource/interventions
measures – How to address the challenges

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- Water Boards / Corporations
- Ministries of Water and Environment Water Providers
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- Consulting Engineers
- Environmental Scientists, Water Chemists and Microbiologists
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- Public Health Officials
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- Water Project Financing Organizations
- Researchers/Students
- Agricultural Extension Officers

Papers and posters on the Orange River's place in southern Africa are invited.

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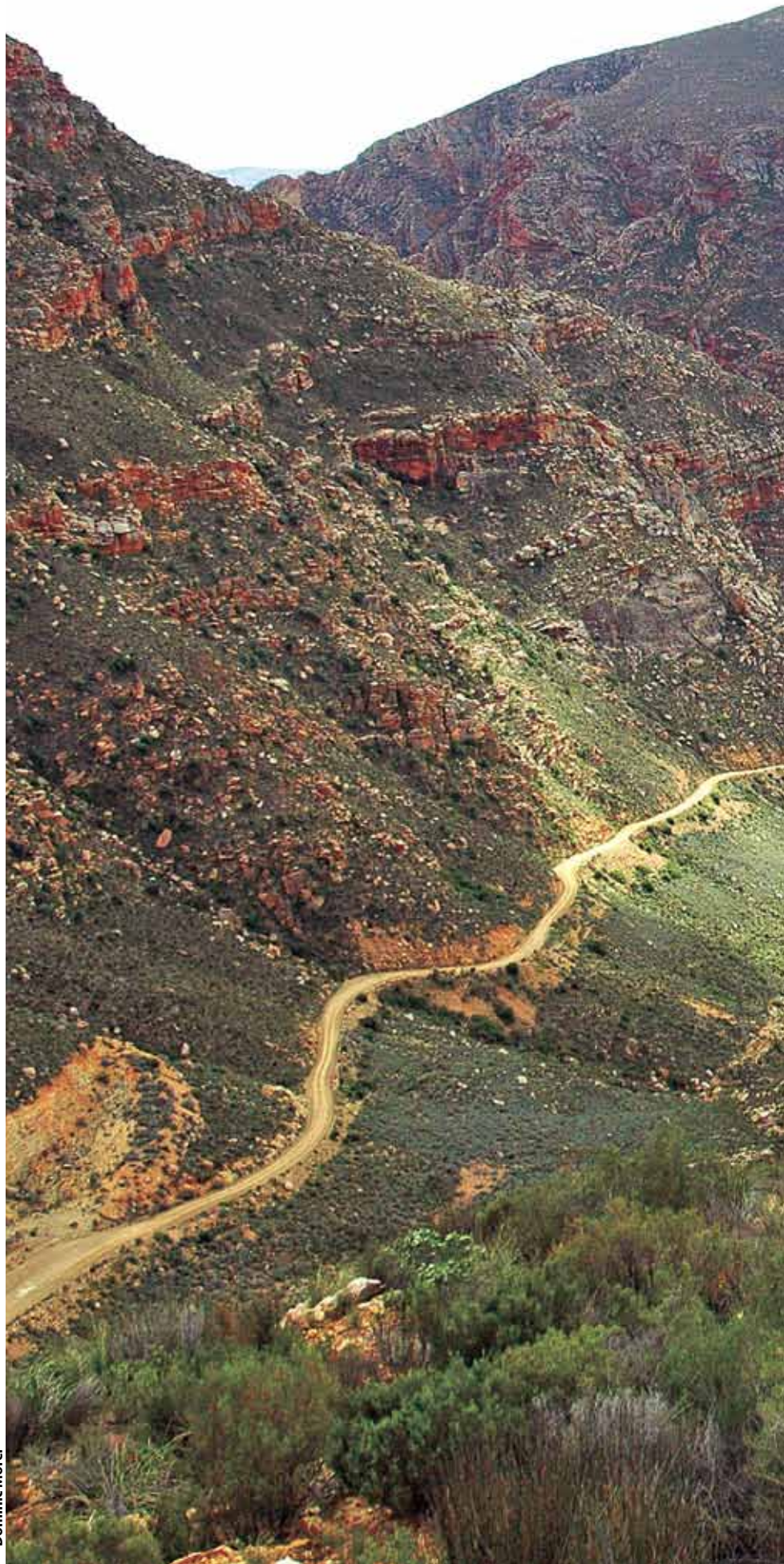
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Calls to Improve Water Management in Klein Karoo

*Water resources in the Klein Karoo are reaching a state of severe stress and immediate action is required to ensure adequate water resources remain for the future use of man and the environment. This is according to researchers at CSIR's Natural Resources & the Environment.
Compiled by Lani van Vuuren.*





The Klein Karoo is a long valley bordered by the Swartberg and the Langeberg Mountains in the Western Cape. While the mountains have a relatively high rainfall, the Klein Karoo falls in a rain shadow and only receives 150 mm to 350 mm of rain a year.

The Klein Karoo is an east-west oriented valley in South Africa, located between roughly parallel mountain ranges running along the coast of the Western Cape. In this semi-arid area freshwater is a critical constraint to future economic development. While the mountains have a relatively high rainfall, the Klein Karoo falls in a rain shadow and only receives 150 mm to 350 mm of rain a year.

Despite the importance of water in this area it is difficult to find information on the state of surface and groundwater resources in the Klein Karoo. A CSIR study, led by Dr David le Maitre and published in the January/February 2009 edition of the *South African Journal of Science*, highlighted some key issues affecting the state of natural resources in the region.

There are few perennial rivers in this region, the largest being the Gouritz River, which originates in the Greater Karoo and enters the Indian Ocean at Gouritzmond. The river drains an area of

45 702 km² and is about 260 km long. Its major tributaries are the Groot, Gamka and Olifants rivers. The river and its main tributaries were the focus of the study.

Agriculture is by far the biggest water user in the region (up to 90% in one tributary catchment). Principal land uses in the Klein Karoo include irrigation farming for fodder crops, fruits, vines on alluvial deposits of the floodplains and extensive grazing by small stock and ostrich on the footslopes.

The area has been settled by Europeans since the early 1800s and there is evidence that human activities, particularly overgrazing of drylands and cultivation of alluvial areas, have resulted in hydrological and vegetation changes over large areas of the Klein Karoo. Many of the impacts arise from soil compaction as a result of trampling, which destroys the vegetation and reduces water infiltration.

This means that, when it rains, water flows over the ground rapidly, often

forming channels, which erode the topsoil and increase the silt loads and peak flood volumes in the rivers. Regrowth of vegetation is slow and, even once farms are abandoned, the knock-on impacts on rivers continue. In addition to undergoing physical and chemical changes, the large rivers are increasingly subjected to more extreme and episodic flows due to a combination of increased surface runoff from hillslopes and decreased interflow and groundwater recharge to rivers. Alien vegetation, particularly black wattle and Spanish reed, also reduces the flow and water availability.

