THE WATER WHEEL

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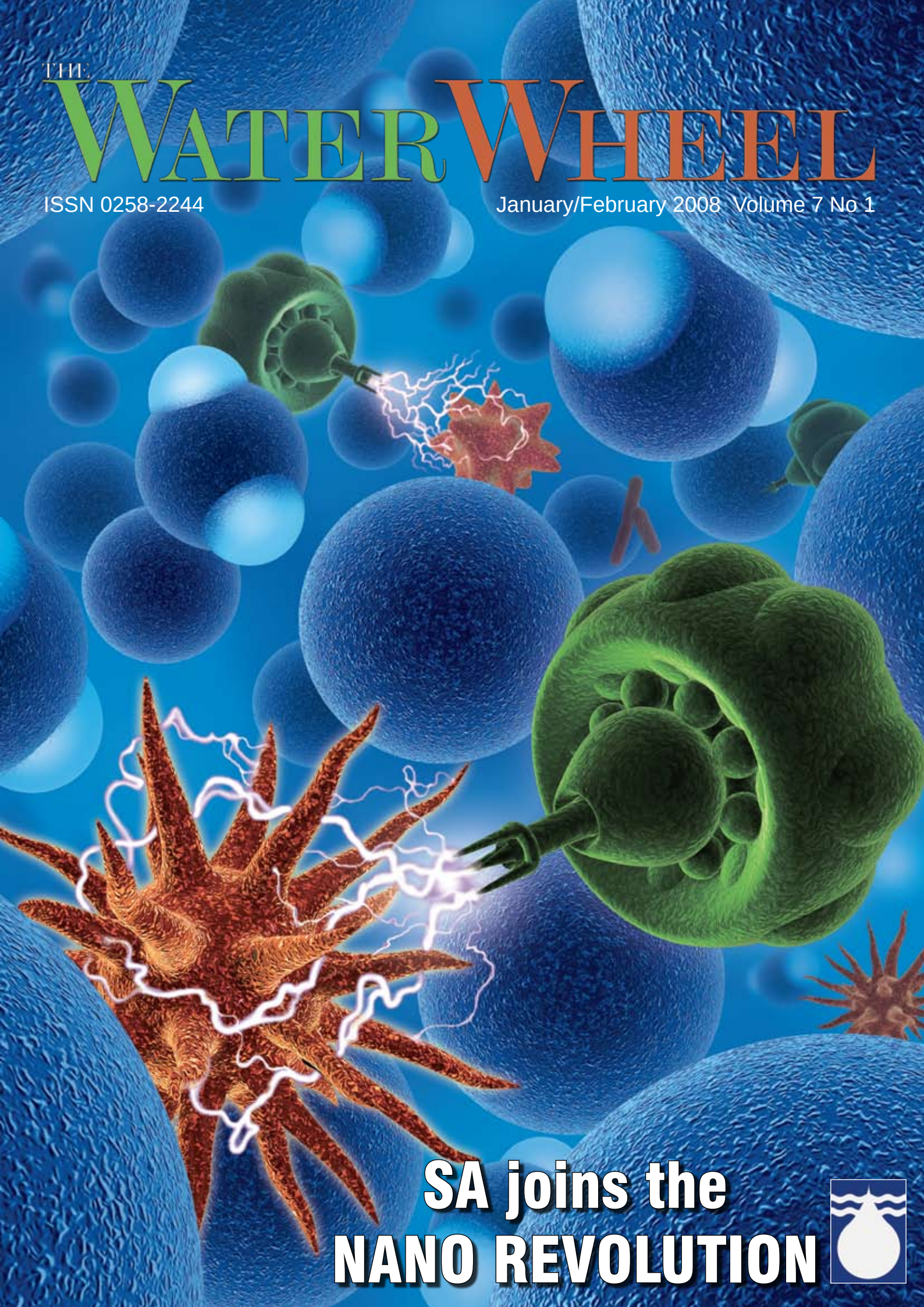

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WATER RESEARCH COMMISSION (WRC), South Africa
and the
DEPARTMENT OF WATER AFFAIRS & FORESTRY (DWAF), SouthAfrica

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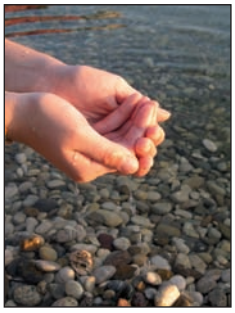

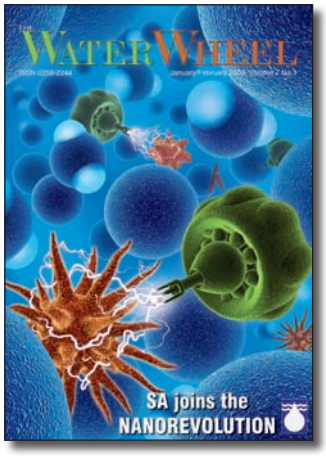

***Cover**: Nanoparticles have the potential to revolutionalise the local water treatment industry (see page10). Cover illustration: Ralf Broemer.*

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

Article inspires food workshop

Your article, '*Wild Vegetables Tamed to Decrease Hunger*', in the November/December 2006 issue of *the Water Wheel* was the inspiration behind a traditional foods workshop held at Durban's Botanic Gardens in October 2007, to address the value of traditional food in today's society.

Our committee decided to make 'raising the profile' of traditional foods as a contribution towards reducing malnutrition the major thrust this year. A small group representing this committee, the Diakonia Council of Churches and Mr Martin Clement, education officer at the Botanic Gardens, Durban, worked for some months and were delighted by an attendance of approximately 110 persons at the Botanic Gardens Visitors' Centre. The 'tasting' at the close of the function was provided by Woolworths, using recipes from the recipe book recently launched by the KZN Department of Agriculture and Environmental Affairs. Two ladies from the department who were instrumental in compiling the recipe book also attended and spoke on their work. We were also grateful for attractive plastic bags donated by the department, in which we were able to include relevant leaflets and booklets and other items of interest for folk to take home. Also included was a small pack of pumpkin seeds to encourage immediate planting!

Thank you for getting us started on this venture! It has raised a lot of interest and enthusiasm (many young people attended) which will hopefully result in more action. Your magazine is much appreciated and a synopsis of the main articles is sent to committee members regularly before the magazine is distributed.

Cynthia McKenzie, Anglican Diocesan Environment Committee, Hyper-by-the-Sea

Wrongful impression

While I fully concur with your opinions on illegal modifications of riverbeds ('*Poor Decisions of the Past May Cost Cape its Living Gold*', *Water Wheel* September/October 2007), I am annoyed that you should choose as an illustration for this the constructed rock bar on the Crocodile River at Malelane/Kruger National Park Bridge/TSB Pump Station (p. 23).

This was not only a carefully considered options to repair damage caused by the February 2000 floods, but was also fully supported and licensed by DWAF and DALA. I would appreciate your bringing this to the notice of readers to whom the implication was that the illustrated work was illegal.

Robin Clanahan, PrEng MPhil (Environmental Management), White River

Letters must be addressed to The Editor and can be faxed to (012) 331-2565 or E-mailed to laniv@wrc.org.za. Letters are published at the editor's discretion, and may be edited for length. Letters are strictly the opinion of the author(s) only and do not necessarily reflect the considered opinions of the members of *the Water Wheel* or the WRC.

Water quality labs under the microscope

A nationwide call is going out to all laboratories engaged in water quality testing to participate in the compilation of a database which will provide potential clients with information of testing services in their areas.

The initiative is being spearheaded by the Water Research Commission (WRC), who has appointed a research team from Jeffares & Green, Umgeni Water and the National Laboratory Association to undertake the investigation. The WRC is seeking to implement an accepted and practical water quality testing standard for all laboratories in South Africa thereby preventing the irregularities and occasional health risks currently experienced in water quality.

In order to produce such a standard, an investigation is being conducted into the existing conditions, problems and capacities in all water testing laboratories. A comprehensive picture of the current situation is vital as various issues have been reported as stumbling blocks to improving the quality of laboratory results and these need to be addressed.

The first step will be to undertake a survey of laboratories and gather information on expertise, accreditation status, geographic location, procedures and infrastructure. A Geographic Information System (GIS) will be developed and will provide basic information such as laboratory name, location, contact details and the type of testing services provided. The WRC will make this information available to interested parties so that potential clients can find information relevant to a laboratory in their area.

The Department of Water Affairs & Forestry hopes to use the GIS to develop and maintain an up-to-date database of laboratories so as to provide information when requested, thus ensuring that this research remains current and relevant. The results of the investigation will provide insight into the value of SANS 17025 accreditation and perhaps assist in the formulation of practical alternatives to validation and control through self-regulation within the laboratory fraternity. It is anticipated that, following the analysis of the survey results, the research team will be better positioned to present information on the status of water quality testing challenges and basic training needs.

One of the greatest challenges for the project team is to build a comprehensive database of all laboratories that undertake water quality testing. The project team would like to encourage any laboratory that tests for water quality to contact them and be a part of this exercise.

For enquiries, contact the Jeffares & Green Water Research Unit at Tel: (033) 347-1841; Fax: (033) 347-1845; E-mail: jgipmb@jgi.co.za

CT gets new water demand system

The City of Cape Town has introduced a new water demand management system for its residents.

The system comprises a water management device, which is installed in residents' houses. A central control team in the City administration regulates the functioning of these devices with the help of a computer setup.

According to the metro, the system will assist its customers to save water and manage their monthly water bills, while helping the City to manage debt. "It will also help residents to identify any leaks and have them fixed, instead of running up a huge water bill and then being unable to pay."

The water management device measures out a specific supply of water on a daily basis at the pressure and flow rate to which households have become accustomed. It allows residents to receive their free six kilolitre portion of water per month, and it allows them to receive an additional amount according to what they commit to paying.

At the time of writing, devices had been installed in more than 4 000 houses.

WATER BY NUMBERS

6 400 – The estimated number of job opportunities created through the implementation of 11 sanitation projects in North West province in the 2006/2007 financial year to date.

1 345 – The number of infrastructure-related projects the Development Bank of Southern Africa (DBSA) was involved in at municipalities last year. The bank provided project management expertise, assisted in the preparation of technical reports, and also dealt with issues surrounding contract management.

60 000 – The estimated number of deaths annually as a result of climate-related natural disasters, according to the World Health Organisation.

226 – The number of informal settlements in Cape Town.

263 – The number of international shared river basins worldwide, according to UNESCO. Over 45% of the land surface of the world is covered by basins that are shared by more than one nation.

US$799-million – The estimated cost to construct the Bujagali Dam in Uganda. Construction of the hydropower dam on the Nile River started in August last year.

300 – The number of schools in Cape Town out of 956 schools surveyed which reported a high water wastage factor with minimal income for infrastructure purposes.

200 billion tons – The ice lost in Antarctica in 2006 due to the shrinking of the polar cap. According to a report published in *Nature* in January, Antarctica lost an average of 152 km^3/year of ice from 2002 to 2005.

R1-million – The funds donated by the South African Bureau of Standards to improve the mathematics and science skills of 70 teachers in Bushbuckridge.

180 000 – The number of articles available in the online archive of prestigious science journal *Nature*. Every issue, dating back to the first magazine from 1869, has now been included in the journal's digital archive. The project has taken over five years to complete.

