THE WATER WHEEL
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RIETVLEI goes from green to clean

WATER RESEARCH COMMISSION

16th SANCIAHS National Hydrology Symposium

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

Hydrology in a Changing Environment: Science and Policy Interface

First Announcement and Call for Abstracts

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

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

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

Guidelines for Abstracts and Papers

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

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

Conference fees

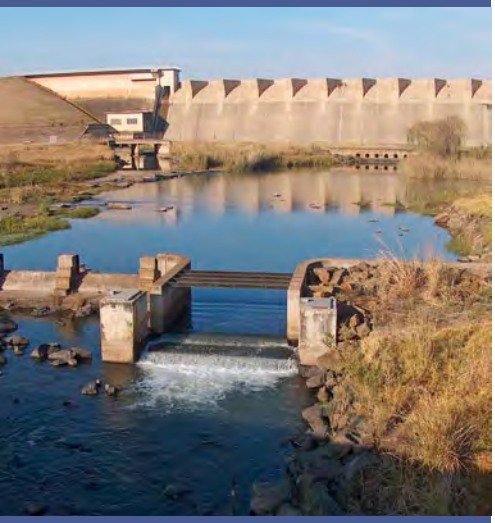
Delegates:	R1700.00
Full-time students:	R800.00

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

Accommodation

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

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



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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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Cover: Rietvlei Dam outside Pretoria has shown a remarkable improvement in water quality. Researchers are now investigating the reasons. See story on page 10.

SA dependence on coal 'not worth it'

Not only has South Africa's dependency on coal resulted in the country's greenhouse gas emissions being double the global average per capita, it is also having devastating effects on our water resources.

This is according to the latest report, *Coal and Water Futures in South Africa: The Case for Protecting Headwaters in the Enkangala Grasslands*, published by WWF-SA in collaboration with CSIR.

"WWF-SA understand the key role that coal and coal-mining plays in the South African economy as well as the country's energy generation," noted Christine Colvin, Senior Manager of the organisation's Freshwater Programme. "However, we would like to urge government to implement better coal-mining practices, which entail planning mining activities in strategic areas that do not compromise critical water resources and ultimately, the country's water security. We therefore call on government to define and declare mining sensitive or 'no-go' areas."

The report is based on research and engagement with the South African mining and water sectors, among other stakeholders. Case studies conducted in the Olifants River catchment (where coal has been mined for the last 100 years) and Enkangala grasslands detail the current costs and impacts of coal-mining on water resources.

According to the report, only 12% of the country's land area generates 50% of the country's river flow. This highlights the need to plan the development of our landscapes to protect the country's most important water, soil and biodiversity resources.

"Our already stressed water resources are under threat from coal-mining operations located in important water provisioning catchments. While many South Africans presently survive with limited or no access to energy, none can survive without water," said Colvin.

The consequences of abandoned mines and resultant acid mine drainage in the gold-mining areas of the Witwatersrand as well as the Olifants River catchment are well known, she continued. "At a national level, policies and strategies to clean up some of the pollution from gold-mining have been established. However, on the ground, prospecting rights for coal-mining are being issued in the headwaters of our most precious and sensitive catchments."

The report also examines how prospecting is unfolding in the relatively pristine headwaters of the Upper Vaal, Thukela and Pongola, where critical water source areas are threatened by new mining. According to Angus Burns of WWF Enkangala Grasslands Programme, these headwaters are sources from the Enkangala area which receives more than twice the average national rainfall and generates nearly three times the average run-off compared to the rest of South Africa.

As the report notes, between 2005 and 2010, approximately 13,7% of Mpumalanga was already under prospecting rights application and 40,3% was under mining rights applications. This means that 54% of the province was under some form of mining activity.

A number of shortcomings around mining are identified which poses risks to South Africa's water security. These include weaknesses in the legislative process and cooperative governance; the application process; enforcing legislation; the Environmental Management Plans application process; as well as weaknesses in the decommissioning process.

In conclusion, the report stresses that extensive mining, whether in a single area or in many smaller areas, can cause major local and downstream impacts and applications should be assessed with extra care. It also recommends that areas highlighted as conservation priorities should preferably remain unmined.

To download a copy of the report, Visit: http://assets.wwfza.panda.org.wwf-web-1.bluegecko.net/downloads/wwf_coal_water_report_2011_w

Letters to the Editor

Praise for the Water Wheel

Thank you for your excellent article on groundwater in the latest *Water Wheel* ('Groundwater – From 'inferior' to 'superior', *the Water Wheel* November/December, 2011) and, in general, the excellent articles in your magazine. It is an absolute pleasure and very informative to read through every edition.
Elias Nel, DWA

I love reading the [*Water Wheel*] magazine every month, especially the articles on the history of the dams.
Francois Swanepoel, ARC – Institute for Agricultural Engineering

The latest issue [November/December 2011] looks great with many articles of interest to me.
Dean Impson, CapeNature

It is always a great pleasure for me when I receive *the Water Wheel* which gives me the opportunity to keep in touch with the WRC and the water issues in South Africa. Congratulations to everyone for the supplement September/October 2011 issue, which is fantastic.
Gerard Dassonville, former senior adviser to DWAF

Correction

The article, 'World agri award, SA does it again' (*the Water Wheel*, November/December 2011) mistakenly reported that South Africa has won the ICID award for 'Best National Committee' three years in a row. The award is actually awarded every three years, and this is the first year that South Africa has scooped the award. *The Water Wheel* regrets the error.

WRC first when it comes to agricultural water research

The Water Research Commission (WRC) is the foremost funder of water-related agricultural research in South Africa.

This is according to a newly-published investigation into project data for all water-related agriculture in the country conducted in 2010. The aim of the research, undertaken by Frost & Sullivan, was to develop a database of such research. A key driver behind this project is the fact that little of this information is publicly available.

According to the final report, initiatives of this nature are important as they promote coordination, improve collaboration between research organisations, and encourage greater transparency, particularly with regards to research funding and dissemination of information. The study considered all projects related to irrigated and rainfed agriculture, woodlands and agroforestry, grassland and livestock watering as well as freshwater aquaculture and inland fisheries.

A total of 65 water-related agricultural research projects were identified valued at a total of R208-million. Of this, the WRC contributed around R130-million. The Commission is also funding the highest number of projects. Other significant funding organisations are the KwaZulu-Natal Department of Agriculture, Environmental Affairs and Rural Development and the Department of Water Affairs (DWA) (this includes funding for Working for Water).

Most of the research was found to be conducted by the Agricultural Research Council, both in terms of funding value and number of projects. The majority of the funding for these projects is attributed to the WRC and DWA. The University of KwaZulu-Natal conducted a similar number of projects, but the funding value was nearly half the value of the ARC projects. Other organisations conducting notable agricultural water-related research include the CSIR, University of Pretoria, University of the Free State and Stellenbosch University.

The high number of projects in the irrigation agriculture category reflects the maturity of South Africa's irrigated commercial sector, and shows big investments being made into the sector, which not only uses most of the country's water but contributed significantly to food production and employment. Much research funds are also focused towards water utilisation for poverty reduction.

To order the report, *Water-related research projects in agriculture undertaken in South Africa* (**Report No: TT 503/11**) and accompanying CD, contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; Email: orders@wrc.org.za; or Visit: www.wrc.org.za to download a free copy.

Government to set up fog harvesting project

The Department of Rural Development and Land Reform plans to conduct a pilot project to investigate the viability of fog harvesting along the eastern escarpment of Mpumalanga.

"If the pilot project yields positive results, we will consider a large scale roll-out to feed into local water distribution networks," reported department spokesperson Eddie Mochoebi. It is hoped the project will alleviate water shortages in South Africa. Communities in Cabazane village near Mount Ayliff, in the Eastern Cape, and Thohoyandou, in Limpopo, are already harvesting fog to provide in their basic water needs.

The Mpumalanga pilot project aims to produce 5 000 ℓ/day of water. The first fog harvesting nets will either be erected in Piet Retief, Donkerhoek, Madadeni, Shibange or Ntunda. "At this point it is difficult to determine where exactly the fog will be harvested. The outcome of the feasibility study will determine the suitable area," noted Mohoebi.

Water diary

WATER IN AFRICA
FEBRUARY 20-23

The 16th Africa Water and Sanitation Congress will be held in Marrakech, Morocco, with the theme 'Collaborative mechanisms and innovations for sustainable development of the water and sanitation sector in Africa'. *Email: contact@afwa-hq.org or Visit: http://www.afwa-hq.org/siteweb/index.php?option=com_content&view=article&id=169%3Amarrakech-2012&catid=53%3A-congres&Itemid=111&lang=en*

WATER LOSS
FEBRUARY 26-29

Water Loss 2012 will be held in Manila, Philippines. The conference is intended to present and discuss latest developments, strategies, techniques and applications of international best practices in non-revenue water management. The Conference is the sixth event in a series of IWA water loss reduction speciality conferences. *Email: 2012committee@iwa-waterloss.org or Visit: www.iwa-waterloss.org/2012*

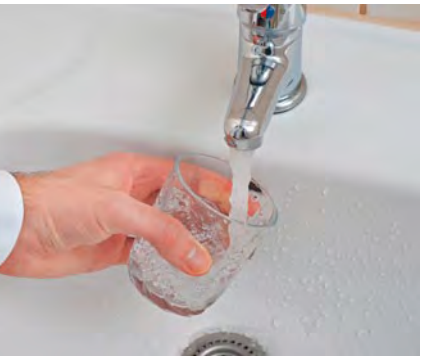
WORLD WATER
MARCH 12--17

The 6th World Water Forum will take place in Marseille, France, with the theme 'Time for Solutions'. The forum, organised every three years, is considered the largest international event in the field of water. *Email: secretariat@worldwaterforum.org or Visit: www.worldwaterforum6.org*

WATER HISTORY
MARCH 22-24

The Third IWA International Symposium on Water and Wastewater Technologies in Ancient Civilisations will be held in Istanbul, Turkey. The symposium is dedicated to themes relevant to water and wastewater technologies in ancient civilisations. The event will bring together research scientists, historians, archaeologists, and engineers from academic to industries around the world. *Email: ww2012@itu.edu.tr or Visit: www.iwa-ww2012.org*

Blue Drop 'not a factor' when it comes to SA consumers perception about water quality – study



When it comes to rating their tap water quality, consumers in South Africa's towns and cities are lead by their eyes, noses and tongues rather than chemical and microbiological quality reports.

This is according to a new study funded by the Water Research Commission. The study, conducted last year, involved a dip-stick survey which investigated urban South Africans' perceptions of their water quality and the variables that influence perceptions.

The majority of urban South Africans (81%) believe that their tap water is safe to drink. However, rather than relying on media reports or the results of the national Blue Drop certification process, most consumers depend on their sense of sight, taste and smell to determine the quality of their water.

In line with international experience, this study found that media reporting has very little impact on the individual's risk perception of drinking water safety. Only a small percentage of people questioned based their perception that tap water is safe or unsafe to drink on what they heard or read in the media. The fact that the Blue Drop status of cities and towns scored very low on the list of drivers of perceptions seems to indicate a general unawareness of the certification process among general members of the public.

Interestingly women are less confident about the safety of tap water than men and more likely to boil or filter water or drink bottled water instead. Younger consumers surveyed (16-35 years) were also found to be more positive about the safety of drinking water than older consumers. Living standards and income made no different to how people perceived the quality of their water supply.

Residents of South Africa's metropolitan areas were found to be more confident about the quality of their water supply than residents in other urban centres, with eThekwini (94% of respondents believe the tap water is safe to drink) coming out tops, followed by Cape Town (93%) in second place and Ekurhuleni (91%) in third place. Regarding survey results for smaller towns, urban residents residing in Gauteng were most confident about their water supply (88% believe the tap water is safe to drink), followed by KwaZulu-Natal (80%) and the Western Cape (78%).

"There is an increasing awareness globally that drinking water quality standards should include consumers' judgement of safety," the report states. "A better understanding of the underlying drivers of consumers' perceptions about the safety of drinking water will assist the regulator and municipalities to improve water management, consumer services and risk communication."

The report will be available later this year.

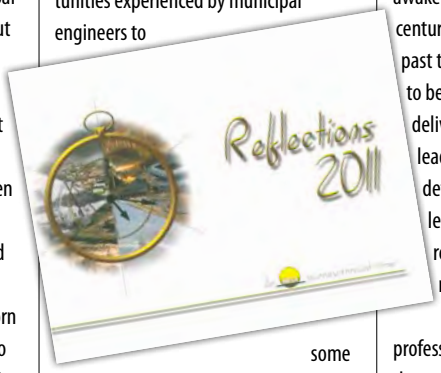
New book explores history of IMESA

In celebration of its 75th anniversary, the Institution of Municipal Engineering in Southern Africa (IMESA) has published a book on its origins and history.

Reflections 2011 – An IMESA Journey through Time is authored by well known civil engineer Johannes Haarhoff, and takes the reader to the start of municipal engineering in South Africa. Throughout the history of the country's towns and cities, the municipal engineer has been a vital contributor at the forefront of new methods of municipal service provision. These engineers had the often difficult task of integrating scientific advances of the time with practical and cost-effective engineering solutions.

Many early town engineers were born and educated in the UK, which stems to reason why IMESA has its foundations in the formation of the African District of the Association of Municipal Engineers (Britain) in South Africa in 1905. This marked the official start of the institutional arrangements that led to the South African association as we know it today.

Reflections investigates the factors influencing municipal engineering over time, from the challenges and opportunities experienced by municipal engineers to



some of the landmarks constructed through the decades. The book also includes information on some of the country's most remarkable municipal engineers, including William Ingham, David Ernest Lloyd-Davies and Solly Morris.

In all, the history of IMESA shows that the challenges are not so different today than they were at the start of the sanitary awakening in the early nineteenth century. There were several factors in the past that were forcefully demonstrated to be prerequisites for timely, efficient delivery. This includes sound political leadership and electoral support; defined interface between political leadership and appointed officials; respectful relationship between municipal engineers and elected politicians; as well as young professional engineers being attracted to the profession.

For more information on the purchase of *Reflections*, Visit: www.imesa.org.za

Water by numbers

- **4,5 million** – The number of job opportunities the government aims to create with Phase 2 of the Expanded Public Works Programme. Last year Public Works Minister Thembelani Nxesi berated local government for underspending on the programme.
- **8,7 million** – The total number of species of Earth, according to the latest count by North American scientists.
- **2,7 mm/year** – The observed sea level rise in Durban in the last 33 years, according to KwaZulu-Natal MEC for Agriculture, Environmental Affairs & Rural Development, Lydia Johnson.
- **81%** – The combined average level of the six major dams feeding the City of Cape Town and surrounds. After lower than usual rainfall this past winter, the municipality has urged its residents to use water sparingly.
- **364 ℓ** – The average per capita consumption per day in the United Arab Emirates. People here have been dubbed the world's largest water consumers.
- **R69-million** – The value of 'irregular expenditure' by the Department of Water Affairs in the last financial year, according to the Auditor General. This department has received a qualified audit on the basis of deficient bookkeeping.
- **US$350-million** – The value of a current project to deconstruct two dams on Washington state's Elwha River. The project is reportedly one of the world's largest dam-removal and river restoration projects currently being undertaken.
- **R12-billion** – The estimate cost at completion of the De Hoop Dam, currently being constructed in Limpopo. Impoundment was scheduled for November 2011.
- **50%** – The drop in incidence of diarrhoea among children under five when hands are washed after going to the toilet and before eating.

