
THE
WATER WHEEL
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Investigating the culture of social protests
WATER RESEARCH COMMISSION

SOUTH AFRICAN NATIONAL COMMITTEE ON LARGE DAMS CONFERENCE

5 – 7 November 2013
Thaba 'Nchu

SANCOLD

Advances in Dam Technology for Water and Energy in Southern Africa

About the Conference

The South African National Committee on Large Dams (SANCOLD) Conference will be held at the Black Mountain Hotel in Thaba 'Nchu, Maria Moroka Nature Reserve between Tuesday 5 and Thursday 7 November 2013.

SANCOLD invites all from Africa and the wider family of ICOLD to participate in the conference, which will include technical presentations, a technical visit and an exhibition.

This is an ECSA Continuing Professional Development (CPD) accredited event. This Conference is a Category 1 activity and offers 3.0 credits.

Programme

Overview
The conference will commence on Tuesday morning 5 November. On Tuesday there will be presentations by keynote presenters and of technical papers. There will be a special programme for the young engineers during the first two days of the conference. The conference dinner will be held on the Wednesday evening. A technical visit to the Metolong Dam site, in Lesotho, has been arranged for Thursday 7 November. Valid passports are required to enter Lesotho.

Registration

Conference registration is now open. Registration forms, with payment, have to be received no later than 7 October 2013.

Please note that:
Payment is required by cheque or by bank transfer; confirmation of registration will be given after payment has been received in full. The registration fee does not include accommodation.

If you have any queries regarding registration and for further detailed information, please visit www.sancold.org.za or contact:

Mrs Merentia Meyer
Tel: +27 21 808 4352
E-mail: merentia@sun.ac.za

or

Marechia Basson
Tel: 079 4909 210
E-mail: msb@aspt.co.za

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

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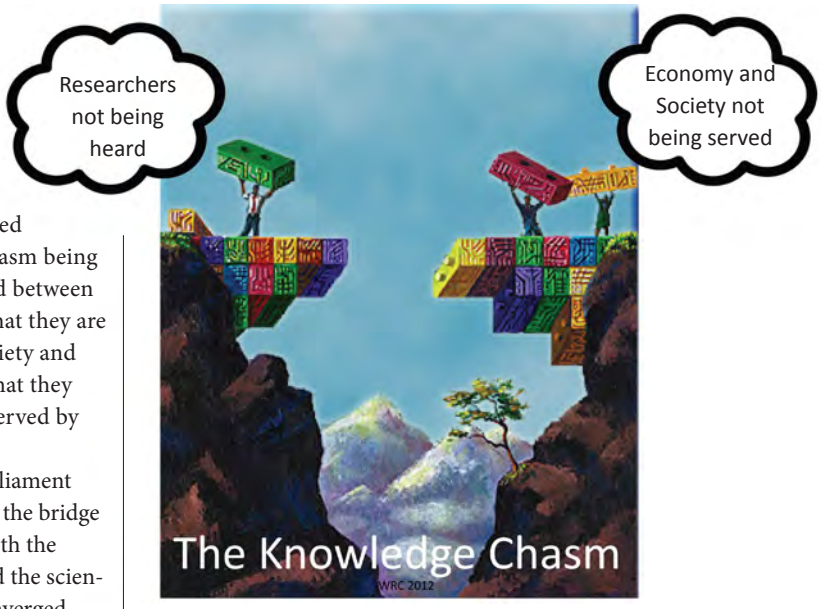
Cover: *Water is playing an increasing role in the rise of social protests in South Africa. See story on p14. (Cover photograph by Greg Marinovich/ Africa Media Online).*

Building bridges between science and decision-making

On 25 September we witnessed a remarkable occurrence. As a special event of the WRC Symposium, the Parliamentary Portfolio Committee (PPC) on Water & Environmental Affairs had an open dialogue with South Africa's water scientists. Portfolio Committee Chair, Johnny de Lange (MP) called it a 'People's Parliament'.

Apart from this being the first time for this type of interaction between legislators and water scientists outside the hallowed halls of Parliament, it gave resonance to the very important notion of creating a sustainable dialogue between the science community and political decision-makers. Much has been said and written about the knowledge chasm, where on the one side you have scientists claiming that they have many of the scientific solutions needed to address South Africa's water challenges, and on the other side the decision-makers and water users feeling insufficiently supported by science to enable better and smarter management of our precious water resources. This has led to the knowledge chasm being described as the void between scientists who feel that they are not heard, and a society and economy that says that they are not adequately served by science.



The traditional knowledge chasm between the scientific community and broader society.

The 'People's Parliament was a cornerstone in the bridge across the chasm. Both the parliamentarians and the scientists very quickly converged on the core issues defining the national water challenge, and with amazing efficiency, to the surprise of the many who expressed reservations on the potential success of the exercise, found resonance on many of the positions.

We should take our hats off to both to the MPs and the truly remarkable candour in which they approached the dialogue, and the remarkably constructive nature in which the scientists unpacked the challenges and the scientific solutions.

The PPC also expressed their pleasure at the great progress this water science community has made to ensure that the pursuit of science is increasingly resulting in positive socio-economic outcomes and impacts, as enunciated in the WRC Knowledge Tree. The strides have been so remarkable that we were able to present during the seminar the Inaugural WRC Knowledge Tree Awards for such scientific work. We know that this recognition will further encourage the South African water research and development sector to

The special parliamentary event at the WRC Symposium.

perform more in this domain.

This brings one to the often debated matter about the bridge. That is the issue about whether or not the academic enterprise has to be sacrificed when re-orientating the scientific effort to better produce outcome, impact and genuine material changes on the ground. In the period of time over which these developments with the WRC Knowledge Tree's six baskets of human capacity development, products and services for the real economy, advising and influencing policy and decision-making, empower communities, developing sustainable solutions and taking forward the national transformation project, the academic performance of the self-same South African water sector has increased.

In fact, we remarkably increased our global standing in production of papers in ISI journals, taking from 19th to 18th place. We also maintained the student participation at Masters and PhD levels in WRC projects of more than 450 a year.

This obviously requires much more rigorous interrogation, but the empirical evidence suggests that not only does the academic enterprise of science in the water sector not diminish through an increased focus on socio-economic development on the core issues of a developing country such as ours, but may even derive enhanced benefit from this orientation. It perhaps describes a pathway to South Africa eventually becoming a global hub of excellence in water development science. We are hopeful of the promise of continued engagement between the budding science-legislative partnership. The WRC will continue to act as the 'glue' agent to facilitate this.

KZN sanitation scheme gets new lease on life

The old Mpophomeni sewage treatment works, which was mothballed in 2001, is getting a new lease on life as a result of a major sanitation upgrade project underway by consultants Royal HaskoningDHV.

The Mpophomeni township and treatment works is located on the western reaches of Midmar Dam. According to project principle, Peter Sibanda, a number of problems led to the plant's closure, most prominently the fact that it was discharging pollutants into the dam – a major water source in the region.

The works was replaced with a sewage pumping transfer scheme to Howick Wastewater Treatment Works, which was upgraded to cope with the additional load. This entire infrastructure, including 11 km of pumping mains and sewers, has now reached maximum capacity. The problem has been further exacerbated by a number of housing projects in the area.

Following several investigations by Umgungundlovu District Municipality, a decision was made to revamp the Mpophomeni treatment works. "The existing works has infrastructure that can be reused, such as backup facilities that can store and subsequently recycle inflows for more than three days when power outages or breakdowns occur," notes project manager, Chris Hazelden.

The revamp project includes the construction of a 6 Mℓ/day treatment works for Mpophomeni, Khayelitsha and spare capacity for future expansion, two new main sewers in addition to smaller sewer refurbishments, and effluent delivery systems, including an artificial wetland effluent polishing system at the treatment works and a subsidiary wetland system on the Merrivale Stream.

The project, which is estimated to cost R160-million, is expected to be completed by February 2015.

Sixty careers in water and counting in new WRC guide

Thought the water sector was all about biology and engineering? Think again.

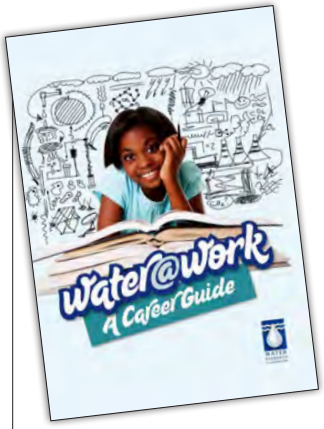
The new updated Water Research Commission's (WRC's) new *Water@Work Career Guide* lists detailed information on no less than 62 career options in the water sector, ranging from accounting and agriculture to social science, water history and zoology. The colourful guide, which is available electronically or in hard copy, is intended as an overview of career paths available in the world of water. It is an ideal resource for learners ready to make subject choices or prospective students exploring possible areas of study. New areas of study, such as polymer science, one focus area of which is nanotechnology, have also been included in the guide.

Readers can also find an exhaustive list of useful contacts, including those institutions which offer bursaries and internships.

Despite its small size, the South African water industry is recognised globally for its innovation and creativity in science and technology, writes WRC CEO, Dhesigen Naidoo, in the foreword of the guide. "The sector faces many challenges, such as the growth of the population, the need to grow the economy, the pollution of our scarce water resources, and the threat of global climate change. These are all opportunities for a new generation of water sector specialists to be innovative in creating the necessary solutions to ensure our country remains on a sustainable path going into the future."

The WRC has for a long time realised the importance of growing capacity in the sector, funding the training of around 500 post-graduate students a year through its commissioned research projects in various fields of study.

Several of the careers in the water sector have been listed as scarce and critical skills. "In order for the South African water sector to remain successful it is vital that young people are enticed to become part of the water family," said Lani van Vuuren, Print Communications Team Leader at the WRC.



"Young people need to know that while mathematics and science are important for a number of careers in the water sector, there are also other career paths to follow. In addition to scientists and engineers, the sector also requires economists, writers, social workers, historians and lawyers, to name but a few."

To order a copy of the *Water@Work Career Guide* (**WRC Report No. SP52/13**), contact Publications at Tel: (012) 330-0340, Fax: (012) 331-2565 or Email: orders@wrc.org.za, or download a copy at www.wrc.org.za.

Innovation and collaboration required to meet water challenges, says Minister

Providing universal access to all of South Africa's citizens not only requires innovation, but also collaboration between scientists and authorities.

This is according to Science & Technology Minister, Derek Hanekom. He was speaking at the WRC Symposium in Pretoria earlier this year.

"Currently only about 74% of citizens have access to stable supply. With regards to sanitation, about 3,2 million households are at risk of service failure or are experiencing service delivery breakdowns. Some 1,4 million households in formal settlements have no services at all," reported Hanekom. "As a nation we are struggling to upgrade and expand bulk infrastructure, ensure the quality of sanitation services, and maintain reticulation and on-site infrastructure."

Because of the number of players and activities in the water value chain the most effective way of addressing the service delivery challenge was through coordination and collaboration – and, most of all, a commitment to finding fresh answers that would carry South Africa forward, Hanekom added.

"The need for joint innovation is particularly critical when one considers that water service delivery is embedded in the Water-Energy-Food security nexus, which highlights the fact that the long-term well-being of the people of the planet are utterly dependent on successful management of not just water, food and energy individually, but also managing the links between them.

Hanekom said that the sector had to deepen existing relationships, as well as forge new ones that would enable it to enter new markets, and drive new socio-economic benefits.

'No Drop' assessment tool rolled out to municipalities

The Department of Water Affairs (DWA) has announced the roll-out of new 'No Drop' report assessments in an effort to curb unaccounted-for water in municipal water networks.

Results from this first assessment period will be published along with the Blue Drop report in 2014.

The assessment is in response to the Water Research Commission's latest non-revenue water report, which notes that South Africa's present level of non-revenue water is in the order of 37%. Of this a quarter is estimated to be losses through physical leakage. The No Drop assessments would provide verified data to support and build on these research results, DWA said in a statement.

In addition, the assessment will provide the public and the water sector with information on water use, water loss and efficiency of water used within a municipality. Similar to the Blue Drop- and Green Drop- reporting, the No Drop report will publish audited and verified values pertaining to water use and management in each local authority, and will report such figures as part of the Blue Drop scorecard. This will allow the public to view the performance and rating of a municipality in terms of its drinking water quality as well as the management of its water volumes.

"South Africa is a water scarce country, and the supply-demand curve shows that South Africa will face a water supply deficit of around 17% of 3,8 billion kilolitres of water by 2030," DWA reported. "The Minister of Water Affairs has prioritised the implementation of measures to reduce water losses and increase water efficiency, as well as tackling water leaks and raising water demand awareness."

Workshop to help banks deal with biodiversity risks

The World Wide Fund for Nature (WWF), together with Citi South Africa and the Business and Biodiversity Offsets Programme (BBOP), hosted a workshop on biodiversity and ecosystem services for the financial sector earlier this year.

The workshop has been designed for banks, companies and consultants to share experiences and engage – collaboratively – around the challenges and opportunities presented by the new International Finance Corporation Performance Standard 6 on Biodiversity Conservation and Sustainable Management of Living Natural Resources.

Understanding biodiversity risks and impacts is becoming increasingly important to financial institutions. The rate and scale of biodiversity degradation is significantly weakening the ability of the natural world to deliver key services such as climate control, air and water purification and protection from natural disasters. These services represent 'natural capital' that companies have treated largely as free 'goods'.

However, losses in biodiversity present large risks to the financial sector and its clients. As much as half of the world's natural habitats have already been cleared, and it is calculated that a single eyar's habitat conversion cost costs society US$250-billion every year into the future.

"Substantial investment in infrastructure is needed to achieve Africa's development and economic growth goals. The course focused on the implementation of the Equator Principles which were developed by the banking industry to address the negative social and environmental impacts of lending to primarily infrastructure projects," notes WWF Sustainable Finance Programme Manager, Malango Mughogho.