WATER DIARY

WATER
MARCH 4-7
Water China 2008, the largest Chinese trade fair for the water industry will take place in Guangzhou, Canton. *Enquiries: Merebo Messe Marketing; Tel: +49-40-6087-6926; E-mail: contact@merebo.com; Visit: www.waterchina.merebo.com*

FRANCHISING
MARCH 19-20
A conference on franchising for the water sector will be held at Helderfontein Estates, in Gauteng. *Enquiries: Juanita Males, Scatterlings of Africa, Tel: (011) 463-5085, E-mail: Juanita@soafrica.com*

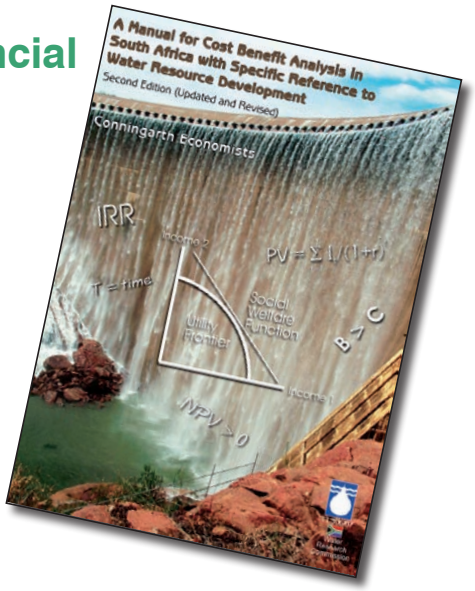
SBR TECHNOLOGY
APRIL 7-10
The Fourth International Conference on Sequencing Batch Technology will take place in Rome, Italy. *Enquiries: Dr Roberto Ramadori; Tel: +39-06-884 1451; Fax: +39-06-841 7861; E-mail: sbr4abstract@irsa.cnr.it; Visit: www.sbr4conference.com*

WATER & SANITATION
APRIL 7-11
The 33rd Water Engineering & Development Centre (WEDC) International Conference will take place in Accra, Ghana. The theme is 'Access to Sanitation and Safe Water: Global Partnership and Local Actions'. *Enquiries: Conference administrator; Tel: +44 (0) 1509 228-304; E-mail: wedc.conf@lboro.ac.uk*

FILTRATION
APRIL 14-18
The 10th World Filtration Congress & Exhibition is taking place in Leipzig, Germany. *Enquiries: info@wfc10.com or Visit: www.wfc10.com*

WATER
MAY 18-22
The Biennial Conference of the Water Institute of Southern Africa (WISA) will be held at Sun City. *Enquiries: Dr Heidi Snyman (technical programme); Tel: (012) 330-0340; E-mail: heidis@wrc.org.za; or Juanita Males (delegates & sponsorships); Tel: (011) 463-5085, E-mail: Juanita@soafrica.com*

Manual to help financial decision making



A new manual for conducting cost-benefit analysis with specific reference to evaluating the development and management of water resources is now available from the Water Research Commission (WRC).

This evaluation of projects is often a difficult task since costs and benefits cannot necessarily be seen immediately, but rather occur over time. Furthermore, costs and benefits are often hidden, making them hard to identify, and also frequently difficult to measure.

The same problems occur when decision makers have to make a choice between a number of projects. These challenges are not limited to capital projects; they also occur when decisions have to be made regarding the merits of expenditure programmes.

The cost-benefit analysis method provides a logical framework by means of which projects can be evaluated, serving as an aid in the decision making process. The manual, authored by Conningarth Economics, is aimed specifically at the decision maker in the public sector.

The manual follows a broader approach to incorporate the relationships between cost-benefit analysis and other aspects of the economy. In this regard the relationship between the principles of cost-benefit analysis and welfare economics; as well as cost-benefit analysis as one component of the range of decision making support instruments, have been included, among others. The manual also includes insight into the cost-benefit analysis application possibilities for decision makers. The manual advocates that the cost-benefit analysis concept needs to be widened to include the broader social costs and benefits derived from a project. Furthermore, it is accepted that cost-benefit analysis is only one of several instruments for evaluating proposed projects.

To order the cost-benefit analysis manual (WRC Project No **TT 305/07**), contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565 or E-mail: orders@wrc.org.za

Clean water vital in fight against AIDS

Access to improved water supply and sanitation could greatly improve the quality of life for people living with HIV/AIDS, according to international organisation, the Water and Sanitation Programme (WSP).

Many of the opportunistic infections that kill people living with HIV/AIDS are transmitted through contaminated water and unsanitary living conditions. People suffering from the disease require safe, sanitary toilets and large quantities of water to keep themselves and their surroundings clean.

In a statement released ahead of World Aids Day on 1 December, WSP said that there was a lack of research on the role the water sector plays for people living with HIV/AIDS. "It is necessary for the global HIV/AIDS community to work with the global water community to develop a consensus list of prioritised research needed on water and sanitation and HIV/AIDS, said Dr Kate Tulenko, a public health specialist of the WSP.

The Water Research Commission has managed research on the importance of access to safe water and sanitation for the efficient caregiving of HIV/AIDS patients (see *Water Wheel* July/August).

Satellite data warn of famine

A NASA research team has reportedly developed a new method to anticipate food shortages brought on by drought.

Molly Brown of the space agency's Goddard Space Flight Centre created a model using data from satellite remote sensing of crop growth and food prices. Until now officials have mainly studied the after effects of occurrences such as floods and droughts that might affect crop production as their best means of warning of a coming food security crisis. "With this new study, for the first time we can leverage satellite observations of crop production to create a more accurate price model that will help humanitarian aid organisations and other decision makers predict how much food will be available and what its costs will be as a result," Brown explained. "This is a unique opportunity for an economic model to take climate variables into account in a way that can aid populations large and small."

Global fund for sanitation

The Water Supply & Sanitation Collaborative Council (WSSCC) has set up a new financing mechanism, the Global Sanitation Fund (GSF).

While sanitation has been hailed as the greatest medical advance of the past 150 years, about 40% of the world's population do not have access to basic sanitation. The fund aims to help large numbers of poor people to attain safe and sustainable sanitation services and adopt good hygiene practices.

The GSF only supports work in countries that have national sanitation policies. It is not open to spontaneous expressions of interest.

The official launch of the GSF is expected March.

Global news snippits

- UK scientists have developed a molecule that chews up **uranium-containing ions**, reports *NewScientist* magazine. Researchers at the University of Edinburgh have found that the large organic molecule, known as a macrocycle, can fold in half to form a structure like a pair of jaws. These 'jaws' are used to capture uranyl ions.
- Uganda's National Water and Sewerage Corporation is constructing a new facility for **training and research** in Kampala. The facility is being established through the company's internally generated funds with support from the German Technical Corporation and Makerere University.
- City Water Services, a subsidiary of international water company Biwater, has lost an international **legal case** for breaching its contract to deliver water and sanitation services in Dar es Salaam, Tanzania between 2003 and 2005. Tanzania has been awarded more than £3 million in damages and over £500 000 in legal costs.
- Drought-stricken Cyprus is considering **importing water**. The Mediterranean island is experiencing its fourth consecutive year of drought. Authorities are evaluating importing water via sea tankers from the Greek island of Crete.
- South African investment bank ABSA Capital has teamed up with Barclays to arrange for the commercial debt facility for the US$867-million **Bujagali hydropower** project in Uganda. The project involves the construction of a 250 MW hydroelectric power station on the Nile River.

Brazilian fishways 'deathtraps' – study

Researchers in Brazil have found that the fishways designed to help fish swim up-river to breeding grounds are actually trapping the animals, sending them to their death.

Science journal *Nature* reports that fishways or fish ladders have been instituted in many large dams after it was found that fish numbers were declining. However, the situation has not improved, causing researchers to think that the fishways themselves might be to blame.

The fishways provide river-like flow conditions that attract migrant fish looking for spawning grounds. At the top of the fishways, the fish arrive in reservoirs, but because conditions in the reservoirs are not favourable (the waters are too clear and still to provide the cover the fish rely on to hide from predators, or the oxygen they enjoy in rivers), the fish bolt for tributaries to spawn.

If swift-water tributaries are not available, the fish die. If they do manage to spawn, upon hatching the offspring travel downstream and hit the edge of the reservoir, where they often die in anoxic waters or are eaten by predators before finding the ladder that leads downstream to safety.

Researchers have now called on infrastructure development agencies to develop fishways specifically for Brazilian fish populations.

R&D crucial to Rand Water revamp plans

Continuous research and development into new techniques and materials to repair or replace old pipelines remains a critical element of Rand Water's pipeline renovation programme.

The country's largest water utility operates a network of more than 3 000 pipelines, supplying water to more than 11 million people in Gauteng and parts of Mpumalanga, North West and the Free State. With some of its pipelines being more than 70 years old, the company has embarked on an expansive programme to upgrade and refurbish its distribution infrastructure.

According to its latest annual report, Rand Water invested R630-million in augmenting, refurbishing, upgrading and maintaining its water supply infrastructure during the 2006/2007 financial year. Over the next five years, the company plans to spend close to R4-billion on renewing its pipelines. Of this amount, 57% will be allocated to augmentation projects, with the remaining 43% allocated to renovations and upgrades of existing infrastructure, said Acting CE Zvinaiye Manyere.

Rand Water's R&D is focused mainly on the development and application of new processes and materials for pipelines, which account for the major part of the company's capital budget expenditure. Research is conducted both by internal staff and using external agencies such as universities, the Water Research Commission (WRC) and suitably qualified consultants and contractors.

Typical pipeline-related projects are those dealing with leaks, friction factors, biofilms, detection of air pockets, performance of epoxy and polyurethane linings, and in-line filters for bitumen particles. One project funded by the WRC involves the use of grouted polyethylene liners to seal leaks in old steel pipelines. This five-year project is due for completion by 2009.

New publication offers solutions to skills shortage

The South African Institution of Civil Engineering's (SAICE's) latest publication dealing with sector capacity, *Numbers & Needs in Local Government: Civil Engineering – the Critical Profession for Service Delivery,* is now available.

The publication, authored by former SAICE president Allyson Lawless, covers extensive research on the challenges of service delivery in local government and the suggested interventions that will affect a turnaround, which are both feasible and achievable. "There is no alternative for South Africa but to build a strong third tier of government," said Lawless at the launch late last year.

For various reasons experienced engineers continue to leave for the private sector or emigrate. The status of civil engineering staff in local government was estimated to be between 1 300 and 1 400, indicating a net loss of 70 to 90 a year since the late 1980s. This means an average of less than three civil engineering staff per 100 000 people. According to Lawless, South Africa has a limited window of opportunity of maximum ten years to turn around the skills decline and transfer expertise. This periods relates to the fact that the majority of experienced civil engineering professionals are in their late fifties and older. Local government carries the responsibility for ensuring sustainable and efficient water supply, sanitation, roads, electricity, waste disposal, health facilities, which are only achievable with appropriate engineering skills in place.

Lawless provides sets of practical short-, medium-, and long-term interventions. She has created a model of three parallel streams of activities, including a turnaround team in engineering departments, to develop plans and grow capacity. Lawless believes that the preoccupation with restructuring should be replaced with a determination to rebuild technical structures. "The zoom-in and zoom-out short-term support currently being offered, while necessary to address burning issues, does little to build the long-term sustainability of local government."