New from the WRC

Report No: TT 490/11

Introduction to integrated water meter management: Edition 1 (JE van Zyl)

Currently there is a lack in the proper management of water meters and meter data, resulting in increased levels of water losses and reduced income for municipalities. In addition, initiatives of water demand management and conservation are hampered by a lack of good information. This book covers all aspects of water meters and water metering in municipalities. It covers the theoretical principles of meters, legal and metrological requirements, meter types, best practice guidelines as well as practical aspects of water meter management (among others).

Report No: 1934/1/11

Management of the microbial water quality in catchments (SN Venter; A Lötter; LM Burke; WJ le Roux & M du Preez)

Management of the microbiological quality of water requires a good understanding of the behaviour of microorganisms at an ecosystem level. The behaviour, which is linked to the microbial population structure and diversity, consequently influences the effectiveness of catchment level mitigation strategies that contribute to sustainable management of our surface water resources. Managing microbial loads at catchment levels could provide both financial and health benefits for downstream users. Among others, this study investigated the applicability of novel molecular approaches for the determination of true microbial diversity in surface waters.

Report No: 1842/1/11; 1842/2/11 & 1842/3/11

Towards water resources regulations in South Africa Volume 1: Survey of approaches to water resources regulations; Volume 2: Institutional criteria, functions and arrangements & Volume 3: The use of regulatory impact assessment in developing approaches and tools for pro-poor water resources regulation (B Schreiner; S Chimuti; A Cupido & V Mbanda)

Water resources management provides a broad suite of activities, of which water resources regulation is one important set of activities. It is clear from the current status of water resources and water resource use in South Africa, that regulation is failing. Among others, climate change threatens the reliability of water availability in already stressed catchments, while raw and drinking water challenges are costing the country significantly in terms of foregone exports of crops, waterborne disease, death and lost productivity. This project was aimed at assisting in understanding these issues, including a consideration of institutional arrangements, tools and approaches. The focus of this project is on technical regulation in the water resources sector, rather than economic or governance regulation, although the institutional relationships are a critical part of sound technical regulation.

Report No: KV 271/11

Technology transfer of SAPWAT3, verifying correctness of program output and evaluation of its adoption potential (PS van Heerden and CT Crosby)

SAPWAT3 is the product of 20 years of research related to irrigation, agricultural engineering, soil, crops, agricultural meteorology and agricultural economics funded by the WRC. Development time and the cost involved accentuate the need to disseminate knowledge of SAPWAT3 to as wide a scope of potential users as possible, as well as to provide the necessary back-up, otherwise the danger exists that SAPWAT3 will not be used to its fullest potential and development time and funding would have been wasted. The next program version will include the expansion of functionality and correction of errors that have been identified, some of which is included in this report.

Report No: 1759/1/11

Guidelines on freeboard for dams Volume 1 (Literate review and case studies) (E Bosman & G Basson)

This WRC study on freeboard for dams started in 2007 and was carried out over a period of three years. A literature review was carried out to determine the state-of-the-art knowledge on the quantification of the secondary components to be taken into account in the determination of dam freeboard. Research carried out in the coastal engineering field of aspects which are relevant and applicable to dams was incorporated.

Report No: 1759/2/11

South African National Committee on Large Dams Volume II: Guidelines on freeboard for dams (DE Bosman; J Basson; T Tente & GR Basson)

The revision of the original SANCOLD Interim Guidelines on Freeboard for Dams coincides aptly with the draft revision of the Dam Safety Regulations in terms of the National Water Act. Only one major change has been advocated which is in respect of wave heights to be used in the calculations of freeboard. The revised guidelines also have updated wind, earthquake, and landslide information for South Africa.

Report No: KV 272/11

Remote sensing evapotranspiration (SEBS) evaluation using water balance (L Gibson, Z Münch, M Carstens & J Conrad)

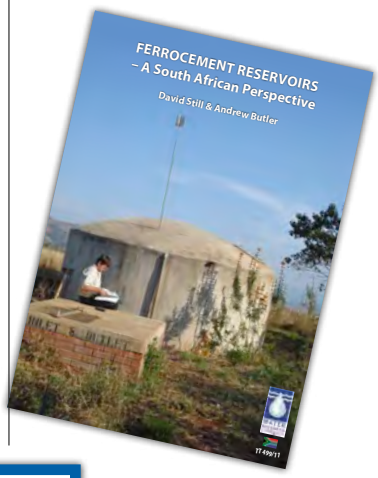
This report follows on from a previous WRC-funded study which investigated remote sensing as a tool for resource assessment. This study showed that due to many uncertainties and limitations with both the input data and methodology it was not possible to determine the actual water consumption of individual farms or compliance to legislation. In this project, the aim was to address the uncertainties and limitations and thereby determine the efficacy or efficiency of the method to highlight water-stressed catchments.

Report No: TT 499/11

Ferrocement reservoir – A South African perspective (D Still & A Butler)

Ferrocement is the name given to a composite material from a high strength mortar cement mix reinforced with steel mesh and wire. Since the 1990s several hundred ferrocement reservoirs have been built in South Africa. The largest such reservoir to date were two tanks built at Osindisweni, some 20 km west of Verulam.

One of the objectives of this study was to carry out field evaluations of ferrocement reservoirs in practice to see how they had weathered in the field. A total of 41 reservoirs were visited and they were checked for signs of spalling, cracking or leakage. It was found that the reservoirs were in general performing well and that they had not undergone any discernible deterioration.



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Awareness and labelling can benefit inland fisheries

Sustainable seafood initiatives, including certification and ecolabelling and awareness schemes, could be extended to more effectively cover inland, freshwater fisheries, according to researchers writing in the November issue of *BioScience*.

The world's growing dependence on fish protein and the imperilled state of many freshwater fisheries argues for such efforts, the authors conclude, although because freshwater fisheries tend to be smaller and are more concentrated in developing countries than marine and coastal fisheries, the efforts would have to be modified substantially to target the different consumers.

Authors, Steve Cooke of Carleton University and colleagues, initially set out to assess the scientific literature on ecolabelling and awareness schemes as they related to freshwater species, but soon determined there were very few such studies. Although freshwater species and those that live in freshwater during part of their lifecycle are included in lists intended to guide consumers on sustainable diet choices, they constitute a small minority, according to a survey of ten certification and labelling schemes.

This imbalance could lead to a public misconception that freshwater species are generally less at risk than marine species, Cooke and his colleagues argue. Grassroots schemes, rather than multimedia marketing-oriented certification schemes, are the most promising approach to increasing awareness of the threats to freshwater species and what choices consumers can make to reduce these, the authors say, because many freshwater fisheries are artisanal.

New snail species discovered in Greece

A new minute freshwater snail species belonging to the genus *Daphniola* was found by researchers of the University of Athens in a snow-covered spring on Mount Parnassos, in central Greece. The new species, *Daphniola eptalophos*, has a transparent conical-flat coiled shell, and a grey-black pigmented soft body. *Daphniola* is endemic to Greece, inhabiting most of the mainland. Two of the three currently known species are categorised as endangered and critically endangered. It is notable that the new species was been found in only one spring to date, and its population abundance seems to be low.

The new species is threatened by habitat destruction as a result of urbanisation, water pollution, waste accumulation, tourism and agricultural practices.

UN report outlines investment strategies to reduce water scarcity

An annual investment of US$198-billion, or 0,16% of global gross domestic product (GDP) in the water sector could reduce water scarcity and halve the number of people without sustainable access to safe drinking water and basic sanitation in less than four years.

This is according to the water chapter in the United Nations Environment Programme (UNEP) latest Green Economy Report. According to UNEP, investing in sanitation and drinking water, strengthening local water supply systems, conserving ecosystems critical for water supply, and developing more effective policies can help avert the high social and economic costs resulting from inadequate water supplies.

Cambodia, Indonesia, the Philippines and Vietnam, for example, lose an estimated US%9-billion a year, or 2% of their combined GDP, due to problems caused by poor sanitation, according to the report, which was released during the World Water Week in Stockholm earlier this year.

"Improving access to cleaner drinking water and sanitation services is a cornerstone of a more sustainable, resource-efficiency society," noted UNEP Executive Director, Achim Steiner. "The Green Economy Report shows how accelerated investment in water-dependent ecosystems, water infrastructure and water management, coupled with effective policies, can boost water and food security, improve human health and promote economic growth."

With the recommendations outlined in the report, global water use could be kept within sustainable limits and the Millennium Development Goals of reducing by half the proportion of the population without sustainable access to safe drinking water and basic sanitation could be met by 2015. Improving the efficiency and sustainability of water use is also vital if the world's increasing energy demands are to be met, said UNEP.

To access the Green Economy Report, Visit: http://www.unep.org/greeneconomy/GreenEconomyReport/tabid/29846/Default.aspx

Australia to share farming lessons with Africa

The Australian government will establish an international food security centre to offer research and technical expertise to willing governments and institutions in Africa.

The Australia International Centre for Food Security will be established in the second quarter of this year. Australian Prime Minister Julia Gillard announced the establishment of the centre late last year. It will be set up at a cost of around US$37-million and be hosted by the Australian Centre for International Agriculture Research.

Under the scheme African scientists will be linked to top Australian research bodies and tertiary education institutions to access solutions to the challenges of farming in tropical and sub-tropical environments. Australian researchers will also train African scientists in the technology the country uses to cope with many of the environmental challenges it shares with Africa, such as extreme climate, soil infertility and climate change.

Gabrielle Persley, adjunct professor at the Global Change Institute at the University of Queensland in Australia, said the centre will help African scientists develop drought-resilient crop varieties, an area where Australia has made great strides. "Developing the capacity of African scientists and other experts in areas such as developing market access for smallholder farmers and deploying Australian advanced technology in helping farmers cope with impacts of climate change will be major facets of this initiative."

The building of the centre will be preceded by an international conference on African food security, in the first of this year. The conference will bring together Australian and African researchers to identify opportunities for cooperation.

Climate change downsizing fauna, flora

Climate change is reducing the size of many animal and plant species, including some which supply vital nutrition, *ABC Science* reports.

From microorganisms to top predators, nearly 45% of species for which data was reviewed in a recent study grew smaller over multiple generations due to climate change. The impact of rapidly climbing temperatures and shifts in rainfall patterns on body size could have unpredictable and possible severe consequences, according to the research which appeared in the 17 October issue of the journal, *Nature Climate Change*. The research was conducted by scientists from the University of Singapore.

According to the researchers, for cold-blooded animals, including insects, reptiles and amphibians, the impact of climate change is direct: experiments suggest that an upward tick of 1°C translates into roughly a 10% increase in metabolism. That, in turn, results in downsizing.

In turn, overfishing has been blamed for decreased body size in both wild and commercially-harvested aquatic species, threatening the key source of protein of a billion people around the world. But experiments and observational studies have shown that warming waters play a role as well, especially in rivers and lakes.

Some of the most worrying changes are at the bottom of the food chain, especially in the ocean, where tiny phytoplankton and calcium-building creates are dwindling in size due to acidification and the reduced capacity of warmer water to hold oxygen and nutrients.

Source: ABC Science

US scientists find evidence of Roman-period megadrought

A new study at the University of Arizona's Laboratory of Tree-Ring Research has revealed a previously unknown multi-decade drought period in the second century AD.

Almost 900 years ago, in the mid-12th century, the southwestern US was in the middle of a multi-decadal megadrought. It was the most recent extended period of severe drought known for this region. But it was not the first.

The second century AD saw an extended dry period of more than 100 years characterised by a multidecade drought lasting nearly 50 years, says a new study from scientists at the University of Arizona.

Geoscientists Cody Routson, Connie Woodhouse and Jonathan Overpeck conducted a study of the southern San Juan Mountains in south-central Colorado. The region serves as a primary drainage site for the Rio Grande and San Juan rivers.

"These mountains are very important for both the San Juan River and the Rio Grande River," explained Routson, primary author of the study, which appeared in the journal, *Geophysical Research Letters*.

Dendrochronology is a precise science of using annual growth rings of trees to understand climate in the past. Because trees add a normally clearly defined growth ring around their trunk each year, counting the rings backwards from a tree's bark allows scientists to determine not only the age of the tree, but which years were good for growth and which years were more difficult.

"If it is a wet year, they grow a wide ring, and if it is a dry year, they grow a narrow ring," explained Routson. "If you average that pattern across trees in a region you can develop a chronology that shows what years were drier or wetter for that particular reigon."

To develop their chronology, the researchers looked for indications of climate in the past in the growth rings of the oldest trees in the southern San Juan region. In particular, the region is known for its bristlecone pine trees, the oldest of which are more than 4 000 years old.

Core samples were taken from these trees. The chronology thus created by the researchers extended back 2 200 years.

The study revealed another period of increased aridity earlier than the two major droughts already known – one in the middle of the 12th century, and the other at the end of the 13th century. "This new record shows that there is also evidence for an earlier megadrought during the second century AD," noted Rouston.

"We are showing that there are multiple extreme drought events that happened during our past in this region. And the climatic events behind these previous dry periods are really similar to what we are experiencing today."

Although natural climate variation has led to extended dry periods in the southwestern US in the past, there is reason to believe that human-driven climate change will increase the frequency of extreme droughts in the future.

Rising air pollution worsens drought, flooding – Study

Increases in air pollution and other particulate matter in the atmosphere can strongly affect cloud development in ways that reduce precipitation in dry regions or seasons, while increasing rain, snowfall and the intensity of severe storms in wet regions or seasons. This is according to a new study by US researchers at the University of Maryland. The research provides the first clear evidence of how aerosols – soot, dust and other small particles in the atmosphere – can affect weather and climate. The findings have important implications for the available, management and use of water resources in regions around the world, according to the researchers.