Learners get up close and personal with river bugs

Around 30 learners from schools in Gauteng and the North West had the opportunity to explore river health monitoring at the Water Research Commission (WRC) Symposium held in September.

The learners were taught how to use the simplified version of the Stream Assessment Scoring System (known as mini-SASS) which assesses river ecosystem health according to the number and variety of invertebrates available in samples.

"One of the key strengths of the miniSASS technique is that the results it produces are very similar to the full SASS," explained WRC Research Manager, Bonani Madikizela. "This allows the tool to act as a 'red flag' indicator on the condition of rivers, helping non-governmental agencies and citizen river monitoring groups to identify hot spots and areas where follow-up investigation is required."

Furthermore, the current school curriculum covers various aspects of environmental and/or life science studies. The miniSASS tool provides an ideal opportunity of integrating the teaching environment with Government's Adopt-a-river initiative, where communities agree to help monitoring and look after stretches of rivers in their proximity.

To watch the Youtube video on miniSASS Visit: http://www.youtube.com/watch?v=ZNFuG2ZcFts or Visit: www.groundtruth.co.za

The Gadget Factory

Holiday Programme

7 December '13 – 15 January '14

The Sci-Bono Discovery Centre is a world class interactive science centre that supports maths, science and technology education. We offer innovative, dynamic learning experiences for learners and teachers of all ages.

A strategic partner of the Gauteng Department of Education, Sci-Bono aims to:

- Improve teaching and learning of mathematics, science and technology in Gauteng schools
- Provide career education to all learners in Gauteng
- Promote and improve public awareness of and engagement with science and technology
- Be a premier family destination for local and international visitors.

Our collection of over 300 interactive science and technology exhibits caters for curious minds of all ages providing hours of fun for kids and adults.

For more information: visit us on www.sci-bono.co.za or 011 639 8400
Miriam Makeba street, between Jeppe and President Streets, Newtown, Johannesburg

SCI-BONO DISCOVERY CENTRE
Discover Science

WRC Symposium shows off creativity and innovation of the SA water sector

Following a very successful fortieth anniversary conference held in 2011, the Water Research Commission (WRC) teamed up with the departments of Science & Technology (DST) and Water Affairs (DWA) to host the 2013 WRC Water Research, Development and Innovation Symposium. The symposium focused specifically on innovation and creativity within the water sector, and apart from interesting discussions delegates were treated to a water innovation marketplace to view the latest technology creations on offer for the water sector. The first day of the symposium also saw a special dialogue session between members of parliament and water scientists, which was well received. At the inaugural WRC Knowledge Tree Awards, several WRC-funded researchers were awarded for their contribution to improve the impact of research in the water sector. The award winners in different categories were Prof Ochieng Aoyi of the Vaal University of Technology, Prof Lingam Pillay of the University of Stellenbosch, Simon Bruton from Groundtruth, Dr Ronnie McKenzie of WRP Consulting Engineers, Dr Sharon Pollard of AWARD, Prof James Blignaut from the University of Pretoria, Prof Neil Armitage from the University of Cape Town, Oliver Ive from Amanz'abantu Services, Jonathan Denison from Umhlaba Consulting, Dr Nico Benadé from NB Systems, and Prof Leon van Rensburg of the University of the Free State.

All photographs by Elske Kritzinger

Prof Anthony Okoh of Fort Hare University with Bonani Madikizela and Bennie Mokgonyana of the WRC.

Water Affairs Acting Director-General, Trevor Balzer.

Prof Leslie Petrik from the University of the Western Cape and Dr Nonhlanhla Kalebaila, Research Manager at the WRC.

US water expert, Dr John Todd, was one of the keynote speakers at the symposium.

Award winner, Dr Sharon Pollard with WRC Chair, Barbara Schreiner.

Chair of the Parliamentary Portfolio on Water & Environmental Affairs, Adv Johnny de Lange, Minister of Science & Technology, Derek Hanekom, and WRC CEO, Dhesigen Naidoo.

Dr Chris Moseki of the WRC with his wife, Monkie, Prof Geoff Pegram of Pegram & Associates and Ashwin Seetal of Royal HaskoningDHV.

WRC Executive Manager, Dr Gerhard Backeberg (centre), with award winners Prof James Blignaut, Dr Nico Benadé, Prof Leon van Rensburg and Jonathan Denison.

Award winner, Prof Ochieng Aoyi.

Award winner, Oliver Ive and Jay Bhagwan, Executive Manager of the WRC with Zama Siqalaba, Ronnie McKenzie and Willem Wegelin , all from WRP Consulting Engineers.

Award winners Simon Bruton and Prof Neil Armitage.

WRC personnel Lani van Vuuren, Charmain Smit, Zagry Scholtz, Adriaan Taljaard, Dr Shafick Adams, Thobile Gebashe and Dr Sudhir Pillay at the WRC stand.

Award winner, Prof Lingam Pillay with WRC Research Manager, Dr Jo Burgess.

The IWA-WISA Young Water Professionals practiced their debating skills during the symposium.

Warmer world threatens 500 million people more with water scarcity

More than 500 million people might face increasing water scarcity. This is according to studies published by scientists of the Potsdam Institute for Climate Impact Research (PIK).

"We managed to quantify a number of crucial impacts of climate change on the global land area," says Dieter Gerten, lead author of one of the studies. Mean global warming of 2°C, the target set by the international community, is projected to expose an additional 8% of humankind to new or increased water scarcity.

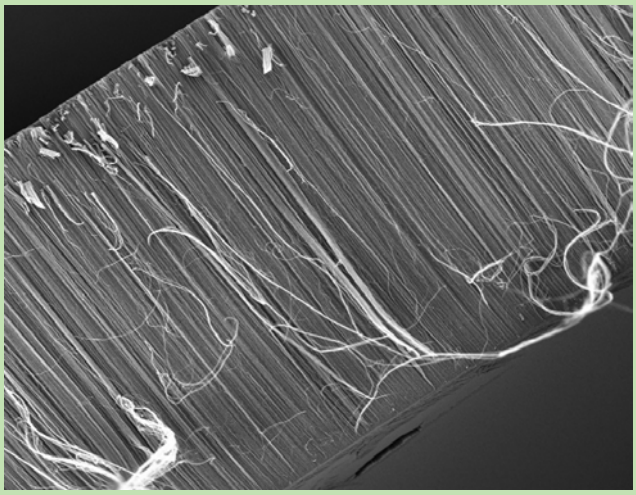
"If the population growth continues, by the end of our century under a business-as-usual scenario these figures would equate to well over one billion lives touched," Gerten points out. "This is on top of the more than one billion people already living in water-scarce regions today." Parts of Asia and North Africa, the Mediterranean and the Middle East are particularly vulnerable.

Plasma-treated nano filters cited to help purify world water supply

Access to safe drinking water is a step closer to being a reality for those in developing countries, according to research published in *Nature Communications* earlier this year.

The study paves the way for the next generation of portable water purification devices, which could provide relief to the 780 million people around the world who face every day without access to a clean water supply.

An international team of researchers – led by Associated Professor Hui Ying Yang from Singapore University of Technology and Design – showed that water purification membranes enhanced by plasma-treated carbon nanotubes area suitable for removing contaminants and brine from water. According to Dr Han, these membranes could be integrated into portable water purification devices the size of a tea pot that would be rechargeable, inexpensive and more effective than many existing filtration methods. Contaminated water would go in one end, and clean drinkable water could come out the other.



"Small portable purification devices are increasingly recognised as the best way to meet the needs of clean water and sanitation in developing countries and in remote locations, minimising the risk of many serious diseases," said Dr Han. "The large industrialised purification plants we see in other parts of the world are just not practical – they consume a large amount of energy and have high labour costs, making them very expensive to run."

The team's study showed that carbon nanotube membranes were able to filter out ions of vastly different sizes – meaning they were able to remove salt, along with other impurities.

Now that the researchers have proven the effectiveness of the method, they plan to extend their research to investigate the filtration properties of other nanomaterials. They will begin by looking at grapheme, which has similar properties to carbon nanotubes, but could be made considerably denser and stronger.

To access the original article, Visit: http://www.nature.com/ncomms/2013/130813/ncomms3220/full/ncomms3220.html

Global first online water footprint tool launched

The Water Footprint Network has launched the world's first online tool to calculate and map water footprints and assess their sustainability.

The Water Footprint Assessment (WFA) Tool 1.0 was created by the Water Footprint Network in collaboration with the University of Twente and three funding partners: DEG, IFC and Unilever.

The tool is free and can be used by anyone interested in sustainable, efficient and fair water use, including businesses, governments, non-governmental organisations, investors, researchers and communities. It provides them with insight into how water is used and the impacts resulting from those uses.

The tool takes users through a structured process to quantify and map their water footprints. This can be carried out for a geographic area (by specific location, such as a river catchment, in multiple locations or across an entire country), or for a single production process/multiple processes (by sector, company, individual facility, throughout the supply chain).

Then the tool analyses the sustainability of water footprints in terms of water scarcity. This means that users can identify whether their water footprints are in a 'water hotspot' – a location where water use exceeds freshwater availability.

To access the WFA Tool 1.0 free of charge Visit: www.waterfootprint.org/?page=files/waterfootprintassessmenttool

Water advice to African farmers via cellphone

The information revolution has transformed farming in many parts of the world. Sophisticated computer models can now process huge quantities of data from satellites to local hydrological stations, producing accurate forecasts for even the remotest regions.

Poor farmers in Africa, however, often struggle to get even basic information about water, weather and other factors that might affect their crops. Recent innovations in computing have enabled extension workers with access to the Internet to partly address this information gap. However, coverage is patchy and the information supplied can be too vague or too late to be of much use.

To address this, the International Water Management Institute (IWMI) and its partners at eLeaf have been exploring the use of information and communication technology to increase agricultural productivity. The outcome of this project was launched in Turkey earlier this year at the First World Irrigation Forum.

"The project aims to provide farmers with irrigation, agriculture and weather-related advice and information direct to their cellphones," said project leader, Bharat Sharma. "The tool enables growers to make more informed decisions, and negotiate more efficient and equitable transactions with water- and farming-related service providers."

The project is currently being

Despite progress high rates of child mortality still plague southern Africa

Southern Africa, along with Eastern Africa, has managed to improve its child survival rate by more than 50% since 1990 – and in the past seven years has been among the best performing regions in the world.

This is according to the latest report from the United Nations Children's Fund (UNICEF).

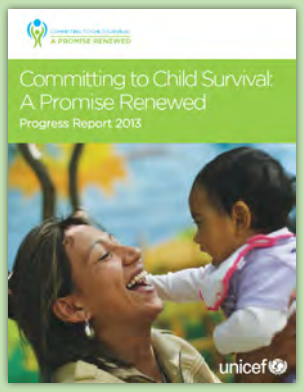
Yet, the region has high rates of mortality, with one in every 13 children dying before the age of five.

According to the report, *Committing to Child Survival: A Promise Renewed,* despite rapid progress in reducing child deaths since 1990, the world is still failing to renew its promise of survival for its most vulnerable citizens.

Diarrhoea, which is largely preventative through measures such as safe drinking water and improved sanitation, accounts for 9% of all under-five deaths – a loss of more than 580 000 child lives in 2012. Most of these deaths occur among children less than two years old.

The good news is that from 2000 to 2012, the total annual number of deaths from diarrhoea among young children decreased by more than 50%, from almost 1,3 million in 2000 to about 0,6 million in 2012. Three-quarters of all child deaths occur in just 15 countries, most of them in Africa.

"Child survival is a shared responsibility," writes UNICEF Executive



Director, Anthony Lake, in the Foreword of the document. "Every segment of society has a role to play. Through investments in domestic production, as well as research and development, the private sector wields enormous influence over the availability, affordability and quality of life-saving commodities and medicines.

"Equally important are the civil society groups that advance the child survival agenda through action and advocacy. Whether delivering life-saving vaccines to the women and children in greatest need, or advocating on their behalf, civil society networks are powerful agents of change. They, like few others, can mobilise their communities to denounce the inevitability of preventable deaths. Each voice that speaks out against the death of a child is a reminder of unfulfilled promises and a call for urgent action."

implemented in Egypt, Ethiopia and Sudan. At the time of writing, about 60 farmers at each of four sites had been trained to use cellphones that can provide instant access to real-time agricultural and climatic data. This is customised to each individual farmer, allowing them to plan at the individual field scale not just what to plant but when the weather conditions will be just right for achieving maximum success. Satellite images, which can depict areas as small as 20 m^2, are analysed weekly for particular characteristics such as changes in field soil moisture.

The imagery is combined with various data, including weather records, river flow measurements and calculations of how well a particular crop may be growing at any given point. "Providing individual farmers with specific advice enables them to plan, at field level, what to plant and irrigate, and they can also find out when weather conditions are just right for achieving maximum success," noted Sharma.

The system is interactive, so farmers can request information via SMS and then receive instant irrigation advice. As the harvest matures, the system will be able to dispense crop-specific advice on when, and how much, to water each field. This will contribute to more efficient use of water resources, and improve the livelihoods of some of the world's poorest farmers.

After the initial phase has been evaluated, researchers plan to explore partnerships with local telecom service providers to further develop and expand these services throughout Africa.

Drip irrigation firms wins international water award

Israeli firm Netafim, a global leader in drip- and micro-irrigation solutions, has won the Stockholm Industry Water Award for 2013.

Currently, more than ten million hectares of farmland are irrigated with drip irrigation, a technology that dramatically improves water, energy and labour productivity. The use of drip irrigation typically halves water use compared to other irrigation solutions, and at the same time increases crop yields.

"Globally, 70% of our freshwater is used for irrigation and, with rapidly expanding demand for agricultural products, there is a dire need to improve water productivity. Netafim's remarkable achievements, helping farmers across the world to 'grow more with less', are directly contributing to a more water and food secure world," said the Stockholm Industry Water Award Committee in its citation.

Recycling, proper waste management can be 'gold mine' – UN study

Some 3.5 billion people, half the world population, lack crucial waste management services, significantly harming the environment, health and economies.