To obtain a copy of the publication, contact SAICE at Tel: (011) 805 5947/48 or Fax: (011) 805-5971; or E-mail: civilinfo@saice.org.za

WATER ON THE WEB

www.bpd-waterandsanitation.org/web/w/www_149_en.aspx
This website provides information on small-scale independent providers in water, sanitation and electricity. It includes documents, studies, other web links, articles, interviews and information on research programmes.

www.circleofblue.org
Circle of Blue is a multimedia initiative providing news, features, photo galleries and videos on the challenges and solutions to the global freshwater crisis. Circle of Blue is a non-profit affiliate of the Pacific Institute, an independent, nonpartisan think-tank based in California, in the US.

www.worldfishcenter.org
This is the official website of the World Fish Center, a non-profit organisation focusing on alleviating poverty and hunger by improving fisheries and agriculture. It is one of the research centres supported by the Consultative Group on International Agricultural Research (CGIAR).

Tackling Unwanted Algae Through Motion

Unsightly blue-green algae or cyanobacteria are a growing problem in lakes and dams, mainly as a result of the increased production and concentration of agricultural, municipal and industrial wastes. One method of dealing with blue-green algae in warm, nutrient-rich, stagnant waters is through the use of long-distance circulation, writes Dr Christopher Knud-Hansen and Linda Steenkamp.

Blue-green algae are particularly undesirable because many species contain toxins that can be extremely harmful (even fatal) to aquatic organisms, as well as humans, pets, and livestock, if ingested. Although the waters may appear green, there is very little food for microscopic animals to feed on because blue-green algae are essentially inedible. As a result, dead blue-green algae either remain floating on the water's surface creating that smelly pond scum, or, sink to the bottom where microbial decomposition depletes bottom waters of dissolved oxygen promoting fish kills.

There are basically three lake management approaches for dealing with blue-green algae. The first approach is to kill them with copper-based algaecides. This approach, however, is losing favour worldwide because the benefits are temporary. The second approach is to starve them. This approach emphasises restricting nitrogen and phosphorus availability via watershed management and/or nutrient removal or inactivation.

In contrast, the third approach of disturbing the blue-green algae's preferred habitat of stagnant waters through long-distance circulation (LDC) has provided the desired control. Long appreciated in the scientific literature that habitat disturbance can provide effective algal control, it was not until the development of the so-called SolarBee solar-powered water circulation machine that LDC has become a practical management approach for water bodies of nearly any size.

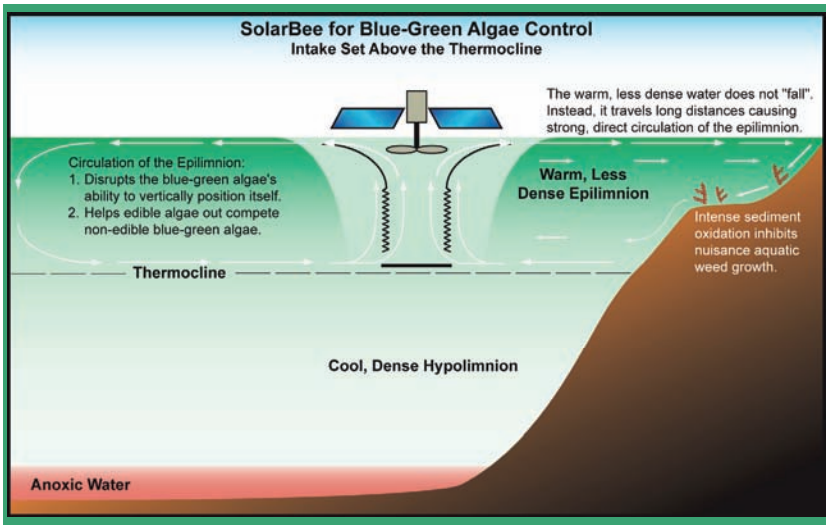
SolarBees are up-flow pumps with a flexible intake hose that can draw water up from any depth. The bottom plate beneath the one-metre diameter intake hose enables water to come into the machine horizontally from long distances. This prevents resuspension of bottom sediments, even when the intake hose is less than a metre off the bottom. The specially designed distribution dish at the surface allows up to 40 000 ℓ/minute to move radially in all directions up to about 200 m away from the machine. In this way, the upper waters where the blue-green algae grow are put into a slow but continuous motion. Three 80 Watt solar panels provide enough energy to run the sealed, magnetic motor and digital control box 24 hours a day. One unit can treat up to 14 ha of lake surface area.

Since 2000, SolarBees, which are now available in South Africa, have achieved more than 95% success in providing LDC for consistent and effective blue-green-algal bloom control to over 200 water bodies worldwide, including over 80 municipal raw water storage reservoirs. Preventing harmful algal blooms allows nutrients to change into edible, more beneficial algae. Since beneficial these algae do get eaten, water clarity improves. Because blue-green algae are not decomposing on the bottom, deeper waters remain better oxygenated, thus reducing the threat of fish kills. Furthermore, SolarBee-induced circulation has also proven effective at improving fish spawning habitats in near-shore sediments as naturally oxygenated surface waters move down along the sediments and back to the machine.

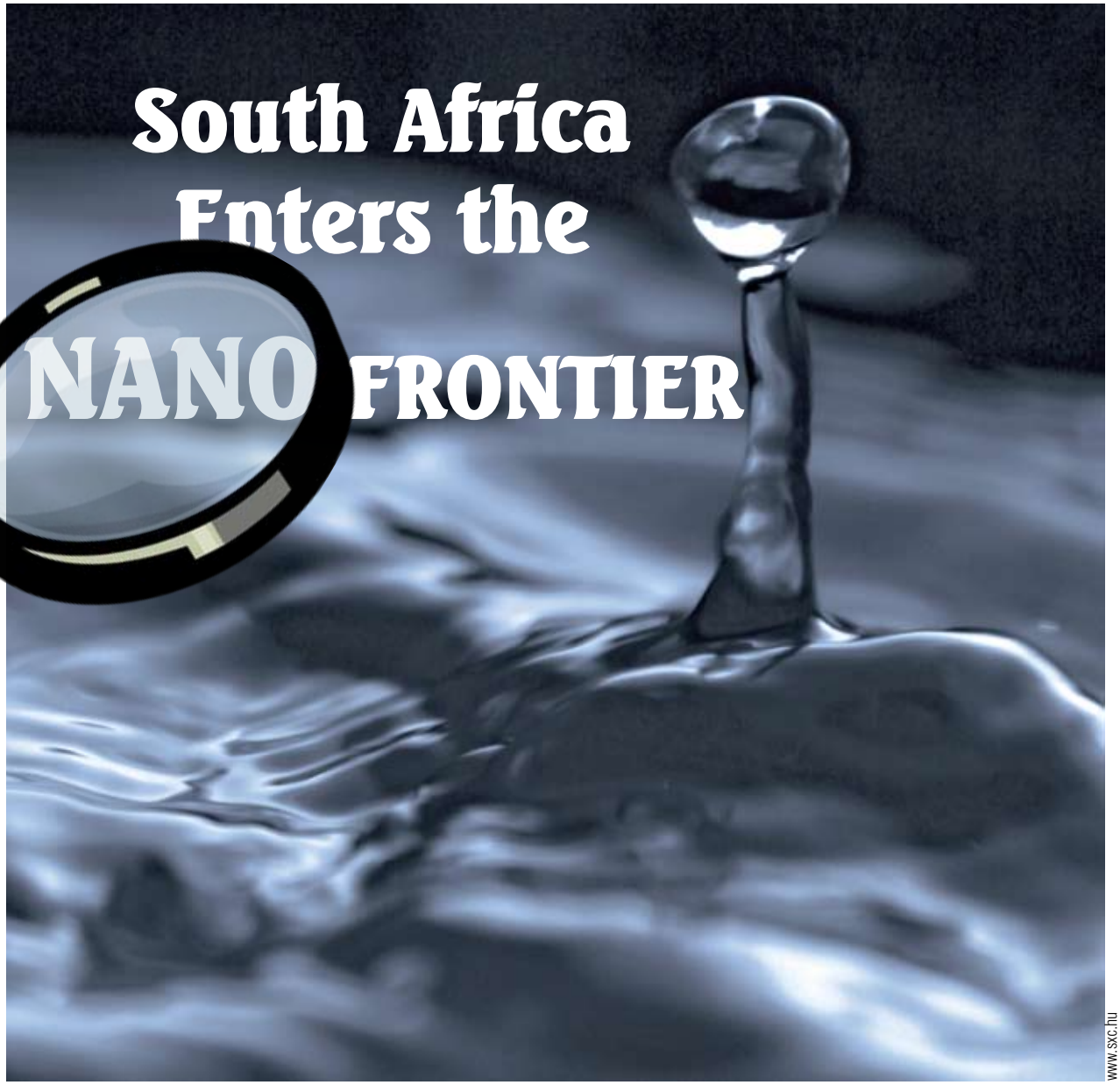
From the human perspective, benefits of LDC are also numerous. Lake users frequently note that near-shore sediments are firmer and more compacted, a logical result of oxidising the organic muck accumulated on the sediments. These water quality improvements are unrelated to nutrient concentrations – the elimination of algal blooms is by habitat manipulation that impairs their ability to out-compete non-blue-green algae, and not by limiting their nutrient availability. LDC has proven equally effective in wastewater lagoons as well as nutrient-rich lakes.

As human development continues to increase the amount of algal nutrients entering surface waters, it has become increasingly imperative to prevent algal blooms from forming. For nearly a decade, solar-powered LDC has proven to be the 'greenest', most energy efficient and ecologically-sustainable tool in the lake management toolbox to address this global problem.

Dr Knud-Hansen is a limnologist and certified lake manager for SolarBee in the US; Steenkamp is the Regional Director for Southern Africa. For more information,
Tel: 083 273 8111;
E-mail: lindas@solarbee.com



How the solar-powered water circulation machine works.



www.sxc.hu

Some deem it as big as the industrial revolution or the dawn of the information era. Now South Africa has officially joined the nanotechnology race following the launch of two Nanotechnology Innovation Centres. Lani van Vuuren reports.

Nanotechnology has captured the attention of governments, researchers and industries worldwide. A new generation of technology it holds the potential to revolutionalise the world we live in. Its possibilities seem endless, bound only by the limits of the imagination.

Independent research firm Lux Research predicts that by 2014, the market for manufactured goods incorporating nanotechnology would be worth US$2,6-trillion. There are already more than 500 products being sold that claim they are made with nanoscale or engineered nanomaterials, from nanotube-infused graphite tennis rackets to antimicrobial bandages.

Nanotechnology is the act, science and engineering for manipulating objects at the nanoscale. We are talking minute scales here – one nanometre is about one million times smaller than a millimetre. Or to put it another way, one nanometre is about 10 000 times narrower than a human hair or ten times the diameter of a hydrogen atom.

At this size materials often take on unique and sometimes unexpected

properties. Nano-sized gold, for example, can appear red rather than metallic yellow. Nano-sized carbon tubes are many times stronger than the same weight of steel, while bulk carbon (i.e. graphite or coal) can be very brittle.

This means that at the nanoscale, materials can be 'tuned' to build faster, lighter, stronger and more efficient devices and systems, as well as new classes of materials. In the water sector, nanotechnology can be applied to develop more cost-effective and high-performance water treatment systems as well as instant and continuous ways to monitor water quality, among others. Nano-technology is a multi-disciplinary research and development activity, bringing together chemists, physicists, biotechnologists, and engineers.