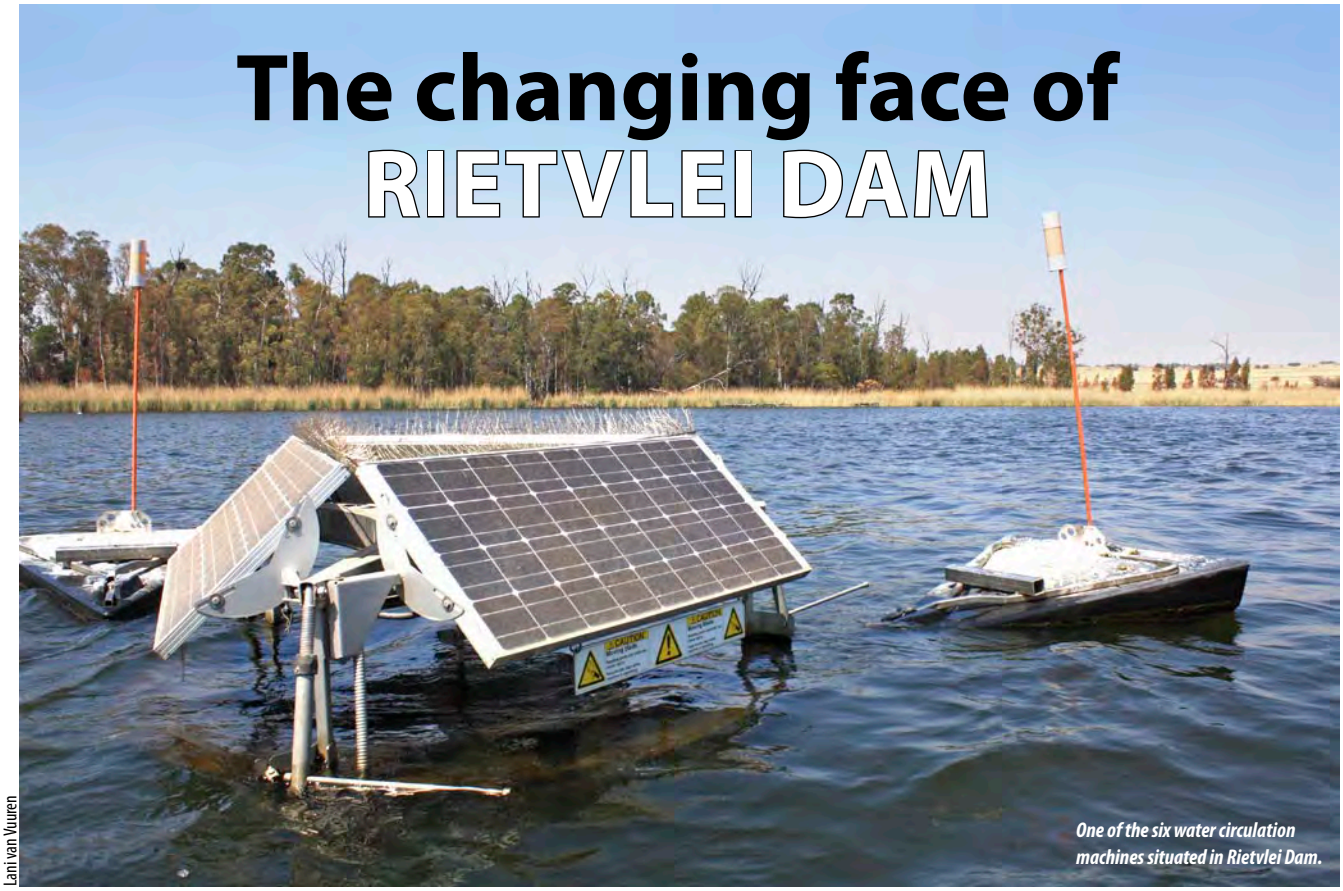
"Using a ten-year dataset of extensive atmosphere measurements from the US Southern Plains research facility in Oklahoma, we have uncovered, for the first time, the long-term, net impact of aerosols on cloud height and thickness, and the resultant changes in precipitation frequency and intensity," reported lead author Zhanqing Li, a professor of atmospheric and oceanic science at Maryland.

The study found that under very dirty conditions, the mean cloud height of deep convective clouds is more than twice the mean height under crystal clean air conditions. "The probability of heavy rain is virtually doubled from clean to dirty conditions, while the chance of light rain is reduced by 50%," said Prof Li.

The scientists obtained additional support for these findings with matching results obtained using a cloud-resolving computer model. The study is published in the November 13 issue of the journal, *Nature Geoscience*.

"These findings of long-term impacts, which we made using regional ground measurements, are also consistent with the findings we obtained from an analysis of NASA's global satellite products in a separate study. Together, they attest to the needs of tackling both climate and environmental changes that matter so much to our daily life," concluded Li.

The changing face of RIETVLEI DAM



Lani van Vuuren

One of the six water circulation machines situated in Rietvlei Dam.

Visitors to the Rietvlei Dam, in the past described as one of the most eutrophic dams in South Africa, might be pleasantly surprised by the blue, odour-free water that greets them nowadays. And while the jury is still out as to what exactly is responsible for this incredible turnaround the finger is increasingly pointing to 16 unassuming pieces of machinery scattered around the dam. Article by Lani van Vuuren.

In South Africa, eutrophication has been recognised as a water quality problem for over 30 years. The country has some of the most nutrient enriched water bodies in the world, with around 35% of our dams being either eutrophic (very nutrient enriched) or hypertrophic (extremely nutrient enriched).

Constructed between 1932 and 1934, Rietvlei Dam has been an important source of drinking water for the City of Tshwane. Today, it still provides around 6% of the city's drinking water requirement while also being the centre of one of the country's few urban nature reserves. The 32 m-high wall holds back around 12-million m^3 of water, and the dam covers a surface area of 1,87 km^2.

Unfortunately, the location of Rietvlei Dam's catchment, which extends as far as OR Tambo International Airport and the resultant urban, industrial and agricultural pollution, has caused the dam to become hypertrophic. Algal blooms were reported as early as 1974, and often comprise mainly of *Microcystis*, a species of cyanobacteria (blue-green algae) which produce harmful toxins that are neurotoxic and hepatotoxic in nature.

More prolific during the warmer, summer months, these blooms are not only harmful to the animals of the nature reserve and recreational users of Rietvlei Dam, but can also cause bad tastes and odours in drinking water. To cope with the water quality hassles associated with eutrophic blooms the Rietvlei Water Treatment Works has had to repeatedly extend its treatment capabilities through the years. The original processes of flocculation, settling, filtration and chlorination have been augmented with dissolved air flotation in the 1980s, followed by granular activated carbon as a polishing step in 2000. Online turbidity units have also been installed on all filters and on the incoming and final water produced. This has been followed by the recent introduction of ozonation.

Despite the availability of these sophisticated technologies, keeping the drinking water quality up to standard has been challenging. "The inconsistency in incoming water quality has made the water from Rietvlei Dam very difficult to treat," explains Leanne Coetzee of

the City of Tshwane Scientific Services. "Dosage and types of chemicals used have had to change quickly, particularly as a result of the blooms' influence on turbidity. In addition, we have experienced a significant pH bump with high pH readings during the day as a result of the cyanobacteria's photosynthesis during the day followed by a drop in pH at night when no photosynthesis occurred." As a result it has not been unusual for Leanne and her team to get called to the plant in the middle of the night to deal with these sudden changes in water quality. The algae also resulted in filter clogging and increased backwashing, reducing the output of drinking water from the plant while increasing operational costs.

INVESTIGATING THE OPTIONS

The City of Tshwane investigated several possible options to control eutrophication and prevent the outbreak of cyanbacterial blooms at Rietvlei Dam. A challenging aspect was that any solution had to be wary of the conservational and recreational importance of the dam. "The management of the Rietvlei Nature Reserve were very clear that any solution we implemented was not to disturb or be harmful to the fauna and flora of the Reserve. We also had to take cognisance of the importance of Rietvlei for Pretoria's water sport enthusiasts. This ruled out the use of any chemicals, for example," says Coetzee.

As a result, the City took a very brave decision by implementing a solution previously untested in South African waters. In 2008, the metro installed the first of a series of SolarBee units – solar-powered water circulation machines developed in the USA. SolarBees are basically upflow pumps with a flexible intake hose that can draw water up from any depth.

The specially-designed distribution dish at the surface allows up to 40 000 ℓ/minute direct and induced

RIETVLEI – A CITY ASSET

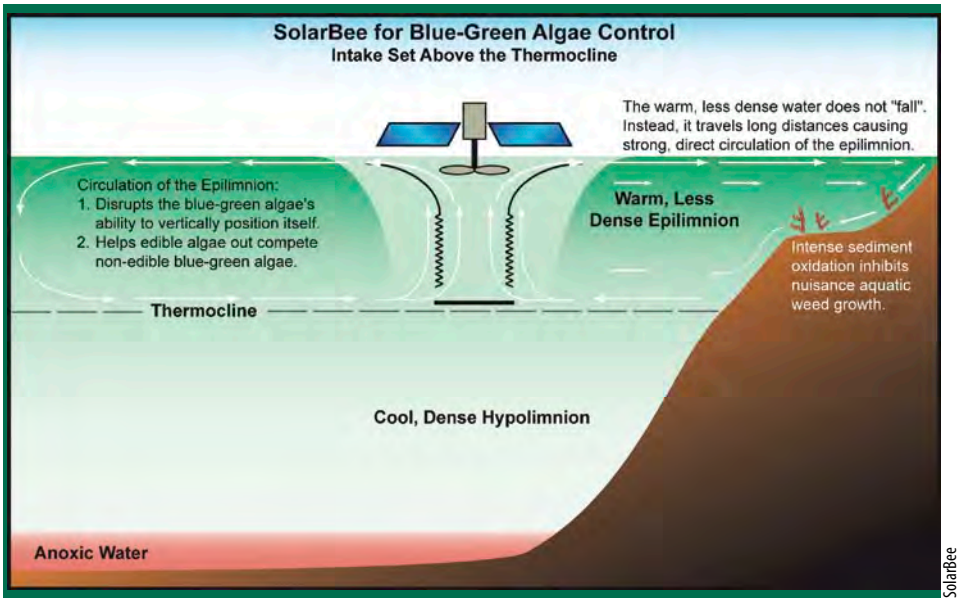
Situated about 18 km from the Pretoria CBD, the Rietvlei Nature Reserve covers about 3 800 ha of grassland, extensive vlei areas and the scenic Rietvlei Dam.

The supply of clean drinking water and the protection of the catchment are the main reasons for the establishment of the reserve. There are three sources of water on Rietvlei, namely the dam with its purification plant below the wall, five fountains and five boreholes. The reserve supplies about 15% of Pretoria's drinking water (about 40-million ℓ/day).

The reserve is owned and managed by the City of Tshwane, and features some 1 600 head of game, including blesbuck, black wildebeest, red hartebeest, eland, Burchell's zebra, waterbuck, reedbuck, springbuck, mountain reedbuck, steenbuck and grey duiker. Nocturnal animals such as brown hyena, black-backed jackal, aardwolf and porcupine, to name a few, can also be found here. Over 270 species of birds have been identified and confirmed on the reserve.

"The water quality in the dam has improved tremendously and the occurrence of cyanobacterial blooms has almost disappeared."

How the solar-powered water circulation machine works.



Lani van Vuuren

Rietvlei Dam before (2007, top) and after (2011, bottom) the installation of the SolarBees.

flow of water to move radially in all directions up to 200 m away from the machine. In this way, the upper waters where the cyanobacteria grow are put into a slow but continuous motion. Three 80 Watt solar panels provide enough energy to run the sealed, magnetic motor and digital control box 24 hours a day. One unit can treat around 12 ha of lake or dam surface area.

STEADY IMPROVEMENT

"Research has shown that when the habitat of cyanobacterial blooms is disturbed it creates a habitat in which cyanobacteria are no longer the dominant species and there is more species diversity," Coetzee tells *the Water Wheel*. Monitoring and data collection since the installation of the SolarBees has shown slow but steady improvement in the water quality of Rietvlei Dam.

"The water quality in the dam has improved tremendously and the occurrence of cyanobacterial blooms has almost disappeared," says Coetzee. "Cyanobacterial growth has decreased allowing the ecosystem to return to a more natural state by enabling the growth of green algae. These green algae are consumed, allowing for the improvement of the entire food chain. "The changes have been gradual but water quality has improved every year since installation," notes Coetzee.

With the raw water quality now more consistent, the water treatment plant is able to run smoother without needing sudden changes in protocol. In addition, operational costs have decreased as less expensive chemicals and backwashing are required since the water contains only low or no cyanobacteria toxins.

The SolarBee units are a true 'green' technology. Virtually maintenance free the only problem experienced so far has been that they tend to move out of position during periods of high rainfall or wind. However, they are easily towed back into position, and the City is now looking into using a different anchoring mechanism to improve their spatial stability.

The inconspicuous machines have proved a significant attraction to the local water bird population. Luckily the SolarBees have been equipped with bird repellent kits to prevent the birds from using the machines as nesting perches. Yachters and canoeists have also expressed their satisfaction with improved conditions at the dam.

In fact, at the time of writing the City of Tshwane was investigating the possible implementation of the units at other reservoirs, such as Leeukraal and Roodeplaat. Security issues and budget constraints are among the factors that will influence whether the machines are deployed there.

The implementation of the SolarBees is not the only factor that could have lead to improved water quality

conditions at Rietvlei Dam, though. Good rainfall over the last couple of years, as well as improvements at upstream wastewater treatment plants, could also have played a role. Working for Wetlands has also done much to restore the reserve's wetland, which aid in clean the incoming water to the dam.

The Water Research Commission has launched a new project that will, among other aims, seek to unlock some of the scientific reasons behind the improvement of the dam's water quality. The study, lead by North West University, will compare present ecological data with historical data to present a clearer picture of the ecological status of the dam and the influence of the SolarBees. Its primary focus, explains WRC Research Manager, Dr Kevin Murray, is to test the validity of a model originally developed to forecast the occurrence of cyanobacterial blooms up to three weeks ahead. The project has just kicked off and will run until 2015.

Whatever the reason it is clear that after four decades of battling eutrophication and cyanobacterial blooms, Rietvlei Dam has turned the corner. It is hoped that its success will be long term, and that it can be replicated to improve the water quality in other eutrophied dams in South Africa on which we so much depend for our daily drinking water. ❑

"The SolarBee units are a true 'green' technology. Virtually maintenance free the only problem experienced so far is that they tend to move out of position during periods of high rainfall or wind."

Lani van Vuuren

Lani van Vuuren

Top right: *The clearer water of the Rietvlei Dam has now become a recreational pleasure for Pretoria's yachters and canoeists.*

Middle right: *Rather than deterring wildlife the water circulation machines have become a huge attraction to Rietvlei Dams' waterbirds.*

Below: *Every SolarBee treats around 12 ha of dam surface area.*

Lani van Vuuren

Supporting South Africa's WATER FACTORIES

A nationwide project is demonstrating how corporate water users can plough back income from freshwater, for freshwater. Article by Petro Kotzé.

It is well known that South Africa is a water scarce country, and one with an almost constant battle being waged between the goals of economic development, ecosystem conservation and mitigation of the damage that has already been done to most of our freshwater ecosystems. It is also widely accepted that most of these issues cannot be solved by traditional engineering solutions or infrastructure development alone.

Rather, innovative solutions need to be found that call for a balance between these goals of economic development and ecosystem conservation. The Water Balance (WB) Programme, under the auspices of the World Wide Fund for Nature (WWF) aims to do just that. The programme literally gives corporates the opportunity to 'balance' the amount of freshwater they use with a monetary investment that will result in the approximate amount of water to be returned to the country's critical catchments. The high-water yield areas, also known as 'water factories', are recognised as such because they contribute significantly to the overall water supply of the country, often supporting the country's economic hubs with water.

Helen Gordon, the WWF Water Balance Programme Development Manager says that by supporting the WB, corporates who are big consumers of water are investing back into the country's (and their own) present and future water security. The programme started in 2008 with a two-year limited pilot phase ending mid-2010, but the "WWF plans to run this programme for many years to come," says Gordon. Since its inception, the programme has already resulted in promising achievements, both in the areas of corporate participation and on-the-ground results.

SUPPLY-SIDE INTERVENTIONS

As a start, the WWF is concentrating its efforts on the quantification of water made available through the removal of invasive alien plants. Not only does the National Water Resource Strategy of 2004 identify the clearing of invasive alien plants as one of the most important water supply-side interventions that can be made at a national scale, but the large amount of data available on the topic through the current and historic experiences of the Working for Water Programme has made this an obvious first choice. Currently, WB is also exploring the possible expansion of their implementation to include restoration in cleared sites in dire need of active restoration.

