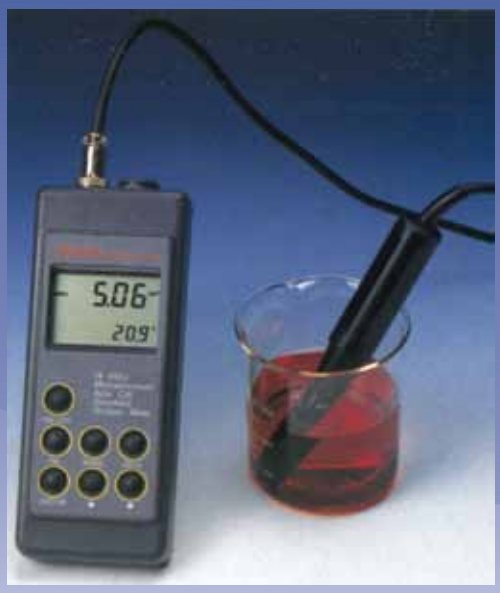
THE WATER WHEEL
ISSN 0258-2244 November/December 2009 Volume 8 No 6

SA's farmers are SAVING WATER

WATER RESEARCH COMMISSION

WATER QUALITY TESTING INSTRUMENTS



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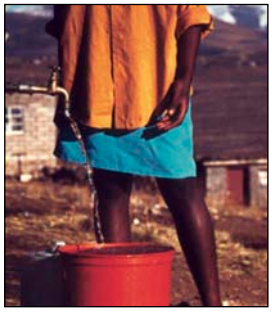

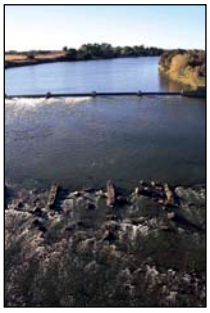

***Cover**: The Vaalharts Water User Association has reduced water losses from 32% to 26,7% as a result of improved management (See page 12).*

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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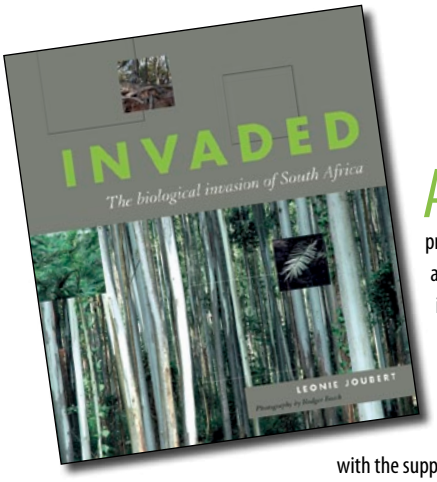


SA's biological invasion captured in new book

A popular science book that provides a readable account of the impact of invasive species on South Africa's plants and animals has been published with the support of the Centre of Excellence for Invasion Biology (CIB) at Stellenbosch University.

Invaded: The Biological Invasion of South Africa is authored by science journalist Leonie Joubert with photographs by Rodger Bosch. The book tells the tale of how species such as pine trees, wattles, the Mediterranean mussel, the Japanese oyster, the triffid weed, Argentine ants and European wasps have traversed the borders of their natural habitat and found their way to South Africa over the past 300 years.

Unhindered by the predators and diseases which once kept their populations in check, many of these species have come to outnumber and outcompete species in South Africa in such a way that they have had a serious impact on local ecosystems, agriculture and the provision of water.

Invaded not only serves as a checklist of species that have invaded the South African environment, but also includes discussions on genetically modified crops, how to contain invasion and the management of transformed landscapes.

"The invasion biology story is not as sexy as climate change or the global economic crisis," says CIB Deputy Director Sarah Davies. "It seldom makes headline news and yet it is one of the greatest threats to our healthy environment. An invasive species is like an oil spill that can never be cleaned up because it is constantly replicating itself. It is a form of biological pollution that is so subtle and insidious that many people do not realise it is there."

Invaded is published by Wits University Press.

Millions budgeted for water supply in Limpopo

Vhembe District Municipality in Limpopo has set aside R700-million to implement water and sanitation projects this financial year.

According to General Manager for Development and Planning, Masala Makumule, projects will be implemented in the four local municipalities of Mutale, Makhado, Thulamela and Musina. "We admit that many of these areas are without tap water, but we are changing the situation for the better."

Part of the R700-million budget has already been used to start connecting water pipes from the Mutale River to serve the Helula, Ha-Mabila and Gwangwatini areas. The Mutale project, worth R14-million, is expected to be completed in January.

Source: BuaNews

Water demand management gets a leg up

The Development Bank of Southern Africa (DBSA) has kick-started the third phase of a regional Water Demand Management (WDM) Programme aimed at ensuring southern Africa makes the best possible use of its available water resources.

The programme, which is being implemented across the Southern Africa Development Community (SADC) region, is funded by the Swedish International Development Cooperation Agency (Sida). The development objective of the programme is to 'entrench a WDM culture in SADC that contributes to its goals of regional integration and poverty alleviation through pro-poor, efficient and sustainable utilisation of water in the region," the DBSA said in a statement.

The Programme intends to build on the two previous phases of the programme, also funded by SIDA, which ran between 1997 and 2004. All activities being undertaken through the programme can be categorised in one or several of three types of services: support, project development, and finance facilitation services.

Support services will assist in promoting a favourable environment in which WDM actions can take place. It is envisaged that the support services will create a well informed demand.

Project development services are largely grant-based. The types of services envisaged here are

LETTERS TO THE EDITOR

Department skills lack requires urgent attention

Thank you for publishing the correction to my contribution to the article on 'Partnerships the lifeboat over troubled waters' published in the September/October 2009 issue of *the Water Wheel*. However, the title to the letter: 'Department skill shortage not a crisis' now projects the opposite view that the skills shortage in the DWA does not constitute a crisis.

While the problem has not yet assumed the paralysing proportions that have long afflicted many local authorities, it is still extremely grave. Having been eroded down to only 40% of the vital engineering posts filled, a steadily widening middle management gap and the life blood of new recruits haemorrhaging out of the organisation due to hopelessly inadequate remuneration packages speaks of a dizzying complacency.

It is already seriously impairing the functioning of a fine department and if not attended to with the utmost urgency will cripple it to the lasting detriment of the entire water sector and our economy that depends so heavily on it.

We are already in this predicament. Each year more of the scarce skills and experience are being lost to retirement and resignation and they are not yet being replaced. It is a bit like watching a train smash approaching in slow motion. Make no mistake, this is a national crisis that needs to be addressed immediately or it will make the crisis within the smaller local authorities pale into insignificance.

Chris Herold, Umfula Wempilo Consulting

Correction to article

In the article 'State of water in South Africa – are we heading for a crisis' the name of Prof Bärbel Haldenwang, Associate Professor at the Institute for Futures Research was mistakenly omitted as the author of the article. *The Water Wheel* apologises for this error.

Editor

numerous. The services include technical assistance, project proposal assistance, capacity building and training.

The Programme will be in a position to assist, where relevant, in obtaining finance (loans from local banks and/or development fund institutions), and providing supplementary funding, loan guarantees and load administration fees if appropriate. It is one of the objectives of the WDM Programme that services move from being grant-based to loan based. The project development and finance facilitation services will be offered in response to a demand for actual implementation of WDM practices.

The strategic approach of the Programme is to use grant-funding to crowd in rather than crowd out market finance. By stipulating that utilities mobilise a portion of the total investment from market the Programme serves as a catalyst for financial market participation in raising funds, even at an early stage of WDM projects. The Programme intends to support several WDM demonstration case studies in the SADC region through a 'package' approach focusing on both broader WDM reforms and individual transactions aimed at building experience and confidence between finance institutions and water utilities.

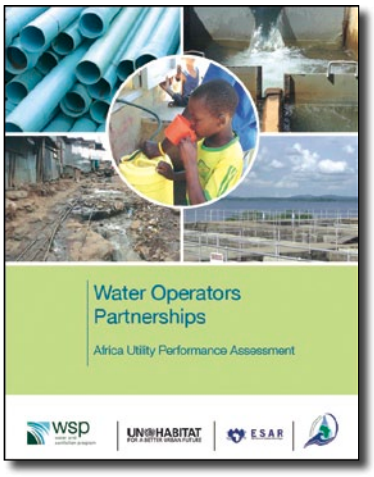
African utilities assess their performance

Learning partnerships among water and sanitation utilities in Africa have the potential to realise improved services for hundreds of thousands of the urban poor, according to a new report released by the Water and Sanitation Programme together with the African Water Association, the Eastern and Southern Branch of the International Water Association and the Global Water Operators Partnership Alliance coordinated by UN Habitat.

The report – *Water Operators Partnerships: Africa Utility Performance Assessment* – synthesises data collected from 134 water utilities from 35 countries in sub-Saharan Africa, including South Africa. It provides examples of utilities that are doing well as well as those which are lagging behind. The data shows that there is a wide variation in utility performance.

"We believe that efficient and financially viable utilities are a prerequisite for provision of services to the urban poor. This report provides an opportunity for utilities in sub-Saharan Africa to help each other through identification of the stronger and the weaker utilities to improve their performance," said WSP Africa Regional Team Leader, Wambui Gichuri.

To download the full report, Visit: www.wsp.org/UserFiles/file/WOP_Report.pdf



A rare find in the pristine waters of the Waterberg

CSIR principal researcher and limnologist, Dr Paul Oberholster, has discovered *Ophrydium versatile* in a tributary of the Lephalale River in the Waterberg. This is the first ever recording of this species of protozoa in an African river.

A subsequent battery of tests on water samples from the river at the CSIR laboratories has confirmed the link between the occurrence of the species and the pristine quality of the water. Oberholster suggests that the distribution of *Ophrydium versatile* can be used as an indicator of possible environmental changes in rivers.

The researcher made his discovery while he was doing research in a riverine in the Waterberg as part of a CSIR study on the ecological status of rivers and wetlands in the Waterberg. "I came across unusual, jelly-like blobs, some as large as 18 cm in diameter, that were attached to a rock layer and for a moment, I thought that they were jellyfish, except that they had no visible tentacles."

Since then, molecular taxonomic identification has confirmed the species as ciliate (protozoan). A ciliate is a single-cell organism that, at some stage of its lifecycle, possesses cilia, short hairlike organelles used to move about and gather food. These protozoans live in colonies that are made up of jelly-like spheres. They are usually permanently attached to a solid substrate such as a rock and they have symbiotic algae inside their cytoplasm, making photosynthesis possible.

"These type of single-cell organisms live close to minimal conditions and they therefore are dependent on optimal water conditions. Our analysis of the water samples taken during our three field trips confirmed that the water was absolutely optimal for their survival," notes Dr Oberholster.

The conditions in which the protozoa was found matched the conditions of lakes in Europe and America where it typically occurs – with low water nutrient content and transparent conditions (low turbidity).

Will *Ophrydium versatile* in the rivers of the Waterberg be there for future generations to marvel at? "We have developed the ecological indicators that reflect the current status of the rivers and the wetland ecosystems. It has been recorded and will be widely communicated to land owners, conservation groups and industrial stakeholders," reports Dr Oberholster.

"My hope is that this time the environment will be taken seriously, that decision-makers will base their plans on the scientific understanding of the specific ecological situation. Our indications to date have given me reason for hope – the hope that the first recorded occurrence of *Ophrydium versatile* in an African river will not also become the last sighting."

New from the WRC

Report No: TT 350/09 and TT 351/09

Guidelines for the Utilisation and Disposal of Wastewater Sludge Vol 4 & 5 (JE Herselman; P Moodley)

The WRC, together with the Department of Water Affairs and other stakeholders developed a series of guidelines to encourage the beneficial use of wastewater sludges. Each guideline volume deals with a specific management option. The last two volumes of the series are now available. Volume 4 deals with the requirements for the beneficial use of sludge at high loading rates, while Volume 5 deals with requirements for thermal sludge management practices and for commercial products containing sludge.

Report No: 1419/1/09

Groundwater Flow Conceptualisation and Storage Determination of the Table Mountain Group (TMG) Aquifers (Y Xu; L Lin and H Jia)

The TMG Aquifer constitutes a major regional aquifer system in South Africa. This project aimed to improve the understanding of the TMG aquifers at both regional and local scales through the classification of hydrogeological units, the analysis of their aquifer properties and the quantification of groundwater recharge, discharge and storage.

Report No: 1567/1/08

Refining Tools for Evaporation Monitoring in Support of Water Resource Management (C Jarmain; CS Everson; MJ Savage; MG Mengistu; AD Clulow; S Walker and MB Gush)

Most techniques for estimating evaporation have been around since the 1940s, but only in the last 20 years has technology enabled them to come into their own as reasonably affordable and practically applicable methodologies. Their full potential has yet to be realised, especially in South African circumstances. Among other, this project looked at classifying and characterising land uses/units of water resource management applications for which evaporation measurement are needed and assessed the accuracy and precision requirements relating to evaporation measurement for various water resource management applications.