NATIONAL NANOTECHNOLOGY STRATEGY

To date, nanoscale research and development has been rather on a small-scale in South Africa, driven mostly by individual researchers' interests. A recent investigation by the University of Pretoria on behalf of the Water Research Commission (WRC) into local nanotechnology found that the country's nanoscale research is below what one would expect in light of its overall publication output. At present, the country's nanoresearch is distributed at a number of universities with a sub-critical concentration of researchers.

This is set to change, however. Government's interest in the potential of nanotechnology has led to the National Nanotechnology Strategy, which will see the coordination of nanoscale research and development at a national level. Joseph Molapisi, Manager: Emerging Research Areas at the Department of Science & Technology (DST) explains that the explosive interest in nanotechnology internationally meant that the South African government could no longer ignore its potential. "Our interest lies in its socio-economic potential."

"One nanometre is about 10 000 times narrower than a human hair or ten times the diameter of a hydrogen atom."

South Africa is one of the first countries to have an official nano-technology strategy. It is an ambitious long-term plan which seeks to position the country as a player in this emerging area of science and technology. The focus areas are very clear, namely water, energy, chemical and bioprocessing, mining and minerals, and advanced materials and manufacturing.

Molapisi is quick to point out that government's investment in nanoscale research is not "for the fun of it". "The activities we support are aimed towards identified, tangible measures to address some of the countries social challenges while enhancing our industries' competitiveness. For example, we would like to see the development of marketable products such as low-cost filters to provide clean drinking water, medical devices to detect and treat diseases more effectively, and enhanced nano-materials. "

An initial sum of R170-million over the 2006/07 period has been secured from Treasury to support the development of this field of science. "This is a drop in the ocean compared to the investments being made by other countries and much less than we initially anticipated, however, we realise that we are competing with other, more pressing needs in the country," says Molapisi.

Due to its multidisciplinary nature nanoscale research is an expensive business, and it is hoped to get more buy-in from the private sector who will eventually be the beneficiaries of the research outcomes. "Many industries still see nanotechnology as pie-in-the-sky research, thus it is difficult to

Lani van Vuuren

Prof Bheki Mamba of the Department of Chemical Technology at the University of Johannesburg with equipment used in the generation of nanomaterials.

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INTERNATIONAL NANO WATER INNOVATIONS

- In India, a nanotechnology product which removes dissolved pesticide residues has been developed. Dispersed in a cartridge that is 120 mm long, particles of silver measuring 60 to 80 nanometres are used to destroy pesticides found at elevated levels in Indian water supplies.
- The wax-like exterior of the Stenocara beetle, which lives in the Namib Desert was reportedly the inspiration behind the Massachusetts Institute of Technology's development of a nano-sponge material that snatches water droplets from the air. Compared to the polypropylene nets used to harvest fog in some regions, the new material can reportedly increase water capture by tenfold. The material features enhancements, including a decontaminating agent which eliminates harmful bacteria that might otherwise develop in rainwater as it collects.
- Rice University researchers have devised the nanotechnology equivalent of arsenic magnets – nano-sized rust particles that bind to the contaminant. In this process a magnet can remove the combinations of arsenic and rust, leaving behind clean water.

SO HOW BIG IS NANO?

One nanometre = one billionth of a metre
One DNA molecule = 2 nanometres
Virus = 50 nanometres
Visible colour = 400-700 nm
E. coli = 2 000 nm
Red blood cells = 5 000 nm
Hair diameter = 75 000 nm

attract them, especially in the early stages," notes Molapisi.

South Africa is also set to play a leading role in nanoscale research and development in the Southern African Development Community. A workshop is being planned later this year to discuss how the southern African countries can pool their resources to enhance their nanotechnology knowledge. South Africa already has cooperation agreements with countries such as France and Argentina to enable its researchers to gather crucial experience.

NANOTECHNOLOGY INNOVATION CENTRES

South Africa's first two Nanotechnology Innovation Centres (NICs) were launched at CSIR and Mintek last year. The activities at these centres are strongly aligned with DST's nanotechnology strategy. At the CSIR, the focus is on the design and modelling of novel nano-structured materials. The centre at Mintek, which is collaborating with the WRC, the Medical Research Council, as well as the universities of Johannesburg, the Western Cape and Rhodes, is focusing on research in the fields of sensors, biolabelling and water nanotechnology.

The Water & Health Research Group at the University of Johannesburg (UJ), which acts as the water platform of the Mintek NIC, has been investigating nanotechnology for water treatment since 2002. The group's research focuses on the use of nanoporous polymers to remove organic pollutants in drinking water, explains Bheki Mamba, associate professor at the Department of Chemical Technology, This involves the synthesis of water insoluble cyclodextrin- and calixarene-based polymers and their derivatives to remove organic pollutants, which include trihaloethylene, endocrine disrupting compounds (EDCs) and medications, which can be potentially toxic.

"At present, efficiently and affordably detecting and removing these compounds from water supplies remains a significant challenge," Prof Mamba tells *the Water Wheel*. "While conventional treatment technology such as activated carbon is being used with some success, it is not always effective in the removal of minute quantities (parts per billion). The so-called 'nanosponges' developed by UJ have been shown to remove pollutants at nanograms/litre

with high efficiency (>80%). In addition, they are reusable, which reduces treatment cost." The research is attracting students from various disciplines, and the UJ group now boasts 27 post-graduate researchers, including postgraduate students from Swaziland and Zimbabwe and post-doctoral fellows from India.

"The activities we support are aimed towards identified, tangible measures to address some of the countries social challenges while enhancing our industries' competitiveness."

Prof Mamba is excited about the potential pooling of resources and exchange of information being offered through the NICs. "Rhodes University, for example, is focusing on nanosensors for the early detection of diseases, such as cancer. The possibility exists that we might be able to apply these nanosensors for the real-time monitoring of pollutants at water treatment plants." In the long term, smart membranes with specifically tailored nanopores might be designed to both detect and remove pollutants from drinking water.

With South Africa's drinking water quality coming under increased scrutiny, the time has come to look increasingly towards alternative treatment technologies which could offer a more efficient solution, maintains Prof Mamba. "In the end we do not just want to offer South Africa's citizens drinking water, but good-quality drinking water. Nanotechnology offers us the opportunity to tailor-make solutions to meet our country's unique challenges."

Lani van Vuuren

NANOTECHNOLOGY & WATER

Nanotechnology shows much potential for the water sector, and research efforts in this field could serve to ameliorate many of South Africa's water problems. It seems that a window of opportunity has opened and that a number of exciting developments in this field holds great promise for improved treatment technologies, water quality assessment and for other environmental applications.

Water treatment: Nanomaterials can already be harnessed to enhance existing water treatment processes. Replacing existing materials and equipment such as activated carbon and reverse osmosis and nanofiltration membranes by nanotechnology modified or produced materials can lead the way for more advanced nanotechnology processes. Nanosize iron, for example, can detoxify organic solvents. Other nanoparticles that are bioactive, such as silver and magnesium oxide, can kill bacteria and might be used in place of chloride to disinfect water.

Water pollution: There are several new techniques being investigated for the remediation of water pollution. One of the most promising examples is zero-valent, nano-iron which is being tested for use in removing solvents from pumped groundwater.

Diagnostic tools: Great potential exists for the development of nanotechnology-based diagnostic tools can be used for real-time drinking water quality assessment. Detection of viruses, bacteria and parasites in real-time is needed rather than culture-based techniques that could provide information in days.

*** Source**: *Evaluation of Nanotechnology for Application in Water and Wastewater Treatment and Related Aspects in South Africa* (WRC Report No **KV 195/07**). To order the report contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; E-mail: orders@wrc.org.za

Kouga Catchment Enters Rehab

A pilot project in the Eastern Cape is exploring ways of rehabilitating riparian zones after alien-clearing. Sue Matthews reports.

Tucked away in the foothills of the Eastern Cape's Kouga River catchment are two tiny tributaries – the Baviaans and Heuningnes rivers. Despite their lowly stature and remote location, these waterways are the focal points of a hive of activity, having been selected as the study site for a pilot partnership project between WWF, Working for Water and Working for Wetlands. The Kouga Riparian Rehabilitation Project will be used as a platform to develop best management practices for the rehabilitation of riparian zones following the clearing of invasive alien plants.

"The Kouga catchment was chosen for the pilot project because it was identified as a priority system by the CSIR in the State of the Rivers report," explains Rodney February, head of WWF's freshwater programme. "It also feeds the Kouga Dam, which provides much of the water supply for Port Elizabeth, and is close to the Baviaanskloof Mega-Reserve, an important conservation area."

A healthy riparian zone – the area along the riverbank – is not only vital to a river's ecological functioning, but also helps regulate flows. Natural riparian vegetation provides habitat for creatures that live in or move through the river corridor, reduces erosion by stabilising the banks, and filters sediment and nutrients from the surrounding landscape. And, as is the case elsewhere in the catchment, it has a sponge effect, absorbing water and releasing it slowly over time, resulting in a more constant river flow.

By contrast, invasive alien plants – particularly tall trees such as pines, gums and wattles – have higher water requirements than the indigenous vegetation they replace, so infestations in catchment areas and riparian zones generally reduce total runoff and hence river flow. The trees tend

Sue Matthews

***Left**: A Working for Water team member finishes clearing a plot in the Baviaans River valley. Behind him, a stand of young black wattle trees await the same fate.*

***Right**: Denuded slopes are testimony to the intensive alien-clearing work being conducted in the Kouga catchment.*

Sue Matthews

Sue Matthews

Japie Buckle of Working for Wetlands explains how the black wattle invasion of the Baviaans River valley has caused headcut erosion and a deeply incised river channel. Subject to an EIA, a weir will be installed to raise the channel bed so that riparian vegetation can be planted.

to fall over when the river is in spate, ripping out sections of the bank and causing blockages that lead to further damage to the river channel. What's more, wattles are nitrogen-fixing plants that increase nitrate levels in the soil, excluding indigenous vegetation that is adapted to nutrient-poor soils – such as the fynbos of the Cape Floristic Region – and allowing the alien invaders to form dense monocultures. With little groundcover to bind the soil, erosion increases, resulting in siltation downstream.

"There has been almost no recovery of the natural vegetation, and now there's evidence of severe erosion in the riparian zone ..... It's clear that active intervention is needed to restore ecological functioning."

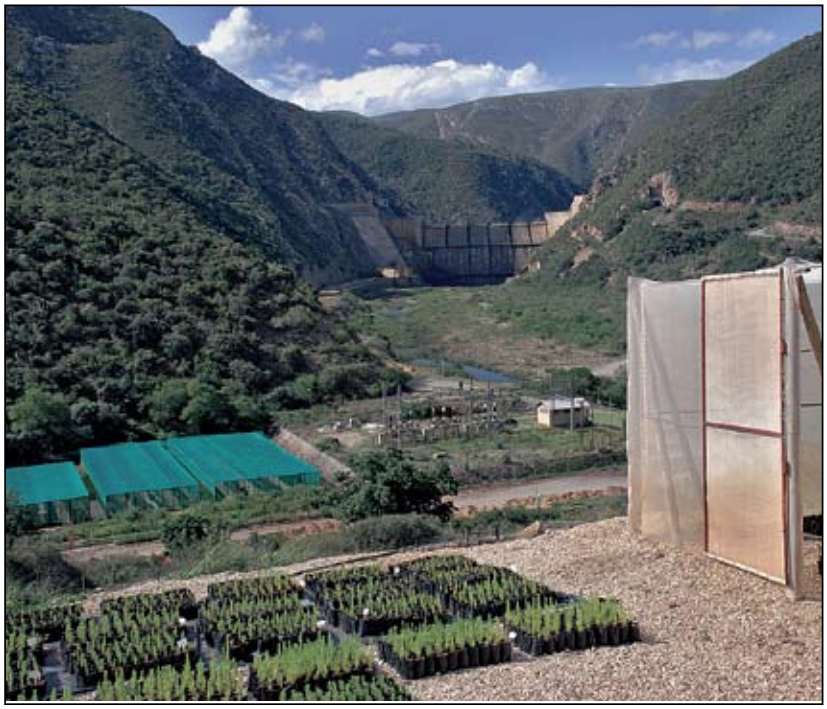
Both the Baviaans and Heuningnes River valleys are heavily invaded by the black wattle, *Acacia mearnsii*. Working for Water teams cleared and then burnt the Baviaans several years ago, and two follow-up operations involving herbicide spraying and slashing of regrowth have since been conducted, but the wattle has re-invaded in force. Beneath its bright green canopy, the valley floor is brown and barren.