This is according to the United Nations study, *Guidelines for National Waste Management Strategies: Moving from Challenges and Opportunities.* The report further stresses that recycling and proper management can be a literal and metaphorical gold mine

"Open dumping, the most prevalent waste disposal method in many countries, can lead to acute health impacts for those living closest to dumping sites, most often the urban poor," the UN Environment Programme said. "In addition, poor waste management can lead to significant environmental hazards: leachate from waste can contaminate soil and water, open burning of waste can cause air pollution and a failure to use recycled materials from waste means acceleration in the depletion of 'raw' materials," it added.

Beyond the potential amount of recovered gold possible from electrical and electronic waste, the study notes that recovered copper, aluminium and rare metals would exceed by many times the levels found in typical ores. Printed circuit boards are "probably the richest ore stream you are ever going to find," it says.

New from the WRC

Report No. 1723/1/13

Technical support document to the development of guidelines for the utilisation and disposal of water treatment residues (JE Herselman)

Water treatment residues (WTRs) are produced on a daily basis and should be managed. Therefore guidelines for the use and disposal of these residues are important. This guideline has been developed to ultimately allow regulatory bodies to distinguish between wastewater sludge and WTR in their land disposal requirements, and should enable water treatment works to dispose of their residues onto nearby land, thus saving on transport and landfill costs.

Report No. 1942/1/13

Operational and design considerations for high rate clarifiers in the South African water treatment industry (S Budhram; M Nyuswa; R Rajagopaul & P Thompson)

This study was initiated with the intention of contributing to bridging the current knowledge gap that exists in developing countries regarding the use of high-rate clarifiers for water treatment. The project aimed to contribute to the current understanding of the operation, maintenance and process requirements as well as limitations for high-rate clarifiers, based on investigations conducted on a demonstration plant, and to provide practical guidance on the selection, design and operation of high-rate clarifiers, among others.

Report No. KV 308/12

Potential climate change impacts on Karoo aquifers (R Dennis; I Dennis; P Ranlhomela & C Hogan)

To date, very little research has been conducted on the future impact of climate change on groundwater resources in South Africa. Climate change can affect groundwater levels, recharge and groundwater contribution to baseflow. This document serves as a first step in assessing the impact of climate change on South African Karoo aquifers.

Report No. 1680/1/13

Thyroid-disrupting activity in the South African aquatic environment (JH van Wyk)

Global concerns have been raised about the possibility that environmental chemicals (mostly man-made) may interfere with the endocrine systems of wildlife and humans. The overall objective of this project was to set up and evaluate the so-called XEMA approach to identify thyroid disruption activity, and to evaluate the potential to actually screen environmental water using *Xenopus laevis* tadpoles. At the same time the potential to include freshwater fish species as models was also investigated.

Report No. TT 564/13

Social franchising partnerships for operation and maintenance of water services: Lessons and experiences from an Eastern Cape pilot (K Wall & O Ive)

The franchising concept to operate and maintain water services was implemented on rural schools and household water and sanitation facilities in the Eastern Cape with funding from the WRC and Irish Aid following extensive research. The primary objectives of the pilot project were to demonstrate the suitability of social franchising partnerships and to develop a model which can be used for rolling out similar services to more schools. This report records the success of the project in terms of the quality and reliability of service delivered.

Report No. 2111/1/14

Remote and manual radio telemetry methods to monitor and use fish behaviour in South Africa's inland waters (TJG O'Brien; F Jacobs; M Burnette; P Krüger; IF Botha & JA Cordier)

Remote and manual monitoring techniques are internationally recognised as an effective way of acquiring a wide range of behavioural information of freshwater fishes and other aquatic animals over extended periods within their natural environments. This WRC-funded study was established to develop remote and manual radio telemetry methods to monitor and use fish behaviour in South Africa's inland waters. The system was then successfully tested during four case studies.

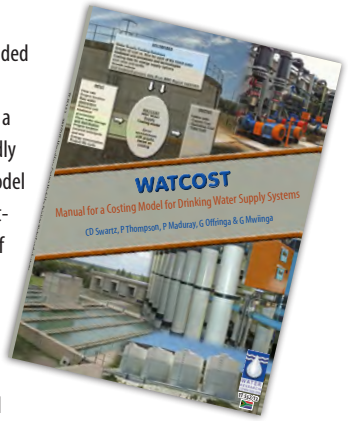
Report No. 2090/1/13

Upscaling community-based partnerships in South Africa (M Goldman; K Gull; T Jooste; N Kola; L Loate; V Munnik; I Palmer & BF Rawat)

The objectives of this study were to undertake an assessment of the current scale of community-based service provision in South Africa and locate places where good practice is being applied; identify the key factors of success for the large-scale implementation of community-based service provision; draft a strategy discussion document on integration of community-based water services provision; and further develop and/or refine the draft strategy through interactive engagement with key stakeholders responsible for water service provision in rural areas.

Report No. TT 552/13

WATCOST – Manual for a costing model for drinking water supply systems (CD Swartz; P Thompson; P Maduray; G Offringa & G Mwiinga)



A WRC-funded project developed a user-friendly costing model for estimating costs of drinking water-supply systems. This model allows economic comparison between different water treatment and supply options being considered for a water-supply scheme. It further allows costing reports to be created for existing water treatment systems, which assists with budgeting and asset management processes. The aim of this manual is two-fold: firstly, it can be used as a reference document for information on costing data for water-supply projects, with actual costing figures that can be obtained from the tables and graphs in the document. Secondly, the manual is also an aid to using the WATCOST model to obtain costing data for water-supply projects, either in total or for specific components in the drinking water-supply cycle.

Report No. 1930/1/12

The estuary health index: A standardised metric for use in estuary management and the determination of ecological water requirements (J Turpie)

This manual sets out a standardised and tested method for assessing the health of an estuary as a baseline and against which to set future objectives and measure progress according to management targets. Its intention is for use in the determination of the freshwater Reserve for estuaries, as well as for use in management of estuaries generally. The manual is written for use by estuary scientists in carrying out the assessment as well as for water, catchment and estuary managers who manage the process.

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

Water diary

Ecosystem health
November 20-21

North West University is hosting its fourth Annual Eco Health Research Forum at Golden Gate Highlands National Park, Clarens. The theme for this year's conference is 'Multidisciplinary Reflections on Environment, Health and Well-being Research in Southern Africa'. *Enquiries: Yolandi Krone (Conference administrator); Email: yolandi.yevents@gmail.com; Cell: 082 553 6463.*

Microbiology
November 24-27

The South African Society for Microbiology is holding its 18th Biennial Congress at Forever Resorts Warmbaths in Bela Bela. The theme of the congress is 'From Africa to the World: Trending Microbiology'. *Enquiries: Shelley Abrahams (Conference Secretariat); Tel: (011) 463-5085; Fax: (011) 463-3265; Email: shelley@soafrica.com or Visit: www.sasm2013.co.za*

Water history
November 29 to December 5

North West, Pretoria and Great Zimbabwe universities, together with the Kara Heritage Institute are hosting an international conference on water research and heritage. The safari style conference will take delegates to the Modjadji and Mapungubwe World Heritage sites in Limpopo as well as the Great Zimbabwe World Heritage Site in Zimbabwe. *Enquiries: Dr Marika van der Walt (Email: marikav@law.co.za) or Prof Johann Tempelhoff (Email: www.johann.tempelhoff@nwu.ac.za)*

Food security and climate change
December 3-5

The third Global Conference on Agriculture, Food and Nutrition Security and Climate Change will be held in Johannesburg. The conference will include high-level discussions on a Climate Smart Agriculture Alliance. The conference is organised by the governments of South Africa and the Netherlands, in collaboration with partners such as the FAO and the World Bank. *Visit: www.arc.agric.za*

Young Water Professionals
December 7-10

The 7th International Young Water Professionals Conference will take place in Taipei, Taiwan. The deadline for abstract submission is 31 March 2014. Conference topics include water treatment and management, water reuse and desalination, energy saving, nutrient removal and recovery, health-related issues, nanotechnologies, sludge management and wetlands and climate change. *Email: ywp2014@iwahq.org or Visit: www.iwa-ywp7.org*

Young Water Professionals
December 9-11

The Third East African Young Water Professionals Association Conference will take place in Nairobi, Kenya, with the theme 'Securing our water and energy resources in the face of climate change'. *Email: keywpa@gmail.com*

Gender and water
February 19-21

A conference on Gender, Water & Development will be held at the ICC East London with the theme 'Gender, water and development – The untapped connection'. The conference is hosted by the Water Research Commission, together with the Department of Water Affairs, the African Ministers' Council on Water, the Women in Water Partnership and the Southern African Development Community. *Enquiries: Conference Secretariat, Glaudin Kruger, Tel: (028) 316-2905; Email: Kruger@kruger-associates.com; Visit: www.global-water-conference.com*

Report No. 2035/1/13

Assessment of the long-term response of two wetlands to Working for Wetlands rehabilitation (C Cowden; D Kotze & T Pike)

This WRC-funded project investigated the long-term response of two selected wetland systems in KwaZulu-Natal to the rehabilitation that was undertaken by Working for Wetlands. The study included an assessment of the integrity and survival of the rehabilitation interventions; a rapid assessment of the ecological integrity and ecosystem services supplied; a more detailed investigation of the response of aspects of the system, particularly vegetation, to rehabilitation interventions; and documenting lessons learnt in terms of rehabilitation planning and the challenges of the long-term monitoring of wetland rehabilitation efforts.

Report No. 2012/1/13

Extended investigations into recovery of water and salts from multi-component hypersaline brines using eutectic freeze crystallisation (D Randall; A Lewis; M Rodriguez-Pascual; J Nathoo; T Reddy; G Apsey; M Kapembwa; T Egan & J Chivavava

Hypersaline inorganic brines are generated by a number of industries, including mining operations, power generation and petrochemical refining. In addition, because of water resources, and thus further water recycling and reuse, these brines present an increasingly significant global problem. Eutectic freeze crystallisation (EFC) has been identified as a possible novel brine treatment method, but to date it has not been applied to multi-component streams such as brines. Therefore, the overall aim of this project was to investigate the applicability of EFC to the multi-component hypersaline brines produced by major South African industries.

Water by numbers

95% – The probability that most of the global warming since 1950 has been caused by human influence, according to the latest report of the United Nations (UN)-backed Intergovernmental Panel on Climate Change (IPCC).

74% – The number of South African citizens who have access to a stable water supply, according to Science & Technology Minister, Derek Hanekom. In addition, about 3,2 million households are at risk of sanitation service failure or are experiencing service delivery problems.

R2-billion – The money the South African government plans to spend over the next four years to rid the country of malaria, *News24* reports. The money will be spent on spraying, providing nets and treating those who contract the disease.

4% – The percentage of water in the Vaal River catchment being used by Sasol's Secunda and Sasolburg operations. This is significantly less than the 17% of water losses currently being experienced in the catchment, the group reports.

2,5 billion – The number of people who lack proper sanitation, according to the United Nations. A further 1,1 billion are forced to defecate in the open. In order to bring attention to the importance of safe attention in preventing illness and improving dignity, the UN has declared 19 November 'World Toilet Day'.

40 Mℓ – The additional water required to address growth in Rustenburg local municipality, according to the Department of Water Affairs (DWA). The town, along with others in the North West province, has initiated water restrictions to due to drought.

Poor and angry – Research grapples with reasons behind social protests

Social protests over service delivery issues, such as housing, water and sanitation have become a daily occurrence in South Africa. But what is driving people to the streets, and why are some angry why others stay silent? These were among the issues discussed at a recent seminar, hosted by the Water Research Commission (WRC), on social protests and water service delivery in South Africa. Lani van Vuuren reports.

In Cato Manor in Durban a woman is shot and killed and another injured as the community protests over housing. Meanwhile, in Bekkersdal, in Johannesburg, 18 people are arrested for public violence and looting as people march for better service delivery. At the same time, at Mooiplaas informal settlement in Pretoria, police are stoned by protesting community members. These are typical headlines describing the almost daily occurrence of social protests in South Africa.

Public protest is not a new phenomenon in South Africa. However, as research by the University of Johannesburg (UJ) shows, these protests have reached unprecedented levels. According to UJ's Dr Carin Runciman, in 2012, at least 470 social protests had occurred in South Africa – more than one a day.

The latest data on service delivery protests available from the Service Delivery Protest Barometer, an initiative of the Community Law Centre at the University of the Western Cape, confirms that protests are becoming more frequent, more widespread and more violent.

Most social protests occur in Gauteng and the Western Cape, which together accounted for over half of protest activity during 2012. However, social protests are no longer an urban phenomenon, with an increasing number of protests occurring in rural areas.

Protests are not only increasing in frequency, but are also far more likely to turn violent. According to Prof Jaap de Visser, Project Coordinator at the Community Law Centre, in the first eight months of 2012 nearly 80% of protests turned violent – a 27% increase from the average of the previous five years. (Violent protests are defined here as protests where some or all of the participants have engaged in actions that create a threat or actual harm to people or property).

Of the 180 protests Prof De Visser and his team have counted in 2013 to date around 70% have been violent. This includes the flinging of excrement by protesters in Cape Town earlier this year. Prof Runciman, however, is quick to point out that violence does not always stem from the side of the protesters only. "Heavy handedness by public order police can lead to an escalation of violence," she noted.

UNDERSTANDING SOCIAL PROTESTS

Why do some communities choose to protest? Researchers at the WRC seminar agreed that the underlying reasons for social protests are much more complex than media

reports often lead us to believe, and requires deeper investigation. While 'flagship' issues, such as labour issues or service delivery might be raised by the press, there might be many hidden reasons for communities to go over to protest action.

Seminar keynote speaker, South African Human Rights Commission Deputy Chair, Pregs Govender, called on researchers to not only identify the cause of social protests in South Africa, but to find ways in which to address these causes. She noted that it was often poor communities' frustration at not being heard by government which led them to voice their anger in the streets. "Twenty years after apartheid we are still seeing [communities] venting frustration over a situation they cannot change."