Groundwater is an important water source in the area. For example, the Klein Karoo Rural Water Supply Scheme, abstracts groundwater from the Table Mountain Group aquifers to supply the Dysseisdorp to Calitzdorp area. The Klein Karoo is the most sparsely populated region in the country and urban water use for municipalities and industries is generally low.

Like other semi-arid to arid ecosystems, productivity of the Little Karoo's dryland vegetation is limited by the quantity and timing of rainfall.



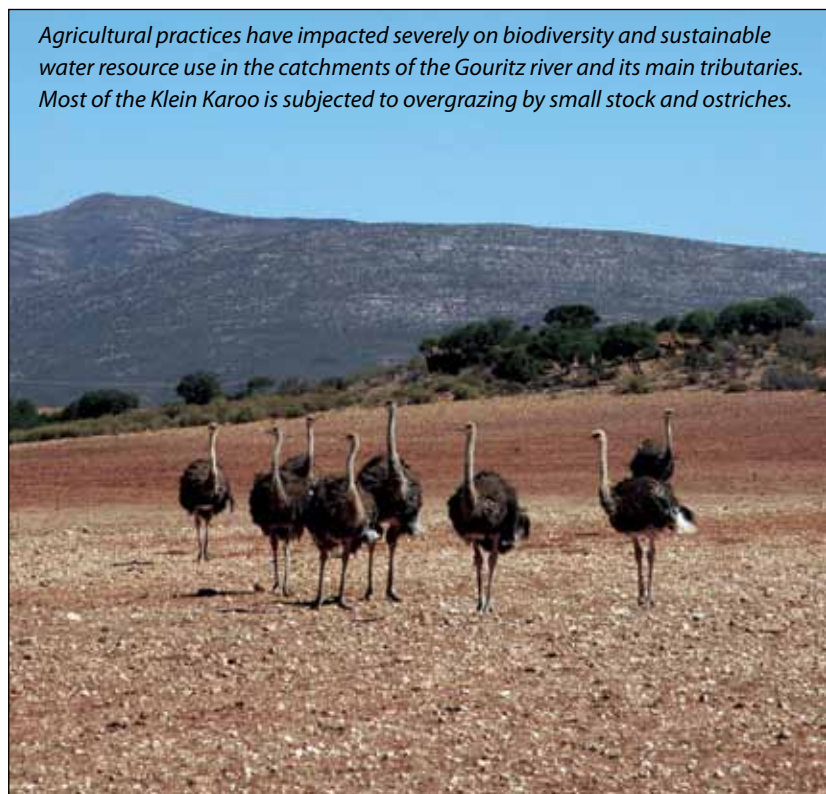
An assessment by the Department of Water & Environmental Affairs shows that the current demand for water in the Gouritz River catchment and those of its main tributaries is 182 million m³/year, which exceeds the available yield. With water demand projected to increase even further change in the approach to water management is required, including improving the efficiency of irrigation and land restoration to improve water infiltration and soil erosion say the researchers.

According to the authors, the high levels of existing demand and use in the region are particularly concerning because of government's present drive to establish new irrigation schemes for formerly disadvantaged farmers and develop the resource base for rural communities. Irrigation farming is seen as the only form of agriculture that is currently economically viable and could be used for this purpose.

"As irrigation is the major water user it is clear that there will have to be a strategy aimed at improving water-use efficiency." One suggestion to achieve this are to ensure that the most efficient technologies are used in both water delivery and application to maximise crop yields while minimising the volume of return flows, and thus, salinisation caused by irrigation. The possibility of changing to crops with a higher water-use efficiency and value should also be assessed.

Also, although water consumption by urban areas is small, the authors say that upgrading of urban water service infrastructure to reduce water losses (through, for example, leakages) could be beneficial at the local scale as well as reduce the volume of water that requires treatment. In addition, making use of managed aquifer storage, including artificial recharge, could reduce water loss through evaporation compared with storage dams.

Another measure advocated is implementing alien vegetation control,



Dominic Morel

Agricultural practices have impacted severely on biodiversity and sustainable water resource use in the catchments of the Gouritz river and its main tributaries. Most of the Klein Karoo is subjected to overgrazing by small stock and ostriches.


particularly in the rivers on the northern slopes of the Outeniqua Mountains and foothills of the Swartberg. Lastly the authors suggest effective landcare programmes exploring the synergies between improving water infiltration, reducing soil erosion and vegetation or crop productivity at small scales, and decreasing sediment loads and increasing sustainable yields at the scale of water supply schemes.

The authors emphasise that although these measures are beneficial and necessary, they are not sufficient. "We believe that it is time to change to a water management approach that is designed to anticipate and manage the inherent variability in water resources in the Klein Karoo, thereby placing the region on a path to sustainable development. The people of the region need to recognise that it is not enough to look at water resources in isolation from land-use practices and human behaviour."