"There has been almost no recovery of the natural vegetation, and now there's evidence of severe erosion in the riparian zone," says Saskia Fourie, project manager for the Kouga Riparian Rehabilitation Project. "It's clear that active intervention is needed to restore ecological functioning."

There are a number of possible reasons for the poor recovery of indigenous vegetation, and a combination of these is probably to blame. The repeated and perhaps excessive use of herbicide – or just poor timing – may have played a role, while the controlled burn may have been too intense due to the high fuel load of the felled trees. Very hot fires are known to alter soil properties and destroy the seeds of indigenous plants. Or perhaps the culprits were overly frequent fires in the past, when the land was used for grazing stock.

"Black wattle has probably been in this area for the last 50 or 60 years, because farmers were given its seed to provide a source of firewood," explains Japie Buckle, Working for Wetlands' Eastern Cape coordinator. "Farmers typically also burnt their land every few years and then used the first green flush, six weeks after the fire, for grazing. You not only lose reseeder species if you burn too frequently, but many germinating plants were probably eaten by grazers, so the indigenous seedbank may have diminished over time. Plus wattles like disturbed areas, and their ability to fix nitrogen gives them a competitive advantage over fynbos species."

The black wattle trees in the Heuningnes River valley are larger and the stands less dense as they have not previously been cleared, yet they are equally devoid of undergrowth. A comparison between three different clearing techniques – fell and stack, fell and chip, and fell and burn – as well as follow-up work with and without herbicide application, will be undertaken as part of the project, to determine which methods promote most natural recovery.



Sue Matthews

The Kouga Dam wall forms an impressive backdrop to the indigenous plant nursery. Plants are transferred from seed rooms to the shade houses, and then put outside during the 'hardening off' phase to toughen them up.

Before clearing the Heuningnes, however, two gauging weirs will be constructed in the river channel to measure base flow and the reaction to rain events. Once data has been collected for a year or two, the wattles will be cleared and the effect on river flow will be monitored.

The main focus of the project, though, is to develop and test rehabilitation methods, so the recovery of riparian vegetation following seed-sowing and low-, medium- and high-density planting treatments will be compared.

"In previous research I found that indigenous commercial grasses were very effective at suppressing wattle regrowth from the seedbank," explains Fourie. "So we will weigh up the costs of sowing commercial grasses versus using herbicides in a cost-benefit analysis."

Other indigenous plants for the rehabilitation work are being cultivated at a nursery set up by Working for Water on DWAF land near the Kouga Dam wall. The nursery is managed by horticulturalist Vicky Wilman, and currently employs some 50 people drawn from local communities. It also supplies plants for other fynbos and subtropical thicket rehabilitation projects within Working for Water's Eastern Cape Restoration Programme. Seeds, cuttings and root stocks are collected close to the sites to be rehabilitated, and brought back to the nursery for propagation.

As with all Working for Water projects, there is a strong emphasis on skills development. Some nursery workers are being given horticultural training, while others are being taught rehabilitation techniques.

"The idea is that after two years they'll be able to form their own business units and supply plants to other landowners undertaking riparian rehabilitation projects," says Wilman.

Since one of the primary aims of the Kouga Riparian Rehabilitation Project is to stimulate the rehabilitation of South Africa's riparian zones, it is likely that their skills will be in high demand.

Sue Matthews

An enthusiastic nursery worker fills a seedling tray with pelargonium cuttings.

Fishways Design Course for South African Rivers

Hosted by:

The Water Research Commission

BACKGROUND

The presence of existing barriers to migration in rivers (weirs, dams, road bridges, causeways, etc.) is considered to be a major factor responsible for the reduction in numbers and range of many migratory fish and invertebrate species throughout South Africa.

It is now a legal requirement in terms of the National Water Act (Act 36 of 1998) and the National Environmental Management Act (Act 107 pf 1998) that when any instream barrier to fish movement is proposed, that the necessity for and design of a fishway be undertaken as part of the Environmental Impact Assessment (EIA) process.

In recognition of the South African needs with regards to fishways the Water Research Commission (WRC) has funded a 5 year research programme. This programme has produced a document called *Guidelines for the Planning, Design and Operation of Fishways in South Africa* (WRC TT 287/07).

The guideline has been developed to aid the regulators, scientists and construction engineers to use local best practice in a consistent manner. Furthermore the guideline includes important issues such as construction, operation, maintenance and monitoring of fishways. The document also has valuable case studies of application of the guideline.

The below reference material will be made available to the course participants:

- Bok, A; Kotze, P; Heath, R & Rossouw, J (2007) Guidelines for the Planning, Design and Operation of Fishways in South Africa: WRC Report No. TT 287/07
- Rossouw, J; Kotze, P; Bok, A; Heath, R & Ross, M (2007) Twin Channel Vertical Slot Fishway Designs and Tests: WRC Report No. KV 197/07
- Heath, R; Bok, A; Fouche, PSO; Mastenbroek, W and Forbes, A (2006) Development of Criteria for the Design of Fishways for South African Rivers and Estuaries. WRC Report No. 1310/1/05

OBJECTIVES OF THE COURSE

The objectives of the course are as follows:

- Aid regulators, scientists and construction engineers as well as environmental authorities to use local best practice in a consistent manner.
- How to determine if a fishway should be built.
- How to determine the most suitable fishway design for particular rivers and sites.
- How to oversee the construction, operation, maintenance and monitoring of fishways.

FORMAT AND PRESENTERS

The workshops will be in the form of full morning's presentations including case studies and will finish with lunch.

The presenters will be well known fishways experts Drs Anton Bok, Pieter Kotze and Ralph Heath, as well as Hydraulics Engineer Dr Jan Rossouw.

WHO SHOULD ATTEND THE COURSE?

Regulators, conservation bodies, fisheries scientists, construction engineers, relevant DWAF officials, provincial environmental staff involved in Environmental Impact Assessment (EIA) management, environmental consultants and dam and weir design engineers.

REGISTRATION AND COSTS

Please register by completing the accompanying reply sheet.

There will be a nominal fee of **R150** (inclusive) per person which will cover refreshments and lunch.

Payment will secure your attendance at one of the courses.

Please fill in the attached reply sheet.

Closing date for registrations is **14 February 2008.**

DETAILS OF COURSES

REGION	VENUE	DATE
Gauteng	Water Research Commission	5 March 2008
Western Cape	Jonkershoek (Cape Nature)	11 March 2008
Eastern Cape	Gonubie Hotel	12 March 2008
KwaZulu-Natal	City Royal Hotel (Pietermaritzburg)	13 March 2008

The courses will start at 09:00 and finish with lunch at 13:00.

South Africa Design Guidelines Course

REPLY SHEET

Please complete and *return to:*

Elrika Croukamp, Zitholele Consulting (Pty) Ltd
P O Box 6002, Halfway House, 1685, Tel: (011) 254 4825, Fax: (011) 805 2100
E-mail: elrikac@zitholele.co.za
Or contact Dr Ralph Heath
E-mail: ralphh@zitholele.co.za

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INITIALS		**SURNAME**	
ORGANISATION			
POSITION			
ADDRESS			
		POSTAL CODE	
TEL NO		**FAX NO**	
E-MAIL			

Region you would like to attend?	
Do you require a VAT Invoice? An invoice will be emailed to the address on the reply sheet.	**Yes / No**
Proof of payment included in fax?	**Yes / No**

NEED ADDITIONAL INFORMATION?

Please contact Elrika Croukamp at:
Zitholele Consulting (Pty) Ltd.
Phone: (+27) (0)11 254 4825
Fax: (+27) (0)11 805 2100
E-mail: elrikac@zitholele.co.za
or Dr Ralph Heath
E-mail: ralphh@zitholele.co.za

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COMMENTS & SPECIAL REQUIREMENTS

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Sue Matthews

The Rupert & Rothschild estate on the Franschhoek wine route was the first to implement the UASB treatment technology.

A project funded by the Water Research Commission has successfully adapted UASB technology to the treatment of winery wastewater. Sue Matthews reports.

South Africa's wine industry has grown phenomenally over the last decade, mainly because the end of apartheid allowed access to international markets, but also due to a worldwide increase in wine consumption. At the same time, local winemakers have had to take heed of tighter legislative controls on environmental impacts, and a rise in consumer demand for 'enviro-friendly' products.

While farming of any kind has a range of effects on the natural environment, at the cellar level it is wastewater that poses the most environmental risk. Large quantities of wastewater are generated during the wine-making process, particularly around harvest time, when grapes are crushed and the juice fermented. Since this water generally has a high organic content, is acidic, and contains both suspended and dissolved solids, it does not meet the stringent criteria set by the Department of Water Affairs & Forestry (DWAF) for disposal in a natural water resource.

Most wineries therefore dispose of their wastewater by spraying it onto land. However, even this practice must be authorised by DWAF, and is subject to restrictions. For a start, it is not permitted where the sole aim is wastewater disposal, but only where it is beneficial in terms of crop irrigation. Given that kikuyu grass is considered a crop, a few horses or cows can be seen feasting on lush pastures on most of the Cape's wine farms, while wine-tasting centres are typically surrounded by flawless green lawns.

Irrigating with massive quantities of highly polluted wastewater could result in soil degradation and groundwater contamination though, so DWAF has also set limits on the quantity and quality of wastewater that can be used for irrigation, published as General Authorisations in terms of the National Water Act in March 2004. Although limits have been defined for a number of water quality parameters (Table 1), it is the COD value that most obviously affects the quantity of wastewater that may be irrigated on any given day.

The COD – or Chemical Oxygen Demand – is a measure of the total organic content of the wastewater, expressed as the amount of oxygen required to bring about its destruction through oxidation. The General Authorisations stipulate that up to 500 m^3 of wastewater may be irrigated per day if the COD is less than 400 mg/ℓ, but only 50 m^3 per day if the COD exceeds this. Wastewater with a COD above 5000 mg/ℓ may not be used for irrigation, and must instead be disposed of at a municipal wastewater treatment works.

However, two audits conducted during the last few years have shown

that the average COD of wastewater from South African wineries is in the 7 000 – 9 000 mg/ℓ range, although values as high as 70 000 mg/ℓ were recorded at one winery. Some kind of pre-treatment of wastewater is therefore necessary if wineries want to avoid paying the stiff charges imposed for disposal at municipal facilities, and irrigate within the legal limits.