Report No: 1732/1/09

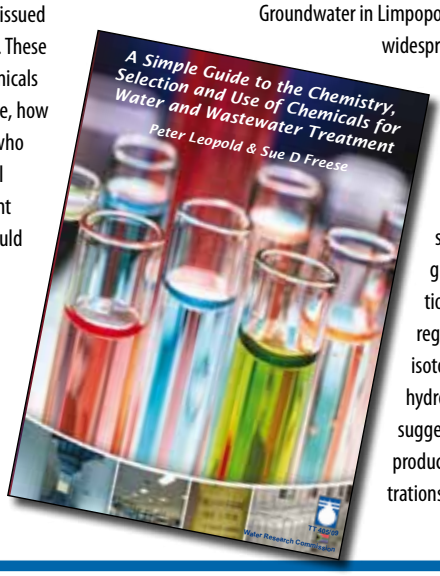
Energy from Wastewater – A Feasibility Study Technical Report (S Burton; B Cohen; S Harrison; S Pather-Elias; W Stafford; R van Hille; H von Blottnitz)

The current view of wastewaters is that they generally represent a burden and necessarily incur energy costs in processing before they can safely be released into the environment. The opportunity exists to improve the current wastewater treatment processes by applying new solutions and technologies that can also reduce energy inputs and/or generate energy for other processes. This study explored the various waste streams and the appropriate technologies that could be used to generate energy.

Report No: TT 405/09

A Simple Guide to the Chemistry, Selection and Use of Chemicals for Water and Wastewater Treatment (P Leopold and SD Freese)

Every year in South Africa an estimated R500-million is spent on chemicals used in the treatment of drinking and waste water. Most of this money is allocated on the basis of tenders issued and contracts awarded. These decisions – which chemicals to use, how much to use, how much should be paid, who is the most professional supplier – are important ones and ones that should be taken while in possession of the most factual and impartial information. This guide aims to provide decision-makers and other users of water treatment chemicals with specific and useful information about water treatment chemicals. It is a chemistry text book aimed specifically at those people who have to make informed decisions but who have not had a formal education in chemistry or whose chemistry education has not been specific in detail relevant to water treatment chemicals.



Report No: 1599/1/09

Guidelines and Training Aids for the Sustainable Operation and Maintenance of Small Water Treatment Plants (CD Swartz; G Mwiinga; M Marler; V Meyer; M Hlophe; R Rajagopaul; K Charles)

The selection and implementation of the correct water treatment system is only a first step in ensuring sustainable supply of potable water to small communities. Of even greater importance for sustainability of supply is the following of the correct operational and maintenance procedures. These guidelines aim to identify the various technical and management issues related to operation and maintenance on small water treatment plants impacting on the quantity and quality of water before distribution; and provide assistance to personnel for the sustainable operation and maintenance of these plants.

Report No: 1328/1/09

A Multi-Traces Study of the Origins, Systematics, and Hydrological Linkages of High Nitrate Concentrations in Groundwater in Bochum District, Limpopo Province (BTh Verhagen; MJ Butler; E van Wyk; S Mutheiwana)

Groundwater in Limpopo is characterised by the widespread occurrence of high nitrate concentrations which were generally accepted to be of anthropogenic origin. In a groundwater resource study in the Taaibosch Karoo graben, part of an International Atomic Energy Agency regional study, environmental isotope, hydrochemical and hydrogeological investigations suggested a model for the natural production of high nitrate concentrations in a basalt aquifer. This was

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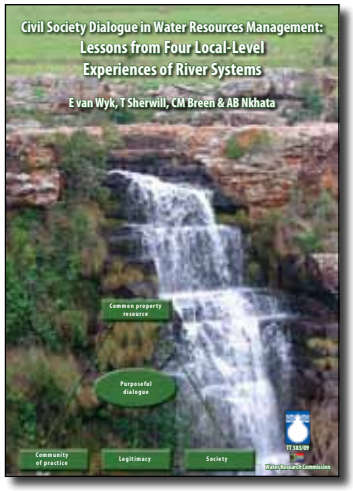
investigated further during this WRC-funded study, which studied the area of Bochum, with numerous rural villages, underlain by metamorphic granite and sandstone. It is concluded from this study that although high nitrate concentrations at Bochum have an anthropogenic component, the natural tree-root driven process may also contribute.



Report No: TT 383/09

Civil Society Dialogue in Water Resources Management: Lessons from Four Local-level Experiences of River Systems (E van Wyk; T Sherwill; CM Breen and AB Nkhata)

Civil society is increasingly expected to participate in and even lead processes that direct behaviours in relation to the sustainable use of natural resources. Within this context, civil society groups and organisations are encouraged to enter into dialogue with others to expose issues constructively and to promote shared understanding and learning. This report proposes a framework that illustrates the role of dialogue in promoting legitimacy of local intent and action through enhanced appreciation of the consequences of actions for river resources and for those in society that depend on river resource services.

Report No: 1614/1/09

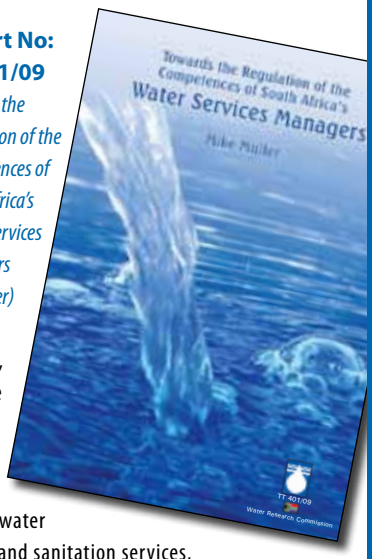
The Development of an Activity Based Costing Model to Quantify the Real Costs of Delivering Water Services in Rural Areas (W Matthews; J de Jager; K van Harmelen; I Wilson and R Duval)

A model has been developed to assist water services authorities to plan for financial sustainability by identifying costs based on activities, including direct and indirect costs accruing from the different levels associated with water services provision.

Report No: KV 218/08

Application of the Department of Water Affairs and Forestry (DWAF) Wetland Delineation Method to Wetland Soils of the Western Cape (N Job)

Identification of wetland presence is important where there is a need to understand how an area functions and its environmental sensitivity, so as to make wise decisions on regulating land use. Accurate identification of the wetland edge is essential when deciding where to commence application of a recommended buffer area adjacent to the wetland, for example for a new building development. This project tested the usefulness and applicability of the DWAF delineation manual to the Western Cape.



Report No: TT 401/09

Towards the Regulation of the Competences of South Africa's Water Services Managers (M Muller)

The efficient, effective and sustainable provision of water supply and sanitation services, essential to public health and social well-being, economic activity and environmental sustainability, requires managers and staff with appropriate competences. South Africa faces a challenge in producing and deploying such competences. This study reviews the challenges and considers measures that could be taken to address them.

WATER DIARY

YOUNG WATER PROFESSIONALS
JANUARY 19-20

The First Regional Conference of Southern African Young Water Professionals will be held at the CSIR International Convention Centre, in Pretoria. The event is being organised under the auspices of WISA and the IWA. *Enquiries: Conference Secretariat; Tel: (012) 667-3681; E-mail: confplan@iafrica.com. Visit: www.wisa.org.za/ywp/YWP2010/*

WETLANDS
FEBRUARY 1-5

An international symposium on Wetlands in a Flood Pulsing Environment will be held in Maun, Botswana. Hosted by the Univ. of Botswana, the symposium is themed 'Effects on Biodiversity, Ecosystem Function and Human Society.' *Enquiries: Lore Mosimi, Conference Secretary, Tel: +267 681-7200; Fax: +267 686-1835; Visit: www.orc.ub.bw/floodpulse/*

WATER BY NUMBERS

- **104** – The estimated number of mines operating without legal water licences, according to Minister of Water & Environmental Affairs Buyelwa Sonjica. In a written response to questions posed in Parliament, the minister said that the majority of these mines were operating in Limpopo and the North West.
- **2-4 ℓ** – The daily drinking water requirement per person.
- **R2 493 million –** The revenue generated by TCTA through the sale of raw water in the past financial year.
- **400 million m³** – The projected capacity of the Dikgatlhong Dam, which is currently under construction in Botswana. The multimillion Rand dam wall will be 48 m high.
- **6** – The number of people who were swept away by floods in South Korea created by an unexpected release of water from the Hwanggang Dam in North Korea. The incident has reportedly sparked a row between the two countries with South Korea accusing its northern neighbour of a 'water attack'.
- **R800-million** – The estimated value of the Komati Water Augmentation Project (KWSAP), set to start in February 2010. The project, situated in Mpumalanga, comprises the construction of a water transfer system and associated infrastructure, to pump additional water to reservoirs at two power stations in the province.
- **1,6-million** – The estimated number of people that do not yet have access to basic water services in Mpumalanga, according to Minister of Water & Environmental Affairs Buyelwa Sonjica. A further 2,6 million in the province still lack access to basic sanitation.
- **2 000 ℓ** – The minimum volume of water required to produce one person's daily food, according to the Food and Agriculture Organisation of the United Nations.
- **145** – The number of nations worldwide who have territory within a transboundary basin.
- **1,4 billion** – The estimated number of people who live in river basins where the use of water exceeds minimum recharge levels, leading to the desiccation of rivers and depletion of groundwater.

Climate change happening 'faster and sooner' – report

The pace and scale of climate change may now be outstripping even the most sobering predictions of the last report of the Intergovernmental Panel on Climate Change (IPCC).

An analysis of the very latest, peer-reviewed science indicates that many predictions at the upper end of the IPCC's forecasts are becoming ever more likely. Meanwhile, the newly emerging science points to some events thought likely to occur in longer-term time horizons, as already happening or set to happen far sooner than had previously been thought.

The *Climate Change Science Compendium 2009*, released earlier this year by the United Nations Environment Programme, point to losses from glaciers, ice-sheets and the polar regions which appear to be happening faster than anticipated. The Greenland ice sheet, for example, has recently seen melting some 60% higher than the previous record of 1998.

"The report is a wake-up call. The time for hesitation is over," says United Nations Secretary-General Ban Ki-moon. "We need the world to realise, once and for all, that the time to act is now and we must work together to address this monumental challenge. This is the moral challenge of our generation."

Among others, the compendium points to perennial drought conditions already being observed in South-eastern Australia and South-western North America. Projections suggest that persistent water scarcity will increase in a number of regions in coming years, including southern and northern Africa, the Mediterranean, much of the Middle East, a broad band in Central Asia and the Indian subcontinent.

To download the full report, go to www.unep.org/compendium2009/.

Historical agreement opens door for world's largest transboundary biosphere reserve

The governments of Croatia and Hungary have signed a joint declaration to a establish a transboundary biosphere reserve along the Mura, Drava and Danube rivers in 2010.

This represents the essential core of a much larger riverine protected area linking Austria, Slovenia, Croatia, Hungary and Serbia. Once established the transboundary protected area will be the world's first biosphere reserve to be commonly shared and managed across five countries.

The agreed reserve between Croatia and Hungary will protect a 500 km section of the Mura, Drava and Danube river system in both countries, connecting over 630 000 ha including highly valuable natural and cultural landscape.

The area is a hot spot of rare natural habitats in Europe such as large floodplain forest, gravel and sand banks and oxbows. It is home to the highest density of breeding pairs of the white-tailed eagles (*Haliaeetus albicilla*) in Europe and hosts endangered species such as little tern (*Sterna albifrons*), black stork (*Ciconia nigra*), otter (*Lutra lutra*) and sturgeons (*Acipenser* sp.) as well as being an important stepping stone for more than 250 000 migratory water fowl every year.

Turkish student, 18-year-old Ceren Burçak Dag won the 2009 Stockholm Junior Water Prize. The young woman won the coveted honour by developing an innovative method for generating energy through piezoelectric pulses from falling rain drops.

Pretty Cape tulips pestering Aussie pastures

CSIRO and the Department of Agriculture and Food Western Australia (DAFWA) are collaborating in an attempt to outwit one of southern Australia's worst agricultural weeds – the Cape tulip.

Cape tulips were introduced to Australia from South Africa in the mid-19th century as garden plants. Since then they have become major pasture weeds in Western Australia, South Australia, Victoria and New South Wales. They are unpalatable and poisonous to livestock.

A one-year study has been initiated to see if it would be feasible to control one and two-leaf Cape tulips (*Moraea flaccid* and *M. miniata*) using the rust fungus *Puccinia moraceae* as a biological control agent. Plant pathologist Dr Louise Morin is testing various rust isolates to see how pathogenic they are on the Cape tulips occurring in Australia as well as testing them on a few key closely-related, non-target plant species.

According to CSIRO Entomology's Dr John Scott Cape tulips appear to be suitable targets for biological control as they are only a few close relatives among Australian native species and no related crops. The local place to look for possible biological control agents for Cape tulips was their home range. Earlier CSIRO surveys in South Africa identified three biological control agents, of which the rust appears the most promising.

This initial study, funded by DAFWA, will yield information on the aggressiveness of the rust on Cape tulips and assist in determining its biological control potential. "It will also provide preliminary information on the susceptibility of non-target plant species to the rust. This is an important step in deciding if the rust should undergo future comprehensive host-specificity testing," noted Dr Scott.

Researchers go underground to reveal 850 new species

An Australian team of researchers have discovered 850 new species of invertebrates, which include various insects, small crustaceans, spiders, and worms, in underground water, caves and micro-caverns amid the harsh conditions of the Australian outback.

The team – led by Prof Andy Austin (University of Adelaide), Dr Steve Cooper (South Australian Museum) and Dr Bill Humphreys (Western Australian Museum) – has concluded a comprehensive four-year survey across arid and semi-arid Australia. "What we have found is that you do not have to go searching in the depths of the ocean to discover new species of invertebrate animals – you just have to look in your own back yard," said Prof Austin. "What we have discovered is a completely new component to Australia's biodiversity. It is a huge discovery and it is only about a fifth of the number of new species we believe exist underground in the Australian outback."