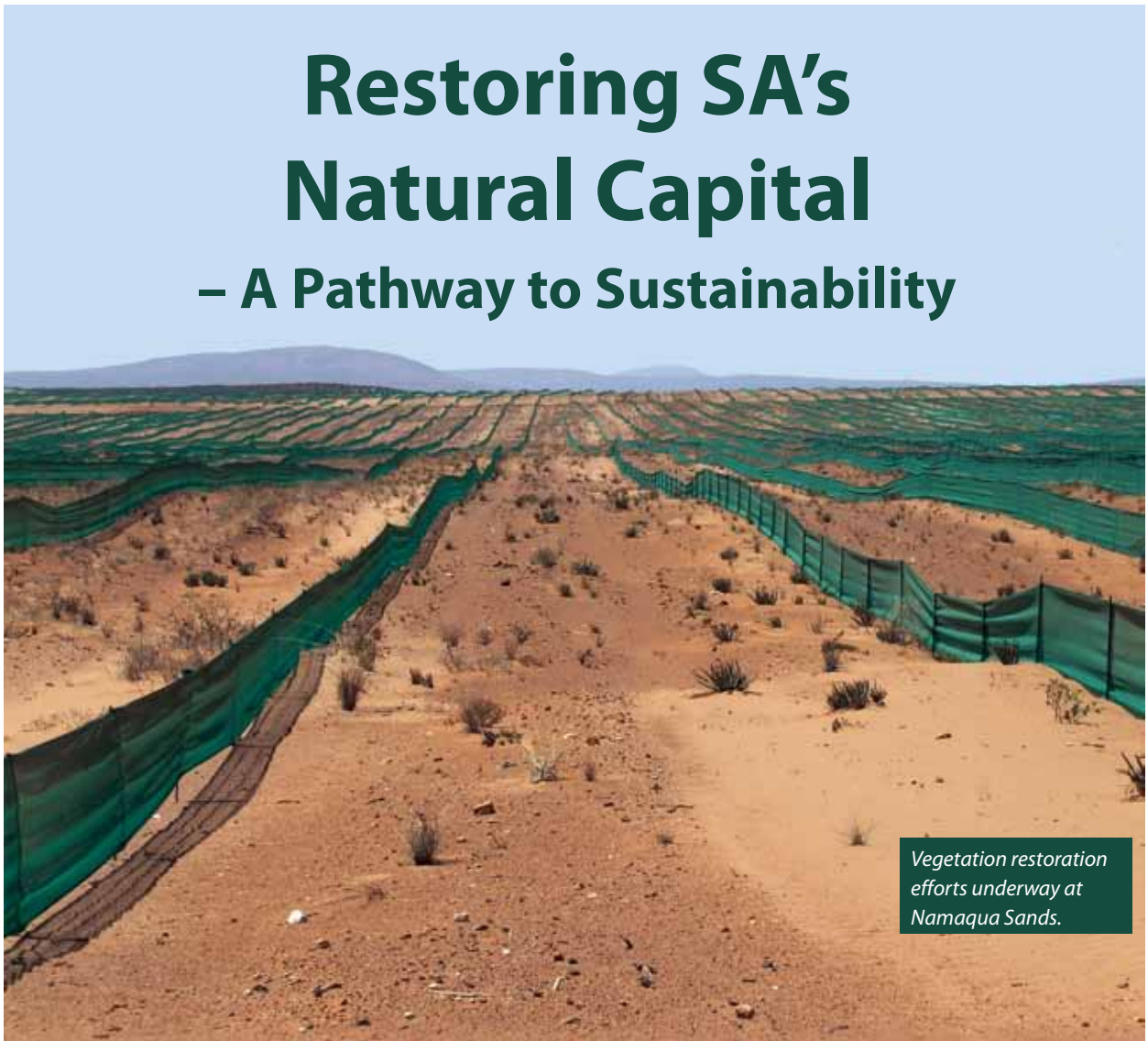
"There needs to be a fundamental rethink of the way the land and water resources of the Klein Karoo are being managed,"

they continue. "This rethink needs to be based on the fact that rainfall is highly variable in space and time with marked multi-year dry and wet cycles superimposed on shorter cycles. The variability in rainfall drives land productivity and the water resources available for irrigation, and thus the economy."

According to the authors the focus should steer away from the use of technology to fix the problem (for example, building more dams) with more attention being paid to living habits within the constraints of the natural systems (rather than despite them). "A good question to start the dialogue might be: If we plan to bequeath our descendants the Klein Karoo, what should we start doing now so that they can inherit it as we would like it to be?"

Whatever action is taken steps should be taken immediately not only for the future of the people of the Klein Karoo and their livelihoods but also for the environment, which provides the ecosystem services on which their livelihoods and well-being depend. 

Restoring SA's Natural Capital – A Pathway to Sustainability



Vegetation restoration efforts underway at Namaqua Sands.

The first phase of a five-year project initiated by the Water Research Commission (WRC) to investigate the value of ecosystem restoration projects in South Africa is nearing completion.

Article by Leandri van der Elst and James Blignaut.

Marco Pauw

Natural capital is an economic metaphor for the stock of physical and biological natural resources. These resources comprise renewable natural capital, non-renewable natural capital, replenishable natural capital, and cultivated natural capital.

Once the capital stock has been depleted it is no longer possible to produce stream flows; i.e. ecosystem services, which are invaluable and essential

for life on Earth for all species. It is from this point of view that natural and social scientists begin investigating the restoration of natural capital and the impact thereof on ecosystem services and the change in human well-being.

The science and theory behind restoration have been widely researched, and it has been implemented to some extent by various industries. For example, mines have to restore the environment to a

certain level before a closure certificate can be obtained, relieving the mining company of its financial and statutory obligation toward the government, society and the land.

The problem arises in the fact that the implementation is not done by the same people or institutions undertaking the research. Implementation is therefore not always informed or even properly measured. While restoring natural

capital is important, restoration to improve future use and improve the benefits such as soil quality and water flow are almost more important.

It is not good enough for example, to clear an area of invasive alien plants or to replant a mined area just for the sake of doing it. The restoration effort has to improve the degraded environment to such a degree that the natural capital can be used for sustainable living and development thereafter. The link between restoration and human well-being is therefore very important. The value of the restoration and the underlying process, as well as the economic justification thereof, is linked to the benefits such restoration has for people.

EVALUATING RESTORATION EFFORTS

It is from this vantage point that the WRC decided to commission a research project in 2008 to investigate restoration's economic linkages. The main focus of this research project therefore is to determine whether restoration, in fact, yields the desired results and improves the socio-economic value and agricultural potential of restored land. ASSET Research was commissioned to conduct the research over a five-year period.

The organisation has pulled together researchers, students and collaborators from various institutions to conduct the research. The first phase included seven MSc students and one PhD student working on four study areas. The second phase, which will start in 2010, involves a further six students and four study areas. The research team consists of Prof James Blignaut, Prof Martin de Wit, Prof Karen Elser, Prof Sue Milton and Dr David le Maitre.

The students are from various disciplines, including ecology, hydrology and economics, and represent various tertiary institutions. This ensures that the results will have a multidisciplinary, multi-institutional focus. The study areas are: Beaufort West, Namaqua Sands, Oudtshoort-Calitzdorp and Agulhas.

“While restoring natural capital is important, restoration to improve future use and improve the benefits such as soil quality and water flow are almost more important.”

The project research is being undertaken on existing restoration projects with the assistance of the people and institutions involved. It is thus rooted in reality ensuring it is relevant and current. Apart from the WRC, other collaborators include the Department of Water & Environmental Affairs, Flower Valley, Exxaro, Western Cape Department of Agriculture, Centre of Excellence for Invasion Biology and the Ostrich Business Chamber.

BEAUFORT WEST

The Northern Cape and some parts of the Western Cape (including Beaufort West) have become densely invaded by *Prosopis* species, a fast-growing, drought-tolerant legume tree originating from South America, which was introduced to the country to provide fodder for domestic stock. Unfortunately,

this species has turned out to be a very aggressive invader, disturbing and displacing the natural grasslands.

It has become particularly dense in areas with deep alluvial soils, which serve as important groundwater supply to farmers, livestock and rural settlements. In essence, this plant ‘steals’ water from people and the natural landscape.