In 2002, the WRC began funding a project that investigated the potential of treating winery wastewater using combined UASB and ozonation processes. The project was led by the Food Science Department at the University of Stellenbosch, and the resulting technology has now been implemented at the Rupert & Rothschild winery in Franschhoek. Last year an information session was held at the wine farm to demonstrate the technology to interested parties.

"UASB stands for Upflow Anaerobic Sludge Blanket," explained Prof Trevor Britz to a large group that included winery managers, consultants and environmental staff from local authorities and DWAF. "It was originally designed in the 1960s by Dr Bill Ross, a South African, but was patented by the Dutch. Worldwide, there are now more than 3 000 full-scale UASB plants for treatment of industrial effluents, but most have operational volumes of 100 000 to 10 million litres – very few operate on less than 50 000 ℓ."

UASB technology relies on anaerobic digestion, a biological process in which organic matter is converted in the absence of air to methane and carbon dioxide. The process involves a synergistic relationship between four different trophic groups of bacteria, namely hydrolytic, fermentative acidogenic, acetogenic and methanogenic. The bacteria cluster into granules, which settle out to form a dense bed of sludge that is retained in the system. This is a distinct advantage over aerobic systems, which produce masses of surplus sludge that must be disposed of.

TABLE 1
LEGISLATED LIMITS FOR IRRIGATION WITH WASTEWATER

Parameter	< 50 m³/day	< 500 m³/day	< 2000 m³/day
COD [a]	5 000 mg/l	400 mg/l	75 mg/l
Faecal coliforms	1 000 000 per 100 ml	100 000 per 100 ml	1 000 per 100 ml
pH	6 - 9	6 – 9	5.5 – 9.5
EC [b]	200 mS/m²	200 mS/m²	70 – 150 mS/m²
SAR [c]	< 5	< 5	Other criteria apply

[a] Chemical Oxygen Demand (COD) is the amount of oxygen required to oxidise all organic constituents in water to inorganic end products.

[b] Electrical Conductivity estimates the amount of total dissolved salts (TDS), or the total amount of dissolved ions, in the water.

[c] Sodium Adsorption Ratio (SAR), the concentration of sodium relative to calcium and magnesium, is an indicator of the sodium hazard of irrigation water.

On the down side, nutrient removal is not feasible in anaerobic systems – although winery wastewater is in any case low in nutrients – and trained staff are needed to operate them.

Anaerobic digestion is often limited by the presence of refractory and toxic compounds in wastewater, but ozone helps counter this effect. Pre-ozonation has been shown to enhance the biodegradability of organic matter by converting these compounds into simpler molecules, while post-ozonation may be used as a 'polishing' step. The project team therefore set out to investigate the efficiency of using various ozonation scenarios with UASB technology for optimal treatment of winery wastewater.

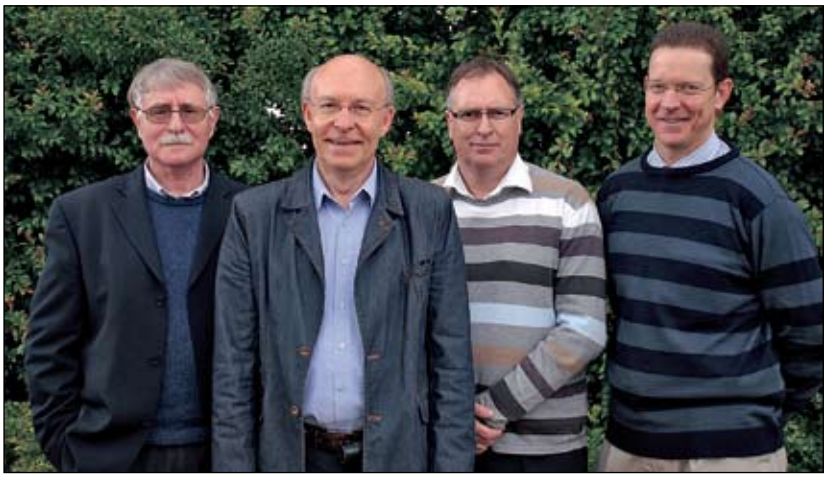
They began with a laboratory study, and later scaled up the combined treatment process in a 600 litre mobile unit, which was tested at the Bergkelder winery in Stellenbosch. Here the raw winery wastewater had an average COD of 5 370 mg/ℓ, and UASB treatment alone was able to reduce this by 77-81%. Adding a pre-ozonation step increased the reduction efficiency to 92%, bringing the

Sue Matthews

WRC Research Manager Gerhard Offringa and the bio-active filter.

Sue Matthews

Delegates at the information session view the treatment plant.



Sue Matthews

Trevor Britz, Gerhard Offringa, Neels Barnardt and Gunnar Sigge presented the treatment technology at the information session.

COD value down to 455 mg/ℓ. Post-ozonation was found not to be as effective as pre-ozonation, and even adding it as a final polishing step only increased the reduction efficiency by another 1%.

"Importantly, though, this little bit extra was enough to reduce the COD to 377 mg/ℓ," said Dr Gunnar Sigge, during his presentation at the information session. "That brought it below the legal limit of 400 mg/ℓ for irrigation of 500 m^3 of wastewater per day."

The WRC project came to an end at that point, but the story doesn't stop there. Dr Neels Barnardt, an environmental consultant working with the Rupert & Rothschild winery to help reduce their 'footprint', was keen to put the technology to the test. The winery had already become the first in South Africa to achieve ISO14001 environmental management certification, and improved wastewater control had been identified as a future target. Under the project team's direction, a 14 000 ℓ full-scale treatment plant was therefore constructed at the winery and housed in a dedicated building, at a total cost of R270 000. Named the bio-active filter, it consists of four tanks driven by four recirculation pumps, with a diesel-driven boiler to maintain the temperature above 20°C. The plant processes up to 25 000 ℓ/day of wastewater, incurring running costs of about R1 500/month.

While the COD of the winery's raw wastewater varies between 3 000 and 6 500 mg/ℓ depending on the season, that of the treated effluent is now well below 1000 mg/ℓ throughout the year, and often below the holy grail of 400 mg/ℓ.

"The fact that the COD is not maintained below 400 mg/ℓ can be attributed to the manual operation," noted Dr Barnardt. "This system requires that somebody checks the flow regularly and adds lime on a daily basis to control the pH. We have since installed a duplicate, but fully automated, system at the La Motte winery, and the COD stays at around 250 mg/ℓ all year round, which tells me that the technology is fully capable of achieving the 400 mg/ℓ goal."

Dr Barnardt also stressed the importance of good cellar practices, such as reducing water consumption – and hence the volume of wastewater produced – and separating out solids as soon as possible to keep the COD low. He noted that Rupert & Rothschild had reduced water consumption to four litres of water per litre of wine produced, compared to the industry average of 6,5:1, and had replaced all the conventional drains in the cellar with wedge wire ones to prevent solids from entering the wastewater stream.

WRC Research Manager, Dr Gerhard Offringa, who oversaw the project and chaired its steering committee, expressed his delight at the success of the project. "The project team did the fundamental research in the lab, transferred it to a pilot plant, evaluated it, then built a full-scale plant," he said. "They went from innovative idea to implementation in five years, which is very impressive."

Hopefully, other wineries will harvest the fruits of their labour and implement the technology, helping to ensure that the red and white wine we drink is just a little more 'green'.

Mercury Levels in SA Water Resources Probed

Today, very little remains known about the extent of mercury pollution in South Africa, because until now most studies have been in response to emergency incidents and effluent spills. To address this knowledge gap, the South African Mercury Assessment (SAMA) Programme was set up in March 2006 with the aim of developing a framework for mercury-related research. Sue Matthews reports.

SAMA is a partnership programme with representatives from government, academia, industry, and parastatal and non-governmental organisations. "We suspect that South Africa's mercury emissions are not as high as has been suggested because the estimated emissions were based on volumes of coal combustion and gold production, yet the gold industry has largely phased out the use of mercury," says Dr Joy Leaner of the CSIR's Natural Resources and the Environment Group.

Courtesy of CSIR

Sampling water for mercury analysis.

Dr Leaner serves as coordinator of the SAMA Programme, and is also the project leader for a recently initiated research project – funded by the Water Research Commission (WRC) – to investigate mercury levels in South African water resources.

Mercury is particularly dangerous once it gets into water, because under certain conditions it is converted into methylmercury – a more toxic form. It is readily taken up by phytoplankton and then accumulates up the food chain, with the result that people eating contaminated fish on a regular basis soon experience the symptoms of mercury poisoning.

The main focus of the WRC project is to conduct a national survey of mercury levels in water resources by sampling water, sediment, and freshwater fish and invertebrates from all 19 of South Africa's water management areas (WMAs). Sampling sites were selected on the basis of their proximity to likely sources of mercury emissions, and those shown to have markedly high levels of mercury will be identified as 'hotspots' for more intensive study.

Coal-fired power stations are the primary source of mercury emissions globally, and given that most of South Africa's power stations are located in Mpumalanga – where 80% of the country's coal is produced – the Olifants and Upper Vaal WMAs will come under special scrutiny. Another major mercury emitter is the cement industry, which uses coal as a kiln fuel. Although the cement industry is more evenly distributed throughout South Africa, there is a concentration of facilities in the Crocodile (West) and Marico WMA, which will be thoroughly sampled by the research team.

"We'll also be focussing on the Barberton area," reports Dr Leaner, "because artisanal gold mining took place there in the past. Worldwide, mercury is still used by small-scale miners to form an amalgam, after which it is burnt off over an open flame. Obviously this is a threat to their own health, as well as to people who consume mercury-contaminated fish from freshwater ecosystems nearby."