There are numerous benefits associated with the removal of alien plants. Environmentally speaking, it results in better water quality and availability by contributing to

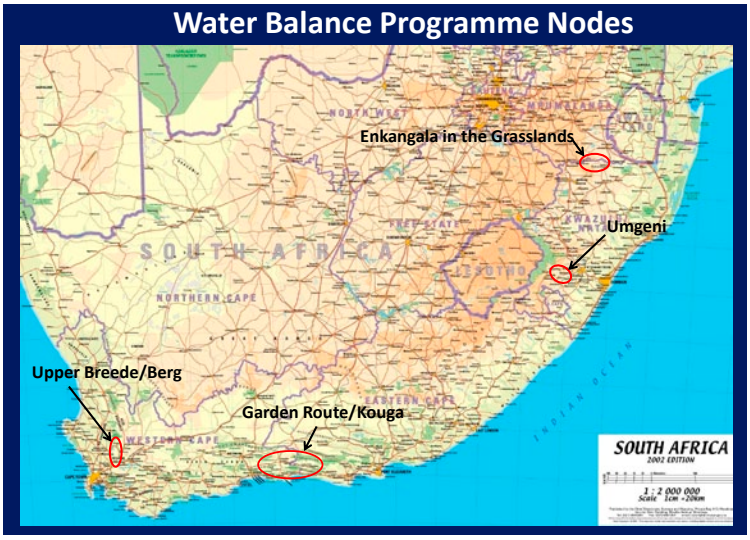
the healthy functioning of riverine systems. The removal of invasive alien plants also reduces wildfires, while enabling the re-establishment of natural vegetation. Economically speaking, decreasing amounts of water in a catchment places economic development at risk. On a social level, jobs are created through the clearing work but, perhaps more importantly, a contribution is made to the continued provision of water.

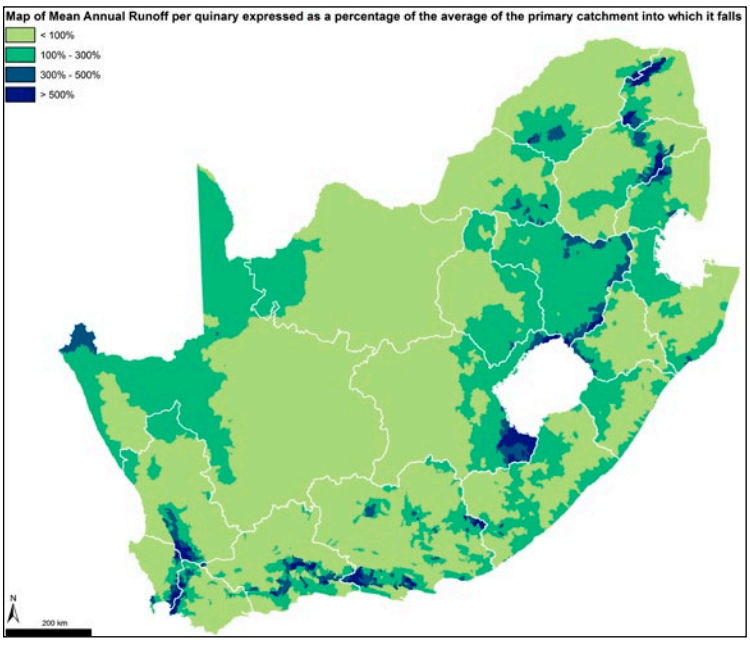
The clearing work done through the WB will be focused on the said 'water factories'. The WWF has identified five nodes in which these catchments lie, says Gordon. She adds that the prioritisation is based on several other factors, including high biodiversity benefits, willingness of landowners to enter stewardship agreements, other existing WWF initiatives which can be leveraged and any additional social benefits that can be achieved, like using biomass (plant debris after clearing) to create secondary markets. "Having a focused effort will have greater results where it counts the most for the entire country," she says.

The prioritised nodes are:

- **Upper reaches of the Berg and Breede catchments:** This is the heart of the Western Cape water supply system, catering for the City of Cape Town, urban water users and irrigators along the Berg, Eerste, Lourens, Steenbras and Palmiet rivers, domestic and industrial users on the West Coast, as well as irrigators and urban users in the Riviersonderend catchment of the Breede water management area.
- **Garden Route from George to Plettenberg Bay in the Western Cape:** A highly water stressed area; it is also one of the country's biggest tourist attractions.
- **The Kouga River catchment in the Eastern Cape:** An important water resource for the Nelson Mandela Metropole, this catchment has also been identified as a priority catchment by the River Health Programme's State-of-the-Rivers Report.
- **The Umgeni catchment in KwaZulu-Natal:** This is the heart of the province's water supply, catering for Durban, Pietermartizburg and surrounds.
- **The Mpumalanga Grasslands**: Water runoff from Mpumalanga's southern highland grassland catchments supplies most of the water used for electricity production in the Highveld power stations and the Secunda petrol-from-coal plant. It also supplies water to north central KwaZulu-Natal and Gauteng.

Within these catchments, says Gordon, the WB programme will clear the tributaries, especially in areas where their work overlaps with that of Working for Water (WfW), which tends to focus on the main stem of a river. "However," she adds, "the WB sites are on private land within the prioritised nodes where WfW is not currently clearing." In such cases the WB focuses on clearing efforts in the riparian zone and requires landowners to cover the cost of clearing other terrestrial infestations. This support serves as an incentive for landowners to conserve biodiversity through stewardship agreements in order to





Top left: *The water balance priority nodes.*

Bottom left: *Mean Annual Runoff per quinary expressed as a percantage of the average of the primary catchment into which it falls.*

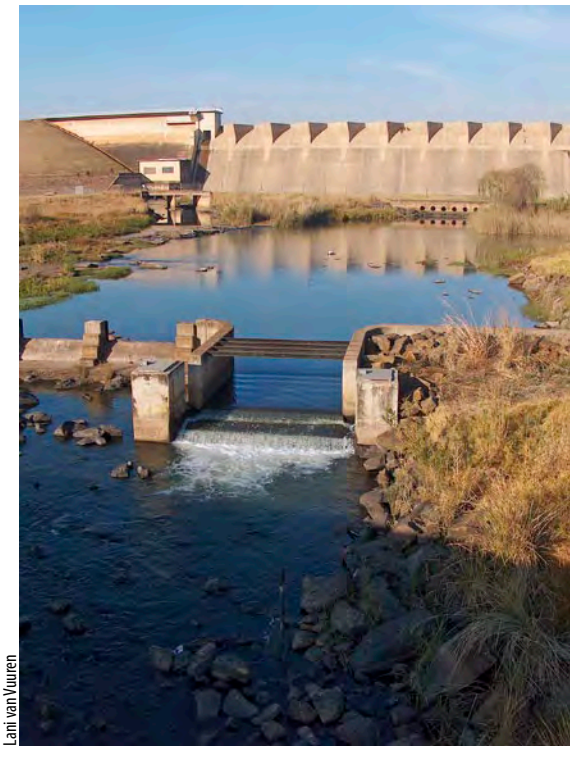
Helen Gordon/WWF

There are numerous benefits associated with the removal of alien plants. Environmentally speaking, it results in better water quality and availability by contributing to the healthy functioning of riverine systems.

receive financial assistance to subsidise their invasive alien plants clearing costs while achieving long-term commitment to maintaining their land free of invasive alien plants.

The collaboration between WWF, WfW and private landowners is seen as an integral ingredient to the success of the WB. "We recognise that an impact on the landscape can only be made with close collaboration and partnerships," says Gordon. There is a particularly close relationship with WfW where clearing areas overlap. In addition, the WWF has a memorandum of agreement with the Natural Resource Management Programme regarding the provision of herbicide to relevant landowners. Other implementing agents or partners include CapeNature, LandCare, Cape Winelands District Municipality and Working for Wetlands.

In order to work out the amount of corporate funds that need to be invested, the WWF has collaborated with scientists to estimate the water used by various invasive alien plant species and the national norms for the costs to clear such species. This information has been used to calculate the proportionate investments to be made by the water user. Notably, the WWF sees this private sector investment not as a benevolent act, but rather as "a sound decision to contribute towards risk mitigation."



Lani van Vuuren

Midmar Dam on the uMgeni River. The Water Balance programme is focused on strategic catchments that are of significant importance to the country's economic hubs.

THE VALUE OF CORPORATE INVESTMENT

By investing in the WB Programme, water users are encouraged to take ownership of South Africa's common water challenge by going beyond reducing their own water demand to also making an investment back into water provisioning ecosystems.

As such, each corporate or participant involved with the WB Programme, explains Gordon, is required to commit themselves to the 'triple R' process of review, reduce, replenish. They are required to accurately measure and provide their operational water use, including not only their municipal bills, but also borehole water or any water used directly from the river. Secondly, participants are required to develop and implement a water reduction and efficiency strategy. Lastly, they are required to invest in projects that will cause 'new' water to be made available into freshwater ecosystems, estimated to be in proportion to their water use.

When determining the Rand value of the proportionate investment that a water-user will make, three principal input values are used. Firstly, the water user's operational water use is determined. This is then divided by the national average amount of water 'replenished' through the clearing of a hectare of invasive alien plants and maintaining it in a natural infestation-free state. Lastly, this is multiplied by the average cost of clearing a hectare of invasive alien plants and maintaining it in an infestation-free state.

The participants, says Gordon, enter into a five-year renewable contract with the WWF, during which time the WWF achieves the extent of invasive alien plant clearing and restoration considered necessary to balance the participant's operational water use.

The first retailer to join the programme was Woolworths. Reflecting its annual operational water use of just over 350 000 kℓ, the company has committed R2,3-million. Under a recently refined programme model, Sonae Novobord and Nedbank also joined the programme in 2010 and 2011 respectively. Sonae Novobord has committed R2,8-million in proportion to its annual operational water use of 200 000 kℓ, while Nedbank is balancing its annual operational water use of 550 000 kℓ with a R9-million investment, which may contribute to achieving additional restoration.

As the WB sites earmarked for clearing are on private land, these funds are also used as a financial incentive to support landowners in one of two ways. Either, to encourage landowners to enter their land into stewardship agreements, which is a longer term commitment beyond that of WB and involves a far greater management plan for the land, ensuring additional biodiversity gains. Or, to support landowners who have already made this impressive commitment, as is the case with five farmers in the Luneberg area in Mpumalanga. "These farmers are hard workers who have shown commendable commitment to alien plant clearing and a few of them are ahead of schedule with the clearing of the required hectares," says Gordon.

These five willing landowners, some of the first to enter contracts of this nature with the WWF, count among the highlights of the project to date. "And," adds Gordon, "a couple of these landowners are prepared to over-deliver on their contracts, with one farmer exploring active restoration at his own cost and another using his own funding to clear land that he is only leasing." More highlights in this specific area in Mpumalanga include the rejuvenation of a stream which used to only run in summer but, after four months of clearing along its banks, is now flowing in winter. Moreover, a new spring has begun flowing. "In future, the farmer now has the option to use this camp in winter," says Gordon.

In addition, Nedbank is engaging with WWF to ensure that the clearing of alien plants on their own land (while not part of WB) is done in a similar manner to that of the programme. Lastly, Gordon adds that the mentioned MoU regarding herbicide provision "shows how partnerships can extend the effectiveness of action on the ground, contributing to delivering on both WB's and government's goals."

Regardless, the programme is not without its challenges. "Sufficient capacity to deal with the implementation needs," is one, says Gordon. As the high water yield areas in question contribute significantly to the overall water supply of the entire country, rehabilitation work requires a cross-country implementation programme. "Management of on-the-ground-implementation is also difficult from a distance." Furthermore, although costly and time consuming, regular site visits are vital to flag potential problems at an early stage.

An additional challenge of working in these areas is that they are often mountainous and the invasive alien plants are hard to access, which makes dealing with the debris after clearing especially challenging. While the most sustainable approach to WB roll-out entails the landowner managing the clearing of plants with his own staff (especially since the landowner is required to continue the alien plant control after the five-year contract with WB), managing the clearing methodologies and the environmental impact thereof is more complicated when executed on private property by the owner of that property.

Regardless of these challenges, the WB Programme is a practical example of how corporate water users can invest funds in our common water-secure future. So far, the programme has been successful in creating a platform that links corporate private funds to responsible landowners greatly in need of financial assistance in order to confront the often overwhelming and costly challenge of invasive alien plant clearing. Even more so, WB aims to contribute to the country's future water security by achieving tangible and secured results in the landscape, while highlighting the importance of the health of catchments in the continued provisioning of water. ❑

Helen Gordon/WWF

Among the highlights of the WWF Water Balance Programme to date is the rejuvenation of a stream in Mpumalanga. The stream used to only run in summer but, after four months of clearing along its banks, is now flowing in winter.

Helen Gordon/WWF

The Water Balance Programme focuses on the quantification of water made available through the removal of invasive alien plants. Here is an example of how clearing is taking place along a river (the area already cleared is in the foreground).

SA's first freshwater prio

The same kind of commitment, passion, and collaboration that went into the identification of South Africa's priority freshwater ecosystems should be applied to ensure that these areas are indeed protected. This was the main message during the launch of the country's first* Atlas of Freshwater Ecosystem Priority Areas *towards the end of last year. Article compiled by Lani van Vuuren.

The uThukela water management area has the highest density of freshwater ecosystem priority areas.

Despite its reputation as a water scarce country, the South African landscape comprises a diverse range of freshwater ecosystems: from sub-tropical in the north-eastern part of the country, to semi-arid and arid in the interior, to the cool and temperate rivers of the fynbos. Apart from inspiring our communities with their beauty, these rivers, wetlands, lakes and estuaries have also long provided for many of our fundamental needs.

It is no secret that South Africa's freshwater ecosystems are under increasing pressure from socio-economic development. Urbanisation, population growth, pollution, and a naturally variable climate with a low average annual rainfall are but some of the threats to the health of our water systems. These do not only influence the quality and quantity of water, but also impact on our freshwater fauna – at least one third of freshwater fish indigenous to South Africa is reported as threatened.

Deterioration in the health of freshwater ecosystems negatively affects their ability to continue providing important services.

Drinie van Rensburg

Three years ago a need was identified to conserve some natural examples of the different ecosystems that make up the natural heritage of the country for present and future generations. Out of this need came the National Freshwater Ecosystems Priority Areas (NFEPA) project, which aimed to answer the questions around which freshwater ecosystems and how many to protect. In what can be described as arguably the most extensive collaboration between water-related organisations since the drawing up of the National Water Act (NWA), the NFEPA project has drawn together an incredible number of organisations, from the national and provincial departments of water and environmental affairs, to the CSIR, WRC, South African National Biodiversity Institute (SANBI), World Wildlife Fund (WWF), to the South African Institute for Aquatic Biodiversity (SAIAB) and South African National Parks.

In addition to the project team and reference group, the project also relied on the participation of some 150 stakeholders, representing about 1 000 person years of collective experience in either aquatic science or biodiversity planning. "One of the biggest success factors of this project has been the collaborative spirit of the freshwater scientific community in South Africa," says SANBI Director: Biodiversity Policy,

rity areas atlas launched

www.sxc.hu

Mandy Driver. "Freshwater ecologists from around the country spent days in workshops, studying maps, contributing their data and expertise. The freshwater ecologists who have tramped around our rivers over many years have an enormous wealth of knowledge. What we have managed to do through NFEPA, is to capture some of that and to ensure that the collective knowledge from around the country is consolidated."