The research question for this site is whether alien clearing restored socio-ecological value through improved groundwater yield and grazing recovery. In the hydrology component, methods such as groundwater recharge estimation, monitoring of groundwater levels, rain gauging and measuring soil moisture and species composition will be used to analyse the impact restoration. Aerial photo analysis, grazing value measurement, as well as measurement and sampling of ecosystem features will be used to evaluate the ecological impacts of restoration.

NAMAQUA SANDS

Surface mining (as undertaken at Namaqua Sands) is expanding in the arid, winter rainfall areas of South Africa. Although economically important, it is



Mining accommodation at Namaqua Sands.

Marco Pauw

having detrimental effects on biologically diverse environments where plant growth is restricted by aridity, wind and salinised, nutrient-poor soils.

The research question at this site is to what extent restoration has restored grazing value and other land-use options on a coastal mineral sands mine. For the ecology and hydrology components vegetation cover and species richness as well as grazing capacity, hydrological effects (such as infiltration, groundwater recharge and groundwater quality), and ecosystem functioning will be measured.

OUDTSHOORN-CALITZDORP

The Klein Karoo between Oudtshoorn and Calitzdorp has been the centre of the ostrich industry for 150 years. Ostriches, when kept in natural veldt

at the high densities needed to make ostrich farming viable, destroy vegetation and trample the soil surface, leading to accelerated runoff and erosion. Because of their restless behaviour, continual foraging, dustbathing and nesting activities, the keeping of ostrich at high densities damages the veldt even when the birds are supplied supplementary feeds.

This part of the Klein Karoo is particularly rich in endemic plants, particularly succulents, and is a priority area for conservation under the Succulent Karoo Ecosystem Programme (SKEP). The research question for this site is how restoration can enhance the social-ecological acceptability of ostrich farming.

Vegetation field sampling, vegetation cover and species richness, veldt

condition and grazing capacity, and quantitative soil surface assessments will be used to measure the hydrological and ecological impacts of restoration.

AGULHAS

Lastly, the Agulhas plain has been recognised as an area with high plant diversity and vegetation type variability, partly due to the array of soils which range from deep, acidic sands to skeletal soils on limestone to moderately fertile soils on shale. However, the area has been subjected to a series of land-uses ranging from extensive grazing to wheat cropping and, more recently, the establishment of vineyards in addition to the long-standing tradition of ornamental wildflower harvesting for the florist trade.



Sue Milton

An erosion control site outside Oudtshoorn in the Klein Karoo.



Sue Milton

Hand-dug pits, each able to trap 20 ℓ of water, reduces loss of water and nutrient from the landscape and facilitates vegetation recovery on a site outside Oudtshoorn.

There are a few conservation areas, notably De Hoop-Potberg, and more are in the process of being established as either conservancies or contractual parks. The specific research question for this site is whether the socio-ecological value of fynbos restoration for the flower and related industries outweigh its costs. GIS modelling will be used to determine the effects of restoration on water availability and efficiency.


The research conducted during the course of this study is expected to shed more light on restoration efforts' impact on the environment and people across various ecosystems and restoration methods. Part of the study is also to develop a systems model from the information gathered during the site-specific research. This model can then be used in future to evaluate and guide



Mirjam Gaertner

Seed collection at the Agulhas study site.

restoration efforts. In turn, this could be used to reduce the gap between research and implementation and

improve the results of restoration for the environment as well as rural and sustainable development. 

Ancient Southern African Irrigation Technology Unearthed



Jonathan Denison

Agricultural practices such as stone terracing to retain rainwater and soil have been practiced for thousands of years in southern Africa.

Our ancestors had a closer relationship with water than initially realised – early southern African communities used irrigation technologies to manipulate water to survive and thrive in a harsh land.

Compiled by Lani van Vuuren.

It has long been realised that there existed a special bond between the ancient peoples of southern Africa and water. The southern African climate is highly variable over space and time and thousands of years ago communities were reliant on their deep-seated knowledge of the landscape's water whims, passed on from generation to generation, for their survival.

However, little is known about the use of water for irrigation purposes prior to the arrival of European settlers in

the fifteenth century. "There seems to be a historical blind-spot regarding the acknowledgement of the heritage of indigenous irrigation technology," reports Prof Johann Tempelhoff of the School of Basic Sciences at North West University's Vaal Triangle Campus, who has been researching the subject.

Yet, early irrigation technologies played an important role in shaping these early communities thousands of years ago. "The small irrigation furrow of the subsistence farmer was just as important to an insular

community of Bantu-speaking people in southern Africa in pre-colonial times as is the sophisticated irrigation technology used in many irrigation projects in a highly industrialised society in present-day South Africa," Prof Tempelhoff points out.

DOMINANCE OF PASTORALISM

There are various reasons for this dearth of information. One reason is that few traces of evidence remain of these pre-colonial irrigation works. Indigenous

irrigation systems have either been washed away by floods or destroyed to make way for modern agriculture.

The focus on ancient communities' pastoralist natures have also resulted in the role of irrigation being downplayed, notes Prof Tempelhoff. "While there is clear evidence today that practices of mixed pastoral and agricultural activity prevailed in many parts of southern Africa, there remains a somewhat superficial impression that pastoralism dominated about two millennia ago. The overall effect of this perception was that agricultural activity, specifically irrigation farming, hardly enjoyed attention in broader historical discourse."

Prof Tempelhoff points to a number of examples of irrigation technologies being practiced by Iron Age communities unearthed in southern Africa. These include the sites at Nyanga in eastern Zimbabwe, the Limpopo River catchment area, the Lowveld and the Drakensberg escarpment region of Mpumalanga and KwaZulu-Natal. "At these sites are traces of past cultural activities that relate to irrigation technological innovation. There is clear evidence of structures such as terraces, furrows and aqueducts."

In Iron Age southern Africa (from about 1800 years ago to the early twentieth century) irrigation activities were conducted in two very specific environmental localities. The first has a bearing on irrigation in the fertile hills, where furrows would typically have been used to lengthen the cultivation season to support denser populations. The second type of irrigation was that found in valleys where rivers flow into the dryer land and where planting is specifically dependent on good furrows.

EVIDENCE OF IRRIGATION TECHNOLOGY

According to Prof Tempelhoff, the best regional example of pre-colonial irrigation technology is to be found in the Nyanga district in the north-eastern part of Zimbabwe, where a veritable archaeological treasure trove was discovered

"The small irrigation furrow of the subsistence farmer was just as important to an insular community of Bantu-speaking people in southern Africa in pre-colonial times as is the sophisticated irrigation technology used in many irrigation projects in a highly industrialised society in present-day South Africa."

in the late nineteenth century. The site contains a vast number of old aqueducts, some 3,2 km or more in length, running from artificial dams on the mountain streams, and crossing from hill to hill. These furrows are all 400 to 600 mm wide and about 600 mm in depth.