Only half of the species discovered thus far have been named. Generically, the animals found in underground water are known as 'stygofauna' and those from caves and micro-caverns as 'troglofauna'.

Farmers growing and protecting significant amount of world's trees

Agriculture, particularly in the developing world, is often associated with massive deforestation. However, scientists from the World Agroforestry Centre have demonstrated in a new study that almost half of all farmed landscapes worldwide include significant tree cover. The study made use of detailed satellite imagery.

The World Agroforestry Centre is one of 15 centres supported by the Consultative Group on International Agricultural Research (CGIAR). The centre's study is said to be the first to quantify the extent to which trees are a vital part of agricultural production in all regions of the world. It reveals that on more than a billion hectares – which make up 46% of the world's farmlands and are home to more than half a billion people – tree cover exceeds 10%.

"The area revealed in this study is twice the size of the Amazon, and shows that farmers are protecting and planting trees spontaneously," reported Dennis Garrity, the centre's DG. "The problem is that policymakers and planners have been slow to recognise this phenomenon and take advantage. Trees are providing farmers with everything from carbon sequestration, to nuts and fruits, to windbreaks and erosion control, to fuel for heating and timber for housing."

The scientists found that about 10 million km^2 of agricultural land have at least 10% tree cover. That includes 3,2 million km^2 in South America, 1,9 million in sub-Saharan Africa and 1,3 million in Southeast Asia. According to the report, 'trees are an integral part of the agricultural landscape in all regions except North Africa and West Asia.'

Is your showerhead making you sick?

Your showerhead might be making you sick, says US researchers following a recently published study.

The team from the University of Colorado at Boulder found that along with their daily shower, people might be getting a dousing of pathogenic bacteria. Water spurting from showerheads can distributed pathogen-filled droplets that suspend themselves in the air and can easily be inhaled into the deepest part of the lungs.

For the study, researchers used high-tech instruments and laboratory methods to analyse roughly 50 showerheads from nine cities in seven American states. They concluded about 30% of the devices harboured significant levels of *Mycobacterium avium*, a pathogen linked to pulmonary disease.

It is not surprising to find pathogens in municipal waters, said project leader Norman Pace, however, some *M. avium* and related pathogens were found clumped together in slimy 'biofilms' that clung to the inside of showerheads at more than 100 times the 'background' levels of municipal water. "If you are getting a face full of water when you first turn your shower on, that means you are probably getting a particularly high load of *M. avium*, which may not be too healthy."

Symptoms of pulmonary disease can include tiredness, a persistent, dry cough, shortness of breath, and general weakness. Immune-compromised people such as pregnant women, the elderly and those suffering from other diseases, are more prone to experience such symptoms.

So is showering bad for you? "Probably not, if your immune system is not compromised in some way. But it is like anything else – there is a risk involved," said Pace.

Buff tomatoes fed on urine diet

Using human urine as a fertiliser produces bumper crops of tomatoes that are safe to eat, according to scientists.

Surendra Pradhan, an environmental biology researcher at the University of Kuopio, Finland, and colleagues gave potted tomato plants one of three treatments: mineral fertiliser, urine and wood ash, urine only, and no fertiliser. Urine is high in nitrogen, phosphorus and potassium.

Yields for plants fertilised with urine quadrupled and matched those of mineral-fertilised plants. The urine-fertilised tomatoes also contained more protein and were safe for human consumption. The research was published in the August edition of the *Journal of Agricultural and Food Chemistry*. A pilot programme based on the research is to be launched this month.

According to Pradhan, further studies will be done to assess how acceptable the idea of collecting urine is in different cultures. His team will also investigate ways of decontaminating any faecal matter in urine collected from a toilet using a jerry can.

Source: SciDev.Net

Think twice before installing borehole pumps in dams and rivers

The current trend of installing submersible pumps designed for boreholes in either dams or rivers is often perceived as a cost saving, but can have serious financial implications if not done correctly, according to Franklin Electric SA.

It is generally not recommended to use borehole submersible pumps in a river or dam instead of a standard centrifugal pump and motor, but they can be used in certain instances as borehole submersible pumps do not get water damage unlike standard electric motors if flooded. Should a borehole pump be used in either a dam or river, however, several criteria should be considered.

When a borehole pump is used in a borehole, it should pump clean water, stand vertical in the borehole, almost automatically have an immediate pressure against the pump caused from the depth of the borehole, and have a certain velocity of water moving past the motor to ensure cooling of the motor. This does not occur automatically in a dam, reservoir or river. If using a borehole pump in one of these installations, it is necessary to simulate a borehole to prevent the pump or motor from being damaged.

Excessive sand and vegetative matter is often present in ground dams and rivers and although sand is present in some boreholes, it will cause damage. Sand must always be prevented from entering the pump.

A borehole pump is normally installed vertically at a certain depth under the ground, with the water level also at a certain depth under the ground. An additional rise of pressure will occur in order to get the water through the pipe and into the tank or wherever the water is being pumped to. A back pressure (mass of water pushing back on the pump) will almost immediately surge onto the pump which is very important to prevent the motor from going into 'up-thrust' position. Up-thrust is a dangerous condition where the entire rotating assembly of the pump pushes up due to over-pumping and will cause the thrust bearing in the motor to fail.

On start-up, the pump must first fill the pipeline to the sprinklers before there is a back pressure onto the pump. Until the water reaches the sprinkler nozzles and the system is pressurised, the pump will be over-pumping and will be operating in an up-thrust position. Often if the motor is in an up-thrust position long enough, it does not revert to a down-thrust position once the system is under pressure. If this situation is severe enough or continues long enough, the thrust bearing at the bottom of the motor will fail causing the shaft height to drop, which will also cause the pump shaft to drop. The damage will be mainly to the motor, but can also damage the pump.

To prevent this, the pump should immediately be throttled on start-up either with a valve or preferably with an orifice plate, an obstruction that is installed in the pipeline that immediately restricts the flow of water in the pipeline at start-up ensuring immediate back pressure onto the pump. The orifice plate must be calculated by a qualified person and installed close to the pump discharge. A submersible pump does not need to be vertical if the support of the pump as well as the back pressure onto the pump is properly calculated.

A centrifugal pump, or impeller-type pump (including borehole submersibles), should be started against an almost closed valve, immediately thereafter opening the discharge valve slowly allowing the water to start flowing evenly without shocks to the system.

Even when used vertically in a borehole, it is necessary to have water flowing over the motor to ensure that it is cooled adequately. This can be achieved if the walls of the borehole are close to the motor; alternatively a flow inducer sleeve is installed over the pump and motor to force the water to flow over the motor en-route to the pump.

The standard motor protection, such as an overload on the starter or even the Blac Box motor protection system do not necessarily eliminate these problems, although they will greatly assist if the motor starts showing signs of stress. However, at the point where they do trip the motor, the damage would have already occurred.

It is imperative to simulate a borehole to evaluate the motor bearings as well as the motor cooling which is not always known by the end user or the installer. In addition, sand or organic matter must be prevented from entering the pump which can cause damage or blockages.

Beer making guzzling hundreds of litres of water

How much water is contained in one beer? According to a new report quite a lot actually. Every litre of beer enjoyed by thirsty South Africans takes about 155 ℓ to make, according to a report published by SABMiller in association with WWF. More than 98% of the water used is associated with crop cultivation, both local and imported.

The report, *Water footprinting: Identifying and addressing water risks in the value chain*, evaluated the water footprints – a way of understanding water use through the whole value chain – of the major brewer's beers produced in South Africa and the Czech Republic. This is reportedly the first ever corporate water footprint study to be undertaken. The report shows that SABMiller's South African beer brands, such as Castle and Black Label, require more water than their Czech counterparts, mainly due to a greater reliance on irrigation in South Africa and the proportion and origin of imported crops.

In comparison with other beverages, beer's water footprint is relatively small, with a recent Pacific Institute study finding that coffee, wine and apple juice all have water footprints more than three times that of beer. However, the water footprint itself does not give the whole picture. More important is the context – where the water is used, what proportion of the area's total water resource it represents, and whether water scarcity creates risks to the environment, communities and businesses now or in the future.

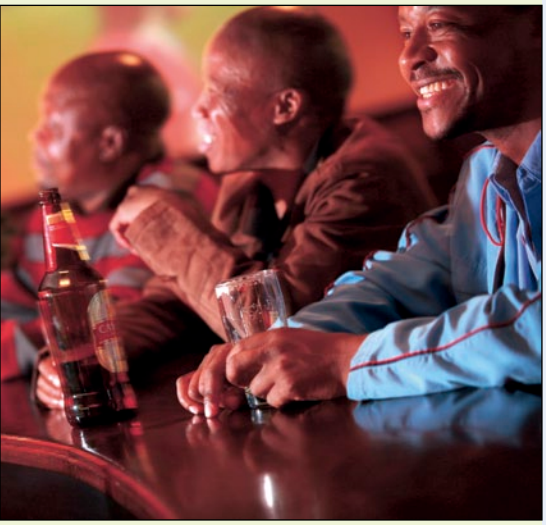
"The water footprints of SABMiller's beers in South Africa and the Czech Republic are the first detailed corporate water footprints to be published

WATER DIARY (continued)

WATER TREATMENT
FEBRUARY 8-11
The University of Stellenbosch is hosting a short course on Water and Wastewater Treatment in Cape Town. *Enquiries: Elmien Lovell; Tel: (021) 808-4352; E-mail: elmienl@sun.ac.za*

WATER & SANITATION
MARCH 15-18
The International African Water and Sanitation Congress and Exhibition will take place in Kampala, Uganda. The event is organised by the African Water Association and the National Water and Sewerage Corporation of Uganda. *E-mail: info@afwa-hq.org or afwacongress2010@nwsc.co.ug*

WATER & SANITATION
APRIL 18-22
The WISA Biennial 2010 conference is taking place at the International Conference Centre in Durban. *Visit: www.wisa2010.org.za*



and are progressive in the way they examine the impact of water use within these countries," reported Stuart Orr, WWF's freshwater footprint manager. "Most important is that this information is now used to ensure that their business partners – particularly farmers – are encouraged to use water more efficiently."

In South Africa, SAB Ltd is working with barley farmers to improve irrigation and yields, and with WWF the company is now considering how to develop this further to protect the watersheds within which it operates.

Impact study shows WRC's commitment to groundwater

The Water Research Commission (WRC) has been the most significant contributor to research and capacity building in the South African groundwater sector over the past decades, a recent study has found.

The WRC launched the impact study last year to evaluate the impression of its commitment to the groundwater sector.

According to Eberhard Braune, Extraordinary Professor at the University of the Western Cape, the WRC has invested steadily in the groundwater sector for over 35 years, with groundwater research projects making up an average 9% of the Commission's research budget every year. In 2008, R7,4-million was spent on groundwater projects.

"The impact of this research investment is significant in terms of the knowledge created and transferred as well as the institutional capacity building for groundwater research and education," he says. The Commission's inputs also directly influenced the establishment of the country's main academic centres for groundwater, such as the Institute for Groundwater Studies at the University of the Free State.

Prof Braune reports that the groundwater sector has experienced a serious decline in capacity, particularly in government and academic circles in the last few years. "It is imperative that the WRC's investment into research and capacity building continues and is made even more effective and efficient."

The study will be published early next year.

Main beneficiaries of WRC research funding 1974-2008

	No of institutions	No of projects	Value of projects
Academic institutions	10	67	R40-m
Science Councils	3	60	R21-m
Consultants	19	59	R29-m

Crunching the numbers to reduce industrial effluent

The University of Pretoria, under the leadership of Prof Thokozani Majozi, is undertaking a new project aimed at reducing wastewater produced during the pharmaceutical manufacturing process.

Currently, the pharmaceutical industry dispenses more than 500 t of product a year as effluent. This translates to more than R7-million in lost revenue. The new project, funded by the Water Research Commission (WRC), aims to develop a zero-effluent optimisation method for multipurpose batch plants and develop a tool that can be used by the pharmaceutical and related industries, regulators and the Department of Water Affairs in assessing and improving the efficiency and environmental performance of batch plants.

In a previous WRC project Dr Majozi, twice recipient of the National Research Foundation President's Award, and his team successfully completed a process integration framework for wastewater minimisation in multipurpose batch plants using a rigorous mathematical optimisation framework. The results of this development were tested successfully in a multinational pharmaceutical facility in East London where freshwater and effluent savings of more than 20% have already been realised. Investigations are currently underway to reduce freshwater intake and effluent generated by the facility by another 10%.

The overall cost savings, derived mainly from reduced effluent discharge costs is estimated to be around R500 000 a year. "In addition to this benefit the developed mathematical techniques promise to streamline the facility's production scheduling activities, since they take time dependence of operations into account," explains Dr Majozi.

He is confident that a mathematical technique can be derived that could lead to almost zero-effluent operation.

Water savings: Persistence pays off at Vaalharts

Lani van Vuuren

With dedication, commitment and assistance from the Water Research Commission (WRC)'s Water Administration System (WAS), farmers at Vaalharts are proving that commercial irrigators can save water while feeding the nation. Lani van Vuuren visited the scheme.

Productive water usage in irrigated agriculture remains a critical issue. While irrigation accounts for 25% to 90% (depending on the crop) of agricultural production in South Africa, it uses about 60% of the country's surface water. It is well known, however, that relatively large volumes of water are required to produce raw material for beneficiation in the food value chain. With competition for water growing from other users such as industry and mining, farmers are under increased pressure to improve water-use efficiency while still contributing to the country's food market demands.