Grievances related to municipal services – including lack of electricity, water, sanitation or roads – are the most frequently cited category of grievance. An increasing number of communities are protesting over water-related issues. This has prompted the WRC to direct a number of calls in recent years to investigate the phenomenon of social protests and their connection to water issues.

"As a country we need to start asking ourselves serious questions when our democracy leads to loss of life and destruction of property," notes WRC Executive Manager for Water Use and Waste Management, Jay Bhagwan. "Once these protests are brought under control it does not necessarily mean that the underlying issues have been resolved."

"It is important that we establish the correct structures within our municipalities for citizens to constructively air their concerns and grievances," he noted. "By understanding the reasons behind the phenomenon of social protest, research can ably inform and advise decision-making."

SOCIAL PROTESTS AND WATER SERVICES

A current WRC-funded study, lead by Dr Barbara Tapela of the Institute for Poverty, Land and Agrarian Studies (PLAAS), is aimed at developing a better understanding of the reasons why communities protest over water-related issues.

The main objectives of the study are to determine the range of grievances pertaining to water service delivery, identify the diversity of local contexts in which water service delivery-related social protests have occurred, and examine the geographical profile, historical background, socio-economic setting, water services issues and social protest features of selected examples.

The project team has sifted through records of hundreds of protests, searching for those related to water. "A major challenge to the filtering of catalogued protests was that water service delivery issues are often part of a range of conflated grievances that masquerade under the generalised rubric of 'service delivery', and underpin many rallying calls for social protest action," noted Dr Tapela. "Although such conflation reflects the inter-relatedness of social services, it also masks the water service delivery issues in question."

With regards to water service delivery issues, findings show that water service delivery issues include inadequate access to water, poor quality of water from existing supply infrastructure, poor operation and maintenance of infrastructure, infrequency of water supply, high tariffs, privatisation, inaccurate water bills, disconnection (due to water demand devices and/or non-payment), and apparent inaction/apathy by local municipalities to address the problem.

The WRC study went further to explore the characteristics of selected

What is a social protest?

According to the University of the Western Cape, any complaint or issue cited by protesters, whether related to service delivery claims or not, over which citizens decide to engage in protest activity.

DE DOORNS UNREST – REALLY A WAGE ISSUE?

In August, 2012, violent protest shattered the normally idyllic rural town of De Doorns, in the Western Cape.

The protest was labelled a 'labour unrest' by the South Africa media, who focused largely on farm workers' call for improved wages. However, closer inspection by researchers from the Institute for Poverty, Land and Agrarian Studies (PLAAS) revealed that there were 21 substantive issues that were strategically muted and encapsulated in the rallying call for "R150 a day!"

These included issues of poor access to water services and sanitation for workers still based on farms, and issues of affordability of water services for evicted farmworkers resettled in agri-villages and rural townships. Interviews revealed that a particularly poignant issue was the lack of housing for farmworkers, some of whom slept in horse stables and lacked secure access to water and sanitation. In other cases farm owners, who were responsible for supplying workers with basic services, would deduct basic service payments from farmworkers' wages. This meant that these workers did not have access to free basic water and electricity as do many other South Africans.

case studies of urban, peri-urban and rural localities in which violent protests have emerged. "Our research findings also show that the majority of social protests associated with water service delivery tend to occur in working-class urban and peri-urban localities characterised by high levels of poverty, unemployment, marginalisation and disjuncture (including communication breakdown) between water services development planning at municipal and national levels and water use at local household and community levels, irrespective of the party affiliation of local government," noted Dr Tapela.

Such disjuncture can predispose people in such localities towards protest action. In many of the cases examined, residents expressed frustrations over unmet expectations for water services, lack of downward accountability by municipal officials, corruption, indifference and lack of monitoring and censure of non-compliance by water services authorities, and officials. On the other hand, municipal officials voiced their frustrations over wasteful water use, unaccounted-for water, infrastructure theft, breakdown and lack of financial budgets for repairs of existing and building of new infrastructure. Both sets of viewpoints tended to be simultaneously complementary and contradictory, thus pointing to a need to develop shared understandings of water service delivery issues in case-specific localities.

The WRC study revealed that violent protests often take place in urban and peri-urban formal housing areas and informal settlements in which dynamics around poverty, unemployment, population growth, relative deprivation, marginalisation, injustice, and histories of struggle activism by predominantly black residents coalesce with unmet expectations for water and related services. Communities in these areas also struggle with uncertainties as a result of drivers of change, such as mining-based economic decline, shifts in agricultural and industrial production systems, and rising food prices.

By comparison, non-violent protests tend to be associated with black and white working class neighbourhoods characterised by different perceptions of relative deprivation. In the predominantly white neighbourhoods, relative deprivation is seen in relation to past experiences of municipal service delivery, which are perceived to have been better than that provided by the post-1994 municipalities. These relatively more affluent sections of the population tend to adopt institutionalised engagement strategies, often declaring legal disputes against the municipality, and thereby withholding rate payments.

Additionally, violent and non-violent social protests are expanding into hitherto 'peaceful' rural areas. The eruption of rural protests appears to mark a critical turning point in rural people's engagement with authorities. It underscores the need for water services planning and development practice to take into account the rural-urban linkages that persist amid rapid urbanisation, decline of mining towns, evictions of commercial farmworkers and farm-dwellers, and rural-urban and cross-border migrations, among others.

Within this rapidly changing social milieu, the South African citizenry no longer seems content to divest the responsibility of tackling issues of marginalisation, deprivation and injustice to an amorphously 'representative and democratic' local government. A critical question is how to channel this renewed energy into tangible gains for water services governance and delivery, and a deepening of democracy.

It is hoped that through the WRC study and others the necessary knowledge will be obtained to constructively address the phenomenon of social protests in South Africa. ❑

PROTESTORS' REASONS FOR PROTESTS WITH REGARDS TO WATER ISSUES

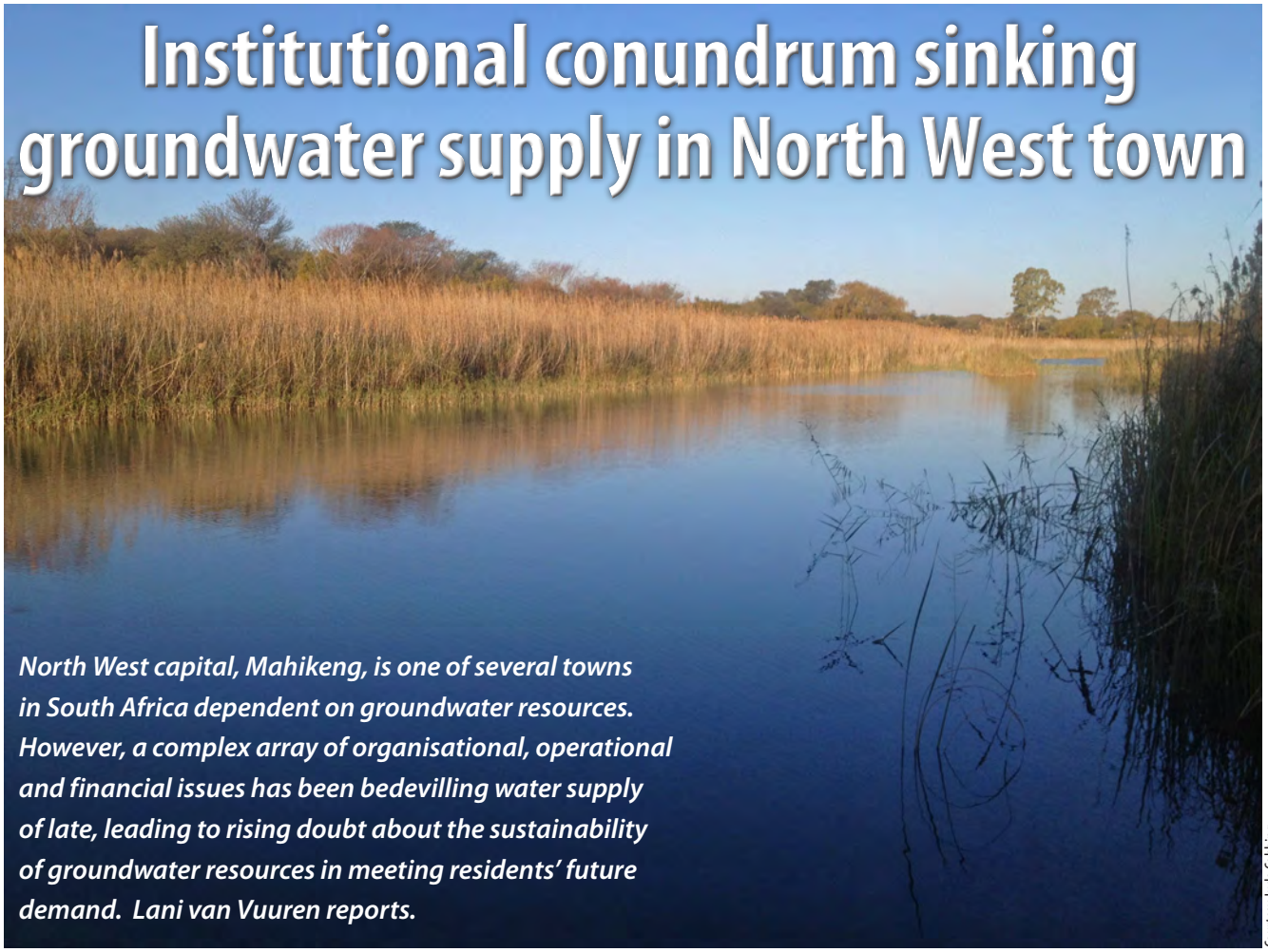
- Inadequate or lack of access to water from existing supply infrastructure
- Poor quality of water from existing supply infrastructure
- Lack of water supply infrastructure
- Poor operation and maintenance of infrastructure
- Old and deteriorated water reticulation networks
- Water shortage or intermittent supplies
- Water cut-offs, restrictions, and/or disconnections
- High tariffs and/or privatisation
- Inaccurate water billing
- Frustration over poor governance, corruption
- Marginalisation of certain groups within municipalities
- Politicisation of water services issues

Source: PLAAS

PLAAS

Lack of sustainable service delivery is a significant issue for many communities, driving many of them to protest.

Institutional conundrum sinking groundwater supply in North West town



North West capital, Mahikeng, is one of several towns in South Africa dependent on groundwater resources. However, a complex array of organisational, operational and financial issues has been bedevilling water supply of late, leading to rising doubt about the sustainability of groundwater resources in meeting residents' future demand. Lani van Vuuren reports.

Courtesy Jude Cobbing

Cries of "the borehole has dried up" or "there is no more groundwater" or even "underground water is unreliable" are not unheard of in many South African communities dependent on groundwater resources. More often than not failure of groundwater supply schemes is blamed on the resource rather than on the infrastructure used to abstract the groundwater.

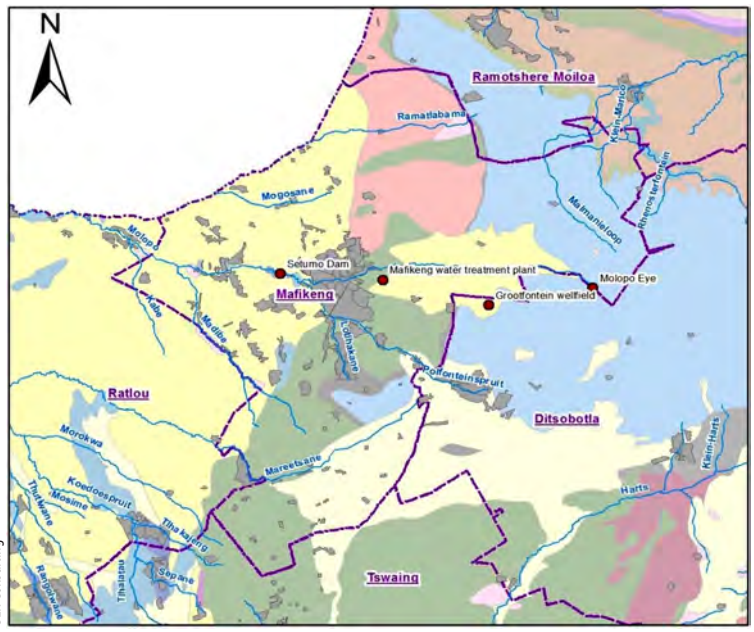
This is partly because groundwater is out of sight – it seems 'mysterious' to most people in comparison with surface water. However, studies show that failure of groundwater supply schemes is almost always either due to failure of infrastructure or unsuitable pumping regimes, rather than a physical lack of water.

Groundwater offers many benefits, for example, it is usually cheaper to develop than surface water resources; it can usually be used with no or minimal treatment, it can be developed incrementally and usually in close proximity to where it is required. However, there still seems to be a reluctance to invest in groundwater supplies, and in the system and organisational requirements needed to keep them operating.

With around 98% of South Africa's surface water already allocated groundwater is bound to play a more meaningful role in local water supply in years to come. At present, only about half of the country's groundwater resources (around 7 500 million m^3/a) are being used. If groundwater is to be used increasingly to provide safe water to South Africans, however, the challenges surrounding its management will have to be overcome.

"The estimated 5-10% of South Africans who do not yet have access to safe water supplies live mostly in rural areas of South Africa, most notably in KwaZulu-Natal and the Eastern Cape. In these rural areas groundwater is often a good option for water supply," reports Jude Cobbing, senior hydrogeologist at SLR Consulting. He is part of a team currently undertaking a research project funded by the Water Research Commission (WRC), which aims to (among others) enhance understanding of the barriers to better use of groundwater for local water supply in South Africa. The other project members include Karabo Lenkoe (of SLR Consulting),

Molopo eye is Mafikeng's main water resource.



SLR Consulting

Map showing water sources of Mafikeng and surrounds.

Kathy Eales (Counterpoint Development) and Jim Gibson (Maluti GSM).