Notable at the Nyanga site are the terraces covering an area of about 22 000 ha. It is believed that these terraces were built mainly (although not exclusively) for agricultural purposes. They tended to

be slanted downwards which ensured a natural form of irrigation and drainage that reached different levels along the hillsides.

These terraces require substantial amounts of labour. The retaining walls of terraces were seldom more than 0,6 m and were built from stones that had been cleared when the lands were prepared. In the Nyanga case, the terraces were about 1,5 to 3 m in width. Once constructed, they were practically indestructible, standing out as a feature on the landscape for centuries.

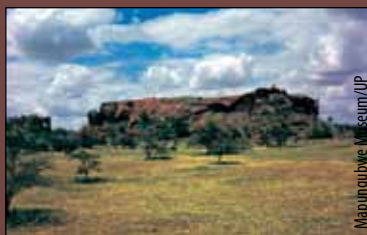
Further south, in South Africa, terraces are common in the Soutpansberg mountain range and along the Drakensberg escarpment into the Mpumalanga Lowveld at Barberton, Waterval-Onder and Elandshoek. In 1956, anthropologist AC Myburgh discovered a pre-colonial irrigation site on a farm near Carolina. There were a number of canals on a fairly level tract of land and a dam of sorts had been built to take water from the Gemsbokspruit. Consequently, a floodplain was formed and water could siphon through the lands.



*The remains of terraced farming activities in the Nyabongwe Valley, Nyanga, Zimbabwe in the mid-twentieth century (*In: R Summers (1951) Ancient ruins and vanished civilisations of southern Africa)*

IRON AGE PEOPLE IN SOUTHERN AFRICA

It is reported that from about 200 AD (around 1 800 years ago) Iron Age people began drifting into southern Africa. They came



Mapungubwe Museum/UP

from the north-westerly and north-easterly directions, where rainfall was high, and trekked across savannah lands where supplies of water were readily available. Apart from smelting and processing or to make iron tools, these people were agriculturalists who cultivated crops such as sorghum, millet, ground peas and cow peas. They also herded sheep and cattle. Their settlements were generally located in low-lying areas near the coast or in river valleys where fertile soil and good summer rainfall ensured reliable harvests.

There were successive waves of migration and in subsequent centuries settlement started taking shape in the central eastern areas of southern Africa. By 800 AD they were well established in the present-day Limpopo, Mpumalanga, KwaZulu-Natal and Eastern Cape. Patterns of

settlement began to change around 800 to 1000 AD, probably as a result of the increasing importance of cattle. People started moving onto the grasslands of the interior and by 1200 AD almost the entire Highveld area was inhabited by Iron Age people.

Between 1200 and 1500 AD powerful centres of socio-economic and political influence came into existence, the most significant of which were Mapungubwe and Great Zimbabwe. Mapungubwe, situated south of the Limpopo River, developed into the dominant power of the region during the 13th century and was home to over 10 000 people at the peak of its power.

By the fifteenth and sixteenth centuries, the entire interior of South Africa, with the exception of the Karoo, was settled by Iron Age people who practiced mixed agriculture and pastoralism, and who engaged in extensive trade.

Source: A Dictionary of South African History

Myburgh noted that the canals were obviously made for the purposes of irrigation because there were no direct indications of a settlement in the vicinity of what must have been a patch of agricultural land. Another canal on the same farm was presumably used to provide water to the local community resident on the land. Elements of terracing have also been studied in the southern Highveld region of Mpumalanga, and the Free State.

Terracing fell out of favour with agriculturalists in the nineteenth century, partly as a result of the introduction of ox-drawn ploughs, a revolutionary technological innovation introduced by European settlers. It allowed wider tracts of land to be cultivated.

WETLAND FARMING

A more well-known pre-colonial agricultural system was wetland farming, also known as dambos, mapani, matoro, amaxhapozi or vleis. They are primarily situated in wetlands environments that retain water close to the surface for the greater part of the year. Traditionally, Bantu-speaking people in southern Africa exclusively planted sorghum, pumpkins and a variety of gourds. These crops were later largely replaced by maize.

In the case of well-flooded dambos rice crops were produced. Water was near the surface and this meant that shallow wells could be used to water vegetable gardens at all times of the year. This form of agriculture persisted in many isolated parts of southern Africa deep into the twentieth century.

Much more needs to be done to enhance our knowledge of these historical irrigation practices, notes Prof Tempelhoff. "A better knowledge of the past can only enhance our understanding of the manner in which a scarce resource can be used sensibly in the future."

This article is derived from the paper, *Historical Perspectives on Pre-Colonial Irrigation in Southern Africa*, first published in *African Historical Review*, Vol 40, No 1, pp121-159. 



Johann Tempelhoff

Traces of terraced agricultural lands in a nature terrace near Suikerbosfontein near Carolina in Mpumalanga. A major tributary of the Nkomati River passes within 200 m of this site.



Lari van Vuuren

The Institute for Futures Research looks at the current state of affairs and provides some pointers on what the business community and industry can do to relieve water stress.

The issues of decreasing water quality, increasing water scarcity and deteriorating or dysfunctional municipal water infrastructure leading to a potential water crisis in the country have featured strongly in the media. South Africa's water sector faces numerous challenges, e.g. water deficits in an increasing number of water management areas; water pollution and decreasing water quality that affects not only net availability of water but also negatively affects human health; ageing water and wastewater infrastructure; a severe lack of skilled human resources; the impact of climate change on water resources; the illegal use of water; and the inappropriate use of funds by different spheres of local government.

IS THE STATE OF WATER SECURITY DETERIORATING?

Water is critical in sustaining life and it is crucial to economic growth and social

development, as well as for environmental sustainability. In global terms, South Africa's freshwater resources are scarce, extremely limited and disproportionately available, both in time and space, relative to demand. The average rainfall of 497 mm/year is well below the global average of 860 mm/year. South Africa is already categorised as water stressed with an annual freshwater availability of less than 1 700 mm³/person (the index for water stress).

The central question being asked is: Does South Africa have sufficient freshwater resources to sustain both its path of economic growth and its population growth with concomitant needs? In addressing this question, the Department of Water & Environmental Affairs (DWEA) has taken a long-term perspective and is assessing and addressing in a very detailed manner the quantity of water available in relation to projected demand, and ways of addressing imbalances where they

exist. This is done in the form of reconciliation strategies, which have been completed for all of the country's major water supply systems, and are being followed by reconciliation studies for every town in South Africa – a process to be completed by mid-2011.

According to the National Water Resource Strategy of 2004, the total annual demand for freshwater in South Africa in 2000 amounted to 12 871 million m³, just slightly less than the available yield of freshwater of 13 227 million m³. This means that 98% of the national water resource was already allocated or in use in 2000, with little surplus water left.