FIRST IN SA

The result is South Africa's first comprehensive assessment of its freshwater ecosystems priority areas or those areas of the country that are most important for ensuring the integrity and continued functioning of our freshwater ecosystems. The priority areas have been summarised as a series of maps contained in the *Atlas of Freshwater Ecosystem Priority Areas in South Africa*.

"In the context of water resources management, catchments can be designed to support multiple levels of use, with natural rivers and wetlands that are minimally used supporting the sustainability of hard-working rivers that often form the economic hub of the catchment," explains project leader Dr Jeanne Nel of the CSIR. "This concept is firmly embedded in the National Water Act and forms the foundation of the water resources classification system."

National freshwater priority areas need not be fenced off entirely from human use, but rather they should be supported by good planning, decision-making, and management to ensure that human use does not impact on the condition of these ecosystems.

The criteria for identifying freshwater priority areas were based on earlier work in which government departments agreed on a vision for managing and conserving freshwater ecosystems. These criteria were reviewed during the regional expert review workshops. Other criteria included: areas where populations of threatened or near-threatened freshwater fish occurred; areas that are considered high water yield or high groundwater recharge areas; free flowing rivers and connectedness, as ecosystems that are connected are most likely to support biodiversity. After much investigation, deliberation, debate and refinement,

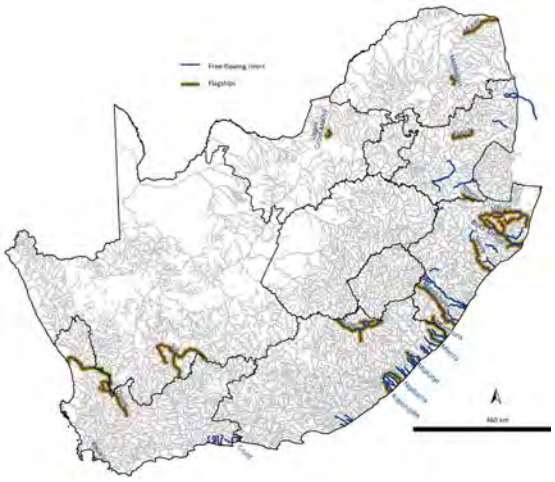
KEY FINDINGS OF THE FRESHWATER PRIORITY AREAS PROJECT

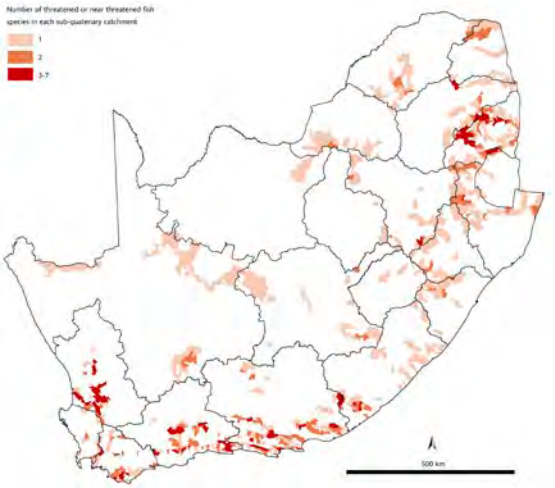
- Only 35% of the length of South Africa's mainstem rivers is in a good condition, compared to 57% of the tributaries.
- Around 57% of river ecosystems and 65% of wetland ecosystems are threatened.
- Only 22% of South Africa's river length has been identified as freshwater ecosystem priority areas.
- South Africa has only 62 free flowing rivers remaining, mostly tributaries.
- The priority areas identified protect over 50 fish species that are on the brink of extinction.

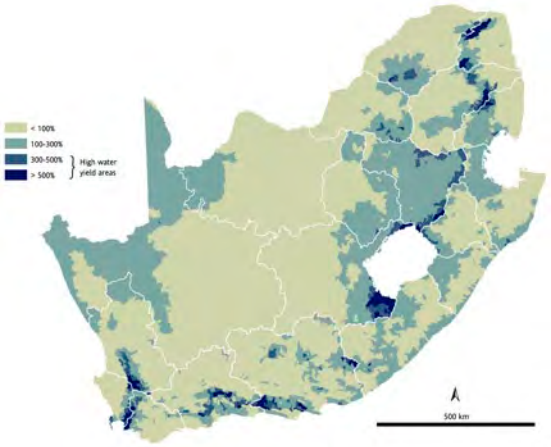
Source: Atlas of Freshwater Ecosystem Priority Areas in South Africa

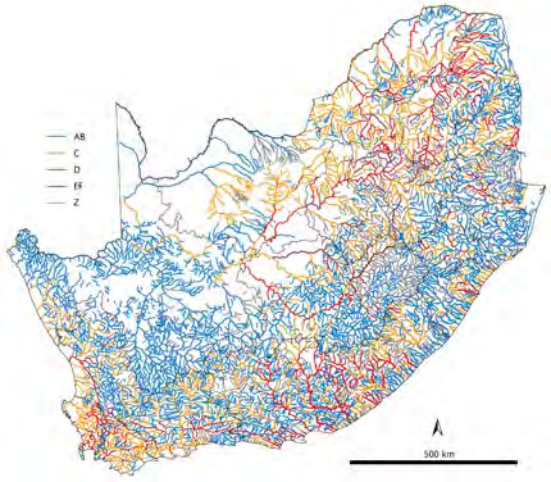
Lani van Vuuren

By protecting a small proportion of South Africa's rivers, it is hoped that the extinction of threatened freshwater species can be avoided.







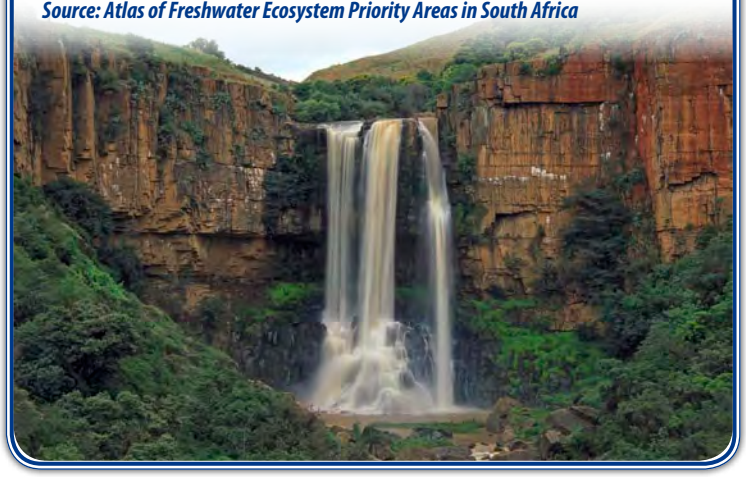


PROVING THE VALUE OF FREE-FLOWING RIVERS: THE ELANDS RIVER EXAMPLE

The Eland River rises on the grassland plateau of the Drakensberg mountains near Machadodorp, then flows downstream until it reaches the Crocodile River in Mpumalanga, which links with the Incomati River that flows across the Mozambican border where it eventually meets the Indian Ocean.

The Crocodile River is a major supplier of drinking water to Nelspruit, as well as an important source of water for irrigation farmers and the animals of the Kruger National Park. The good water quality and quantity of the Elands River helps to dilute pollutants in the more heavily utilised Crocodile River.

Source: Atlas of Freshwater Ecosystem Priority Areas in South Africa



19 freshwater priority maps – one for each water management area in the country – were produced.

In addition to the Atlas, there is a DVD with data and GIS viewer; an implementation manual, and a look-up table listing ecosystem types, species and special features recorded in priority areas. A technical report describing the scientific approach to identify priority areas was also created.

LAST RIVER STANDING

The project has triggered alarm bells in some areas. For example, the Upper Groot Marico River in the North West was found to be the only free flowing river representative of the entire north-western region of the country, with no other free flowing rivers in Gauteng. (A free-flowing river is a river which flows undisturbed - i.e. without dams or other structures – from its source to the confluence with another large river or to the sea) The Upper Groot Marico River, which plays an enormously important role in the cultural and spiritual lives of the communities living beside it, is currently threatened by several mining applications.

The Eastern Cape and KwaZulu-Natal were found to have the highest number of free-flowing rivers in the country. Many of these rivers will undoubtedly lose their free flowing status as these provinces urgently require development of water resources to improve water supply to households and agriculture.

Of South Africa's last remaining free flowing rivers, only 25 are longer than 100 km. This constitutes only 4% of the length of the entire river

Left from top to bottom:

Map 1 *– Remaining free flowing rivers of South Africa.*
Map 2 *– Fish sanctuaries for threatened and near threatened freshwater fish species indigenous to South Africa.*
Map 3 *– High water yield areas in South Africa.*
Map 4 *– River condition in South Africa, with blue indicating unmodified, natural rivers and red and purple indicating largely and seriously modified rivers respectively.*

network in the country. Nineteen of these rivers have been selected as flagship free flowing rivers based on their representativeness of free flowing rivers across the country as well as their importance for ecosystem processes and biodiversity value. These flagship rivers should receive top priority for retaining their free flowing character.

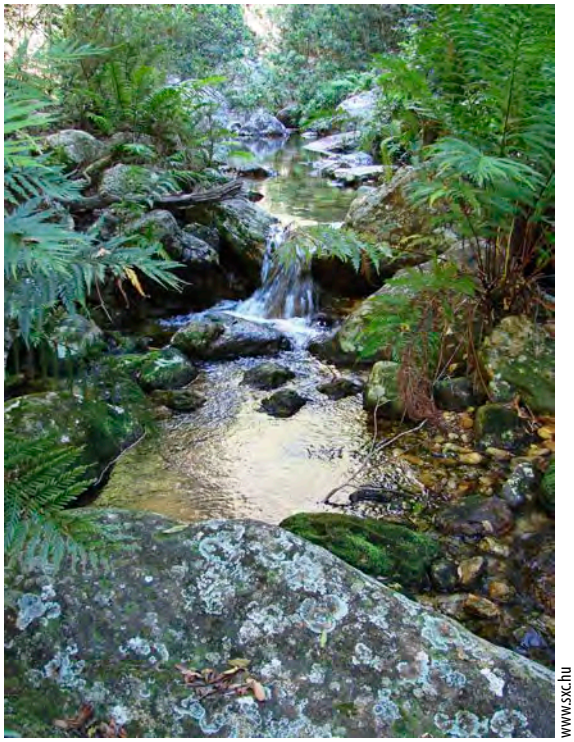
For the first time, threatened freshwater fish species and their surviving populations have been prioritised on a national scale. "The maps are a benchmark for future conservation planning and represent a significant step towards prioritising our efforts to prevent extinction of our unique freshwater fish fauna," notes SAIAB senior scientist, Dr Ernst Swartz. The Olifants/Doorn and Inkomati water management areas, in particular, have been identified as fish biodiversity hotspot areas.

According to Wilma Lutch, Director of Biodiversity Conservation at the Department of Environmental Affairs, the timing of the project is opportune. "We are in the process of implementing various pieces of legislation. This includes the listing of threatened ecosystems in terms of the Biodiversity Act, as well as the implementation of the national protected areas expansion strategy, to which this project will contribute hugely."

ENSURING IMPLEMENTATION

The NFEPA maps are already influencing integrated water resource management plans and decisions in several water management areas. Among other, they are being used for water resource classification, ecological reserve determination and the issuing of water licences. Organisations such as CapeNature, for example, are using the maps to determine the priorities around invasive alien plant clearing and deciding on where alien fish may be stocked.

One of the greatest challenges going forward is to ensure that the project maintains its momentum and that the products emanating from the NFEPA initiative do not end up gathering dust on a shelf. "Implementing and sharing the knowledge emanating from this project is now important," says WRC CEO Dhesigen Naidoo. "For this we need to continue to build on the partnerships created by this project."



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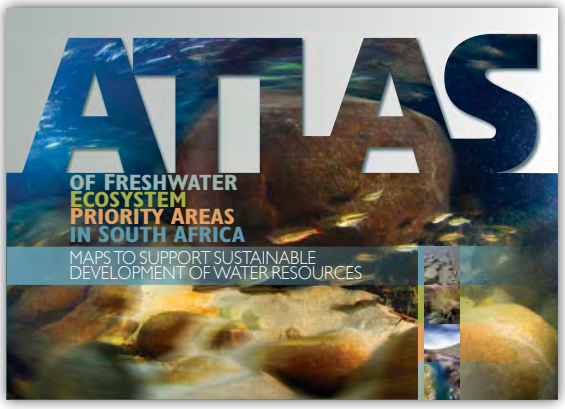
Opportunities for conserving the country's last remaining free flowing rivers are fast disappearing with the growing demand for development of water resources.

- To order the *Atlas of Freshwater Ecosystem Priority Areas in South Africa* (**Report No: TT 500/11**) and related reports, contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565 or Email: orders@wrc.org.za



THE MAIN THREATS TO SOUTH AFRICAN RIVER SYSTEMS

Flow alteration – Flows can be altered either by removing water from a freshwater ecosystem or adding more water through return flows or water transfer schemes. In South Africa most large rivers are heavily utilised and regulated to improve water security, and large dams can store up to two thirds of the country's total annual runoff.

Water pollution – This is a very serious and growing problem in South Africa, especially as failing water treatment infrastructure battles to treat the increasing domestic and industrial effluent from towns and cities.