The project, which will run until next year, also hopes to develop useful products for local municipalities on the groundwater availability of their area for resource development and management purposes.

GROUNDWATER IN MAHIKENG

Speaking at the 13th Biennial Groundwater Division Conference, held in Durban earlier this year, Cobbing presented results from the project team's research in Mahikeng where they investigated existing groundwater supplies as well as perceptions about groundwater among various stakeholder groups. It is a case study that illustrates the often complex and interdependent factors that govern sustainable groundwater supplies for municipal purposes in South Africa.

The town, which has a population of around 300 000 (when including the surrounding peri-urban area) is almost solely dependent on groundwater. The main sources of water to the town are the Molopo Eye spring, which yields about 20 Mℓ/day of water, and the Grootfontein Wellfield, which yield about 8 Mℓ/day.

Mahikeng also has a small surface water resource in the form of the Setumo Dam, located on the emphermal Molopo River. However, for much of the year the water flowing into the dam is return flows from two wastewater treatment works, and the quality of the dam water is poor, which makes treatment expensive.

Courtesy Jude Cobbing

Water from Mahikeng's groundwater sources are chlorinated at the Mahikeng Water Treatment Plant. While the plant also has a sand filtration facility, this is rarely required due to the general good quality of the groundwater.

Water from the groundwater sources is piped to the Mahikeng Water Treatment Plant where the flows are combined and the water is chlorinated. Sand filters have been constructed at the water treatment plant, but since the natural groundwater quality hardly warrants filtration, these are rarely used. From the treatment plant the water is reticulated into the town.

The surrounding peri-urban area makes use of boreholes, which are equipped with various electric, diesel and wind pumps. Groundwater quality from these boreholes are variable, with high nitrates a particular concern in some areas. High levels of salinity, high hardness and microbiological problems have also been reported. Water quality problems have partly been blamed on inadequate sanitation.

OVERABSTRACTION OF GROUNDWATER

The WRC project has found that apparent overabstraction of groundwater, mainly for irrigation, has resulted in falling water levels – especially from the Grootfontein wellfield. Of the nine existing pumping wells, five have reportedly already been lost due to falling water levels.

"There is perceived competition between irrigation farmers and water services providers for a finite resource," Cobbing reports. In the cases where over-abstraction is taking place, it is uncertain whether this is due to farmers exceeding licensed amounts or the actual licensed amounts being inappropriately high.

"Greater pressure on the groundwater resource in dolomite compartments implies a need for better monitoring, better enforcement of rules and agreements, and greater involvement of local organisations (particularly water user associations) in the management of the resource," notes Cobbing. In Mahikeng's case, all of these institutions appear to be weak, and there is a definite need for better regulation and enforcement.

OPERATIONS AND MAINTENANCE

Since December parts of Mahikeng have experienced regular water shortages, with some residents believing that the groundwater resources have become unreliable. This has resulted in increasing calls to augment the town's supply, most notably via a bulk water pipeline to the Vaal River, although this seems rather uneconomic at this stage.

"While most residents seem to be content with groundwater supplies as long as the water keeps flowing, there does seem to be a preference at municipal management level for surface water, which is perceived to be of superior quality," says Cobbing. "During our interview process more than one respondent spoke about wanting a bulk water pipeline from the Vaal River. In one case, the approval of the second phase of the Lesotho Highlands Water Project has given the impression that relatively abundant water will soon be available from the Vaal River system."

Research shows that the additional requirements of Mahikeng could be met by groundwater and by implementing water conservation and water demand management. So if the resource itself is not the problem, then what is?

The WRC project team uncovered a complicated management system at Mahikeng where various institutions are responsible for the groundwater resource. For example, while the Department of Water Affairs (DWA) is responsible for the operation of the Grootfontein boreholes, the monitoring of the resource and the pipelines from Grootfontein and Molopo Eye to the Mafikeng Water Treatment Plant, once the groundwater reaches the treatment plant it becomes the responsibility of the Botshelo Water Board.

In turn, reticulation of drinking water, removal of wastewater, billing of residents, maintenance of local water infrastructure and other functions are the responsibility of the relevant local municipality. While the wastewater treatment plants servicing Mahikeng are owned by the Ngaka Modiri Molema District Municipality (the water service authority of the area), they are operated by Mahikeng Local Municipality.

A dispute between Botshelo Water and the district municipality regarding alleged non-payment as well as on-going disputes between DWA, the water board and the district municipality are said to have contributed to water-supply interruptions to Mahikeng as there is little coordination and cooperation on technical water matters. This has resulted in sub-optimal operations and maintenance (O&M) of water supplies. (Ironically, this lack of O&M is currently protecting the aquifers to some extent as it is reducing actual abstractions)

"Most respondents highlighted the strong requirement for adequate O&M of boreholes to achieve reliable supplies, and agreed that O&M failures were the primary cause of groundwater source failure to Mahikeng and surrounds," notes Cobbing. The O&M issue is far from simple, however, and raises issues of responsibility, funding, authority, complexity and organisational function and interaction.

If O&M problems can be overcome, leading to boreholes yielding more water reliably, then stress on the source will increase and source monitoring (as well as associated management measures) will become more important. Poor O&M does not only affect water quantity, but can affect water quality as well – for example, through leaking diesel tanks or cracked sanitary seals.

It is often cheaper to maintain or rehabilitate a borehole than to replace it, once its performance has deteriorated significantly. Ironically, however, even when rehabilitation is more economical, as is often the case, money for rehabilitation is often more difficult to obtain than money for new projects.

Courtesy Jude Cobbing

The Molopo eye still provides good-quality water to the residents of Mahikeng.

This case study supports the contention that rolling out better and more reliable groundwater supplies is not primarily a technical or hydrogeological issue at all, but that many other factors are involved. It is highly unlikely that Mahikeng will be able to augment or replace its existing groundwater resources with alternative sources, such as surface water. All responsible parties will have to come to the table to make the town's groundwater supplies work. ❑

Courtesy Jude Cobbing

The Grootfontein wellfield, which supplies the town with about 20 Mℓ/day of water.

Lani van Vuuren

Study proves the economic worth of BIODIVERSITY REHABILITATION PROJECTS

Can we put a price on rehabilitation projects and are some more valuable than others? A recently-completed project, funded by the Water Research Commission (WRC), aimed to answer these and other questions. Article by Petro Kotzé.

Globally, the degradation of ecosystems has reached unprecedented levels. In what seems like a near constant battle of economic development vs. the environment, the latter is paying by far the biggest price. In the process, the capacity and ability of natural resources to supply high quality and quantities of ecosystem goods and services such as fresh water, grazing, soil stabilisation and climate amelioration through the sequestration of carbon dioxide is weakening.

One way to reverse this trend is through the restoration of natural capital – the elements of nature that produce value to people, including rivers, land, minerals and oceans. In South Africa such activities are often enforced by legislation that makes provision for mandatory restoration projects, such as mining rehabilitation.

Another example is government's Natural Resource Management Programmes, which work toward the eradication of alien vegetation. Since 2005, the Working for Water programme, for example, has been responsible for the clearance of more than one million hectares of invasive alien plants. Globally, the programme is recognised as one of the most outstanding environmental conservation initiatives on the continent, and enjoys sustainable political support for its job creation efforts and the fight against poverty.

But, does restoration pay? This is a question that has long begged to be asked, says Prof James Blignaut of ASSET Research and the Department of Economics at the University of Pretoria. And, if it pays, under which circumstances? Furthermore, can the development of markets for ecosystem goods and services aid the development of the restoration industry? If it can, under which conditions would it be applicable?

Blignaut until recently led a study commissioned by the WRC to investigate restoration's economic linkages. The main focus of the project was to determine whether restoration, in fact, yields the desired results and improves the socio-economic value, and particularly the agriculture potential, of restored land. WRC Executive Manager: Water Utilisation in Agriculture, Dr Gerhard Backeberg, reports that the idea for this research topic came about when the late environment and resource economist, Dr Roland Mirrilees, investigated the production potential of degraded landscapes. Mirrilees was particularly interested in what incentives would be necessary to convince people to restore natural capital.

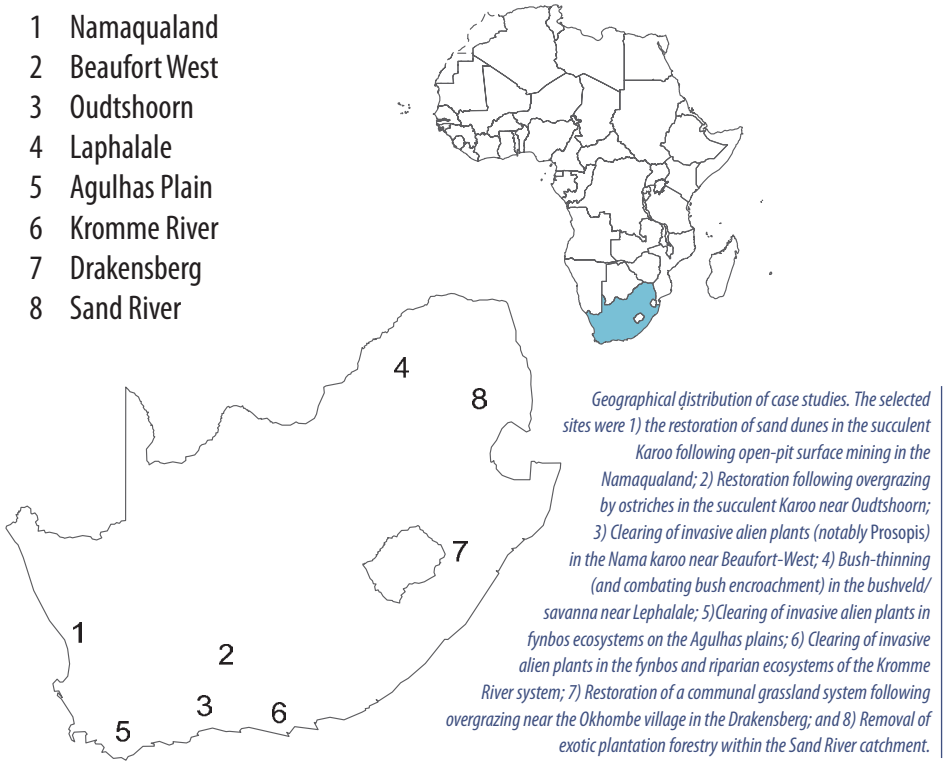
For the current study's purposes, the focus was placed on the relevance of the restoration of natural capital to agriculture, explains Dr Backeberg, and how this restoration can lead to more productive use of the resources available, by providing income to farming households and enterprises. ASSET Research was commissioned to conduct the research over a five-year period, with funding from the WRC and the Natural Resource Management programme of the Department of Environmental Affairs.

The study aimed to develop an evidence base for the use of economic tools and instruments in the decision-making process to restore degraded land, explains Prof Blignaut. "We have neither investigated the need, nor the moral or intrinsic reasons, for restoration.

One of the eight selected case studies was the restoration of a communal grassland system in the Drakensberg.

We applied the conventional return/risk economic decision-making framework to eight existing restoration projects to evaluate whether it could be applied to restoration over a range of environmental conditions and in different contexts."

While it is true that some evidence of the ecological and hydrological implications of restoration for individual projects already exist, the links between these activities and the economy across various spatial scales and biomes have not been established. "There is also no clear understanding of how the benefits before and after restoration might affect agriculture through improved returns from terrestrial ecosystems," says Prof Blignaut. While these



Geographical distribution of case studies. The selected sites were 1) the restoration of sand dunes in the succulent Karoo following open-pit surface mining in the Namaqualand; 2) Restoration following overgrazing by ostriches in the succulent Karoo near Oudtshoorn; 3) Clearing of invasive alien plants (notably Prosopis*) in the Nama karoo near Beaufort-West; 4) Bush-thinning (and combating bush encroachment) in the bushveld/savanna near Lephalale; 5)Clearing of invasive alien plants in fynbos ecosystems on the Agulhas plains; 6) Clearing of invasive alien plants in the fynbos and riparian ecosystems of the Kromme River system; 7) Restoration of a communal grassland system following overgrazing near the Okhombe village in the Drakensberg; and 8) Removal of exotic plantation forestry within the Sand River catchment.*

SANITATION

1.8 billion people gained access to improved sanitation facilities between 1990 and 2010

2.5 billion people still lack improved sanitation. 1.1 billion people still practice open defecation, that's 15% of the world population

If current trends continue, **2.4 billion** people will still lack improved sanitation facilities in 2015

Access to sanitation, the practice of good hygiene, and a safe water supply could save **1.5 million children a year**