Based on the latest available data (including the completed reconciliation studies), five of the nineteen water management areas (WMAs) were already experiencing water shortages in 2000, while only four experienced water surpluses and the remainder were still in balance. A water supply/demand

scenario by DWEA illustrates that by 2025 water shortages will become more prevalent 'if proper attention is not given to providing more water, and managing demand'. In general, water deficits are projected to widen and surpluses to narrow. Thus, the country is 'more likely to experience water shortages than water surpluses.'

It is important to note that for the country as a whole, water consumption/demand is projected to exceed water availability/supply by 2025 in both the base and high scenarios of DWEA. Although there is the potential for the development of an additional 5 410 m³/year, mainly through the construction of new storage dams and further groundwater utilisation, the potential for water resource development exists mainly in the southern parts of KwaZulu-Natal and the Eastern parts of the Eastern Cape.

Of particular concern is the status of water security in the major metropolitan areas of South Africa. Not only are these the hubs of economic growth (and economic development leads to increased water use), but these are also the areas experiencing relatively high population growth rates due to rapid urbanisation, which, in turn, increases the stress on water infrastructure. In fact, it is stated by DWEA that based on the existing reconciliation strategies, 'water shortages are predicted for the majority of large towns (not only for the metropolitan areas) in the short to medium term, necessitating urgent intervention.'

The possibility of Gauteng, a largely metropolitan province, experiencing water shortages as soon as 2013, especially if there is a period of severe drought, has been debated in the media. Although former Minister of Water Affairs & Forestry Lindiwe Hendricks reacted to this by stating that the water shortage in the province can be averted, given the recent decision of Cabinet to go ahead with Phase 2 of the Lesotho Highlands Water Project, subject to the conclusion of a protocol with the Lesotho government, the project is expected to be completed in 2019 – six years after the expected 2013 water shortage in Gauteng.

WHAT ABOUT WATER QUALITY?

The availability of quantity of water is closely linked to the quality of water. If the latter deteriorates, it has a negative impact on the net availability of water. In South Africa, water resources are comprised of the following three sources, viz. 77% is sourced from surface water (e.g. dams and rivers), 14% from return flows (e.g. sewage and effluent purification) and 9% from groundwater (e.g. boreholes). The major sources of water pollution include uncontrolled sewage, poorly managed wastewater treatment works, chemical discharges, petroleum leaks and spills, dumping in old mines and pits, human settlements, and agricultural chemicals that are washed off or seep down from farm fields.

Bacterial contamination, which arises not only from the absence or the poor maintenance of sanitation facilities, but also from livestock defecation entering rivers and streams, is widespread in South Africa. If used untreated, such contaminated water can cause waterborne diseases such as diarrhoea, cholera, dysentery and skin infections.

The recent severe cholera epidemic in Zimbabwe, which infected more than 90 000 people and caused the death of more than 4 100 people comes to mind. Although a host of factors combined to make this outbreak of cholera so devastating, the main cause was the total breakdown of water and sanitation infrastructure. Compared to Zimbabwe, South Africa has a well developed water and sanitation infrastructure system in place, and tap water is still among the best in the world (excluding some rural areas), according to DWEA. However, about 5 million people still lacked adequate and safe water supplies in 2008, while 15 million still lacked basic sanitation in spite of millions of South Africans gaining access to a formal water supply and sanitation services since 1994. Until this backlog is completely eradicated, the threat of waterborne diseases remains a reality.

In general, the quality of South Africa's freshwater resources is deteriorating. According to Dr Anthony Turton, Director Touchstone Resources, South Africa's water resources have lost their dilution capacity, "so all pollutants and effluent streams will increasingly need to be treated to ever higher standards before being discharged into communal waters or deposited in landfills." Decades of mining for gold and other minerals have left much of the water supply heavily polluted with heavy metals and other pollutants.

A 2008 CSIR study entitled *State of the Nation Report*, found cyanobacterial blooms recorded in many "if not most" of river and reservoir systems – from where most of South Africa's drinking water is obtained – because of "prevailing high levels of eutrophication caused by inadequate treatment of domestic and industrial effluents" discharged in their catchments.

"Of particular concern is the status of the wastewater treatment works, which are



Lami van Vuuren

The status of water security in the major metropolitan areas of South Africa is a major concern.

affected by failing infrastructure (water purification and reticulation infrastructure), poor wastewater collection and treatment systems, lack of human resources (capacity and skills) to meet effluent standards. The impact of poorly managed wastewater treatment works is the inability to sustain safe drinking water," said DWEA in the Water for Growth & Development Framework.

Addressing a municipal conference on water and sanitation in Johannesburg in 2008, former Minister Lindiwe Hendricks said that far too many municipal wastewater treatment works were operating below the required standards. "Indications were that 60% of the treatment plants, the facilities that treat sewage, required maintenance or intervention, with poor compliance to the required effluent standards." According to Dr Turton, South Africa has failed to maintain its investment in the infrastructure needed to maintain a clean water supply. Capital investment in water and sanitation infrastructure peaked in the 1980s and has since declined drastically.

Not only is there a need to invest in new infrastructure in areas that lack safe water supplies and sanitation services, but there is also the need to invest in the upgrading and maintenance of existing water and sanitation infrastructure. According to DWEA, limiting factors for addressing backlogs and expanding service delivery include:

- ◆ Lack of skilled contractors to render services and poor construction supervision, which diminishes the life expectancy of infrastructure;
- ◆ Lack of municipal staff (especially engineers, scientists and technicians) to operate and maintain water services infrastructure; and
- ◆ Absent or weak municipal systems for infrastructure management.

IMPLICATIONS

South Africa is a water scarce country with demand already exceeding supply in certain WMAs and cities. In addition, water quality is deteriorating and many municipalities are unable to maintain ageing water and wastewater infrastructure particularly due to a lack of skilled personnel such as engineers and technicians. Factors that could worsen the

water situation in South Africa are the impact of climate change on precipitation, increasing urbanisation, population growth, expansion of business activity and increasing affluence. If South Africa's water resources are not properly managed, the country is heading for a crisis.

Although the provision of freshwater and sanitation services is primarily the responsibility of the government, water is everybody's business and everybody's responsibility. In conclusion, the main recommendations of the Water for Growth and Development Framework (WGDF), launched by DWEA earlier this year are summarised, that is how government intends to avoid a water crisis, followed by some pointers on what industry/business can do to alleviate water stress.