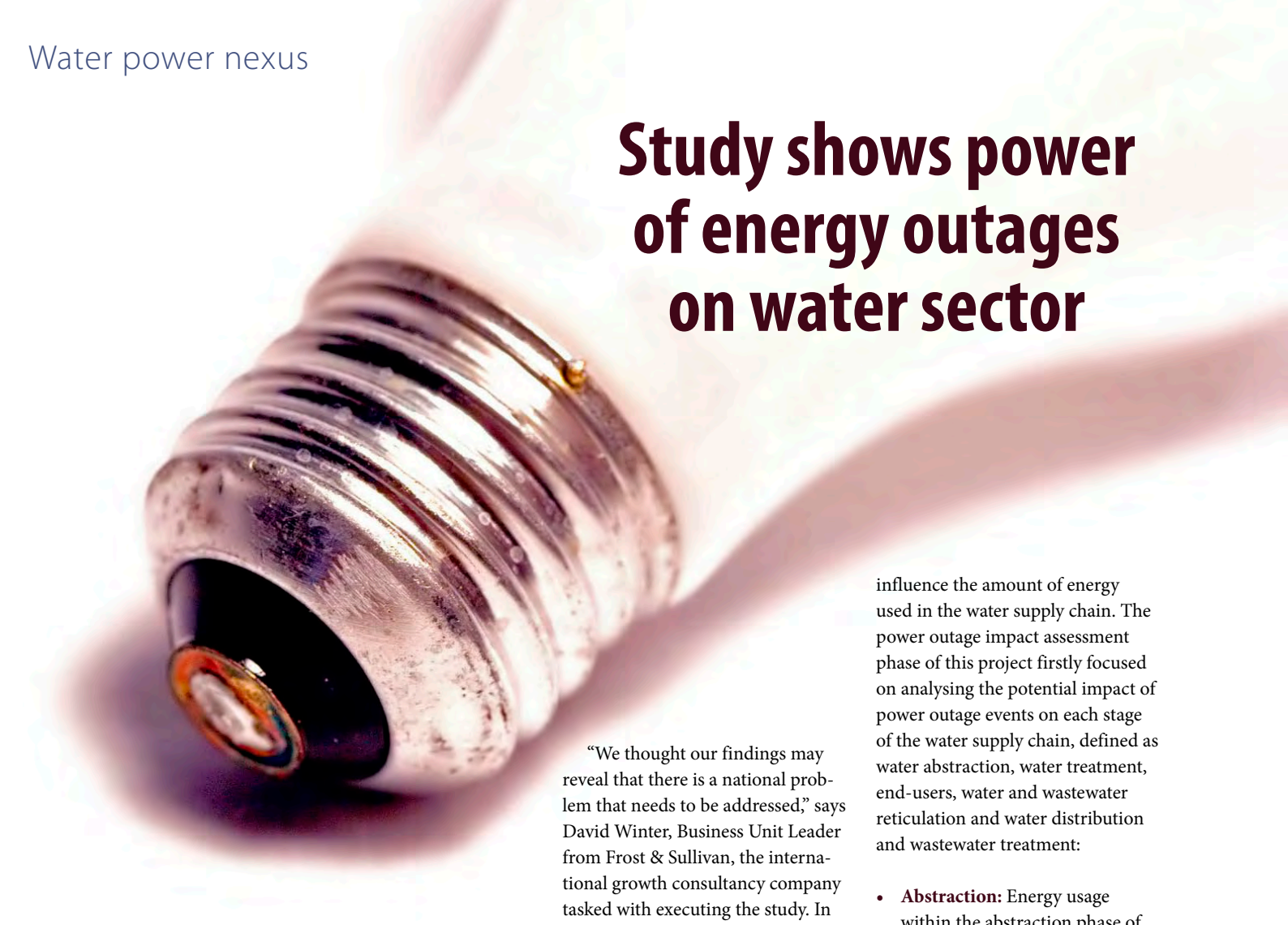
Destruction and degradation of natural habitat – This includes direct impacts, such as bulldozing and planting of crops in wetlands or river channels, and indirect impacts, such as clearing natural vegetation in the surrounding catchment, which results in increased sediment loads and erosion.

Invasive alien species – Invasive alien plants have a substantial impact on riverine habitat and water yield, consuming an estimated 7% of South Africa's total annual runoff.

Climate change – Predicted changes in rainfall and temperature will impact on water resources. These changes are likely to have a disproportionately large impact on runoff and river flow, with implications for future planning and management of water resources, especially around extremes such as floods and droughts.

Source: Atlas of Freshwater Ecosystem Priority Areas in South Africa

Study shows power of energy outages on water sector



A newly-published study by the Water Research Commission (WRC) explores the effects of power outages on South Africa's water and wastewater services. Article by Petro Kotzé.

Without water, energy cannot be produced and without energy water cannot be transported or treated. Water and energy have a crucial dependence on each other and, if the one fails, the other is severely affected. In light of this interdependence between energy and water, and South Africa's electricity capacity shortfalls, the question begs to be asked: If the one does fail, what exactly will happen to the other?

This was answered during a recent study commissioned by the WRC on the impact that energy supply challenges are having on South Africa's water and wastewater services. Funded jointly by the WRC and the South African Local Government Association, the project aimed to provide stakeholders within the South African water and wastewater treatment sectors with an objective and logical evaluation of the current and expected impact and consequences of power outages on water and wastewater treatment services.

"We thought our findings may reveal that there is a national problem that needs to be addressed," says David Winter, Business Unit Leader from Frost & Sullivan, the international growth consultancy company tasked with executing the study. In order to address this research problem, the research team looked at, among others, the potential impact of power outages across the entire water supply chain and conducted a regional water demand impact analysis.

ENERGY USAGE IN SOUTH AFRICA'S WATER AND WASTEWATER SECTORS

Even though raw water resources in South Africa are of a high quality, especially in comparison to more developed nations, our challenges lie in water distribution. Gauteng's water supply, for example, is supplemented by a complex water transfer scheme from Lesotho. Still, South Africa has one of the most advanced water and wastewater sectors on the continent and according to the report, understanding our water supply chain is a critical component of analysing the impact of power outages in this sector.

There are numerous factors that influence the amount of energy used in the water supply chain. The power outage impact assessment phase of this project firstly focused on analysing the potential impact of power outage events on each stage of the water supply chain, defined as water abstraction, water treatment, end-users, water and wastewater reticulation and water distribution and wastewater treatment:

- **Abstraction:** Energy usage within the abstraction phase of the water value chain is limited to pumping activities. Water abstraction schemes use gravity to move water, but when there are topographical limitations, high lift and booster pumps are used to lift water to a point where gravity can be used.

- **Water treatment:** The significant variation in the levels of water treatment between water boards and water service authorities directly influence the amount of energy consumed at each plant. For example, the country's largest supplier of potable water, Rand Water consumes approximately 662 kWh per Megalitre of water treated for its approximately 20 million water users. In comparison, Sedibeng Water (supplying the Free State and Northern Cape) uses approximately 1154 kWh per Megalitre of water treated. The latter's energy figures includes other operational costs, but the significantly

higher cost is because they do not use gravitational feeds.

- **Water end users:** Water is utilised in varying quantities by different end-users. By far the largest consumer, the bulk of irrigation water utilised is untreated and bypasses the traditional water supply chain (thus, largely left out of this study). On the other hand, limitations in water supply due to power outages could result in significant negative impacts on the mining and bulk industry, for power giant Eskom itself and for some urban commercial activities.

- **Water and wastewater reticulation:** Energy usage for the reticulation of water and wastewater is very similar to that of water distribution. Pumping is the largest energy consuming component, with telemetry control systems also requiring consistent power. The quantity of energy used is determined by the level of pumping required; in areas where gravity is utilised significantly less energy is consumed.

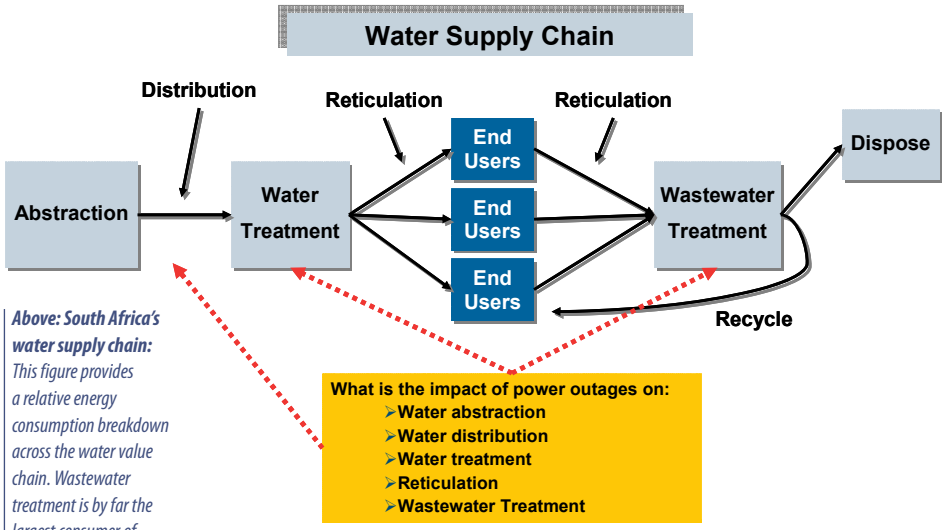
- **Wastewater treatment:** In total, wastewater from the urban and commercial sectors, industry and mining equates to about 7 600 Mℓ of wastewater per day. In the entire water supply chain, wastewater treatment is by far the largest consumer of energy, but the amount of energy consumed differs significantly between different treatment plants. In general, the bulk of the energy consumed results from the aeration process. However, in the event of a power outage the treatment monitoring systems are also important to ensure that wastewater does not pollute the surrounding environment. The study found that both water and wastewater treatment processes utilise 'significant' amounts of energy.

In general, it was concluded that the water supply chain is impacted to varying degrees in the event of a power outage, depending on the characteristics of the plant and the availability of back-up power. While pumping is the most vulnerable activity in the water supply chain, the use of gravity feeds can reduce the severity in many cases. While water security for end users is directly influenced by power outages on abstraction, distribution or water treatment points of the supply chain, water services authorities and water boards generally have sufficient back-up water supply to mitigate power outages.

Wastewater treatment is also very energy intensive, and hence vulnerable to power outage events. Again, plant characteristics dictate impact levels. Plants with back-up power supply and overflow dams are generally not impacted by power outages, but less prepared facilities can experience significant environmental, economic, health and social impacts. Overall, the amount of energy consumed in these treatment processes are influenced by a variety of factors, like the location of the treatment plant (and the resulting use of gravity or pumping feeds), the treatment technology used and the quality of water being treated.

Lani van Vuuren

In the entire water supply chain, wastewater treatment is by far the largest consumer of energy.



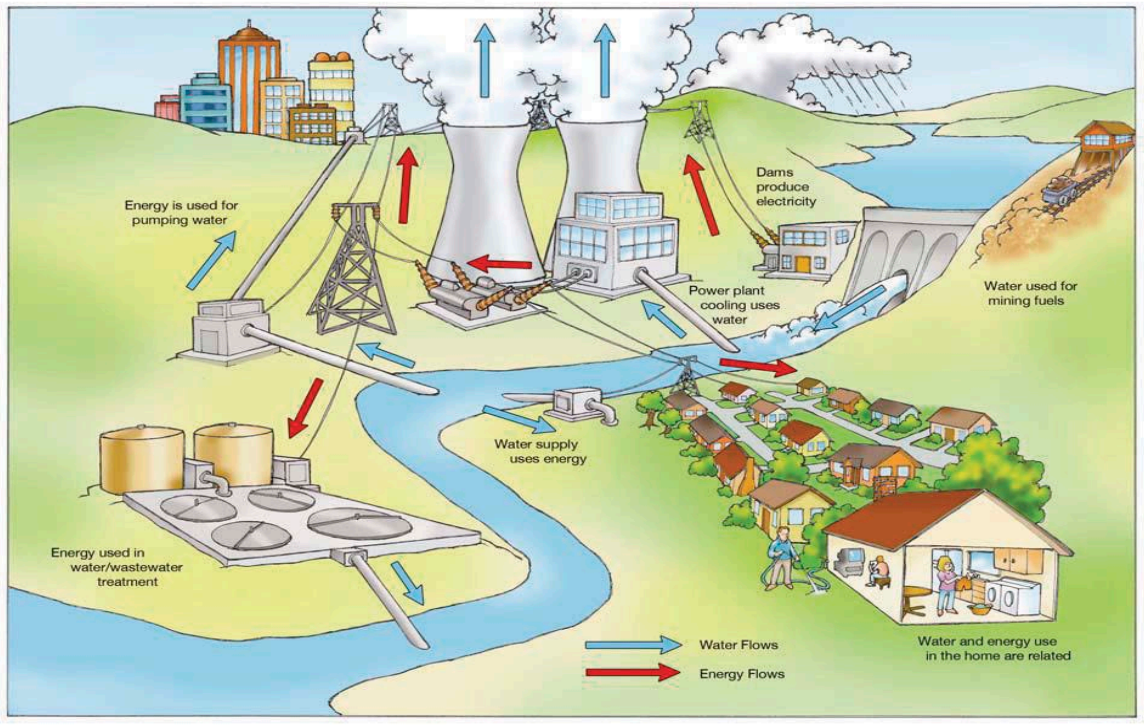
Above: South Africa's water supply chain: *This figure provides a relative energy consumption breakdown across the water value chain. Wastewater treatment is by far the largest consumer of energy with a range of 200 – 1800 kWh/Mℓ treated. Water treatment typically reflects lower energy consumption figures at 150 – 650 kWh/Mℓ treated. Abstraction, distribution and reticulation vary depending on whether gravitational feeds are utilised or not.*

Contributing factors that could aggravate load shedding include old and badly maintained water treatment plants (including the pipes used to distribute water to towns and cities), poor management and lack of skills among municipal staff, lack of funding and emergency preparedness, limited technical support and lack of monitoring equipment. Recent research by the Department of Water Affairs also revealed that the majority of wastewater treatment works do not operate within their design capacity, which will impact heavily on the possible consequences of power outages. It is estimated that 40% of these do not monitor their volume of discharge and do not adhere to licence agreements, while the majority of plants are 30 to 50 years old and many are poorly managed.

A second tier of the analysis entailed a regional comparative impact analysis. This part of the study looked at water demand levels across the region, and focused specifically on economic and social water requirements. Gauteng was identified as the highest risk area in terms of the potential impact of a lack of water services resulting from a power outage event. The high concentration of high water consumption economic activities and a large concentration of South Africa's population afforded it this status, while the Western Cape and KwaZulu-Natal were afforded medium level economic and social risks. More key areas that cannot afford energy and water shortages include manufacturing and mining industries.

The analysis found that power outages have, without any doubt, a direct impact on water and wastewater delivery in South Africa, across a range of economic, environmental, social and health areas and several examples of power outages event impacting the South African water supply chain were identified. The Cedarberg Municipality, for example, has been plagued with power outage events, which indirectly impact water and wastewater service delivery.

Besides the impact on the local community there is a real financial



Right: Energy and water – the inextricable link: *Without water, Eskom would not be able to produce the country's power supply, necessary, among others, to provide water to users through the entire country. Eskom uses approximately 325 million cubic meters of water per annum to produce this energy, mostly by using coal to heat water, convert it into steam and release it to turn large turbines to create power. The majority of power stations were built in water catchment areas, but some need water to be transferred via pipelines, pumping systems and various other components between inter-basin transfers – all of which require energy to operate.*
Source: American Water (2008)

cost to provide back-up services. A case in the Ugu district revealed a direct impact on a commercial business, which resulted in a loss of revenue and salaries for casual labour. Other cases include health impacts in Howick, KwaZulu-Natal, environmental impacts at Zandvlei in the Western Cape and economic impacts for the City of Cape Town who has had to install back-up power supplies. All of these examples can be attributed to power outage events that have impacted the water supply chain.

In order to ensure that the impacts highlighted in the report are eliminated or at least reduced, the study results indicate that water decision makers and managers must take appropriate mitigatory steps or there will be costly consequences. "However," adds Winter, "an important finding was also that each location and treatment plant has unique characteristics that may or may not make it vulnerable to a power outage event." He adds that one cannot generalise about all treatment plants as many of them are unique and are in unique situations that may render them either vulnerable or not.

In general though, smaller providers who don't have back-up generators or sufficient plans to manage a power outage event, would be hardest hit by power outages, says Winter. For these service providers, challenges will arise when energy-intensive activities (like pumping or treatment) cannot function and either water cannot be delivered to end users or, there is a risk that wastewater will pass through a treatment plant without being treated and contaminate the receiving environment.