EVERY

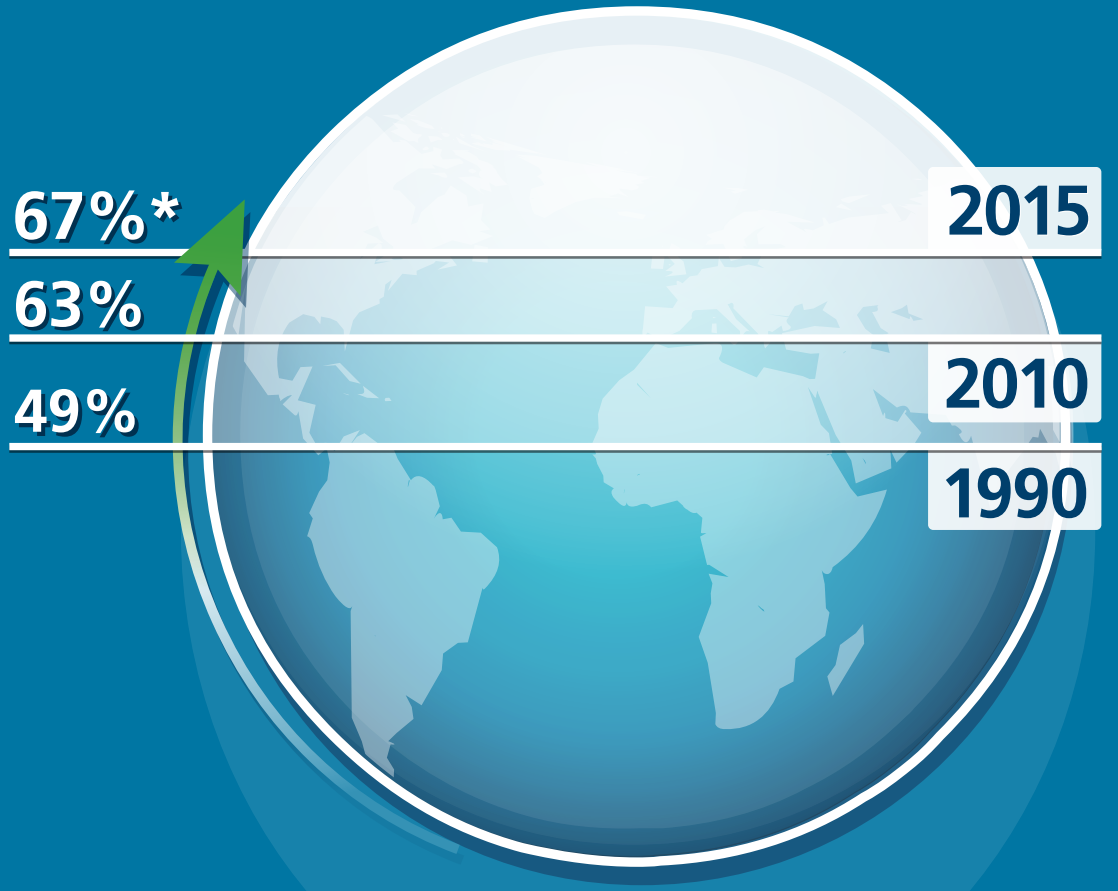
ACCESS TO SANITATION

EVERY

20

SECONDS,
A CHILD DIES
AS A RESULT
OF POOR
SANITATION

ACCESS TO SANITATION AS A PERCENTAGE OF WORLD POPULATION



* Projected total
(Millennium Development Goals' target is 75%)

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The outputs from these studies were used to develop an integrated system dynamics model on the likely impact of restoration on the ecology, hydrology and economy of notably agriculture.

HOW THE STUDY RESULTS CAN BE APPLIED: THE CASE OF THE KROMME VALLEY FARMERS

The Kromme River is a high energy river system in a long narrow catchment of the Eastern Cape and supplies roughly 40% of Port Elizabeth's drinking water. Once, there were pristine palmiet wetlands along the entire length of the valley, which provided many crucial ecosystem goods and services such as water infiltration, filtration and decreasing the impacts of floods. Poor farming and management practises have led to the formation of headcuts, or dongas, which resulted in erosion, loss of soil and a drop in the water table. These headcuts and the invasion of alien trees have destroyed the wetlands. As a result, less water is available. Unless this land management is changed in the Kromme immediately, the damage will become irreversible.

MSc student Jane Rebelo's thesis (which formed part of the project) investigated the hydrological impact of the land-cover changes in the Kromme River Catchment over the last 50 years. Modelling results predict that over the past 50 years, the transformation of the floodplain wetlands in the Kromme River has shifted the flow regime, reducing baseflows and increasing the responsiveness of the catchment to extreme rainfall events. The invasion of *A. mearnsii* has also caused a reduction in river flow. Various restoration scenarios were considered. If the Kromme were to be restored back to a land-cover state comparable to the 1950s, 26.9 km^2 (65.1%) of *A. mearnsii* would have to be cleared, and 5.2 km^2 (34.2%) of the wetlands would have to be restored. The hydrological benefits would include a predicted increase in riverflow (42 mm/a), baseflow (2.9 mm/a), an increase in flood protection and improved water quality. This restoration strategy could be regarded as a type of insurance plan, and the benefits gained in terms of increased ecosystem service delivery would be the insurance premium. Rebelo concluded that it appears that restoration, insuring natural capital in the Kromme River, would provide significant economic returns on investment.

To try and facilitate behavioural change following these findings, researchers facilitated articles in popular magazines, met with municipal decision-makers and held a workshop for all farmers and landowners in the Kromme catchment.

The latter was seen to be 'extremely successful' and resulted in three key outcomes: Firstly, the farmers recognised that communication needed to be improved in the area. Secondly, the need to form a committee which would provide a platform for communication among landowners and between landowners and organisations that apply restoration was identified. Most importantly, farmers acknowledged the importance of protecting water supplies, using water more sustainably and the importance of working together towards this goal.

benefits are generally believed to be very real and significant, they are not well understood.

This study thus also endeavoured to provide these links. "In effect, restoration is no different from the capital expenditure on any project and the return to the land," notes Prof Blignaut. The value of environmental services emanating from the ensuing flows (as a result of the capital expenditure) is the annual stream of benefits delivered at an annual maintenance and operation cost. "This is not unlike any other investment that does have an upfront capital component with regular or annual operational and managerial cost, but that yields an ongoing stream of benefits in the form of products or services being sold."

"By making both the cost and the benefits of restoration explicit, we aimed to illustrate the potential for the development of markets for ecosystem goods and services offered by restoration. Our underlying assumption was that by changing market signals, market participants will adjust their behaviour."

WHAT DID THE RESULTS SHOW?

Ecological, hydrological, and socio-economic assessments were undertaken to determine the impact of restoration at the chosen eight existing restoration sites. These were compared with degraded or unrestored areas in close proximity.

The study sites that were chosen reflect a broad range of biophysical parameters, such as ecosystems (fynbos, desert, riparian, grassland and savanna), soil types and precipitation. The sites also varied with respect to socio-economic parameters, such as the types of beneficiaries (e.g. farmers, rural and urban water users, tourists and recreationists), and the value they would be willing to pay for an increased flow of higher quality ecosystem goods and services.

The outputs from these studies were used to develop an integrated system dynamics model on the likely impact of restoration on the ecology, hydrology and economy of notably agriculture. This model was specifically focused on internalising the economic (societal) costs and benefits of restoration and to apply an economic decision-making rationale to the results in an effort to make the societal benefit of restoration explicit.

According to Prof Blignaut, results indicate that in semi-arid South Africa, restoration projects yielding water services are the 'pearl' projects, with high likelihoods of success and high payoffs. As a general rule, downstream water consumers benefit from these restoration projects. The Agulhas, Beaufort West, Kromme and Sand study sites are all examples of this.

Restoration projects yielding grazing and crop services are mostly the 'bread and butter' projects, ones which are likely to succeed but yield low rewards.

The Lephalale project, again, is a potential oyster, with untested and therefore uncertain long-term benefits from restoration. Fairly low levels of resources are committed to this activity.

ASSET Research

Top right: *Decomposing* prosopsis *in cleared veld at Brandwagt Farm, one of the study sites.*

Bottom right: *Prof James Blignaut and Dr Christo Marais during a site visit to the Oudtshoorn study area.*

Summary of projects classified by type

	Oyster	Pearl	Bread and Butter	White elephant
Description	High risk projects with uncertain merits	Projects with high likelihood of success	Essential projects that enterprises cannot do without	Projects which are preferable to avoid
Water projects	Drakensberg; Kromme (no agriculture)	Agulhas, Beaufort West, Kromme (with agriculture), Sabie Sand		
Crop projects		Sabie Sand	Agulhas, Kromme (with agriculture)	
Grazing projects	Lephalale	Oudtshoorn (passive only)	Beaufort West, Drakensberg, Kromme (with agriculture)	Namaqua Sands

PROJECT SCOOPS WRC KNOWLEDGE TREE AWARD

Prof James Blignaut scooped an Award in the 'Human Capital Development' category of the inaugural WRC Knowledge Tree Awards held earlier this year. The award was particularly made for the project on the restoration on natural capital. According to Backeberg, the strong capacity building factor, and the way in which regular colloquiums were used to streamline study results, was some of the project's biggest benefits. The project saw the training of no less than 11 post-graduate students in various disciplines. The students conducted the bulk of the research, and their theses were the backbone of the study. They were supported by numerous supervisors. "It was a huge honour to be able to help put this project together," says Prof Blignaut.

The eleven students were Helanya Vlok, Marco Pauw, Megan Nowell, Thabisisani Ndhlovu, Petra de Abreu, Worship Mugido, Alanna Rebelo, Katie Gull, Jacques Cloete, Dane Marx and Douglas Crookes.

Elske Kritzinger

Economic tools and instruments can indeed assist the restoration industry to be more effective and efficient.

Under certain extreme conditions it is also possible to have 'white elephants'. These are projects where large amounts of resources are committed to the restoration project, but with proportionally little reward and low probability of success in terms of restoration outcomes. The rehabilitation of sand dune mining in arid areas, such as the west coast of South Africa is one such project where large resources committed to it and proportionally little reward and low probability of success in terms of restoration outcomes. Despite the cost the restored area's level of ecosystem function is still below that of the undamaged area, indicating an unmitigated loss despite restoration. The project, however, is a legal requirement placed on the mining company as part of its licence to operate and therefore, requires a different type of evaluation.

"Clearly, the economic outcome of restoration projects is highly context dependent and definitely not uniform," notes Prof Blignaut. While the development of markets for ecosystem goods and services might be appropriate in some cases, in others it might not.

The need for and urgency of investing in restoration, however, does not depend on the development of markets for ecosystem services, he cautions. "Restoration of natural capital remains a moral obligation towards both the current and future generations if an activity has caused degradation, and the reduction in the potential flow of future streams of ecosystem goods and services."

The Oudtshoorn study site is an example of a 'pearl' project – one with a high likelihood of success.

ASSET Research

HOW CAN WE USE THIS KNOWLEDGE?

It is important to note that this study did not seek to provide a motivation for restoration per se, but only sought to identify under which conditions markets could contribute to restoration. "We do not suggest that only monetary values are of importance within the larger restoration decision-making picture," says Prof Blignaut. While those restoration options that have high risk/low reward outcomes over time should not necessarily be abandoned, the

study results suggest that markets are ill-equipped to assist in restoration under such conditions.

"We acknowledge that there may be a suite of other drivers for doing restoration, such as legislation on mining, where restoration needs to be conducted according to legal requirements and also socio-economic considerations like job creation."

However, he adds that when considering economic development that will cause environmental degradation, where the most plausible restoration outcome is likely to be one of high risk and low reward, extreme caution should be taken before embarking on such a project. Also, it then becomes particularly important that legal checks and balances are in place to safeguard the residents and the environment from undue exploitation.

In essence, says Prof Blignaut, the team has proved that, under particular conditions, economic tools and instruments can indeed assist the restoration industry to be more effective and efficient.

Chief Director of the Natural Resource Management Programmes at the Department of Environmental Affairs, Dr Christo Marais, adds that one of the biggest values of the WRC project was that primary ecological and field studies served as input for the economic studies. Two previous substantial, multi-disciplinary (ecological, hydrological and economic) studies that were done on the value or cost advantages of natural resource restoration were largely based on existing literature. In comparison, the WRC project rendered new primary, in-field research instead of historical research that was used as assumptions in economic analysis. The ecological and hydrological studies' research questions were asked in in such a way that the results can be used in the economic studies. "It is probably the first of its kind in South Africa," says Dr Marais.

He adds that the results can definitely be used in the so-called mainstreaming of watershed services in water resource management decision making processes. "Closer to home, we will use it to prioritise where and how much resources must be invested across South Africa."

- To order the report, *Determining the economic risk/return parameters for developing a market for ecosystem goods and services following the restoration of natural capital: A system dynamics approach. Volume 1: Main Report* (**Report No. 1803/1/13**) contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy. ❑

ASSEF Research

The rehabilitation of sand dune mining is an example of a large volumes of resource committed with proportionally little reward and low probability of success in terms of restoration outcomes.

Description of restoration study/project sites

Site	Biomes	Climatic zone	MAP	Ownership	Size (km²)	Extent of degradation
1	Succulent Karoo	Arid	160	Private	26	Severely degraded: Restoration following open-pit surface mining
2	Nama Karoo	Arid	239	Public/Private	8	Degraded: Clearing of invasive alien plants
3	Succulent Karoo	Arid	242	Private	1 762	Severely degraded: Restoration following overgrazing ostriches
4	Savanna	Semi-arid	400	Private	9 249	Degraded: Bush-thinning (and combating bush encroachment)
5	Fynbos	Semi-arid	478	Public/Private	548	Degraded: Clearing of invasive alien plants
6	Fynbos	Semi-arid	650	Private	46	Degraded: Clearing of invasive alien plants in the riparian ecosystem
7	Grassland	Temperate	900	Communal	1	Severely degraded: Restoration of a communal grassland system following overgrazing
8	Forest/Savanna	Temperate	1 275	Public/Private	32	Degraded: Removal of exotic plantation forestry

MAP = Mean annual precipitation; size refers to the size of the study site from an economic perspective

Appraising the lifecycle costs of SA's INTERBASIN WATER TRANSFER PROJECTS

South Africa has one of the most sophisticated bulk water infrastructure networks in the world where water is often pumped hundreds of kilometres from areas of surplus to areas of need through inter-basin transfer schemes (IBTs). Research undertaken by Dr Peter van Niekerk, formerly of the Department of Water Affairs (DWA), has shown that the way in which lifecycle costs have been historically evaluated, especially in South Africa, has not been done optimally, which could have severe repercussions for operational cost estimation.

From the 1960s South Africa has seen an increasing number of IBTs being constructed to meet its growing water demands. One of the most sophisticated of these is the complex interconnected Vaal River system, which includes a number of IBTs constructed to serve the economic heartland of the country. The most well-known of these IBTs is the Lesotho Highlands Water Project (LHWP) of which planning of Phase 2 is currently underway.

IBTs often involve pumping water to overcome differences in elevation. The associated energy costs typically form a significant part of the lifecycle costs of IBTs, and it is expected that such energy costs will proportionally increase in future as water has to be sourced from more distant basins. It is therefore important that a robust appraisal methodology be followed when assessing the costs of water transfers of future IBT projects.