RECOMMENDATIONS BY GOVERNMENT

The WGDF is intended "to guide actions and decisions that will ensure water security in terms of quantity and of quality to support South Africa's requirements for economic growth and social development. The main recommendations of the framework are:


- ◆ Strengthening institutional capacity;
- ◆ Mainstreaming water – i.e. water must be placed at the heart of all development planning decisions;
- ◆ Diversifying the water mix. While surface water will remain the predominant source of water in the long term, DWEA expects surface water to contribute proportionately less (65% by 2040 compared to 77% in 2008), with significant increases in return flows through the treatment of urban and mining effluent and desalination. The latter is considered to be highly feasible for limited use in coastal locations;
- ◆ Promoting water conservation and water demand management;
- ◆ Promoting and maintaining water quality;
- ◆ Addressing service backlogs and achieving the 2014 target for universal access to water and sanitation services;
- ◆ Changing water use behaviour for the future, especially the unlawful and damaging extraction from, and pollution of the Vaal River system by commercial users and the extent of water use inefficiencies

- ◆ among commercial irrigation agriculture;
- ◆ Nurturing attitudinal and behavioural changes towards the value of water by means of national awareness campaigns.

THE ROLE OF INDUSTRY/BUSINESS

The business community forms part of the solution to issues or problems related to water and sanitation. Jack Moss of the Business Action for Water recently stated at the Fifth World Water Forum, in Istanbul, Turkey: "Without water, there is no business. Without business, there is no water."

According to the World Business Council for Sustainable Development, industry/business can do the following to alleviate stress on water resources:

- ◆ Put its house in order by
 - Measuring and monitoring water use – understanding the water 'footprint' of the business both inside and outside the corporate fenceline;
 - Continuing to reduce water consumption per money unit of output and work towards the goal of zero discharge by:
 - Recycling and reusing water;
 - Lowering toxic and other contaminants in all operations involving water;
 - Changing production processes to be more water efficient
 - Encouraging suppliers and purchasers up and down the supply chain to adopt best management practices – assisting small- and medium-sized enterprises to improve water management;
 - Innovating – searching for new more efficient water treatment technologies.
- ◆ Enter into creative partnerships with:
 - Municipalities where business operates to develop cost-effective water supply and sanitation options;
 - Non-governmental groups to encourage water conservation and improved water management systems; and
 - The scientific community to improve understanding of water resources and their management and to develop technologies to get the most value of the water cycle. 



New World- class Standards for Water Treat- ment Chemicals

*The adoption of close to 50 new standards for drinking water treatment chemicals is a positive step towards the improved regulation of the sector in South Africa.
Lani van Vuuren reports.*

The Water Research Commission (WRC), together with Umgeni Water initiated a project to investigate and propose possible standards for the South African drinking water treatment chemical industry after it was found that the very chemicals added to treat water were not subject to any form of regulation or control.

Every day more innovative chemical blends are found to disinfect drinking water. Chemicals are used throughout the treatment process, from coagulation and flocculation to fluoridation, algae control, pH adjustment and final disinfection and polishing. With the right blend of quality chemicals, correctly dosed, even the smallest treatment plant can produce good potable water from almost any source.

However, processes used to manufacture these chemicals may result in the presence of impurities which can be a potential contaminant in drinking water. In small dosages the health effects of these impurities might not be evident immediately, but can manifest later if exposure continues over the long term.

While there is a statutory requirement that treated drinking water complies with the South African National Standard (SANS 241) the chemicals commonly used to purify water are not subject to any control. The WRC investigation found existing standards for water treatment chemicals to be extremely outdated, with several standards issued more than 20 years ago. In addition, there were many treatment chemicals for which no national standards existed, in spite of the fact that some of these are used extensively in the water and wastewater treatment industries. These include ferric sulphate, ferric chloride, bentonite and activated silica.

With no regulatory process, it has been left largely to manufacturers to police themselves regarding the contaminant levels in their products. Some South African manufacturers have applied for international accreditation

while others rely on rigorous on-site quality and safety testing.


The lack of regulatory control has left especially smaller water service authorities in a vulnerable position. Unlike larger municipalities and water boards small towns are in no position to conduct sophisticated review and analyses of products and do not have resources for such evaluations. This has resulted in numerous reports of sub-standard products being supplied to these towns over the years.

Through the WRC project, undertaken in consultation with stakeholders such as the South African Bureau of Standards (SABS) and the Department of Water & Environmental Affairs, 46 new standards covering the majority of drinking water treatment chemicals used in South Africa have been adopted for use.

It will be up to individual manufacturers to make sure their products comply with the new standards. The standards are similar to those used in Britain and Australia, two countries which are considered to have among the most highly developed regulatory and approval systems in the world.

WRC Research Manager Dr Jo Burgess explains that the new standards will assist the water treatment sector greatly in selecting the best quality products. "Water service authorities will be able to insist on good quality imported and locally produced chemicals simply by using only SABS-approved chemicals. It will prevent technical water people from arguing with accountants who might be attracted to cheaper, lower-quality chemicals."

If all municipalities and water boards use only SABS-approved products unscrupulous manufacturers will be driven to either clean up their products or exit the South African market. "The standards will enable water boards and municipalities to feel secure that the chemicals they use are fit for human consumption, thus eliminating one source of possible contamination of drinking water," concludes Dr Burgess.

To order the report, National Standards for Drinking Water Treatment Chemicals (WRC Report No: 1600/1/09) contact Publications at Tel: (012) 330-0340 or E-mail: orders@wrc.org.za 

DRINKING WATER TREATMENT CHEMICAL CONTROL IN OTHER COUNTRIES

The World Health Organisation recommends the use of legislation as the best means to control the quality of drinking water treatment chemicals.

Australia does not have national processes for the regulation, control and use of drinking water treatment chemicals. The closest proactive management is at the point of retail, where there may be contractual agreements in place with chemical suppliers regarding minimum technical requirements. Similarly, Canada does not have any system in place. Although attempts were made to introduce the Drinking Water Materials Safety Act, the intent of the Act being to incorporate the relevant American National Standards Institute/National Sanitation Foundation standards to regulate drinking water treatment chemicals at the point of retail, it was not passed by parliament.

New Zealand currently has five standards that are similar in structure to that of the European and American Water Works Association standards. The standards provide manufacturers, purchasers and suppliers with guidance on the minimum technical requirements and methods for physical and chemical testing.

In the UK, drinking water treatment chemicals are heavily regulated using a unique approval system under the control of the Drinking Water Inspectorate. Product compliance is monitored at the water supplier rather than the product supplier. Furthermore, minimum technical requirements are specified in legislation rather than in national standards.





Heidi Shyman

Blue-green Algae – Making Water Dangerous

Hartbeespoort Dam, perhaps South Africa's most well documented case of a eutrophied water body.