Water for agriculture is transported over long distances by means of rivers, canals, on-farm furrows and irrigation fields. On average, around 30% to 40% of water supplied to irrigation farms is lost in conveyance structures due to evaporation, spillage, leakage and incorrect water management with river and canal distribution. Older systems can record periodic losses of up to 70%. This means that, in most cases, significant water savings through better water loss control are possible.

VAALHARTS WATER

Situated at the confluence of the Harts and Vaal rivers on the border between North West and the Northern Cape, Vaalharts irrigation scheme was established by the government during the Great Depression years of the 1930s to curb poverty and unemployment, and remains the largest in the country. The Vaalharts Water Association (Vaalharts Water) took over the water management of the government water scheme in 2003.

Water for this scheme is sourced from the Vaalharts Weir which, in turn, is fed by water from the Bloemhof Dam on the Vaal River. Over 90% of the water supplied by Vaalharts Water is for agricultural use, with a small percentage being supplied to towns in the area.

From the weir the water is diverted into two main canals which divide into smaller canals to bring water to consumers. Apart from Vaalharts, the water user

Lani van Vuuren

Constructed in the 1930s, the Vaalharts Weir has a capacity of 48,7 million m^3 and supplies the entire constituency of the Vaalharts Water User Association.

Wheat and barley are some of the main crops under irrigation at Vaalharts.

association also serves three other areas, each with its own water quota, namely Barkly West; Spitskop and Taung. There are about 1 873 abstraction points in the system.

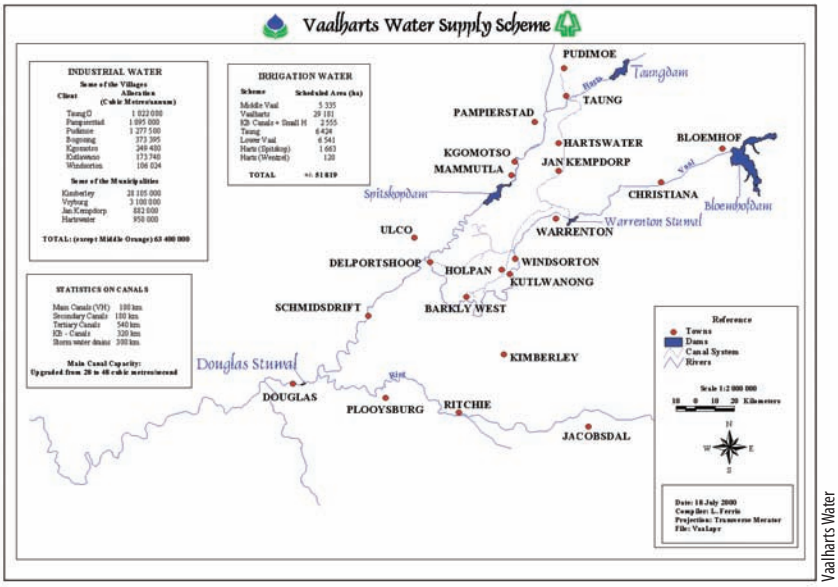
The largest served area is Vaalharts itself, which has a scheduled area of 29 181 ha. A total of 1 120 km of main canal, feeder, community and drainage canals criss-cross this area, delivering water to hundreds of commercial and emerging farmers according to a set allocation. Farmers grow mostly cash crops, including groundnuts, wheat and lucerne. A small number of farmers also grow pecan nuts, citrus and grapes for wine production. All major forms of irrigation are used, including flood irrigation, sprinkler and micro irrigation.

Like many irrigation schemes in South Africa, Vaalharts works on the demand system, i.e. farmers only receive water once they order it. Farmers order water from Vaalharts Water through a 'segman' (spokesperson). This system is quite unique in South Africa. There are 240 such 'segsmanne' or spokespeople at Vaalharts.

THE WAS PROGRAM

WAS is a uniquely South African water administration system aimed at increasing the productivity of water use in irrigated agriculture. Developed by Dr Nico Benadé with funding mainly from the WRC, WAS essentially provides irrigation schemes with decision support for effective and efficient water management. The program assists water user associations to manage their water accounts as well as their water supply to clients through rivers, canal networks and pipelines.

WAS makes use of seven modules: the administration, water order, measured data, water release, crop water use, accounts and report modules. These



Vaalharts Water

The Vaalharts Water management area.

Dam 6 which feeds the Taung Irrigation Scheme, served by Vaalharts Water. The water user association stocked the dam with grass carp to control aquatic weeds.

Lani van Vuuren

modules are fully integrated, making it possible to cross-reference relevant data and information. The system can be installed on a single computer or on a server for use over a network.

Among its many capabilities, the program is able to calculate water releases into rivers and canal networks, taking lag times and various water losses into account. Monthly invoices are generated automatically from water usage and scheduled area information captured in the database. WAS also promotes efficient water use at farm level by enabling water supply of the required volume at the requested time.

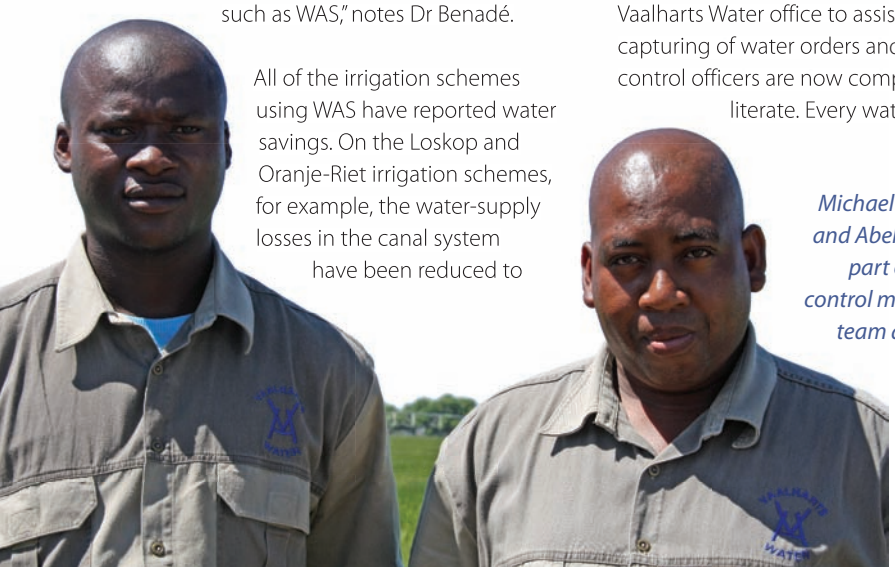
The program is currently being used by all major irrigation schemes on a total of 143 000 ha. This includes 9 500 abstraction points, with a total water allocation of 1 163 million m^3. "Effective water loss control can only be achieved through a comprehensive management system such as WAS," notes Dr Benadé.

All of the irrigation schemes using WAS have reported water savings. On the Loskop and Oranje-Riet irrigation schemes, for example, the water-supply losses in the canal system have been reduced to 20% per year and lower over a number of years. In general, water losses of 20% and below are considered extremely good for irrigation schemes. In 2006, Dr Benadé received the WatSave Innovative Water Management Award from the International Commission on Irrigation and Drainage for his development and continued implementation of the WAS.

FROM MANUAL TO DIGITAL

According to Vaalharts Water Head Water Control Officer Kobus Harbron, water management was mainly a manual business prior to the installation of WAS. "All water orders, balances etc. were captured and calculated manually. This was a laborious, time-consuming process, leaving much room for human error."

The WAS program is now used extensively for water distribution management and reporting purposes. Eight computers have been installed at the Vaalharts Water office to assist in the capturing of water orders and all water control officers are now computer literate. Every water control officer comes into the water office once a week to capture their own water orders, which are used for the release calculation.



Michael Mathathau and Abel Sehako are part of the water control management team at Vaalharts Water.

Lani van Vuuren

Paper work has been minimised and all reports are now generated electronically. This has greatly reduced water shortages on the canals as a result of human error. Not only has WAS enabled the water user association to keep all their water usage information up to date and accurate, it has also freed up personnel. Rather than capturing data their time is now spent out in the field inspecting and maintaining canal infrastructure and liaising with clients.

For effective water monitoring a number of OTT-type chart recorders are in use at Vaalharts Water. Eleven canal tail ends are monitored with chart recorders and almost all of the feeder canals have chart recorders installed at the inflow.

Digitising capabilities were specifically integrated into the WAS program for Vaalharts Water allowing charts from the OTT recorders to be digitised into the WAS database in a fraction of the time it used to take. This also reduces the chances of mistakes. "We have also installed an electronic measuring station at the start of the main canal to import water release data into the WAS database," reports Harbron.

All of these efforts have reduced water losses from 32% to 26,7%. "Vaalharts is a prime example of what can be achieved with dedication and a system such as WAS," notes Dr Benadé. This was one of the contributing factors for Vaalharts Water receiving the First Runner-up Water Conservation and Water Demand Management Sector Award in Agriculture from the Department of Water Affairs (DWA) in 2008.

Harbron praises his team for their dedication and hard work in reducing water loss and improving water management at Vaalharts. "Having an excellent system such as WAS is one thing, but without disciplined and passionate people

Lani van Vuuren

Vaalharts Water Head Water Control Officer Kobus Harbron.

nothing can be achieved. We have been receiving many compliments from farmers in the area for the manner in which we are managing our water. This makes us even more determined to bring about further water loss reductions."

Now that management aspects have improved Harbron hopes to achieve further water savings by improvements to operational aspects. Infrastructure maintenance especially is a huge challenge. With most of the infrastructure older than 60 years, leaking and crumbling canals is a huge issue. The water user association spends millions of Rand every year in an effort to keep its infrastructure from falling apart. A massive capital injection is required to rehabilitate the irrigation scheme and calls have gone out to government in this regard.

SAVINGS ACROSS THE SECTOR

There is now a drive to extend WAS to all of South Africa's irrigation schemes. "We believe that with the application of WAS on all irrigation schemes, the water savings for commercial farming can over time increase significantly," says Dr Benadé. "This saving can be achieved with training to improve water management and investment in water measuring installations over a relatively short period, compared to the lead time for investment in additional storage to increase supply."

Dr Gerhard Backeberg, Director: Water Utilisation in Agriculture at the WRC comments: Over the last 15 years implementation of WAS on irrigation schemes has practically proven that real water savings through water loss control are achievable. The higher these losses, the bigger the opportunities are for savings. These savings ensure that existing water use entitlements can be complied with and additional allocations can be made to provide for ecological balances (as part of the Reserve) and alternative uses within or outside of agriculture."

In the case of the Vaalharts irrigation scheme, for example, 11 580,4 m^3 per hectare instead of 12 064,8 m^3 per hectare now has to be released at the weir, to deliver the allocation of 9 140 m^3 per hectare at the farm edge. This is a saving of 14,135 million m^3 a year for the whole irrigation scheme.

"This water remains in the Vaal River for the ecology or alternative downstream uses," notes Dr Backeberg. "Similar or higher savings are achievable if implementation of WAS is expanded from the current 143 000 ha to the estimated 500 000 ha of irrigation schemes in South Africa. This can be done with support of water managers in water user associations and public servants in the regional and head offices of the DWA."

VAALHARTS WATER USER ASSOCIATION MANAGES FOUR SECTIONS:

Vaalharts
Scheduled area: 29 181 ha
Allocation: 9 140 m^3/ha/year
Main canal length: 100 km
Feeder canal length: 180 km
Community canals: 540 km
Drainage canals: 300 km
Max flow capacity: 38,3 m^3/s

Klipdam/Barkley West Canals
Scheduled area: 2 396,7 ha
Allocation: 11 855 m^3/ha/a (mainly for grazing)
Canal length: 320 km

Hartrivier/Spitskop Dam
Scheduled area: 1 663 ha
Allocation: 7 700 m^3/ha/year
River length under dam: 55 km
Max flow capacity: 5 m^3/s

Taung scheme
Scheduled area: 6 424 ha (only 3 759 ha currently irrigated)
Allocation: 8 470 m^3/ha/year
Max flow capacity: 18 000 m^3/hour

Lani van Vuuren

More than 300 km of drainage canals transports water from agricultural fields back to the Harts River.

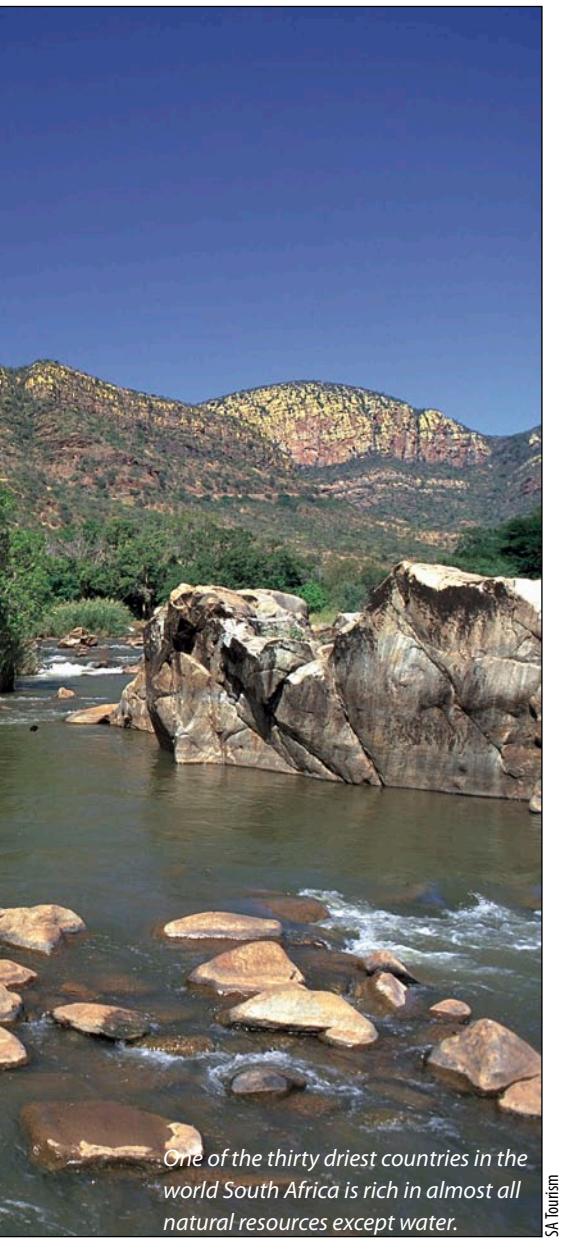
Water Resources: South Africans Must Start Saving EVERY DROP

South Africa's latest national water resources assessment has sounded warning bells over the way we allocate and use water. Lani van Vuuren takes a peek at the Water Resources 2005 study (WR2005) published by the Water Research Commission (WRC) earlier this year.