LOWERING THE IMPACT OF POWER OUTAGES

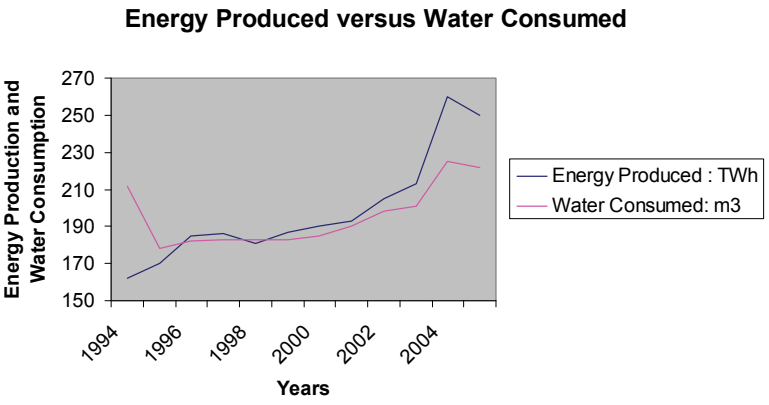
In conclusion, the analysis found that tackling power supply challenges in the water and wastewater sectors will require a multifaceted approach. No individual mitigatory measure will successfully account for every eventuality that may arise in terms of a power outage.

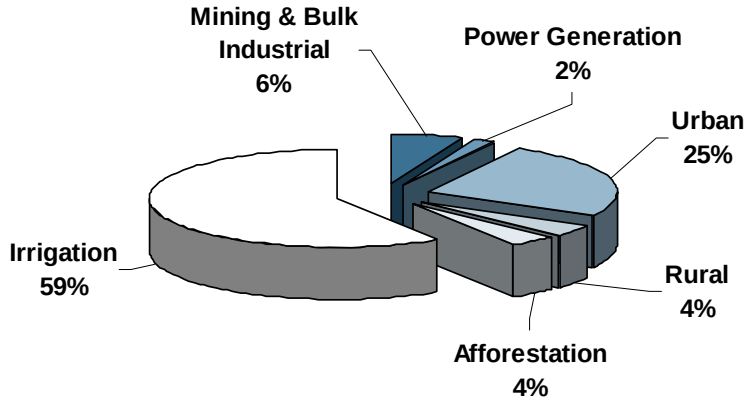
The key areas that should be addressed include improved communication between the water sector and the energy sector. If load shedding is required, critical processes along the water supply chain need to be prioritised. While large consumers of water like Eskom and Sasol work closely with water and energy service providers to secure levels of supply, this needs to be extended to smaller water services authorities.

A second key recommendation is on-site power generation capacity, seen as the best solution to ensure that critical processes continue to function in the event that power outages cannot be avoided. Additionally, it is imperative that personnel are adequately trained and know what mitigatory measures need to be implemented in the event of a power outage. Lastly, contingency plans need to be put in place so that water managers and operational staff know what to do in the event of a power outage. This initiative should be managed and driven by the Department of Water Affairs and rolled out across all water services authorities.

According to Winter, "the value of the findings lies therein that we know that load-shedding will not cause a national-level crisis, impacting all treatment plants." Treatment plants and their vulnerability to power outages are location and plant specific. "In addition," he says, "most load shedding events are location specific and not typically at a national level, which further reduces the impact of a nation-wide risk."

- To order the report, *Power Outages and their Impact on South Africa's Water and Wastewater Sectors* (**Report No: KV 267/11**) contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; Email: orders@wrc.org.za or download an electronic copy at www.wrc.org.za ❑





Top left: Energy produced vs. water consumed – *The graph shows the relationship between the water consumed and the energy produced by Eskom from 1994 to 2005. Regardless of the various measures to conserve the use of water implemented, the graph clearly depicts the co-dependency that exists between water and electricity production.* ***Source: Eskom***

Bottom left: South African end user water consumption breakdown – *Water is used in varying quantities by different end-users. By far the largest consumer is agriculture, followed by urban areas, mining and bulk industrial, and then rural and afforestation.*

DWA/eWISA

The inlet/outlet works in Rockview Dam comprise a reinforced/pre-stressed concrete tower, 68 m high. To ensure the tower's stability in the event of an earthquake it was necessary to provide 32 anchors, each of 3 000 kN capacity, anchored 20 m into the rock.

PALMIET – An environmentally sound example

Long before the passing of formal environmental management legislation, the Palmiet Pumped Storage Scheme proved that infrastructure development can be sensitive to the needs of the environment. Article by Lani van Vuuren.

Numerous large water engineering projects in the 1950s, such as the raising of the Steenbras Dam and the completion of the Wemmershoek Dam, proved to be inadequate to meet Cape Town's insatiable demand for water. All eyes turned to the Palmiet, a short river (only about 74 km) which rises in the Hottentots-Holland mountains and winds south-west to its estuary near Kleinmond.

The river had actually been identified as a possible water source as far back as the 1900s. A Mr St V Erskine, learning that the Town Council of Cape Town was investigating potential water supplies, looked to purchase land around one such a possible river and acquiring the water rights. (His plan was to sell the land and water rights back to the municipality for a profit). He passed by the Steenbras River 'a mere dribble he could jump over' and settled on the Palmiet River, which he had to cross by using a punt and wire rope.

With financial backing of a London firm and some local investors Erskine started acquiring land in the catchment. However, the distance of the Palmiet River to Cape Town at that stage completely put off the municipality (it would have to be pumped 130 km – quite a task at that time). Erskine then offered to build the infrastructure himself, selling the water to the municipality at 7½ d per 1 000 gallons (4 546 ℓ), but even that did not persuade them. Instead Cape Town chose to develop the Steenbras scheme.

We do not know what happened to Erskine, but 70 years later the Department of Water Affairs (DWA) conducted investigations to survey possible dam sites in the Palmiet River to further augment Cape Town's water supply. Initially it was assumed that a long tunnel would be needed to convey the water from such a dam north-westwards under the Kogelberg and Hottentots

ENGINEERING FEATURES OF THE ROCKVIEW DAM

- **Type**: Rockfill with clay core (main embankment), and earthfill and rockfill with clay core (northern embankment)
- **Height above lowest foundation**: 48 m (main embankment), 33 m (northern embankment)
- **Gross storage capacity**: 16,8 million m^3
- **Crest length**: 1 300 (main embankment), 670 m (northern embankment)
- **Material content of dam wall**: 3,1 million m^3 (main embankment), 450 000 m^3 (northern embankment)
- **Type of spillway**: None
- **Surface area at full supply level**: 77 ha

ENGINEERING FEATURES OF THE KOGELBERG DAM

- **Type**: Mass arch gravity concrete with separate earth embankment
- **Height above lowest foundation**: 54 m
- **Gross storage capacity**: 17,3 million m^3
- **Crest length**: 182,5 m
- **Material content of wall**: 72 000 m^3 (concrete)
- **Earth embankment**: 202 000 m^3
- **Type of spillway**: Ogee (uncontrolled)
- **Surface area of reservoir at full supply level**: 142,6 ha

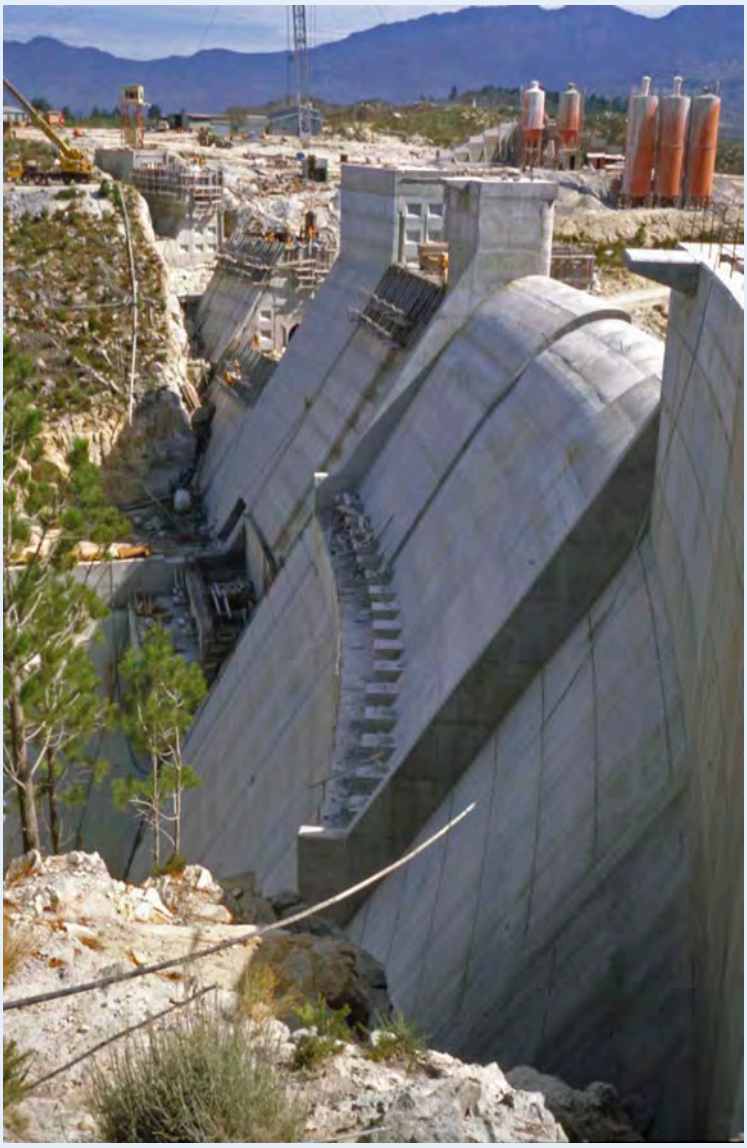
Mountain ranges towards the city (both economically and environmentally unsound), however, the construction of the Steenbras Pumped Storage Scheme in 1978 opened up a new avenue.

By incorporating this scheme to convey Palmiet water towards Cape Town the length of the conduit could be shortened. If the new scheme could be developed as another pumped storage scheme this would even make it more economical as pumping cost would be reduced by using the cheaper off-peak power. So the idea of the Palmiet pPumped Storage Scheme was born.

Eskom undertook the initial feasibility study into the viability of such a scheme, which was completed in 1979. Between 1978 and 1979 initial geological investigations were also conducted. Among others, this involved mapping of the geology from aerial photographs, ground surveys and the examination of borehole longs. A complex geology was uncovered, and it was realised that much more geological data would be required in critical areas before a final feasibility study and cost estimate could be undertaken.

Thus, a second geological study was undertaken between 1979 and 1980. Together these two studies produced 47 boreholes recovering 2 452 m of core material upon which the final feasibility study and cost estimate were based. As the scheme developed, it was found that Eskom's need for peak power generating capacity was more urgent than Cape Town's need for additional water and that the required generating capacity far outweighed the pumping capacity required for the transfer of the available water. As a result, the project took the form of a major hydroelectric pumped storage facility, with provision for the water transfer facility to be brought into use when required.

The final proposed scheme comprised two new dams with an active storage capacity of 15 million m^3 each and a level difference of 285 m to be linked by a 2 km tunnel and 400 MW hydropower station. During the night and over weekends water would be pumped from the lower reservoir (Kogelberg) on the Palmiet River, to the upper reservoir (Rockview) situated on the



DWA/eWISA

Kogelberg Dam nearing completion as part of the Palmiet Pumped Storage Scheme. The dam features a two-level spillway that is a 45 m-long uncontrolled crest in the river section.

Eskom

Eskom

***Above and top**: The Palmiet hydropower plant during construction. The plant has a total power generating capacity of 400 MW and can be brought on stream in less than 3 minutes, compared to coal-fired stations which require around eight hours to start generating power from cold start-up.*

watershed between the Palmiet and Steenbras rivers.

During hours of peak electricity demand, electricity would be generated by releasing water from Rockview through the same waterway system to the power station and returning it to Kogelberg. Additional water over and above that required for generation would be pumped to the upper reservoir and released into the Upper Steenbras Dam. In this way, Cape Town's water would be augmented by about 25 million m^3 a year.

A close working relationship was forged between members of Eskom and DWA involved in the scheme. Eskom became responsible for the design and construction of the power station and the waterways. In turn, the two dams together with the connecting canal and pipeline between the Rockview and Upper Steenbras dams became the responsibility of DWA.

The scheme was approved in 1982 and construction started soon after. The consulting engineers on the project were Ninham Shand and VKE along with Elektroconsult Engineering Services of Switzerland. The main civil works contractors were Clifford Harris-Marti Tunnelling and Philipp Holtzmann of Germany, although the dams were constructed internally by DWA, with Peter Hume and Niel van Wyk of the department acting as resident engineers.

Most of the workforce on the dams were transferred from the Jonkershoek tunnel project and, at the height of construction close to 800 people worked on the dam sites. No housing could be established on site, and so everyone had to be accommodated in nearby Grabouw.

The environment was always going to be an important consideration of the project. The Palmiet runs through the Kogelberg Nature Reserve – a particularly sensitive area endowed with a wealth of fynbos species, and the pumped storage scheme was to be situated close by. DWA carried out environmental studies during the planning stages of the project, and it was during this time that a special environmental ministerial committee was found under the chairmanship of Dr Paul Roberts to investigate the potential environmental impacts of the scheme. The committee included wide representation from key institutions and individuals using water in the catchment.

Various alternatives were investigated while the committee identified pertinent issues requiring attention. A 'construction plan' was eventually drawn up with 54 recommendations on reducing the anticipated negative environmental effects of the project. This included demarcating work areas prior to the start of any construction activities; delineating specific eating areas in order to contain the spread of exotic Argentinean ants; inspecting construction materials to eliminate the possible introduction of non-indigenous plants; providing adequate toilet facilities for workers (largely unheard of on construction sites at the time); and devising a refuse control system. In addition, all polluted and sediment-carrying water had to be controlled and directed to special ponds before being released, while all disturbed areas had to be rehabilitated by replacing the topsoil that had been removed and stored (restoration was done concurrently with construction).

Even access roads were routed to avoid scenic outcrops of rock of sensitive plant growth areas and followed natural contours thus blending in with the landscape. The Palmiet power station – as well as the waterway linking the Rockview and Kogelberg dams – was placed underground. The recommendations were accepted and a resident environmental control officer was appointed to see that they were carried out. The main approach of the environmental programme was to prevent pollution. Interestingly, this preventative approach ended up saving as much as 1,5% of the anticipated project cost.

ROCKVIEW DAM

Situated 285 m above Kogelberg Dam, Rockview Dam being situated on a watershed virtually has no catchment area and is solely dependent on pumping to fill it. The dam basin consists of two natural depressions, with the larger one located on the southern side. These depressions are linked by an excavated channel. The main embankment, which is about 1 300 m long and has a maximum height of 48 m, was constructed mainly along the southern perimeter of the basin. This main wall was constructed of rockfill with a central clay core, and has a material content of 3,1 million m^3.

The secondary (or northern) embankment is about 670 m in length, and has a maximum height of 33 m. The natural topography borders the remainder of the basin. The northern embankment also has a clay core and rockfill outer zones but, in order to make use of the sandy overburden material within the dam basin, relatively large sandy

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- Thanks to eWISA for photographs

transition zones were also incorporated. This embankment also houses the outlet system which comprises two pipes each able to discharge the required flow of 6 m³/s at the lowest drawdown level. Each outlet pipe is of 1 500 mm internal diameter, and is provided with a hydraulically controlled slide gate for isolating purposes at its inlet and is terminated by a 1 400 mm sleeve valve. The outlet pipes are encased in concrete over the full length and the concrete encasement is founded on rock.