In South Africa, we are highly dependent on surface water (rivers and dams) for our daily water supply. Pollution of these water bodies can have serious effects, such as eutrophication and the presence of algal blooms.

Nutrient enrichment (eutrophication) remains one of the leading causes of water quality impairment in the world. Agricultural and urban runoff, municipal and industrial wastewater effluents, and septic tank leach fields all contribute plant nutrients (such as phosphorus and nitrogen compounds) as well as other pollutions which eventually end up in our rivers and dams.

Water bodies that are eutrophic experience an increase in algae, especially cyanobacteria. Cyanobacteria (also

known as blue-green algae) are organisms with some characteristics of bacteria and some of algae. They are natural inhabitants of many inland waters, estuaries and the sea. A mass of cyanobacteria in a body of water is called a bloom. When you see a bloom of cyanobacteria in water, it will often appear blue-green (hence the common name). These blooms are not only aesthetically unpleasant but also release bad smells.

Extreme and prolonged eutrophication leads to the deterioration of water quality, taste and odour problems, oxygen depletion and decline of more desirable fish species. The resultant prolific growth in algae also disrupts water treatment, which means the water is more expensive and difficult to treat for drinking water purposes.

CYANOBACTERIAL TOXINS

Cyanobacteria are made up of cells, which can house poisons called cyanobacterial toxins.

Cyanobacterial toxins are usually released into water when the cells rupture and die. Many people have become ill from exposure to freshwater cyanobacterial

DID YOU KNOW?

Eutrophication and associated cyanobacterial blooms have been recognised as a problem for hundreds of years. The first recorded episode of animal poisoning attributable to cyanobacteria occurred in Australia in 1878.

WHAT DOES IT MEAN?

Algal bloom: A mass of cyanobacteria in a body of water.

Cyanobacteria: Simple, single-celled or filamentous organisms that are similar to algae in their photosynthetic abilities.

Cyanobacterial toxins: The natural produced poisons stored in the cells of certain species of cyanobacteria.

Eutrophication: The enrichment of water bodies (such as dams and lakes) with plant nutrients, particularly phosphorus and nitrogen compounds.

toxins, experiencing symptoms such as headaches, fever, diarrhoea, abdominal pain, nausea and vomiting. If you swim in contaminated water you may get itchy and irritated eyes and skin, as well as other hay fever-like allergic reactions.

Cyanobacterial toxins are deadly to animals. Most water-based poisonings by cyanobacteria occur when heavy surface growths or scums accumulate near shorelines of lakes and dams where animals have free access to high concentrations of these toxic cells.

One group of toxins produced and released by cyanobacteria are called microcystins

because they were isolated from a cyanobacterium called *Microcystis aeruginosa*. Microcystins are the most common of the cyanobacterial toxins found in water, as well as being the ones most often responsible for poisoning animals and humans who come into contact with the water.

It is important to note that the presence of cyanobacterial blooms do not always mean that the water is contaminated. About 30% to 50% of cyanobacterial blooms are said to be harmless because they contain only non-toxic species of cyanobacteria.

HISTORY OF CYANOBACTERIA-LINKED INCIDENTS IN SA

Local records of animals poisoning incidents that can be attributed to cyanobacteria data back to the 1920s, when mass mortalities of thousands of cattle, sheep, horses and rabbits living around pans in the north-eastern Free State and south-eastern Transvaal were reported.

The local farmers referred to the condition as 'pan sickness' and although veterinary officers from Onderstepoort suspected algal poisoning it was only after the construction of the Vaal Dam in 1938 that the causative link could be confirmed. As the dam filled, it flooded large areas of fertile farmland, resulting



Hyacinth, a water weed, is also associated with eutrophication.

in eutrophic conditions that triggered a bloom of cyanobacteria. This caused the deaths of thousands of animals on farms adjacent to the dam in the summers of 1942 and 1943. Since that time numerous cases have been reported involving wildlife, livestock, fish and bird fatalities.

Today, the Vaal Dam, as well as other dams known to be eutrophic (including Hartbeespoort, Rietvlei, and Roodeplaat dams) are monitored regularly by the authorities for any signs of algal blooms. Unfortunately, more people, more urbanisation and more industrial and agricultural activities mean more pollution, and eutrophication (with associated cyanobacterial blooms) seems to be on the increase.

REMEDICATION PROGRAMMES

At some dams remediation programmes have been launched in an attempt to improve the water quality. One such a programme is being undertaken at Hartbeespoort Dam.

Known as *Harties Metse A Me*, the remediation programme includes a range of activities to improve the state of the Hartbeespoort Dam. These activities include, among others, a resource management plan, which will determine the use of the dam; a monitoring programme to ensure water quality issues are addressed; restoring shoreline vegetation and placing booms in the dam to assist with physical removal of algae and hyacinth, a water weed. 



Eutrophication not only spoils the aesthetic appearance of a dam but negatively affects recreational activities such as water-sports and angling.

Ultrafiltration Package Plant Unveiled

Residents of Eendekuil outside Vredendal, in the Western Cape, now have access to clean drinking water thanks to a new ultrafiltration package plant unveiled in August. The plant, which provides water to 800 people, was donated by water treatment firm VWS Envig. The

donation was facilitated by the Department of Water & Environmental Affairs. Housed in a 6 m container, the water treatment plant is capable of producing 3 400 ℓ/h of water. The water treatment firm's donation included transportation to site, offloading, commissioning and

supply of the first batch of chemicals, activated carbon and membranes as well as a 12-month guarantee. Black economic empowerment company Malutsa donated operator and maintenance training as well as weekly site visits by a technician for the first month.



Eendekuil Primary School learners participated in a 'Walk for Water' as part of the festivities during the unveiling of the new package water treatment plant.



The Eendekuil plant being unveiled by Bergrivier Municipality Deputy Mayor JA Liebenberg and Rashid Khan, Chief Director of Department of Water & Environmental Affairs in the Western Cape.



The packaged ultrafiltration plant donated to Eendekuil utilises locally-manufactured membranes which are light weight and inexpensive to replace. Low operating pressures and mechanical cleaning technologies ensure that the membranes provide economic operation with no additional chemical requirements for effective water treatment.



Attending the unveiling of the new ultrafiltration plant are (back left to right) B Cannon (MD, Malutsa); C le Roux (Municipal Manager, Bergrivier Municipality); A de Vries (Councillor, Bergrivier Municipality); G Rencken (MD, VWS Envig); R Khan (Chief Director, DWEA); Abrie Wessels (Western Cape Regional General Manager, VWS Envig) and (front, left to right) S Karools (Councillor, Bergrivier Municipality); Dr M Ramphele; JA Liebenberg (Deputy Mayor, Bergrivier Municipality); T van Essen (Mayor, Swartland Municipality).

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