South Africa has a rainfall that fluctuates widely (both in space and time), comprising only 55% of the global average. Added to this the country's evaporation rates are far higher than the amount of rainfall. On average less than 9% of precipitation eventually reaches river systems.

All of this makes South Africa one of the 30 driest countries in the world. But just how dry is the country and exactly how much water resources do we have? Specialists have been trying to answer this question since the late 1950s through a series of water resources studies. The objective of these studies (five in total) has been to assist decision makers at all levels of government to make informed choices about all policies concerning South Africa's water resources.

"Demand for water and competition between different users is increasing all the time. We need to know exactly how big is the cake available to share between domestic, industrial, agriculture and other users, which is exactly what these studies aim to determine," explains WRC Research Manager Wandile



One of the thirty driest countries in the world South Africa is rich in almost all natural resources except water.

SA Tourism

Nomquphu. "As technologies and methodologies improve so this knowledge improves over time."

The WR2005 study comes 15 years after the previous study was undertaken. Since that time there have been numerous changes in the South African water sector, most notably in national legislation. The National Water Act, promulgated in 1998, places a different emphasis on how water is (and will be governed) and therefore allocated. Priority and legislative protection is placed on basic human needs, ecological as well as international water requirements (in the case of river and groundwater systems shared with other countries).

There have also been huge improvements in technologies and methodologies – especially considering advances in computing technology. In addition, significant recent findings have been made as a result of improved research on land-use modelling techniques, improved estimates of water use by different water sectors and the development of water-use estimates for water uses such as alien vegetation and other streamflow reduction activities.

RESOURCE SMALLER THAN WE THOUGHT

Estimates of South Africa's national water resources have been declining with each of the studies undertaken since 1952. The latest calculation of naturalised mean annual runoff for the country has been calculated at 49 210 million m^3/year – 4% less than the figure of the 1990 study. "This means that any development based on earlier estimates will over-estimate the size of the development which can be accommodated," explains Project Director Brian Middleton of SRK Consulting. "While the project did not look at water quality in detail it is becoming apparent that water quality is an ever-increasing problem."

"It is becoming apparent that water quality is an ever-increasing problem."

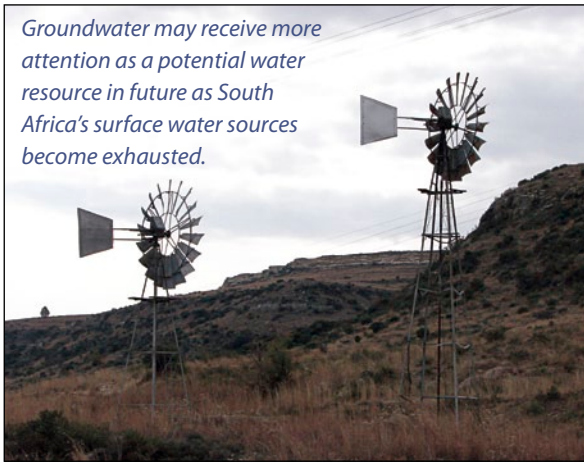
The level of confidence in the results of a complex hydrological or environmental study is an important component of scientific research. According to Nomquphu, the WRC is confident in the results obtained by the study. "With every subsequent study there is more precision and accuracy in the results."

The uncertainty stems from unequal time periods for measurements (e.g. some monitoring points have long uninterrupted measurements while others have short time records), limited precision and accuracy of measurements, to name but a few. The sources of these uncertainties were identified in the previous water resource studies allowing the project team to reduce the degree of error in measurements and observations as well as in methods of data analysis, estimation and modelling in WR2005.

CRUNCHING THE NUMBERS

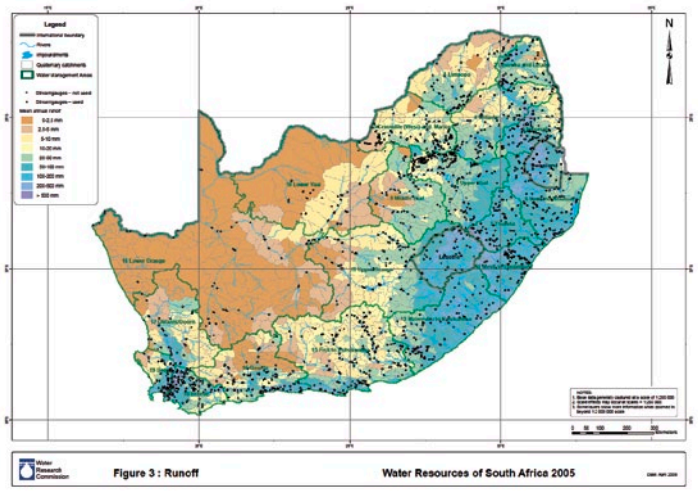
Over 40 people from seven companies worked together over four years to complete the latest water resources study. While previous studies focused almost exclusively on surface water quantities, WR2005, which covered South Africa, Swaziland and Lesotho, includes surface water, groundwater and water quality components. To enable this achievement – a first for South Africa, required a multidisciplinary project team including hydrologists, hydrogeologists, GIS practitioners, civil and water engineers, water quality specialists, computer programmers and scientists, reports Middleton.

Updated data on rainfall, evaporation, streamflow, water use, land use, return flow, releases, and new impoundments, among others, were used to create the latest picture of the state of South Africa's water resources. Various models were used, including the rainfall-runoff model WRSM2000, which was used to perform calibration and

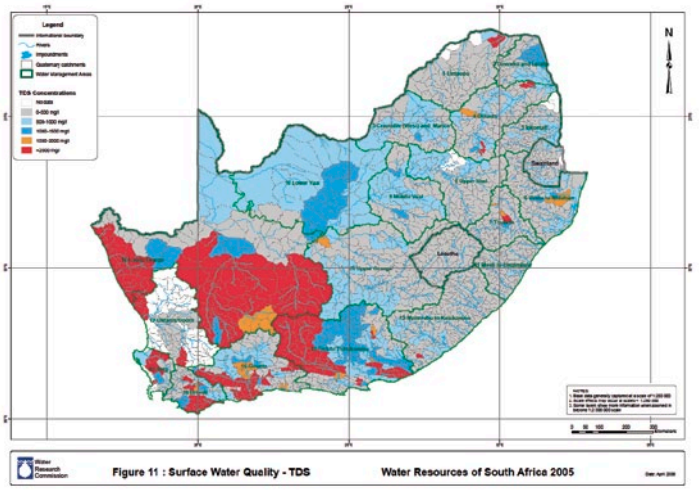


Groundwater may receive more attention as a potential water resource in future as South Africa's surface water sources become exhausted.

Lani van Vuuren



Map 1: Mean Annual Runoff across South Africa



Map 2: Surface water quality across South Africa

Table: Comparison of Naturalised MAR between WR90 and WR2005 studies

Water Management Area	Mean Annual Runoff (MAR) (million m³/a)		
	WR90	WR2005	% change
Limpopo	986.30	931.12	-6
Luvuvhu and Letaba	1 235.20	1 304.02	6
Crocodile West and Marico	748.00	703.49	-6
Olifants	1 990.10	1 919.73	-4
Inkomati	3 361.20	3 088.60	-8
Usutu to Mhlatuze (inc. Swaziland)	6 721.10	6 421.10	-4
Thukela	3 993.90	3 881.72	-3
Upper Vaal	2 580.80	2 452.89	-5
Middle Vaal	1 121.20	912.72	-24
Lower Vaal	235.60	200.85	-15
Mvoti to Umzimkulu	4 928.90	4 922.42	0
Mzimvubu to Keiskama	7 218.90	7 012.20	-3
Upper Orange (incl. Lesotho)	6 945.20	6 756.20	-3
Lower Orange	403.60	274.40	-32
Fish to Tsitsikama	2 152.00	2 183.92	1
Gouritz	1 632.60	1 539.70	-6
Olifants/Doring	1 063.20	1 073.50	1
Breede	2 473.60	2 482.50	0
Berg	1 329.90	1 149.10	-14
Total	**51 121.30**	**49 210.32**	**-4**

Source: WR2005

naturalisation runs as well as the Department of Water Affairs' rainfall database WRIMS to update and patch rainfall data.

"We also used updated GIS tools to produce the maps and information," reports Allan Bailey of SSI Consulting and part of the project team. We had new computer programs written, for example, the water quality analysis tool. We also introduced a user-friendly menu system for accessing computer models, the database, GIS maps, spreadsheets etc."

HOLISTIC VIEW

An important aspect of WR2005 is the inclusion of groundwater data. At present, over 70% of South Africa's water needs are drawn from surface water resources (mostly through dams). With only about 20% of available groundwater resources being used at present, mostly by rural towns and villages, groundwater is considered a huge potential resource.

"Groundwater may well prove to be a strategic resource in the country's efforts to extend basic access to water to all communities."

"The major benefit of including groundwater in the study is that users take cognisance of both surface and groundwater in a holistic way," explains Middleton. "Both are part of the same resource, and components of the hydrological cycle, but previously have been studied separately, usually by different technical disciplines. Integration of both components is vital for the water resource planning for the country."

While the study suggests that there is about 10 000 million m³ of groundwater in South Africa, Nomquphu calls for a cautionary approach. "Groundwater may well prove to be a strategic resource

in the country's efforts to extend basic access to water to all communities, however much research needs to still go into quantifying this resource."

IDENTIFYING DATA GAPS

The study was not without its challenges. The basic data was not always easily accessible, and in some cases information was not available. The integration of groundwater into the rainfall-runoff model also proved problematic, as this was the first time that this integration had been attempted.

Most concerning, however, has been the reduction in the number of data sources, e.g. there are now less usable rainfall stations than there were in the 1990s when the previous study was conducted. "This is a huge concern because spatially representative, long-term consistent records of data are essential for achieving a high level of understanding about water resources," notes Nomquphu. It has been recommended that a national task team be formed to tackle the issue.

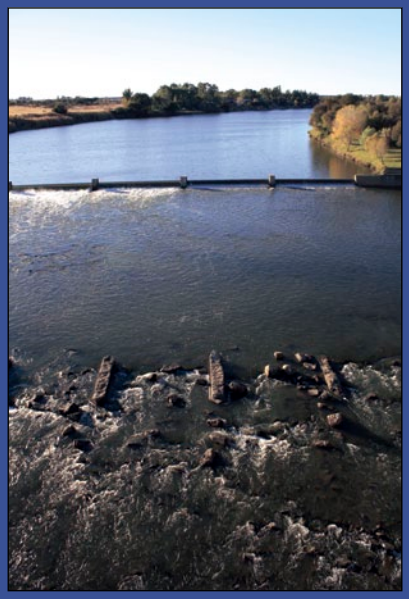
NATIONAL PICTURE

WR2005 brings together, in a library of documents, information about the whole country at the same time at a similar level of detail. "This is of major benefit to planners who are able to get a total picture of the resources," says Middleton.

"Going into the future our biggest strategic challenge is ensuring adequate quantity and quality of water to meet human and ecological needs in the face of competing demands and variable water supply," reports Nomquphu. It is hoped that WR2005 will go a long way to achieving just that.

To obtain the ***Water Resources of South Africa, 2005 Study*** and/or associated products contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565 or E-mail: orders@wrc.org.za

WATER USERS MUST SAVE OR PAY THE PRICE



South Africa's water users need to seriously reconsider the way in which they use water if the country is to stave off imminent shortages.

This is according to Johan van Rooyen, Director: National Water Resource Planning at the Department of Water Affairs (DWA).

Speaking at the International Mine Water Conference held in Pretoria earlier this year, Van Rooyen said all water users would face strict water restrictions and hiked water tariffs if they did not implement water use efficiency measures as a matter of urgency. "It is not only the department's responsibility to look after South Africa's water resources. Water is going to become very expensive in this country and we will all have to use it very wisely."

Historically, the focus has been on developing bulk water infrastructure, such as large dams and inter-basin transfer schemes. However, with almost all readily available water already put to use, the focus has now shifted to careful management and optimisation of existing use.

Water conservation and water demand management is one measure being increasingly considered by the DWA. According to Van Rooyen, water demand would have to be reduced immediately by up to 30% in South Africa's most water-scarce catchments.