A conceptual inaccuracy has, for decades, been part of the water engineering standards of practice so that certain calculations are generally calculated incorrectly. Over time this error has worked its way into the accepted methodology of evaluation of the lifecycle costs of IBTs. This has caused a bias in the estimations of variable costs, such as pumping costs, and made capital intensive gravity schemes seem, in comparison, more attractive than they really are.

INCREMENTAL APPROACH

Case study research and secondary data analysis was employed to examine the accuracy of the appraisal approach, called the Incremental Approach, originally followed during the planning of the Usutu-Vaal Government Scheme (GWS) (Second Phase) as a case study. This IBT scheme was originally planned and built in the early 1980s to supplement the water resources of the Vaal River system. The scheme shown in Figure 4 (along with other IBTs similarly connected) consists of the Heyshope Dam on the Assegai River, a tributary of the Usutu River, and transfer infrastructure to convey water against an elevation difference of 183 m over the continental divide into the Vaal River catchment, upstream of the Grootdraai Dam in the Vaal River.

The Incremental Approach, depicted in general terms in Figure 1, is a deterministic planning approach where the growth in demand is such that a new scheme, an IBT in this case, is required to

meet requirements beyond time T1. The Incremental Approach assumes that all requirements beyond the capability of the existing system, i.e. the shaded area in Figure 1, must be met from the new resource. The annual water transfers therefore will exhibit gradual growth, from time T1 until time T2 and then be capped by the yield capability of the new scheme. As pumping costs are directly related to quantities transferred, these annual costs exhibit the same pattern.

ACTUAL TRANSFERS OF THE USUTU-VAAL GWS

The actual annual volumes of water historically transferred from Heyshope Dam are shown in Figure 2, and compared to the original projection, undertaken in 1981. Whereas the original projection was for a smoothly growing transfer, capped by the capacity of the transfer scheme, the actual transfers exhibited an erratic pattern. It was also found that the average transfer was 26.5 million m³/a over the period – only 35% of what had been envisaged at the planning stage.

Plausible explanations for the differences between predicted and actual transfers were sought by examining possible impacts from other resource developments in the basin, changes in demand and source constraints.

A resource development that did have an effect was another IBT completed in 1988, namely the Slang River GWS. This scheme (also shown in Figure 4) was built primarily to supply water from the Zaaihoek Dam on the Slang River to a new power station, but the facility to transfer water to the upper reaches of the Vaal River was included in its design. Actual water transfers from the Zaaihoek Dam to Grootdraai Dam over the period 1990 to 2010 were combined with the transfers from Heyshope Dam to obtain a more complete perspective as depicted in Figure 3.

The erratic nature observed is, if anything, reinforced by the transfers from the Slang River. The combined average transfer of 42,5 million m³/a reduced the discrepancy somewhat, but it remains significantly less than the average of 73,5-million m³/a water transfer originally envisaged for the period.

Another scheme, the Vaal River Eastern Subsystem Augmentation Project (VRESAP), links the Grootdraai Dam subsystem to the Vaal Dam. The VRESAP was completed in 2009 and made no significant contribution during the period under observation.

An examination of changes in demand revealed that growth had been slower than predicted. This would explain the lower volume in water actually transferred. However, the historic firm yield of Grootdraai Dam had been reassessed in 2001 and found to be only 77% of the earlier estimate. The incremental water requirement, following the approach as depicted in Figure 1, would in retrospect have averaged 61,4-million m³/a for the equivalent period, which still meant that the actual transfers fell significantly short – by some 30%.

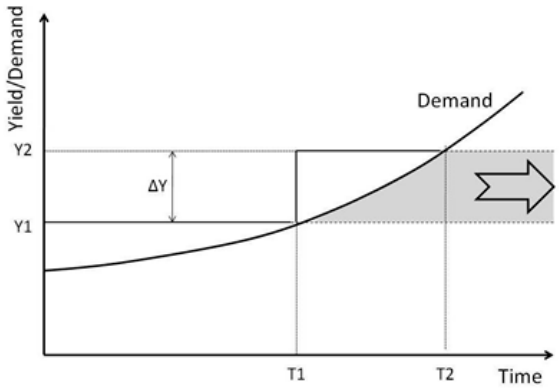
As regards the possibility of supply constraints causing lower transfers, records showed that both the Heyshope and Zaaihoek Dam had been relatively full over the period, indicating that there had been no impediment, from a source perspective, in transferring water to the Vaal River basin.

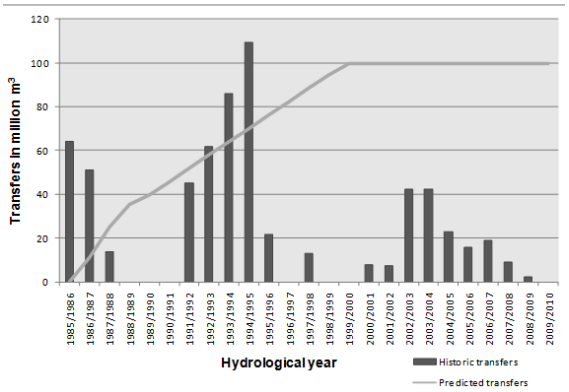
A detailed tracing of the annual operation of the Vaal River supply system, with the inclusion of the Grootdraai Dam subsystem, was required to shed further light on the reasons for the observations depicted in Figures 2 and 3.

ANNUAL OPERATIONAL SYSTEMS ANALYSES

Annually, at the end of the rainy season, the DWA undertakes an analysis of the Vaal River system in order to set the operational regime for the following year. This so-called Annual Operating Analysis (AOA) takes into account the state of the system (i.e. storage of each dam) as at 1 May of each year. The analysis is conducted soon afterwards.

The AOA entails running DWA's Water Resources Planning Model (WRPM) to simulate the behaviour of the Integrated Vaal River System (IVRS), usually for 1 000 stochastic time-series of flows of 20-year duration. This is repeated for various scenarios to test the impact of variations in operational rules, different growth





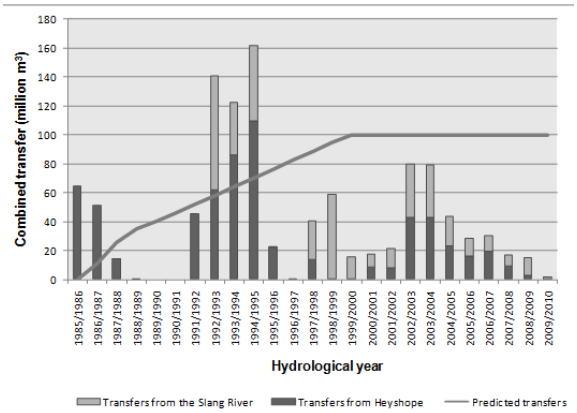


Figure 1, top: *Determining pumping costs with the Incremental Approach of IBT project appraisal.*

Figure 2, middle: *Usutu-Vaal GWS (Second Phase): Historic water transfers from Heyshope Dam against transfers predicted.*

Figure 3, bottom: *Combined historic water transfers from the Heyshope Dam and the Zaaihoek Dam on the Slang River.*

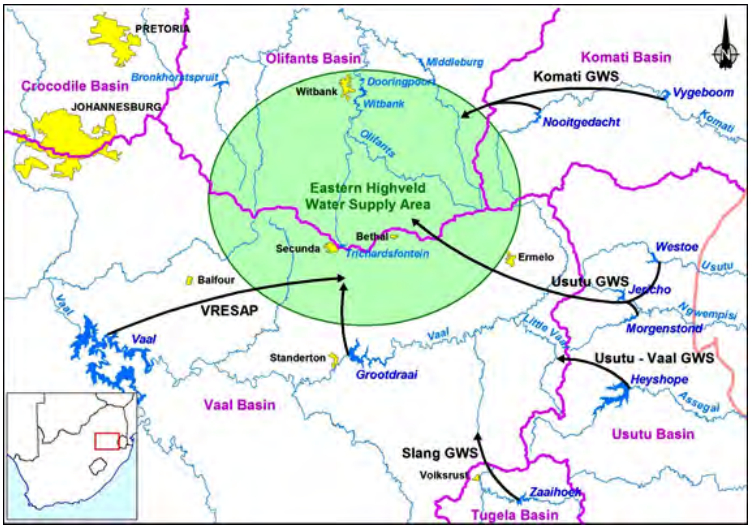


Figure 4: *Locality of Usutu-Vaal GWS (Heyshope Dam) within the upper Vaal River system.*

projections, and possible changes to the configuration of the system.

The WRPM is a South African developed system analysis simulation tool to determine the probabilistic yield characteristics of complex water resource systems. It can accommodate multiple demand centres (i.e. yield channels), take into account growth in demand and changes in land use, allow expansion of the system at future dates, deal with quality constraints, and impose curtailments. Its great advantage is that it explicitly provides information on future risks associated with postulated management and intervention scenarios. It is used for operational as well as planning purposes.

Dr Van Niekerk studied annual reports, covering a period of 22 years, starting in 1990/91 and ending in 2011/12, to see how the IBTs from Heyshope Dam and Zaaihoek Dam were operated in the light of the conditions in the rest of the IVRS during that period, and in particular that of the Vaal River Eastern Sub-System (VRESS) to which these IBTs are linked. A timeline perspective could be obtained of the four variables that influenced the decisions related to the transfers from these IBTs; the state of the system at decision date, the changes in system configuration and capacity, the projections in demand on the system for the short and medium term and the levels of assurance of water supply.

It was found that the state of the system, in particular the level of water in storage in Grootdraai Dam, had been the dominant determinant in the decisions related to the transfers from Heyshope and Zaaihoek dams. The state of the system at the decision date is influenced by the inflows the dams received in the preceding period and the abstractions that were made. Of these, the inflows are by far the dominant factor; abstractions were more stable and predictable.

During the 22-year period the system storage generally remained fairly high, except for a period between 1992/93 and 1995/96 when a drought occurred. This drought was of such a severity that restrictions had to be imposed on all water users on 1 April, 1995. Irrigation water users were restricted by 40%, municipal users by 20%, mines and the SASOL oil-from-coal facility by 10% and Eskom power stations by 5%. Following exceptionally good rains in November, 1995 the drought was broken. Restrictions were lifted in January 1996.

For the four years of the drought, large quantities of water were transferred from the Heyshope and the Zaaihoek dams. Problems with the pumps at the Geelhoutboom pumping station at Heyshope prevented continuous transfer at maximum capacity during these years. The policy at first was to keep all the water transferred in Grootdraai Dam, i.e. not to support the rest of the system. When Grootdraai Dam filled completely (largely as a result of the transfers) it was decided to continue pumping as there were delays in bringing the LHWP on stream, keeping Grootdraai Dam full and the spills to augment Vaal Dam. All transfers were stopped in December 1995 due to the system having recovered from the drought.

After the drought years of 1992/93 to 1994/95 the operating rule for transfers to Grootdraai Dam followed a fairly consistent pattern. The two transfer projects were treated in tandem, and similar recommendations made for transfers from the Heyshope Dam and the Zaaihoek Dam for the year that lay ahead. These recommendations were based on the likelihood that water shortages may develop in the short to medium term. Basically, interbasin transfers were made from Zaaihoek Dam and Heyshope Dam to Grootdraai Dam every time the latter reached a certain percentage of its full supply storage.

For 11 out of the 16 years since the drought, this level was set at 75%. During these years the starting storages of Grootdraai Dam averaged 96.1%. For four of the years a 90% rule was adopted. The average starting storage in these cases was 95.2%, which was not significantly different to the average for the 75% rule. It is noticed that three of these years occurred in the five years before the VRESAP pipeline started at the end of 2008 to augment the system from the Vaal Dam. This is consistent with the behaviour that can be expected of a system that is moving closer to its maximum safe yield capacity, with a growing demand and just prior to the system being augmented.

In the case study of the Usutu-Vaal GWS IBT the lower quantity of water actually transferred, as

compared to what had originally been predicted, as well as the erratic nature of actual transfers as compared to the smooth growth originally assumed, could be explained by tracing the annual operations of the project over 24 years. It was shown that the Heyshope and Zaaihoek transfers were primarily determined by the state of storage in the Grootdraai Dam, and that the latter storage was dependent on the inflow into the dam, i.e. the run-off arising naturally in its catchment. By extension therefore, the Heyshope and Zaaihoek transfers were dependent on the runoffs that occurred in the catchment of the Grootdraai Dam, i.e. the receiving catchment. As these runoffs are inherently uncertain, hydrological uncertainty similarly characterises water transfers.

In the original planning of the Usutu-Vaal IBT, the investigation into the annual operating analysis showed that the assumption that all incremental water requirements, beyond the yield capability of Grootdraai Dam, would be required to be met from transfers had been incorrect.

The Incremental Approach led to an overestimation of the quantities of water to be transferred and, by the same token, operational costs. The correct appraisal approach would be to treat water transfer as a stochastic variable. The Incremental Approach, being a deterministic approach to IBT scheme appraisals, does not capture the essential characteristic of future water transfers – these being of an erratic and uncertain nature.

A further four South African case studies and two international case studies (in Australia and China respectively) showed that the Incremental Approach is still in general use today.

THE PROPOSED COMPREHENSIVE APPROACH

An improved approach, called the Comprehensive Approach, is proposed to explicitly address the probabilistic characteristics of water transfers and, following this, to upgrade the estimation of the costs associated with such transfers.

The Comprehensive Approach firstly requires the integrated analysis of the source basin and the receiving system, in combination. A simulation model, such as the WRPM, must be set to record water transfers, at suitable (typically monthly) intervals. The model is then employed to obtain simulated sequences of future water transfers of IBT schemes under consideration. With stochastic hydrological data input the transfer data sequences thus generated will exhibit characteristics similar to the actually observed water transfers of existing IBT projects.