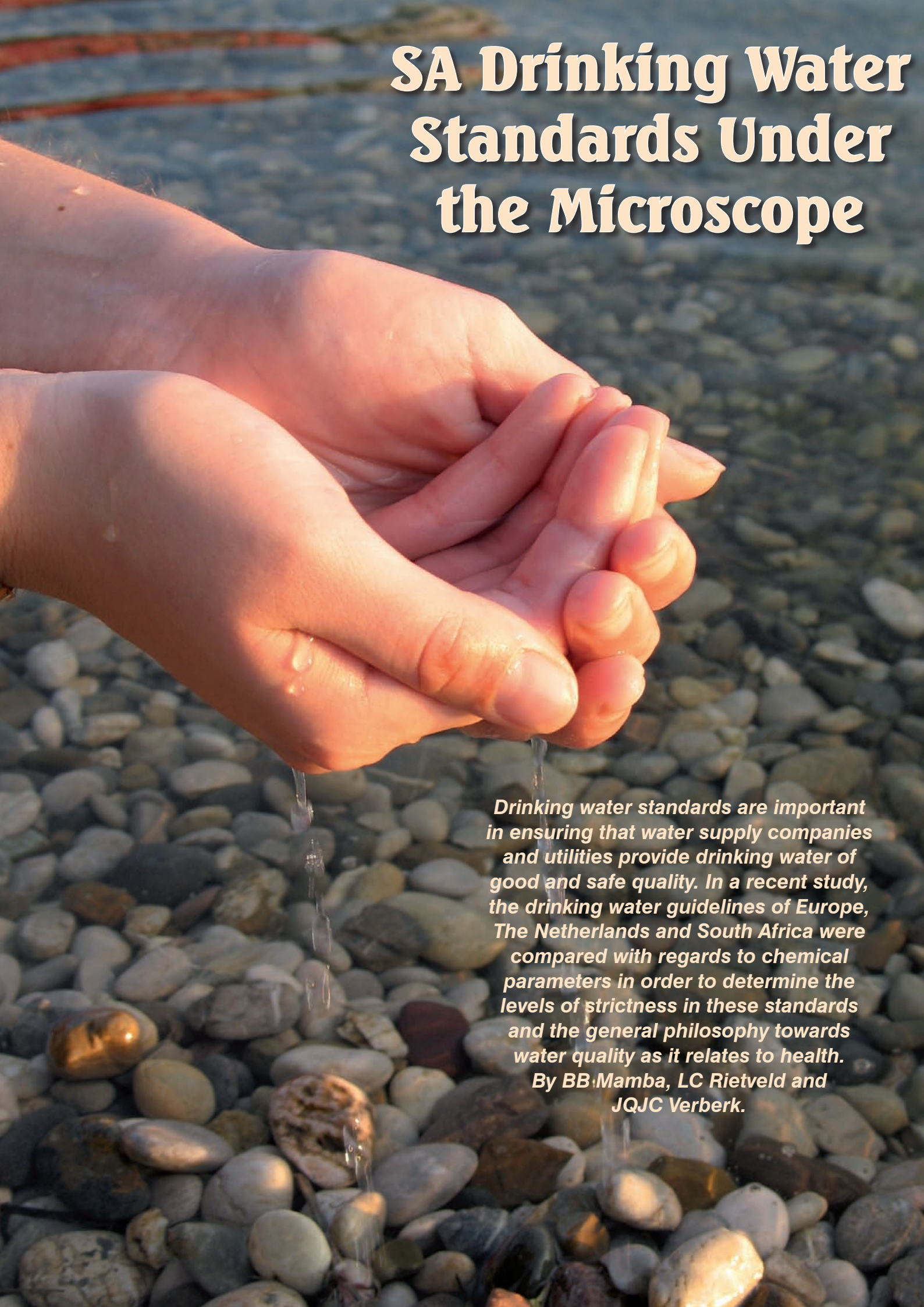
An important aspect of the current research focus on mercury is the development of local capacity in mercury sampling and analysis. Much can be learned from international experts from the University of Connecticut, which – together with the University of Stellenbosch – is a collaborator on the WRC project. At present, all samples collected by the project team are sent to the US for analysis, but the American collaborators are helping to set up a mercury laboratory at the CSIR.

"Our intention is to develop a large-scale reference laboratory, so that the CSIR can provide analytical services to others," says Dr Leaner. "We'll adhere to the methods of the USA's Environmental Protection Agency, which are considered standard protocols."

Technical expertise of this kind is likely to become all the more important if South Africa follows the example of the USA and EU, where tighter controls on mercury emissions are being introduced. In the meantime, the national survey will yield a better understanding of mercury pollution in South Africa, providing support for future government initiatives aimed at addressing the problem.

(Article reprinted courtesy of CSIR)

SA Drinking Water Standards Under the Microscope



Drinking water standards are important in ensuring that water supply companies and utilities provide drinking water of good and safe quality. In a recent study, the drinking water guidelines of Europe, The Netherlands and South Africa were compared with regards to chemical parameters in order to determine the levels of strictness in these standards and the general philosophy towards water quality as it relates to health.

By BB Mamba, LC Rietveld and JQJC Verberk.

The main aim of treating drinking water is to produce water that is safe (without pathogenic microorganisms and toxic compounds), attractive (free from colour, taste and odour) and to avoid accumulation of solids, corrosion and after-growth of bacteria in the distribution and transport pipeline. Drinking water standards or guidelines should be appropriately set up taking into account national, regional and local situations.

The monitoring and enforcement of these standards differ across the world. In most parts of the world the monitoring is done by water suppliers while the data is audited by public health authorities or regulatory authorities responsible for environmental health. The standards often provide a basis for judging the safety of drinking water in relation to the contaminants of concern. These guidelines also cover contaminants and features that are considered vital in the supply of acceptable and safe drinking water. It is not practical to set standards for every contaminant that could reach drinking water. However, water suppliers should always be up to date about emerging pollutants in water supply lines and then take appropriate action regarding reducing the pollutants' concentration to safe levels or completely remove them.

METHODOLOGY AND RESULTS

The study compared the drinking water standards of South Africa and The Netherlands, which is known for its stringent guidelines. The two countries' drinking water standards were also compared with those of Europe as well as the corresponding guidelines from the World Health Organisation (WHO).

Similarities and differences were noted between the South African National Standard for drinking water, the drinking water standards of The Netherlands and the European Union (EU), as well as the guidelines of the WHO. The comparison was made only on the concentration limits of health-related chemical parameters that are reported in all four of the guidelines (Table 1).

DISCUSSION

The guideline values given in Tables 1 and 2 represent an upper limit of the concentration of individual chemical species that does not exceed tolerable risk to the health of the consumer over a lifetime of consumption. Some chemical contaminants, such as lead and fluoride, may cause ill health effects to water consumers when they are exceeded.

Exceeding the guideline values within a given timeframe that is allowed does not necessarily represent a direct serious risk to health. Some limits in the standards for specific chemical contaminants can be exceeded for limited and specific periods of time without posing any health problems. The length of such a period is also proportional to the individual contaminant concerned particularly when taking into account the level of health risk it poses. Where an analysis points to the fact that the limits have been exceeded then this should signal that an investigation needs to be carried out and appropriate action taken. In this case, possible sources of the toxic substance that has exceeded its limit would have to be identified and remedial action taken with the assistance of public health authorities.

With reference to Table 1, it is not difficult to see why the quality of drinking water and water treatment processes in The Netherlands still rank among the best in the world. When comparing the limits that are allowed for a particular chemical substance, one realises that The Netherlands is much stricter than the general EU standard, let alone the South African drinking water standard. For the past decade, The Netherlands has focused on

TABLE 1
HEALTH RELATED CHEMICAL PARAMETERS (INORGANIC)

Determinand	Unit	WHO max limit	EU max limit	NL max limit	SA max limit
Aluminium	µg/ℓ	200	200	200	300
Ammonia	µg/ℓ	No guideline	500	200	1000
Antimony	µg/ℓ	5	5	5	10
Arsenic	µg/ℓ	10	10	10	10
Bromate	µg/ℓ	Not mentioned	10	1*	Not mentioned
Chromium	µg/ℓ	50	50	50	100
Copper	mg/ℓ	2	2	2	1
Iron	µg/ℓ	300	200	200	200
Lead	µg/ℓ	10	10	10	20
Manganese	µg/ℓ	500	50	50	100
Mercury	µg/ℓ	1	1	1	1
Nickel	µg/ℓ	20	20	20	150
Sodium	mg/ℓ	200	200	150	200
Zinc	mg/ℓ	3	Not mentioned	3	5
Chloride	mg/ℓ	250	250	150	200
Cyanide	µg/ℓ	70	50	50	50
Fluoride	mg/ℓ	1.5	1.5	1.1	1
Sulphate	mg/ℓ	500	250	150	400
Selenium	µg/ℓ	10	10	10	20
Nitrate	mg/ℓ	50 (as total N)	50	50	10 (as total N)
Nitrite	mg/ℓ	50 (as total N)	0.5	0.1	10 (as total N)

** With disinfection a maximum of 5 µg/ℓ is allowed (as 90 percentile value with a maximum of 10 µg/ℓ)*

TABLE 2 HEALTH RELATED CHEMICAL PARAMETERS (ORGANIC)				
Determinand	**Unit**	**NL max limit**	**EU max limit**	**SA max limit**
Polycyclic Aromatic hydrocarbons (PAHs) (sum)	µg/ℓ	0.10	0.1	Not mentioned
Trihalomethanes (sum)	µg/ℓ	25	110	200
Polychlorinated biphenyls (PCBs) (individual)	µg/ℓ	0.10	Not mentioned	Not mentioned
PCBs (sum)	µg/ℓ	0.50	Not mentioned	Not mentioned
Pesticides (individual)	µg/ℓ	0.10	0.1	Not mentioned
Pesticides (sum)	µg/ℓ	0.50	0.5	Not mentioned
Tetra- and tri-chloroethene (sum)	µg/ℓ	10	20	Not mentioned
Vinyl chloride	µg/ℓ	0.50	0.5	Not mentioned
Dissolved organic carbon (DOC) Total organic carbon (TOC)	mg/ℓ	*	*	10

** No abnormal changes*

drinking water research with a primary focus on improving water quality and the robustness of the total water system, including its distribution efficiency.

With reference to the Dutch drinking water industry benchmark, it can be concluded that Dutch water, in general, complies with the legal standards for water quality as prescribed in the Dutch Water Act. The challenge for The Netherlands in the future is to maintain and guarantee water quality of a high standard rather than making an effort to attain such standards. The good quality of drinking water in The Netherlands is evidenced by the fact that its people consume the lowest average number of bottled water in the world.

It is proposed that the practice in The Netherlands which makes it mandatory for water companies to report on an annual basis their compliance and non-compliance to the set maximum limits in the drinking water standard be adopted by countries whose water companies aspire for excellent water quality. Non-compliance in the initial phase of implementation should not necessarily result in punitive action, but should provide an opportunity for corrective measures to be taken so that the quality of the drinking water is not compromised.

South Africa's drinking water standard has generally higher limits compared to those of the EU and The Netherlands. In the drinking water standard document of South Africa, the upper limits are further extended for the individual chemical parameters within specific timeframes of a week, three months, six months, a year, seven years and even ten years for some chemical species. This category is referred to as Class II (maximum allowable for limited duration). The Netherlands and EU standards do not make any allowance for similar classes as found in South African drinking water standard, which implies a higher level of control.

The duration of Class II limits are set depending on the determinand and its potential toxicity. A more toxic substance would probably be given a shorter period of time while the cause for exceeding the limits is still being determined and corrected. The time period is normally considered sufficient for the correction of the 'over-shooting'. The danger of this leeway, however, is that it could be overly extended if not carefully monitored. To effectively assess the limits during the leeway periods would inevitably demand the reinforcement of human resource and capacity. Noteworthy is that the EU and Dutch standards do not judiciously make allowances for the concentration levels of the determinand to be exceeded. The Netherlands, for example, only allows a yearly average of sodium concentration up to a maximum of 150 mg/ℓ, which happens to be the operational maximum limit of the EU and South African standards.

One major factor that influences the concentration of metal ions in the water system is the velocity of water as it runs through the pipelines. In one scenario the velocity may have dropped due to many factors such as a leak which could cause a drop in the velocity resulting in the metal ions settling within the pipes. As soon as the velocity increases, deposits that have been settled can be resuspended which causes a sudden increase in the levels of these species to the detriment of the health of consumers. The Netherlands has over the years changed the pipe material from cast iron and lead to polyvinyl chloride which has not only provided durability but also eliminated metal ions produced after water stagnation.

When considering lead, manganese and chromium, the South African drinking water standard provides for a limit of concentration that is twice that of the EU and The Netherlands, and further allows excesses of up to 50 µg/ℓ, 1 000 µg/ℓ and 500 µg/ℓ respectively for water consumption of up to maximum allowable periods of three months, seven years, and three months, in that order. All the above compounds pose health risks to human life and they need to be carefully monitored. It is suggested that there should be a higher level of strictness for ions of chromium which attain higher concentration levels caused by discharge from steel and erosion of natural deposits.