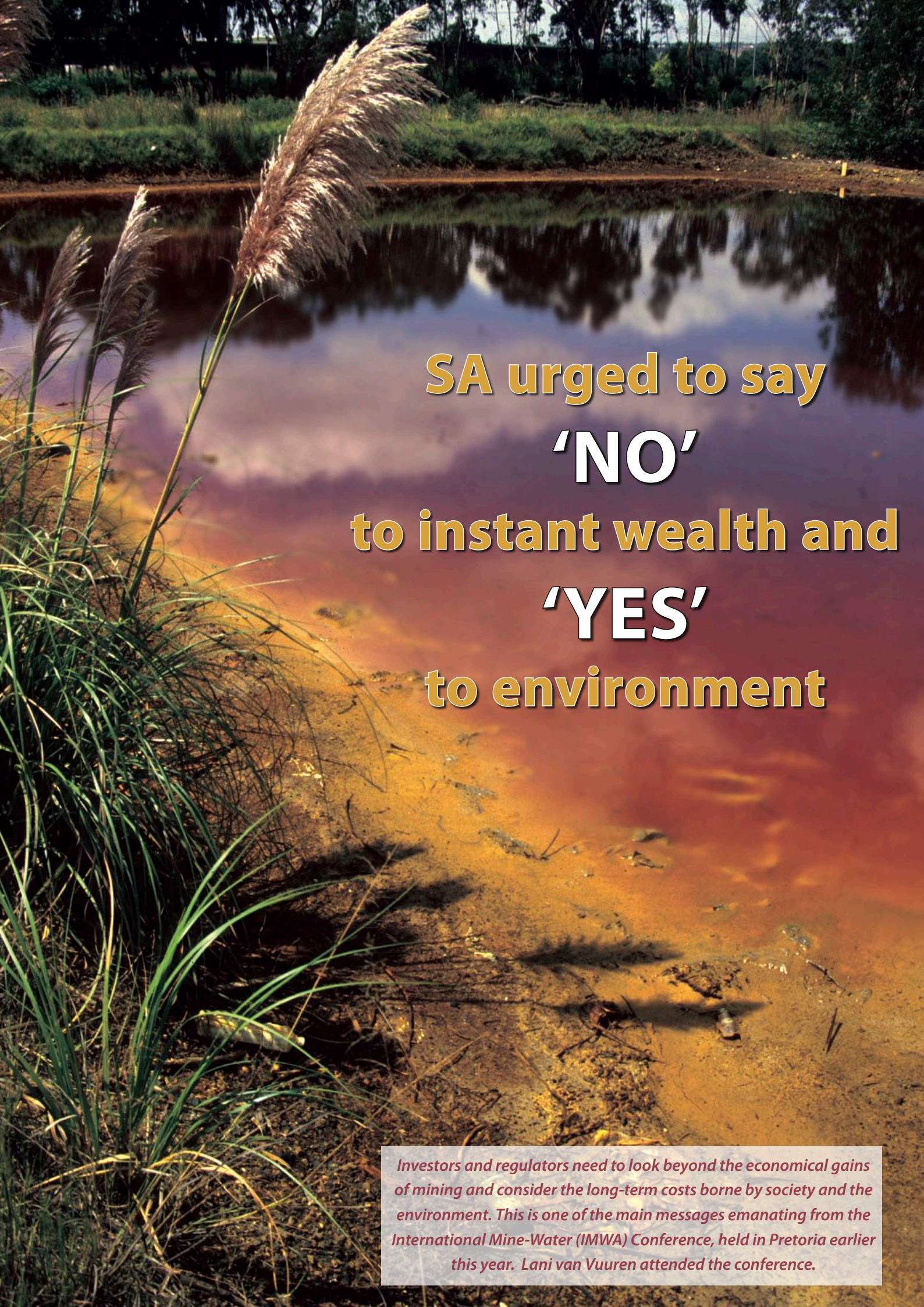
The re-use of water has been identified as another major potential source of water. "Return flows to the Vaal River from the upstream Gauteng metropolitan areas, for example, are increasing to the extent that, with downstream use quite stable, these flows will soon exceed uptake, and thus be in surplus." A portion of these return flows have already been identified as the best resource for the new power stations and a possible coal-to-liquid fuel plant on the Waterberg coalfield near Lephalale in Limpopo.

Groundwater resources are increasing in importance, not only as a potential source of water for rural villages, but also larger cities such as Cape Town and Port Elizabeth. In coastal areas, such as Cape Town and Durban studies were already underway into the possibility of desalination.

"South Africa's golden era of dam building is over. The reliance on ever further exploitation of surface water will have to be replaced with a respect and acceptance of all resources," said Van Rooyen.

Irrigation is the largest water user in South Africa.

Lani van Vuuren



SA urged to say ‘NO’ to instant wealth and ‘YES’ to environment

Investors and regulators need to look beyond the economical gains of mining and consider the long-term costs borne by society and the environment. This is one of the main messages emanating from the International Mine-Water (IMWA) Conference, held in Pretoria earlier this year. Lani van Vuuren attended the conference.

South Africa's economy has benefited greatly from the country's vast mineral and metal resources. More than hundred years of mining have lined government coffers and made many mining houses and their shareholders rich beyond their dreams. However, the environmental costs are only now beginning to emerge.

Large mining operations are present in several of South Africa's nationally important water management areas, including the Vaal, Olifants, Crocodile and Mhlatuze. Some mining operations are even located at the vulnerable headwaters of these catchments with far-reaching consequences.

Many earlier mines now lie defunct and abandoned on the South African landscape. The lack of historical consciousness over the environmental impact of mining has resulted in few of these sites having been rehabilitated, leaving cavernous voids festering with poisonous water. This water, known as acid mine drainage (AMD), is teeming with heavy metals, salts and other toxins, bringing death, rather than life, everywhere it flows.

LEGACY OF THE PAST

When mining started over a century ago, water was approached as something to be avoided in mining operations. Authorities often turned a blind eye to pollution by mines, and there was little legislation compelling mines to clean up.

In later decades, water was considered in mine planning, but the full impact of water on mining – and the long-lasting effect of mines on water and the environment – was neither fully recognised nor appreciated. Today, legislation and policies have changed, but many areas are now suffering due to South Africa's mining legacy.

One such area is the Highveld Coalfields, in Mpumalanga, which contain about 50% of South Africa's recoverable coal reserves. Coal mining started in the Witbank area in 1895, spreading out gradually as demand for coal was fuelled by the export market and the need in South Africa to produce more electricity. Three different methods have been used to extract the coal, namely bord and pillar mining, longwall mining and, more recently, opencast mining.

"Post-closure decant from the defunct coal mines has been estimated at 62 Mℓ/day, with about 50 Mℓ/day of AMD draining into the Upper Olifants River Catchment."

Through the decades some deposits have been worked out and many mines have closed, leaving behind numerous environmental problems, the most significant being that of AMD. In their paper presented at the IMWA conference Prof Terence McCarthy of the School of Geosciences at the Witwatersrand University and Dr Koos Pretorius of the Federation for a Sustainable Environment explained that AMD is the result of the generation of sulphuric acid due to a chemical reaction between an iron sulphide mineral (pyrite) present in the coal and its host rocks and oxygen-bearing water.

"Mining breaks up the rock mass allowing free access of water and the acid-producing chemical reactions proceed faster than the acid can be neutralised. Consequently, the water becomes acidic and toxic to animal and most plant life. The acid water dissolves aluminium and heavy metals, such as iron and manganese, increasing its toxicity."

Today, about 522 million m^3 of water is stored in the Highveld Coalfields (compared to the combined storage capacity of the Witbank, Middelburg and Loskop dams of 514 million m^3). Post-closure decant from the defunct coal mines has been estimated at 62 Mℓ/day, with about 50 Mℓ/day of AMD draining into the Upper Olifants River Catchment. This water eventually flows through the Kruger National Park and ends up in Mozambique.

Coal mining has also disturbed the aquifer structure of the Highveld, explained Prof McCarthy and Dr Pretorius. "Opencast mining completely destroys the groundwater aquifer and creates a single, massive aquifer in the mine void. After mine closure, water fills this aquifer to the lowest elevation of the bedrock rim, and additional water entering the void decants over the rim. This water is of extremely low quality. "

As a result of long-term mining operations, water quality in Witbank and Middelburg dams have, over the past 30 years, shown a steady increase in total dissolved solids (TDS) and sulphate. "Bearing in mind that prior to mining the rivers concerned probably contained about 50 parts per million TDS, mining

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There are about 400 km^2 uranium-bearing gold-mine tailings on the Witwatersrand.

***Left**: Acid mine drainage – South Africa's mining legacy.*

has resulted in a ten-fold increase," noted Prof McCarthy and Dr Pretorius. "Of greater concern is the fact that the sulphate concentration in the Middelburg Dam now exceeds the maximum recommended concentration for water for human consumption, and is still rising."

In the Loskop Dam, fish kills have become commonplace while large-scale crocodile deaths have also started to occur as a result of the cumulative pollution of the Olifants River. (For more on the crocodile deaths, see ***the Water Wheel*** January/February 2009).

Various measures are being implemented to try to mitigate the deteriorating water quality in the Olifants River. These include the construction of evaporation dams, using contaminated water for irrigation, acid neutralisation, water purification, controlled release and soil protection. Notwithstanding these efforts, water resources in the area continue to degrade.

THREAT TO HUMAN HEALTH

Another area where pollution from mining has become acute is the Wonderfonteinspruit catchment. The Wonderfonteinspruit starts near Randfontein on the West Rand of the Witwatersrand and moves all the way down to Potchefstroom on the Far West Rand. It flows through one of the richest gold-mining regions in the world. During more than hundred years of mining in the catchment deep-level gold mining brought more than 100 000 of the radioactive heavy metal uranium from depths of up to 3 000 m to the densely populated surface.

As Prof Frank Winde of the School of Environmental Sciences and Development at North West University reported, the uranium producing gold in this area had exported some 240 000 t of uranium since 1952. More than double that amount (about 600 000 t) is estimated to still be contained in gold-mining tailings covering some 400 km^2 in the Witwatersrand basin.

"These slimes dams and associated infrastructure such as return water dams, pipelines and metallurgical plants, together with unmined uraniferous ore in mine voids constitutes a multitude of sources from which uranium migrates, mostly uncontrolled, into the environment," noted Prof Winde. Like most non-essential heavy metals, uranium is toxic to humans. Consumed above certain concentrations it can lead to damage of the brain and kidneys. It has also been linked to certain cases of cancer and is an endocrine disruptor. The fact that thousands of informal residents are using the uranium-infected water in the Wonderfonteinspruit catchment for drinking and other purposes (such as watering homestead gardens) the situation is particularly serious.

Lani van Vuuren

Mine-water is increasingly being seen as a resource rather than a pollutant. At the Emalahleni Water Reclamation Plant outside Witbank mine-water is treated to potable standard for use by the local municipality.

"Applications are dealt with on a single application basis without a larger development framework context being in place."

A NEW FUTURE

Increased regulatory pressure, coupled with the rising cost of water, has resulted in many South African mines introducing improved water management measures since the 1990s. According to Wendy Mey of BHP Billiton, some of these measures include: selective handling of different mining waste and spoils materials to reduce pollution generation; separating clean and dirty water; implementing better surface rehabilitation practices to minimise water ingress; free drainage of rehabilitated and disturbed areas; and irrigation use of mine-water to enhance rehabilitation vegetation cover.

"There has been a paradigm shift from considering excess impacted mine-water as a nuisance to considering it as a valuable resource," said Mey. "Mine-water is now considered critical to the management of a mining operation." Implementation of the full spectrum of what is considered best practice water management actions may, however, still result in excess

water decanting from mining operations, especially in the later years of the life of the mine and in the post-closure situation.

RECYCLING AND RE-USE

With 98% of South Africa's existing water resources allocated at a high assurance of supply all eyes are turning to 'alternative' sources of water – treated mine-water being one such a potential source. In Emalahleni (Witbank) mine-water is already being reclaimed for potable use by the local municipality. In the Witswatersrand basin, plans are afoot to pump underground mine-water to a central treatment plant in Germiston where the water will be purified and sold to Rand Water. This somewhat controversial project is being led by the Western Utilities Corporation.

Dr André van Niekerk of Golder Associates believes that mine-water can be retained for a number of uses, including municipal and industrial operations, new mining ventures, and agriculture. "There is considerable volumes of water being stored in South Africa's old and active mine workings. In the Witwatersrand basin alone, the volume is reaching 656 million m^3."

Much research effort has been mobilised to find appropriate and reliable mine-water technologies, said Dr Van Niekerk. This includes membrane treatment, precipitated processes such as CSIR's barium carbonate process; ion exchange, passive treatment using renewable carbon sources and biological treatment involving sulphate removal and sulphur recovery.

However, as Mey pointed out, the capital and operational costs associated with mine-water treatment have been an impediment to the implementation of such advanced water treatment processes. Challenges also remain with respect to the handling and disposal of sludges and brines generated by these treatment processes.

Mine-water reclamation and re-use projects not only require substantial capital investment, but also long-term operation and maintenance. This is so even for passive mine-water treatment systems. Mining companies might just not get the 'set up and walk-away' solutions they are seeking following closure.

NEW MINING APPLICATIONS

South African mining development is not at an end. Numerous areas have been earmarked for new mines. Voices of concern have especially been raised over the numerous new coal-mines being proposed for Mpumalanga's Great Lakes District. At least 114 mining-related applications for coal have been received to date.

This hydrologically-sensitive area, which includes South Africa's largest freshwater lake, Chrissiesmeer, lies at the headwaters of three major river catchments, the Vaal, the Olifants and the Komati. The pans that make up the Lakes District are considered geomorphically unique, and are home to hundreds of bird and animals species.