The quarry needed to provide the rockfill was the biggest ever established by DWA at that time and, when completed, Rockview dam was the largest rockfill dam (by volume) in the country. By constructing a rockfill dam DWA was ensured of a larger capacity structure created by the removal of material for the embankment from the dam basin. An estimated 2,5 million m³ additional capacity was created by excavation of rockfill from the basin. At full supply capacity the water area within the dam basin is about 77 ha and the live storage capacity is 15 million m³. Construction of Rockfill Dam kicked off in 1983 and was completed in November 1986.

KOGELBERG DAM

The lower storage unit, Kogelberg Dam, is situated on the Palmiet River some 2 km downstream of the power station. It consists of a concrete arch/gravity wall in the river section with a separate earth embankment on a saddle on the eastern flank. The concrete wall has a total length of 182,5 m with a maximum height of 54 m above its lowest foundation level and contains 72 000 m³ of concrete. The earth embankment is 850 m long, with a maximum height of 17 m, containing about 202 000 m³ of earth. A 45 m-long ogee crest spillway permits passage of a 1 360 m³/s flood, the energy generated being dissipated by a splitter-and-step system that aerates the nappe. A concrete apron protects the riverbed from erosion. River outlets were provided to permit the passage of compensation water to downstream riparian owners. All material for the construction was obtained from the Rockview reservoir basin.

Initially, access to the dam site was difficult, and a 5 km permanent road had to be constructed before construction could start. Eventually building started in May 1983. A 6 t luffing cableway was used to construct the main concrete wall. The cableway towers were 263 m apart and 60 m high. Concrete was transported from the mixer to the cableway in two 2,25 m³ buckets on an electrically-driven trolley. The cableway was able to reach 18 m to each side of its centreline, and was able to cover most of the dam wall. Concrete for the apron was placed by mobile crane.

Work in the riverbed was executed during the summer months when the flows were low and easily diverted. To stop the dam from impounding and thereby flooding the power station works in the basin, a temporary opening of 6 m by 6 m was left in the dam at a low level. This opening was successfully closed in April 1987 by constructing a 2,4 m-thick reinforced concrete wall at the upstream end. The dam was completed in July 1987, and overspilled for the first time on 10 July that year. The entire project was officially inaugurated on 14 October 1988 and in that year won a SAICE Award for 'Most Outstanding Civil Engineering Achievement'. ❑

DWA/eWISA

DWA/eWISA

Below: *Work is undertaken on the bottom of the Kogelberg Dam, the lower storage unit of the Palmiet pumped storage scheme.*

Bottom: *Rockview Dam during construction. At the time, Rockview was the largest rockfill dam in the country by volume.*

A proud history of dam safety

Trisa Hugo

Continuous work by the Department of Water Affair's (DWA's) Dam Safety Office is required to ensure that South Africa maintains its imposing dam safety record. Article by Lani van Vuuren.

The first significant storage dams in South Africa were already constructed during the second half of the nineteenth century, but it was not until 1987 that the country passed its first dam safety legislation. Nevertheless, the country's dam safety record compares favourably with that of developed countries. Loss of life during dam failures has been relatively low through the decades, and in the last 25 years not a single Category II or III (high risk) dam for which there had been a licence to construct has failed in South Africa.

Last year one incident was reported, namely Hogsett Dam, a 15 m high, 125 200 m^3 capacity earthen dam near Dordrecht, in the Eastern Cape, which failed in February after heavy rain. Originally constructed in 1932 the dam was never registered or inspected and thus missed out on the benefits of dam safety legislation.

"The objective of dam safety legislation is to improve the safety of new and existing dams with a safety risk so as to reduce the potential for harm to the public, damage to property or to resource quality," explains Jan Nortje, Chief Engineer of the DWA Dam Safety Office. Dam owners are wholly responsible for ensuring the safety of their dams, with the Dam Safety Office responsible for administering and monitoring compliance with legislation. "We are fortunate that so few medium or large dams have failed in South Africa to date. However, we cannot rest on our laurels. Dam safety depends on regular monitoring and maintenance, and dam safety evaluations, including inspections, need to be undertaken constantly."

Particular attention is paid to the safety of dams with a high hazard potential, and the upgrading and monitoring of existing Category II and III dams remains a priority. Of the 1 926 category II and III dams registered with the Dam Safety Office, 1 422 have been inspected at least once. As an owner of many of these dams, DWA itself has also started with a comprehensive rehabilitation programme to improve the safety of its dams.

Some concern has been expressed over the safety of municipal dams, many of which are in excess of 50 years old. "There are so many other pressing priorities at municipal level, such as the provision of basic services, that the safety issues of dams are often neglected," reports Nortje. "In many municipalities there is also a lack of technical capacity to appreciate and address the shortcomings in structural safety and day-to-day operation and maintenance of municipal dams."

Unfortunately, the Dam Safety Office has limited technical capacity, consisting of only two engineers and one technician, and there are limits to the technical assistance the office can provide local authorities. Municipalities – as other dam owners – must procure technical expertise from the private sector to conduct regular compulsory dam safety evaluations of their dams, and carry out any recommendations stemming from these evaluations. The Dam Safety Office has recently focused on better communications with municipalities regarding the requirements of dam safety legislation.

The 1987 Dam Safety Regulations, originally drawn up under the Water Act of 1956, have now been revised to bring them in line with the current National Water Act of 1998. The biggest change has been that in addition to protecting human lives and property against unsafe conditions at dams, the draft new Regulations have been expanded to also protect water resources by assigning a high priority to e.g. pollution control dams, which have an impact on groundwater and surface water resources. These dams occur mostly in the mining, industrial and municipal sectors.

"The draft new Regulations will also streamline the process of approval of professional persons for dam safety tasks in terms of the Regulations by providing for a Register of Approved Professional Persons, to be compiled in consultation with the Engineering Council of South Africa," explains Nortje. "The old Regulations required that a person had to apply for approval every time he/she undertook a dam safety task, for example, new approval had to be sought even if the same person was requested to perform a second five-yearly dam safety inspection."

Under the draft new Regulations a person on the Register will be allowed to perform dam safety tasks as specified in the Register without having to re-apply. This is expected to greatly reduce the administrative burden on the Dam Safety Office.

In addition, the new draft Regulations will provide for a self-sustaining inspection programme by requiring that Category II and III dams must be inspected by an approved professional person every five years. This will relieve the Dam Safety Office from the administrative burden of having to send instructions every five years. "This will mean that scarce human resources can now be focused on other important tasks, such as monitoring that inspections are done and that the recommendations to upgrade the safety of dams are implemented," notes Nortje.

When dam failures do occur in South Africa, they usually involve small, farm dams. Around 74% of the dams currently registered with DWA's Dam Safety Office are less than 12 m high, with 86% having a storage capacity of less than a million m³. "In the old regulations, requirements for small Category I dams were very superficial, making them almost meaningless," notes Nortje. "More pertinent information is now required by the new regulations for the various actions (when applying to construct a new dam or when inspecting an existing dam). This should help improve the safety of Category I dams."

At the time of writing the draft new Regulations were awaiting final Ministerial approval. ❑

Distribution of registered dams according to size class

Size class	Number	%
Small (5 m-12 m)	3 465	74%
Medium (12 m-30 m)	1 061	22%
Large (30 m and higher)	183	4%
Total	**4 709**	**100**

Source: DWA

Category classification of existing dams

Category classification	Number of dams	%
Category 1	2 456	56%
Category 2	1 622	37%
Category 3	288	7%
Total	**4 366**	**100**

Source: DWA

WHEN DOES A DAM CARRY A SAFETY RISK?

A dam is defined in legislation as any structure capable of diverting or storing water. So a storage reservoir for municipal water supply is a dam, and so is a tailings dump at a mine or power station that may or could contain water as well as a refuse dump that contains water. At present any dam with a storage capacity in excess of 50 000 m³ and a vertical height higher than 5 m is considered as having a safety risk. Every dam with a safety risk must be classified as a Category I, II, or III dam (with I being relatively low risk and III being relatively high risk). This is done on the basis of the dam's size and its hazard potential rating. In South Africa, about 56% of dams are classified as Category I. No person who intends to construct a new dam with a safety risk, or enlarge, alter or repair an existing dam with a safety risk, may begin construction work before he or she is in possession of a dam license to do so, which is issued by the Department of Water Affairs. For more information Visit: www.dwa.gov.za and click on the 'Dam Safety Office' button under the 'Sites' banner.

WATER Kidz

Develop a school policy to IMPROVE WATER MANAGEMENT

We all need to work towards managing our water resources more wisely, whether it is on an individual, group, class, grade or school level. Schools uses many thousands of litres of water every day. Water has many uses in schools, including drinking, flushing the toilet, cleaning equipment, washing hands and watering the garden and sports fields.

Generally, schools in South Africa that have piped water have water meters and so they pay for the water they use. The school has to pay the water bill itself. The more water the school uses, the more it has to pay! If that money was not spent on water it could be used for something else!

One way of ensuring water is not wasted at school is to have a water management policy. A school water policy is a statement of intentions and principles for improving a school's educational and environmental performance. The policy development process involves learners, teachers and other stakeholders and encourages schools to audit existing practices, activities and other elements of the curriculum and to select, evaluate and review environmental education goals and management plans.

Minimising water wastage and using water more wisely usually forms an important part of such a policy. To improve water management at your school you need to start with an audit of current performance. An audit is a careful look at the way things are. A policy then attempts to address what has been discovered in the audit.

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Conserving water will save your school both a precious resource and some Rands and cents.

TOP TEN TIPS TO SAVE WATER AT SCHOOL

1. Bring a water bottle to school to avoid using a drinking fountain that can use more water than a person drinks.
2. Repair leaky taps and toilets throughout the school
3. Install low flow or water-reducing devices on faucets and toilets.
4. Never allow water to run unnecessarily, and avoid using the toilet as a trash can.
5. Encourage maintenance staff to avoid using hoses or pressure washers to clean sidewalks and other paved areas.
6. Make sure spring systems are watering plants and not spraying water onto sidewalks or other paved areas.
7. Develop a poster campaign to help educate the school community on water conserving behaviours, such as repairing leaks, turning off the water while washing hands, landscaping with indigenous plants, etc.
8. Install rainwater harvesting tanks on school grounds.
9. Place ice-cream containers under school water fountains and pour excess water on the garden.
10. Wash paint brushes etc in a bucket or ice cream container, rather than under a running tap.

UNDERTAKING WATER AUDITS AS A CLASS

Divide the class into five groups. Every learner needs a copy of the water audit worksheet provided. All learners need to check the water meter (if your school has one) each day. Each group needs to do the audit on a different day of the week (one group of learners will do it on Monday, the next group on Tuesday and so on) and report any leaking taps or toilets to the teacher.

Once the audits are complete, learners (individually or in small groups) need to brainstorm ideas around how the water management in their school can be improved, based on what they discovered during their audits. Water management actions can include individual learner and teacher actions and whole class/grade/school actions.

Learners then need to write down all the ideas on paper. Teachers can then go round the class, asking individuals (or groups) for their contributions and ideas. These ideas are then listed on the board. The class then decides which ideas (between five and ten) are the most likely that the school will be able to implement. Eliminate the rest.

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MORE WATER CONSERVATION LEARNING IDEAS FOR TEACHERS

- **Poster contest***:* Have students make posters showing water conservation ideas.
- **Research project***:* Have students develop their research skills by looking into water issues in your local area. Have them learn and write about where public water supplies come from, how much water their local community uses and existing or future problems that threaten the security of local water supply.

Once everyone is happy with the policy, write or type it up neatly and present it to the school governing body or headmaster. The school may already have an environmental policy so the water management policy can become part of that.

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Working together we can all help to save water at school.

ONLINE RESOURCES

http://ga.water.usgs.gov/edu/sc4.html
This website of the US Geological Survey features an online drip calculator, which calculates how much water a leaking tap wastes.

http://www.waterwise.co.za/site/home.html
Rand Water's Water Wise website contains stacks of information on how to save water at school and at home.

- The information from this article has been taken from the *Lessons Plans for learners Grades R to 12*, developed by the WRC and Share-Net. To access the lesson plans electronically, Visit: http://wrcwww/Pages/Learning.aspx or Email: orders@wrc.org.za for a hard copy.

Name: .....

Date of audit: .....

Time of audit: .....

WATER	YES	NO
1 Does the school have access to water on tap?		
2 Is the drinking water clean and safe for consumption?		
3 Does the school have tanks to collect rainwater?		
4 Are teachers and learners aware of ways to save water?		
5 Is water management recognised and promoted at your school?		
6 Who among teachers, school governing body members, learners and other staff members know how to change a tap washer?		
7 How many taps are dripping?		
8 How many taps (including baths and showers) are in the school and school grounds?		
9 How many flush toilets are in the school?		
10 How many toilets are leaking?		

If the school has access to municipal water, find and read the water meter in the school grounds. Record the daily use in the table below:

DAY	DATE	TIME	METER READING	LITRES USED
Monday				
Tuesday				
Wednesday				
Thursday				
Friday				
Total for the school week				

SA organisations pledge to protect country's rivers

On 14 November, Deputy Minister of Water & Environmental Affairs, Rejoice Mabudafhasi, launched a new atlas containing mapped river, wetland and estuary priorities for South Africa. The *Atlas of Freshwater Ecosystem Priority Areas in South Africa* is the result of a project that started more than three years ago to answer the question as to how many and which rivers and wetlands the country needs to maintain in a natural condition to sustain economic and social development, while still conserving freshwater biodiversity. The project partners included a host of organisations, including the Water Research Commission. This is the first time such a project has been undertaken in South Africa. Following the launch, all the project partners signed a copy of the Atlas, symbolic of their pledge to take the project forward to ensure the protection of South Africa's critical freshwater systems. Also see the article on page 18.

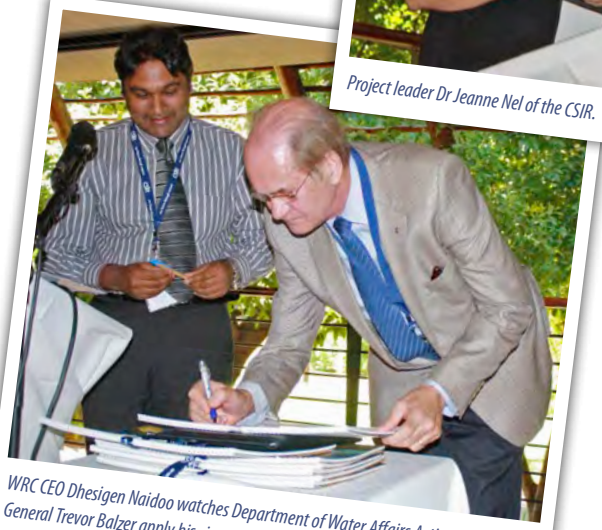
All photographs by Lani van Vuuren

WRC CEO Dhesigen Naidoo with SANBI CEO Dr Tanya Abrahamse.

The national freshwater priority areas project partners pose following the launch of the Atlas.

Project leader Dr Jeanne Nel of the CSIR.

Deputy Minister of Water & Environmental Affairs, Rejoice Mabudafhasi, officially launching the Atlas.



WRC CEO Dhesigen Naidoo watches Department of Water Affairs Acting Director General Trevor Balzer apply his signature to the Atlas.

WRC CEO Dhesigen Naidoo; Deputy Minister of Water & Environmental Affairs Rejoice Mabudafhasi; and SANBI CEO Dr Tanya Abrahamse view the signed Atlas.

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