The concentration limit of nickel allowed in South African drinking water is astoundingly high, at least seven times that allowed by the EU, Dutch and WHO guidelines. Due to the high level of mining operations in South Africa it is expected that levels of nickel could be high. However, such high levels of concentration inevitably call for practical means for the reduction of nickel in drinking water. Reducing the concentration to be within the WHO allowable limits would be the first major step.

Table 2 shows determinands that are organic chemical compounds which can be found in drinking water. The WHO limits are not included here since these guidelines list the individual organic compounds without classifying them. Since the number of organic compounds in water is very large it becomes difficult to measure each one

individually. Thus, in many drinking water standards for organic chemicals, the concentration limits are determined on the basis of some properties or groups of compounds. For example, there are a number of organic compounds which fall under the category of pesticides; hence the norm is to group such compounds together. Drinking water standards of the EU and The Netherlands reflect such classification while the South African standard merely refers to the WHO guidelines.

Organic compounds have now become a threat to human health. Although they are often present in very low concentrations in drinking water, they can still have serious health implications. Compounds such as polyaromatic hydrocarbons (PAHs) are generally unreactive to be removed from water through a chemical reaction with a ligand though they can be removed by advanced filtration technologies. Unfortunately, these organic pollutants are toxic even at low concentration levels of parts-per-million (ppm). Most technologies fail to remove these organic micropollutants to acceptable levels. Some of these organic contaminants cannot even be adsorbed on to the activated carbon or trapped by membranes during drinking water treatment, especially at very low concentration levels.

South African natural water systems have higher concentrations of natural organic matter (NOM) even beyond 10 ppm. Organic matter by itself is not toxic, but causes odour and taste problems in the water. During ozonation treatment, organic matter is oxidised leading to the formation of biodegradable dissolved organic carbon (DOC). Ozonation of water produces some undesirable compounds, such as the formation of aldehydes. This is significant since aldehydes can potentially cause adverse health effects. Formaldehyde and acetaldehyde, which are relatively volatile, can result in the formation of respiratory tumours. The problem with high levels of NOM is that toxic oxidation products are often produced during ozonation in the form of peroxide radicals.

It is worth noting that the EU and The Netherlands have set stringent upper limits for organic compounds, including those that may not result from ozonation treatment. One noticeable practice in The Netherlands is the discontinuation of chlorine as disinfectant, which often results in the chlorination of organic matter – the resultant byproducts are often more toxic than the organic matter. In The Netherlands some water utilities use slow sand filtration after the conventional surface water treatment protocol, which includes coagulation, flocculation, sedimentation, softening, filtration, membrane and activated carbon filtration. Other utilities use ultraviolet disinfection in combination with hydrogen peroxide for disinfection and activated carbon for the removal of organic micropollutants. The slow sand filtration treatment improves the physical, chemical and microbiological quality of the water. The slow sand filtration treatment reduces the levels of assimilable organic carbon, which implies less biological growth. Some parts of Europe still disinfect using chlorine; however, Europe's levels of NOM are generally lower than that of South Africa.

"Organic compounds have now become a threat to human health. Although they are often present in very low concentrations in drinking water, they can still have serious health implications."

South Africa still predominantly uses chlorine as a disinfectant. Chlorination of organic matter often leads to the formation of trihalomethanes (THMs) and other undesirable byproducts. The US Environmental Protection Agency has reported that THMs have the potential to cause liver, kidney or central nervous system problems and possibly increase the risk of cancer. In Table 2, the South African standard allows almost twice the concentration in THMs compared to the limit set by the EU and almost ten times in relation to the maximum limit set by The Netherlands.

Some pesticides which are found in drinking water are considered to be carcinogenic. Within the group of pesticides there is no differentiation with respect to the different toxicities of the pesticides. In addition, standards are often set for technical or aesthetic reasons for compounds which may not be necessarily toxic, but can influence the taste, colour and odour of water. Still, the use of pesticides in drinking water as larvicides is recommended, though the levels of such compounds in water systems should be carefully monitored. The South African drinking water standard makes no mention of pesticides despite widespread use of insecticides, particularly in the agricultural sector.

One major shortcoming of the South African drinking water standard is its lack of detailed coverage of parameters of organic chemicals. With so much organic matter in South Africa's water systems stricter guidelines should be in place.

CONCLUSION

When comparing the limits of all the chemical parameters in drinking water it is evident that The Netherlands has the strictest and a more detailed standard. This strictness also extends to the Dutch water companies which have to report water quality data on an annual basis so that their compliance and non-compliance to the set limits are monitored, enabling corrective measures when needed.

The Dutch drinking water sector is not driven by adherence to standards given its strict benchmarks, but rather by the aspiration to improve its water treatment process, the removal of bacteria and pollutants in water, and the improvement of the distribution system. The distribution system in The Netherlands has a 2% leakage rate which reduces possibilities of recontamination by infiltration of contaminants and bacterial re-growth. Given such a low leakage level compared to the average leakage rate of 20% in Europe, The Netherlands has a very low pressure drop, further reducing the probability of recontamination.

The EU drinking water standard, though not as strict as that of The Netherlands, on the whole falls within the guidelines of the WHO. The South African drinking water standard was found to be least strict compared to the other standards studied. Furthermore, the South African standard gives allowances to exceed the operational maximum limits within a given time period. It is recommended that the organic chemical determinands be included in the South African standard and that the limits be set for the individual groups of these moieties.

WATER Kidz

Ecological Reserve – Keeping SA's Lifeblood Pumping

Courtesy of SA Tourism

South African water law dictates that we reserve water for future generations and to keep our aquatic ecosystems alive.

It is well known that without water we cannot survive. Our bodies are up to 60% water, and each day we must drink water to replenish our systems and stay healthy.

Just like the human body needs water to survive and function, so rivers and other water resources (wetland, estuaries and underground water) need to retain a certain amount of water.

People need water for all sorts of things, not only for drinking, but also for washing, cooking, and growing food. We also need water to power our industries, and create electricity and mine precious metals and minerals. But in the process of using water, people can damage rivers, wetlands, lakes and other watery places. Damaged ecosystems do not work very well and may fail us when we need them most.

Because South Africa is a semi-arid country (the country is among the 30 driest countries in the world), we have to take care of the little water we have. The South African Bill of Rights states that everyone has the right to sufficient food and water and to an environment that is not harmful to their health or well-being. One way of protecting water is through the creation of special laws.

NATIONAL WATER ACT

The National Water Act, which was promulgated in 1998, emphasises that all aspects of water on earth are connected, and that we have to manage water resources within that connected cycle. (Can you still remember how the water cycle works? Water falls from the sky as rain, runs off the landscape, filters into the soil, flows to the sea in rivers, is stored in dams, evaporates into the sky and rains back onto the earth.)

The Act recognises that water belongs to the whole nation and is administered by the government for the good of the people. This legislation protects the rights of all people to have water for their basic needs, but also takes into account the needs of aquatic (watery) ecosystems.

How does it do this? By ensuring that a little bit of all water resources are reserved for future generations. South Africa is the first country in the world to legislate this concept and provide this Reserve as right of law.

RESOURCES

Watermark – The Lasting Impression of the Ecological Reserve (WRC Report No TT307/07)
Some for All, Forever – Water Ecosystems and People (WRC Report No TT 176/02)
These booklets are available from the Water Research Commission at no charge. To order, contact Publications at Tel: (012) 330-0340 or E-mail: orders@wrc.org.za and quote the WRC Report number.

Courtesy of SA Tourism

Rivers do not only provide water, but also 'products' such as fish, medicinal plants and reeds used for basket weaving.

THE RESERVE

The Reserve consists of two parts – the Basic Human Needs Reserve and the Ecological Reserve:

- The **Basic Human Needs Reserve** is the water allocated for human consumption before any other water can be assigned. It provides for the essential needs of individuals and includes water for drinking, food preparation and personal hygiene. The Reserves ensures that people are never overlooked in favour of ecosystems or industrial use. At present, this amount is calculated as a minimum of 25 litres per person per day.

Kathy Eales

We all have a responsibility to ensure that our water ecosystems are protected from pollution and overuse.

- The **Ecological Reserve** relates to the water required to protect and sustain the aquatic ecosystems in order to secure ecologically sustainable development and water use.

In this way, the National Water Act protects the rights of water ecosystems because they provide people with many free services necessary to life – water supply, waste processing and dilution, natural products (reeds, fish, and medicinal plants), nature conservation, flood control, recreation and places for beauty and religious rituals.

This does not mean we are not allowed to use the resources. We must use water and water ecosystems for social and economic development. We must use water and water ecosystems for poverty alleviation. But we need to leave enough water in an ecosystem so that the ecosystem remains alive.

Rivers clean themselves naturally. They provide habitats for a wide range of plants, animals and microbes. When a river is used by many people, the number and kind of plants, animals and habitats change. Feeding processes change. The structure and function of the river change. The health of the river suffers.

The Reserve provides that all rivers, regardless of their health, need:

- Enough water to maintain their structure and to provide habitats for plants and animals;
- Water in the right season so that plants and animals can complete their life cycles;
- Variability of flow so that the groups of animals that thrive in either wetter or drier conditions can be maintained;
- Enough water in severe droughts so that rivers that usually flow all year continue to do so, and seasonal rivers do not dry up for longer than they would naturally.

We all need to work together to ensure we have the water ecosystems we want.

Courtesy of SA Tourism

THE SOUTH AFRICAN BILL OF RIGHTS (Chapter 2 of the Constitution) STATES THAT:

"Everyone has the right to an environment that is not harmful to their health or well-being; and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that:

- prevent pollution and ecological degradation;
- promote conservation; and
- secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."

South Africans Scoop ICID Awards

Two South Africans were among the prize winners at a recent meeting of the International Commission on Irrigation & Drainage (ICID). The 58th International Executive Council meeting took place together with the US National Committee's 4th International Conference of Irrigation & Drainage in Sacramento, in the US.

Dr Abraham Singels, a principal agronomist at the South African Sugarcane Research Institute, received the WatSave Innovative Water Management Award 2007, while Dr Gerhard Backeberg, Director: Water Utilisation in Agriculture at the Water Research Commission, received the Best Paper Award 2007.

Dr Gerhard Backeberg, Director: Water Utilisation in Agriculture at the Water Research Commission (right) receiving the Best Paper Award from ICID President Peter Lee. Dr Backeberg's paper, titled "Reform of User Charges, Market Pricing and Management of Water: Problem or Opportunity for Irrigated Agriculture" was published in Volume 55, No 1 of the ICID Journal Irrigation and Drainage. *His paper examined the changes in the approach to water management. Dr Backeberg's analysis of selected case studies showed that willingness to pay is less than operation and maintenance cost, water licenses are considered insecure and diverse membership impedes cooperation in local organisations. Complications must be overcome to improve efficient use and allocation of water and effective participation in management.*

Dr Abraham Singels, principal agronomist at the South African Sugarcane Research Institute receives the WatSave Innovative Water Management Award from ICID President Peter Lee. Dr Singels received the award for his work on the development and implementation of a system to utilise the potential of sophisticated information and communication technology (crop modelling, mobile phone technology, Internet, automatic weather stations), combined with participatory methods to achieve substantial improvement in water use efficiency and sugarcane yields for the benefit of small-scale growers.

The South African delegation to the ICID conference in Sacramento, in the US.

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