Prof McCarthy and Dr Pretorius have called for a moratorium on new mining applications in this area until such time as the cumulative impact of mining is fully understood and adequate sustainable mitigation measures can be guaranteed. "Experience in the Highveld area provides some insight into what the future consequences might hold. The mitigation measures currently being employed are not adequate to prevent the area from turning into a wasteland. The scale of the problem is going to increase enormously in the future as the mines close and water management becomes more difficult."

"There is currently no large-scaled master plan either in place or planned to prevent this based on knowledge of the impact and within a decision-making framework taking all of the impacts into account. Applications are dealt with on a single application basis without a larger development framework context being in place."

South Africa has made strides in the improved management of mine-water. It is important that we look beyond the bottom-line at the legacy we are leaving our children. Concerted efforts are required by all parties to prevent the country's scarce water resources from being compromised.

Courtesy Jan Myburgh

Fish kills are a regular occurrence in Loskop Dam on the Olifants River.

PHILIP TUNNEL: A South African Irrigation First

Gamtoos Irrigation Board

The look-out which is said to have been William Philip's inspiration.

The lush Gamtoos valley in the Eastern Cape is home to the Philip Tunnel, water engineering wonder and South Africa's first irrigation tunnel. Lani van Vuuren explores the history of this national monument.

Three years after his arrival at the Cape, Superintendent of the London Missionary Society, Dr John Philip, paid a visit to the Eastern Cape. His aim was to purchase land to grow maize for the society's main mission station at Bethelsdorp and to spread the gospel. For this purpose he purchased 1 427 morgen (1 619 ha) of the farm Wagendrift in 1822. Two years later he founded the Hankey Mission Station. Situated at the foot of a ridge along the Klein River, a tributary of the Gamtoos, the mission was named after William Alers Hankey, secretary of the LMS. It initially housed 25 families with surnames as diverse as Windvogel, Stuurman, Dragoonder, Matroos, Konstable and Kettledas.

Despite the apparent abundance of water and fertile soil the mission did not turn out to be the oasis that Philip had intended. Hankey's inhabitants were often plagued by droughts. In 1829 James Wait started digging the first irrigation canal from the Klein River with the assistance of 50 workmen and 50 head of cattle. A year later the canal was finished and 400 acres (1,6 km^2) of land could be irrigated.

Philip's eldest son, William Enowy Philip, was sent to London for his schooling but ran away from College to join the Royal Navy and later the merchant navy to become a navigator. In 1833, after an adventurous cruise on the Indian Ocean, he came back to South Africa to study surveying in Cape Town. Following his training, William accompanied his father to England where he studied for the missionary. He returned to Hankey in 1841 with his Scottish wife, Alison, on his arm.

Upon his return, William was put in charge of the Hankey mission station. At the time, Hankey was experiencing a serious water shortage with the meagre crops there were being devastated by locusts. With little food to eat people started leaving the mission station. Young William was desperate to find a way of feeding the people of Hankey. It is said the he found inspiration from the natural window known as the Bergvenster, in the hill between Backhousehoek and Vensterhoek from which the valley can be seen.

After a careful survey of the valley William found that the land on the southeast side of the Vensterhoek Mountain was more than 3,65 m lower than the bed of the Gamtoos River on the northwest side of the mountain. He could therefore irrigate the fertile soil by digging a tunnel through the mountain.

William had no practical engineering experience before tackling construction

of the 228-m tunnel through the mountain. Descendant of Dr John Philip, Ron Philip, later wrote of William's undertaking: "Although William Philip was a qualified surveyor and had some knowledge of engineering, it was all theoretical. He must have had a clear vision of what would be achieved and had tremendous courage and enthusiasm to undertake this project. His enthusiasm was not shared by everyone and he had to contend with doubt and disbelief as well as the physical aspect of penetrating the mountain. His only instrument was a sextant with which he must have been an expert after his navigational experiences on the oceans."

William's boldness and confidence in the accuracy of his surveying is shown by the fact that he started work in April 1843 with two work parties, one on each side of the mountain. The labourers were all members of his congregation set to work day and night under the guidance of this man, who was at one and the same time their spiritual leader, engineer, surveyor and supervisor.

The primitive methods used caused progress to be painfully slow (about 0,3 m a day). The hole in the mountain had to be dug out with picks, shovels, hammers and chisels, with all the excavated rock being carried out in baskets. Light inside the tunnel was provided by candles and lanterns. There was no ventilation and the threat of rock falls and collapse was constant. One can only imagine what it must have been like to work under these conditions. It is remarkable that even though no protective measures were taken not one injury or death is recorded on this project.

SOURCES

'South Africa's first irrigation tunnel: The Philip Tunnel in the Gamtoos Valley' in *Civil Engineering in South Africa*, November 1971.
'Two civil engineering firsts for the Eastern Cape' in *Water*, House Journal of the Department of Water Affairs, July 1979.
Die Brullende Leeu Getem by GF Malan.
Thanks to Gamtoos Valley Tourism and Gamtoos Irrigation Board's Pierre Joubert for information and photographs.

Fortunately, the conglomerate encountered consisted of hard pebbles in softer matrix which made excavation with such primitive tools possible. During the project William wrote to a friend: "We work day and night on both sides to meet in the middle. The workmen for some time have heard the blows of each other, which are every day becoming distincter."

Just over a year after the start of the project, at 02:00 on the morning of 13 August 1844, the tunnel was holed through and the work parties met each other with jubilation. William described the breakthrough in a letter to his mother: "At about 2 am a shot was fired off at my bedroom window. I knew the signal – the tunnel is through. I looked out of my window and saw the messenger still running with a flaming brand towards the village, screaming as he ran. The measurements have all proved more accurate than I had reason to suspect so that my first lesson in practical engineering has been successful."

The original cross-section of the tunnel measured a little more than an average person's height, and just under a metre in width. By how much were the parties off line where they met? It is estimated that the error in alignment was in the order of 0,8 m. It is thought that as the parties came within hearing distance of one another, the advance was by sound rather than survey.

For the next 123 years, Hankey's water supply flowed through this tunnel. The tunnel was twice extensively damaged by floods – once in 1847 and again in 1867. Both times it was repaired. On each occasion it took many months before the rockfalls had been cleared.

Sadly, William did not live long to enjoy his engineering achievements. On 1 July 1845, on a calm, sunny day, William and his nephew, 11-year-old Johnny Fairbarn, crossed the Gamtoos River using a flat-bottomed boat to inspect the diggings for the water channels. They returned around 13:00 but never reached the other end of the river. Their drowned bodies were found later. William was only 31 years old.

On 9 July, 1845, William's death notice appeared in the Eastern Province Herald. The journalist wrote: "The writer of this notice examined the works in question only a few weeks before the fatal catastrophe and both himself and his fellow travellers were astonished at the magnitude of the enterprise, and the perseverance of its author, especially considering the nature of his material and resources. It is a labour totally unprecedented and equal, if not superior, to any of the public works in the Colony."


Gamtoos Irrigation Board

The foundations are all that is left of the Hankey Mill, which once took its water from the Philip Tunnel.

Upon completion of the Gamtoos canals in 1967, fed from the Paul Sauer (now the Kouga) Dam, all the old water works serving Hankey fell into disuse. On May 6, 1971, Minister of Water Affairs SP Botha unveiled a plaque at the tunnel entrance, declaring it a national monument.


Gamtoos Irrigation Board

Vuyani Dlomo of the Gamtoos Irrigation Board at the outlet of the Philip Tunnel. The entrance is completely caved in.

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SAFER SMALL-TOWN WATER through step-by-step guide

A new manual available from the Water Research Commission (WRC) helps municipalities provide better quality drinking water step by step. Lani van Vuuren reports.

Incidences of disease linked to the supply of poor quality drinking water have been reported in several municipal areas in the last few years. In the latest reported case, at least 30 people died in Bushbuckridge and parts of Mbombela municipality when problems with the local water treatment facility resulted in the provision of poor quality water.

Cases such as these highlight the importance of management of water treatment and supply. For a variety of reasons, this has proven problematic especially for small municipalities situated in far-flung, rural areas. Lack of skilled technical and management personnel along with low financial resources are only some of the challenges experienced by these local and district authorities who have taken on the responsibility of providing water to their constituents.

At the water indaba held in Mpumalanga earlier this year, Minister of Water & Environmental Affairs Buyelwa Sonjica emphasised the importance of proper management and planning in ensuring a safe, reliable drinking water supply. "It is the responsibility of each water service authority to ensure proper planning, budgeting and management of such infrastructure to prevent service delivery breakdowns and pollution incidents. Sufficient provision must be made for operation and maintenance of existing infrastructure to prevent service delivery failures."

PLANNING FOR WATER SAFETY

To assist municipalities with these planning and management aspects, the WRC funded the development of a new water safety plan manual – a step-by-step assessment and risk management tool dealing with all aspects of risk, from where the water is taken from the catchment to where it is delivered to the consumer.

"A properly conducted water safety plan would almost certainly have prevented the outbreaks of water-related disease experienced in several small South African towns in recent years," reports WRC Research Manager Dr Jo Burgess. These include Bloemhof, Delmas and Kanana. A water safety plan is basically an organised, structured system to reduce the chance of failure of the water treatment system through oversight or management lapse.

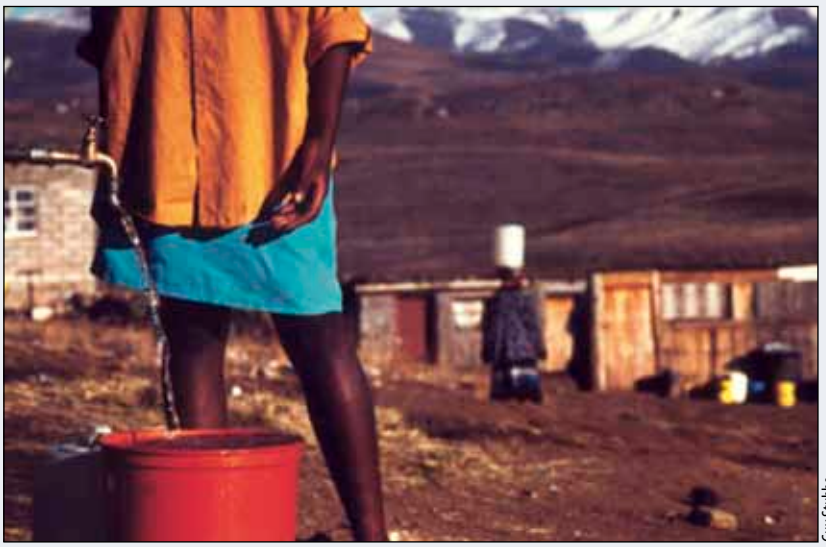
Dr Burgess explains that the key to ensuring clean, safe and reliable drinking water is to understand the drinking water supply from the source all the way to the consumer's tap. "This knowledge includes understanding the general characteristics of the water and the land surrounding the water source, as well as mapping all the real and potential threats to the water quality. These threats can be natural, such as seasonal droughts or flooding, or created by human activity, such as agricultural and industrial practices, or recreational activities in the watershed. Threats can also arise in the treatment plant or distribution system thanks to operational breakdowns or ageing infrastructure."

The water safety plan explained in the WRC manual is built around the so-called 'multi-barrier' approach to ensuring drinking water safety. This approach recognises that while each individual barrier may not be able to completely remove or prevent contamination, and therefore protect public health, several barriers work together to provide assurance that the water will be safe to drink over the long term.

"The multi-barrier approach takes all of the threats into accounts and makes sure there are barriers in place to either eliminate them or minimise their impact. It includes selecting the best available water source (dam, river, borehole) and protecting it from contamination, using effective water treatment. Water quality also needs to be protected from deterioration in the distribution system," notes Dr Burgess.

The water safety plan affords consistency with which safe water is supplied and provides contingency plans to respond to system failures or unforeseeable hazardous events. It guides both day-to-day actions and long-term planning.

Furthermore, the water safety plan will identify crucial aspects that collectively ensure the provision of safe water and aid system managers and operators in gaining a better understanding of the water supply system and the risks that need to be managed. Some of these aspects include regular monitoring and inspections that signal deteriorating water quality (and prompt action); regular maintenance; guidance for improvement and expenditure; additional training and capacity building initiatives; and a list of where to get help, who needs to know details of water quality and how quickly they need to know.

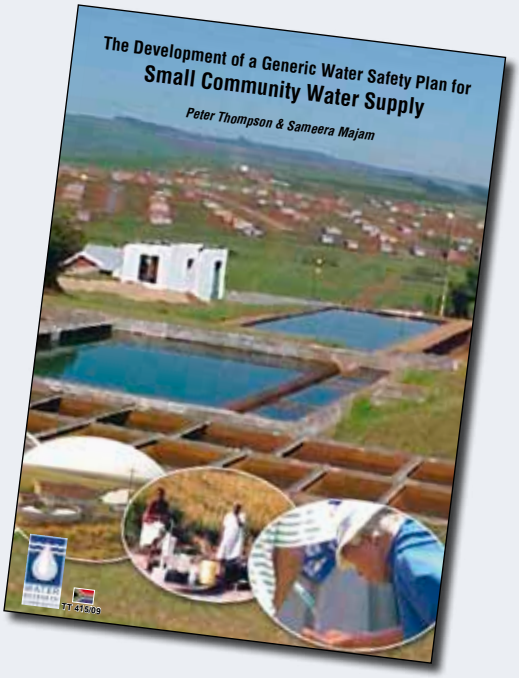


Guy Stubbs

Municipalities need to take the necessary steps to ensure their water meets quality standards.

Importantly, once set up such a plan has to be reviewed at least once a year to ensure it meets all the necessary criteria, Dr Burgess points out. "These reviews should assess operational monitoring results and trends. It is also important to include local operators and/or site visits in these review meetings. In addition to the regular planned review, the water safety plan should also be reviewed when, for example, a new water source is developed, major treatment improvements are planned and brought into use, or following a water quality incident."

To order the manual, ***The Development of a Generic Water Supply Plan for Small Community Water Supply*** (**WRC Report No: TT 415/09**), contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; Email: orders@wrc.org.za or Visit: www.wrc.org.za to download an electronic copy.

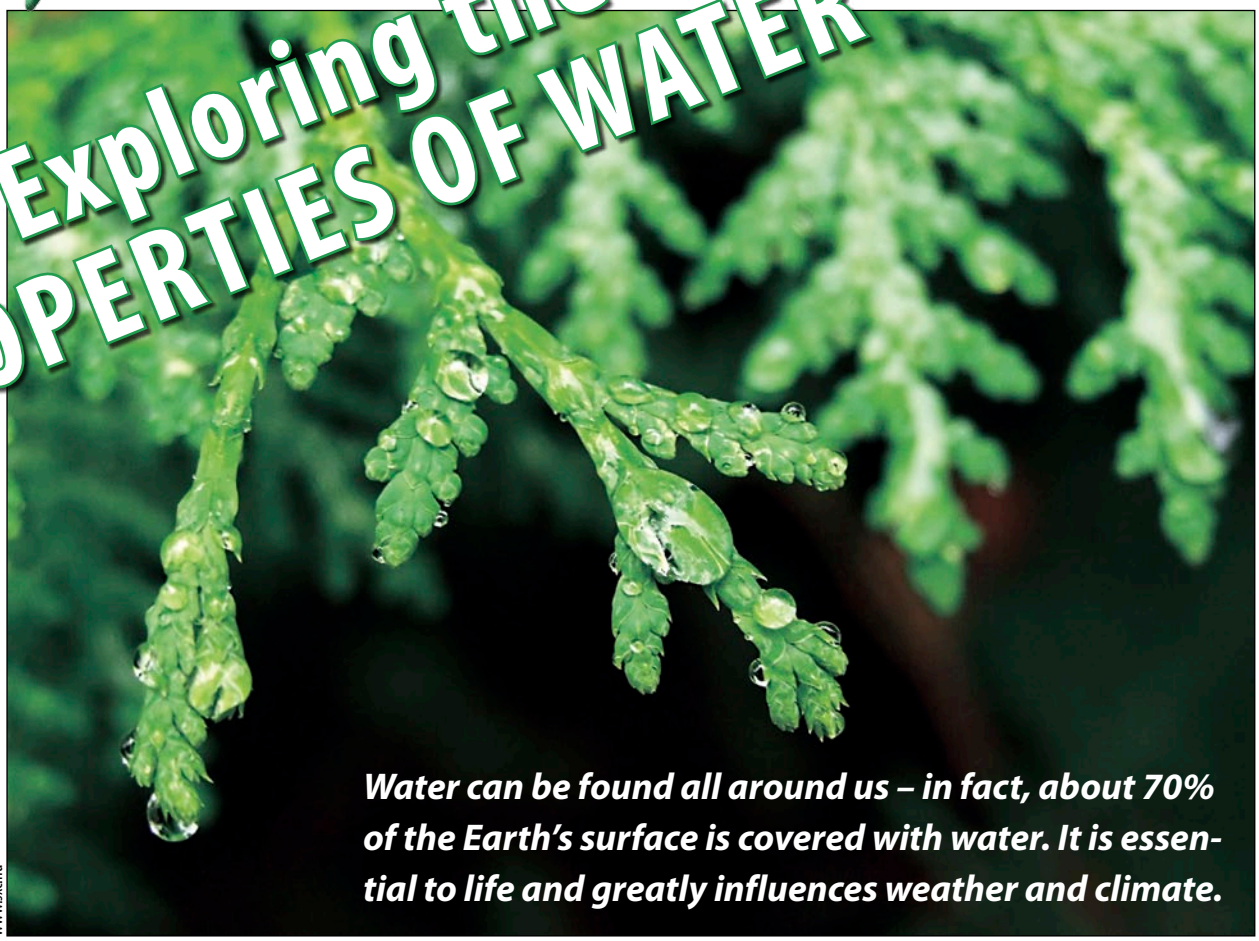


THE STEPS OF A WATER SAFETY PLAN (WSP)

- ☑ Assemble the WSP team.
- ☑ Describe the water supply system.
- ☑ Identify hazards and hazardous events and assess the risks.
- ☑ Determine and validate control measures, reassess and prioritise the risks.
- ☑ Develop, implement and maintain an improvement/upgrade plan.
- ☑ Define monitoring of the control measures.
- ☑ Verify the effectiveness of the WSP.
- ☑ Prepare management procedures.
- ☑ Develop supporting programmes.
- ☑ Plan and carry out periodic review of the WSP.
- ☑ Revise the WSP following an incident.

WATER Kidz

Exploring the PROPERTIES OF WATER



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Water can be found all around us – in fact, about 70% of the Earth's surface is covered with water. It is essential to life and greatly influences weather and climate.

Water is the most common substance on the planet yet it has some very unusual characteristics. Pure water is odourless and tasteless. A drop of water is made up of millions of tiny particles.

Water is one of the greatest natural examples of recycling. We use the same water today than the dinosaurs did millions of years ago.

Water has a very simple atomic structure. Water is composed of two elements, **Hydrogen** and **Oxygen**, making it a compound. Pure water has a neutral pH of 7, which is neither acidic nor basic.

2 Hydrogen + 1 Oxygen = H_2O

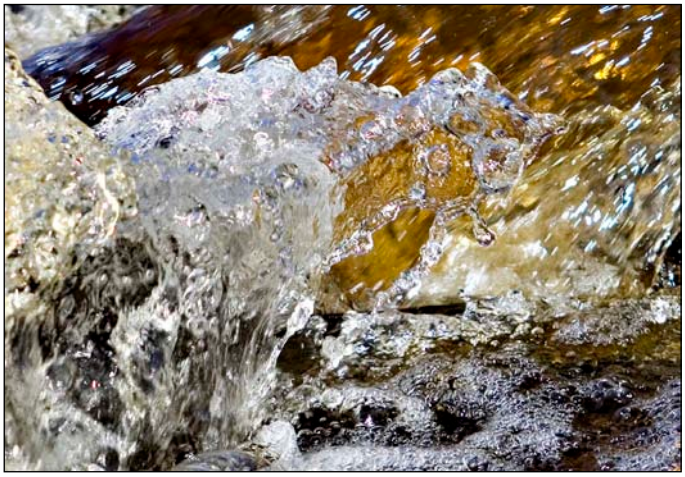
One of the most remarkable things about water is that it can be found in all three states of matter: solid ice, liquid water and gaseous water vapour (or steam). When water is cooled down to about 0°C it will freeze. When it is heated up to about 100°C it boils, changing from a liquid to vapour. Earth's water is constantly interacting, changing and in movement. This perhaps makes water one of the greatest examples of recycling.

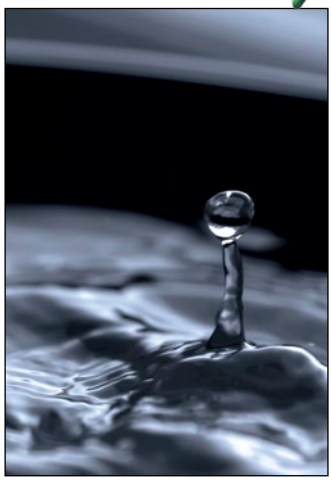
Did you know that water expands (gets less dense) by 9% when it freezes? This is very unusual for liquids. Think of the ice blocks in your glass of water on a hot summer's day. It floats on top rather than sinking to the bottom. This is one of the wonderfully unusual characteristics of water. This characteristic is very helpful in nature. When a lake freezes, for example, ice forms on the surface and the water underneath stays liquid. This helps living things in the water survive cold winters.

If water contracted on changing into a solid, ice would be heavier than an equal volume of water and would sink. The bottoms of lakes and oceans would then fill with ice, out of reach of the sun's warmth. Gradually the Earth would become colder, more and more ice would form, and in time there would be little, if any, life on Earth!

UNIVERSAL SOLVENT

Another remarkable characteristic of water is that it has the capability to





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***Left**: Water is one of the greatest natural examples of recycling. We use the same water today than the dinosaurs did millions of years ago.*

***Right**: Water is sticky and elastic, and tends to clump together in drops rather than spread out in a thin film.*

dissolve many things. This means that wherever water flows, either through the ground or through our bodies, it takes along valuable chemicals, minerals and nutrients. This is why pure water is so rare to find in nature. Even rainwater, the purest natural water, contains chemicals dissolved from the air.

Have you ever tasted how salty seawater is? That is because of the dissolved salts in the water. Take a cup of water and add a teaspoon of sugar. Now stir. See how the sugar is dissolved in the water? Now take a cup of warm water and stir in a teaspoon of sugar. Which cup of water dissolved the sugar the fastest?

Minerals dissolved in water help nourish living things. Harmful substances, such as decaying animal and vegetable matter and poisonous chemicals, may also be dissolved, and for this reason it is important that sources of drinking water be tested (and why water has to be treated before we can drink it safely). It is also because water is such a good solvent, and therefore dissolves dirt, that it is used for washing.

EXTRAORDINARY PROPERTIES

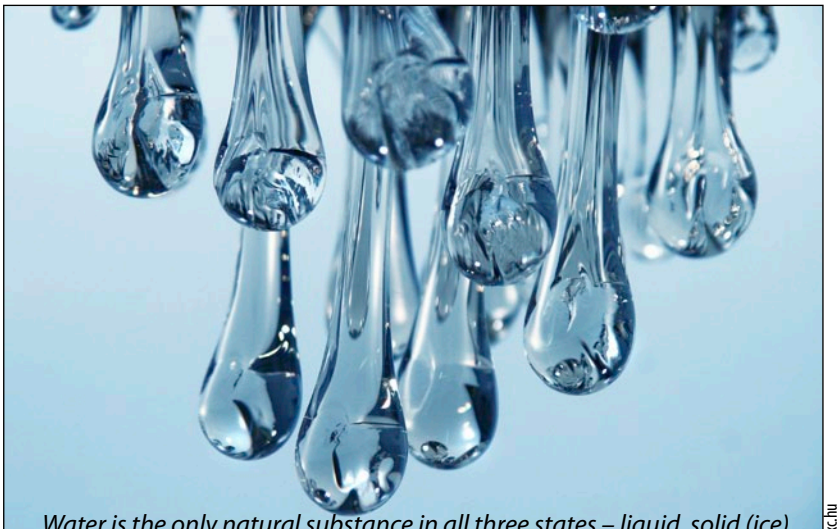
Water has a high specific heat index. This means that water can absorb a lot of heat before it begins to get hot. This is why water is valuable to industries and in your dad's car radiator as a coolant. The high specific heat index of water also helps regulate the rate at which air changes temperature, which is why the temperature change between seasons is gradual rather than sudden, especially near the oceans.

Another interesting characteristic of water is that it has a high surface tension. This means that water is sticky and elastic, and tends to clump together in drops rather than spread out in a thin film. This is why water drops are, in fact, drops. This surface tension is responsible for capillary action, which allows water (and its dissolved substances) to move through the roots of plants and through the tiny blood vessels in our bodies.

You can test the capillary action of water. Place a straw into a glass of water. See how the water 'climbs' up the straw? What is happening is that the water molecules are attracted to the straw molecules. When one water molecule moves closer to a straw molecule the other water molecules (which are cohesively attracted to that water molecule) also move up into the straw. Capillary action is limited by gravity and the size of the straw. The thinner the straw or tube the higher up capillary action will pull the water.

WEB RESOURCES

- http://science.howstuffworks.com/water-info2.htm
- http://en.wikipedia.org/wiki/Properties_of_water
- http://ga.water.usgs.gov/edu/waterproperties.html



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Water is the only natural substance in all three states – liquid, solid (ice) and gas (steam) – at the temperatures normally found on Earth.

World Mine-water Experts Gather in Pretoria

More than 360 of the world's top experts met in Pretoria to discuss the challenges surrounding mine-water at the 2009 International Mine Water Conference. Hosted by the International Mine Water Association and the Water Institute of Southern Africa's Mine Water Division featured papers from as far as China on themes such as mine closure, active and passive mine-water treatment, water management issues and management of radioactivity in mine water.

All photographs by Lani van Vuuren

Tim van Stormbroek of Ferret Mining and Environmental; Wendy Mey of BHP Billiton and John Waterhouse of Golder Australia.

Dr Przemystaw Bukowski of Central Mining Institute, Poland; André Walkow of Exxaro and Dr Andrzej Witkowski of the University of Silesia, Poland.

***Left**: Chamber of Mines Chief Executive Zoli Diliza was one of the keynote speakers at the conference.*

The WRC stand, which featured all of the Commission's mine-water related reports, proved very popular among delegates.

Alon Brauer and Dr Neil Ristow of Phathamanzi Water Treatment; Johan Labuschagne of the University of Pretoria and Hendrik Heyl of SA Lime & Gypsum.

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