With the synthetically generated water transfer data as input into the lifecycle cost model, the analyst is able to obtain a representation of the probabilistic characteristics of the lifecycle costs of an IBT scheme under consideration. Such output would form an important input into further economic investigations, such as cost-benefit analysis, to ascertain the feasibility of a proposed IBT scheme.

The application of the Comprehensive Approach was consequently demonstrated by means of an example using the Thukela Water Project, a proposed IBT to further augment the Vaal River system. It was shown that the Incremental Approach is severely biased with respect to variable costs and that this bias leads to significantly different estimations of likely lifecycle project costs. Such differences conceivably lead to sub-optimal decision-making.

These findings have relevance not only to water scheme comparisons, but also to the institutional and financial design of water augmentation projects, such as seawater desalination works as well as the calculation of international water royalties, such as exist currently between South Africa and Lesotho.

In addition, the generally used unit reference value (URV) measure for appraising and ranking water resource projects in South Africa also required improvement. Dr Van Niekerk has shown that the current approach is conceptually flawed as it fails to distinguish between water transfers and effectiveness outputs. He proposed an expanded and improved determination of the URV measure.

- This article is based on two papers originally published in *Water SA* Vol 39 No 4 titled 'Hydrologic-economic appraisal of lifecycle costs of inter-basin water transfer projects' and 'Unit Reference Value: Application in appraising inter-basin water transfer projects'. Visit: www.wrc.org.za ❑

The Vaal River system combines a number of inter-basin transfer schemes to water South Arica's economic heartland.

Modern system keeping Hermanus' wells flowing

Sue Matthews

A state-of-the-art groundwater monitoring system in Hermanus, on the Cape South Coast, is ensuring that municipal abstraction is efficient and sustainable, while also providing valuable insight into aquifer structure and functioning. Article by Sue Matthews.

Cape Town-based earth sciences consultancy Umvoto Africa was contracted by Overstrand Municipality from 2002 when it became clear that surface water resources would no longer meet the needs of the rapidly developing coastal town. Since then, three wellfields have been developed, with the potential of supplementing the annual municipal allocation of 2.8 million m^3 of water from the De Bos Dam by a maximum of 3.2 million m^3 of groundwater per year.

Currently, only the Gateway Wellfield – named after a nearby shopping centre – is in production, the licence having been issued in June 2011. The Camphill and Volmoed Wellfields in the Hemel en Aarde Valley are still in testing phase under a draft licence, but are expected to become operational this summer. In all cases the production boreholes target the fractured-rock aquifer of the Peninsula Formation – a quartzitic sandstone component of the Table Mountain Group – but the three wellfields occur in separate hydrogeological zones.

The Gateway Wellfield consists of four boreholes, three of which are production boreholes and the remaining one used for monitoring purposes only. The Camphill and Volmoed Wellfields have 11 boreholes in total, with four of these being dedicated to monitoring. In all boreholes, monitoring begun prior to abstraction to establish baseline information and increase understanding about the connectivity between surface waters and the underground primary and fractured-rock aquifers. It also helped inform the development of a hydrogeological model, which will be periodically updated and refined with the knowledge gained from ongoing data collection. The model will, in turn, be used in an adaptive management approach, in which operational procedures are adjusted on the basis of improved understanding.

Most of the borehole monitoring instrumentation is linked to a telemetry system, with data transmitted at either 30-minute or 12-hour intervals, although manual download on a quarterly basis is required at some of the far-field monitoring boreholes. The near real-time availability of data allows for close surveillance of the wellfields' operation by both Umvoto Africa and the local municipal staff.

Production boreholes are equipped with flow meters that automatically record the pumped flow rate at 30-minute intervals, and there is also a flow meter on the groundwater inlet pipe at the Preekstoel water treatment works to measure the total flow from the boreholes. Sensors in both production and monitoring boreholes record water level on either a half-hourly or hourly basis; the few monitoring boreholes that do not have water level sensors are manually monitored every three months.

Sue Matthews

Left: *Karen Burgers of Umvoto Africa lowers a logger into a borehole during a field trip arranged for the Hemel en Aarde groundwater monitoring committee.*

Right: *A production borehole in the Volmoed Wellfield overlooks the lower Hemel en Aarde Valley.*

Umvoto Africa

The three Hermanus wellfields and associated monitoring sites. The red block represents the Gateway wellfield, the green Camphill and the yellow Volmoed wellfield.

Since the Gateway Wellfield is down on the coastal plain and only 2 km from the sea, saline intrusion with over-abstraction was identified as a potential concern. A minimum water level in the boreholes of 5 m above mean sea level has therefore been set, and pump rates automatically decrease if this is reached to allow water levels to recover. In addition, electrical conductivity meters in the Gateway production boreholes record EC every half-hour during pumping, and pumps will stop automatically if EC rises to 150 mS/m. Reaching either of these limits sets off an alarm on the telemetry panel at the water treatment plant and sends out an SMS alert.

"The SMS alerts come through to us and to municipal staff, who can respond quickly if something happens," explains Karen Burgers, Umvoto Africa's geoscientist responsible for management of the wellfields. "Also if there are any infrastructural problems – something stops working, or there's a power failure – they can see on the telemetry system where the problem is, and can go and investigate if necessary. We've trained them so that they know what to look out for, and they only contact us if there's something out of the norm that they can't explain."

"Our role is to look after the monitoring network and keep an eye on the wellfield. Apart from checking the data frequently for any red flags and analysing it for monthly reports, it's a constant maintenance job – for example, checking battery voltages in the telemetry system, servicing loggers and cleaning contacts – whatever needs to be done to ensure a smooth running operation."

Umvoto staff also carry out comprehensive water quality monitoring on a quarterly basis. Every three months EC, pH and temperature are manually measured in all boreholes using handheld probes. At the same time, samples are taken for bacteriological monitoring and for laboratory analysis of EC, pH and the concentrations of chloride, calcium, sodium, sulphate, nitrate, ammonium, magnesium, aluminium, iron and manganese. Occasional elevated levels of some of these chemicals have been attributed to contamination by agricultural fertilizers or farming activity in the vicinity of the boreholes, while iron and manganese concentrations are naturally high, in common with most groundwater sourced from TMG aquifers. Periodically, water samples from the boreholes are analysed for oxygen and hydrogen isotopic signatures, which provide clues to the mechanism of recharge.

An ecological monitoring programme is also conducted with the

aim of detecting any impacts of groundwater abstraction on vegetation, wetlands and other special habitats. Aerial photos taken twice per year since 2008 and remote-sensing data from MODIS (Moderate Resolution Imaging Spectroradiometer) are analysed for any changes in vegetation cover at selected sites, and confirmed through botanical fieldwork. To date, only normal seasonal variation is evident.

Piezometers, which measure water pressure as a substitute for depth, have been installed in a few wetlands and streams to provide a continuous record of water level. Stream flow and water level are also measured manually every three months, using a bucket and stopwatch, so that the relationship between them can be established. The aim is to use this relationship to translate the piezometer water level readings into continuous flow data.

In addition, water samples are collected at the stream sites during the quarterly field monitoring for analysis of silica and dissolved organic carbon concentration (DOC). The silica concentration is naturally higher in groundwater than in streams, given the slow process of dissolution of quartzite and the short residence times of water in streams, while the reverse is true for DOC, since streams have more leaf litter and other organic matter. Their levels are therefore indicative of the relative contribution of groundwater to surface water, which can be expected to vary on a seasonal basis with rainfall runoff.

Rainfall data is sourced from a number of private weather stations in the area, as well as the former Hermanus Magnetic Observatory, now part of the South African National Space Agency. Umvoto have also encouraged local landowners to install monitoring equipment at their own boreholes, which target the shallow alluvium or primary aquifer sands. However, there is no evidence of any link between these and the deeper Peninsula Formation aquifer, supported by the lack of any response to pumping at Gateway. There is likewise no detectable response in the wellfield's monitoring boreholes in the upper aquifers, nor in the recharge zone in Fernkloof Nature Reserve or the Camphill and Volmoed Wellfields in the Hemel en Aarde Valley. Radiocarbon analysis of water samples from the Gateway production boreholes suggest it is stored water approximately 10 000 years old that is being abstracted.

All the data collected in the monitoring programmes are used by Umvoto to compile a comprehensive annual report, as well as an interim report in mid-year. These are presented to monitoring committees made up of representatives from the Overstrand Municipality, Department of Water Affairs, Breede-Overberg Catchment Management Agency, conservation agencies and NGOs, ratepayers associations, local landowners and other interested parties.

The thorough and transparent approach followed has paid dividends in terms of allaying fears amongst Hermanus residents that the 'hidden treasure' of groundwater will be plundered. It will no doubt also help increase confidence in other municipalities that aquifers can provide a viable and cost-effective alternative to surface water supplies.

"Groundwater has had a reputation in a lot of municipalities of being unreliable, because equipment breaks down or the boreholes get clogged. We know we have iron and manganese problems, and borehole cleaning every few years just has to be built into the budget," says Burgers.

An oxidation process causes iron and manganese dissolved in groundwater to precipitate out on contact with air, resulting in reddish brown or black residues that foul boreholes and associated infrastructure over time.

"The biggest problem I think is that groundwater practitioners are generally hired to drill a hole, then hand it over and walk away. Umvoto has turned that on its head, in that we drill the holes, make recommendations, and get involved in the infrastructure and running of the wellfield afterwards. I hope more hydrogeologists go that way. By staying involved in the management of the wellfield we can ensure that its properly operated, and that our recommendations for sustainable pumping are followed." ❑

Sue Matthews

Above: *Paul Lee of Umvoto Africa at the control panel of one of the boreholes as he explains the telemetry system.*

Below: *A transect is marked out for a botanical survey as part of the ecological monitoring programme.*

Umvoto Africa

SIMPLICITY – The key to sanitation sustainability

South Africa will have to look beyond conventional wastewater technology if it is to solve its current wastewater treatment crisis, writes Rhodes University PhD scholar Prudence Mambo.

There is universal acknowledgement of the need to accelerate sanitation service delivery, especially in developing countries. According to the World Health Organisation (WHO), 115 people every hour succumb to preventable illnesses aggravated by poor sanitation, hygiene and water contamination.

At the dawn of democratisation in South Africa in 1994, an estimated 21-million South Africans were without basic sanitation. To eliminate this exigency Government introduced the Water Supply and Sanitation White Paper. However, hindrances attributed primarily to poverty, underemployment and high operational costs incurred by bulk water supply and sanitation schemes ensured the previously marginalised poor were unable to pay service delivery charges.

Governmental efforts, primarily the commissioning of 2 410 water and sanitation projects by the Department of Water Affairs and Forestry (DWAF) culminating in an audit by the Council for Scientific and Industrial Research (CSIR) in 2007, revealed that approximately 60% were incomplete or not operational.

The aforementioned concerns thus served as primary drivers for the National Waste Management Strategy (NWMS) of the *Waste Act* (2008) of South Africa, which in summary mandates minimising pollution, environmental degradation and the consumption of natural resources in an effort to conserve access for future generations. It further mandates implementing waste hierarchy, balancing the need for ecologically sustainable development with economic and social development, while promoting universal and affordable waste services (Republic of South Africa, *Waste Act* 2008).

Wastewater is environmentally detrimental due to its nutrient rich, copious nature and frequency of generation. This causes the proliferation of detrimental conditions, such as the explosion of microorganism and plant populations, to the detriment of endemic flora and fauna. Microorganisms in domestic wastewater are enteric and generally disease causing. Thus it is in the interest of governments to implement sustainable solutions for the remediation of wastewater.

At present, more than 80% of South Africa's wastewater treatment works are in disrepair, underperform or are overloaded. Further, South Africa has experienced the deployment of ill-advised, energy/cost/expertise expensive, 'advanced' technology choices that have proven unsustainable in the long term.

The reality is that technologies like reverse osmosis and desalination schemes are better suited to the developed world where the capital resources, infrastructure and expertise are pre-established. Thus, employment of foreign technologies ensures employment of foreign expertise for construction, operation, maintenance and eventual training, while the implementation of simple indigenous technologies ensures the employment creation and up-skilling of the immediate community where the system is deployed.

Integration of pre-existing knowledge and technology awareness will ensure system adoption and that the communities take ownership of their sanitation management resulting in improved, cost-effective, relatable and consistent service delivery as the communities become self-accountable.

Rapid implementation of robust, easy-to-deploy and operate wastewater treatment technologies is urgently required. Furthermore, climate change together with reduced water availability has major food security implications for South Africa, its neighbours and other arid, water-poor countries.

These factors pose profound management implications for both government and business. Correct implementation and management of Integrated Algae Pond Systems (IAPS) optimised for South African conditions can produce clean water for recycle and reuse, provide energy, and generate a biomass suitable for valorisation. Even so, and as with any near market-ready technology, there is an element of risk and/or failure to comply.

Conceptualised by the late Prof Bill Oswald of the University of California in Berkeley, a staunch advocate of sustainable development and access to sanitation for all, the IAPS streamlines conventional wastewater treatment technologies to essentially remediate wastewater biologically.

He combined the primary facultative pond with an in-pond anaerobic digester and enhanced the efficiency of waste

stabilisation, facultative and maturation ponds by introducing a raceway with a paddle wheel to evenly mix and polish wastewater while reducing the usual retention time within ponds. This resulted in reduced retention times throughout the system in comparison to other conventional treatment technologies, while the construction of the an in-pond digester underground ensured the temperature required by anaerobic microorganisms remained constant regardless of the influent temperature. This ensured the global applicability of the technology.

THE BENEFITS OF IAPS

This technology can be implemented where a wastewater treatment system is most needed. It can be operated and maintained by the community in which it is deployed as minimal skill is required for system operation and maintenance. The system can further and most importantly be retrofitted to support pre-existing overburdened and under-performing technologies improving their efficiency and reliability.

Land is not limiting in South Africa and in most parts of Africa thus this technology can easily be implemented and sustainably deployed. The technology can further be retrofitted to suit the type and quantity of wastewater requiring remediation. With simple amendments to the components of the system, it can easily generate methane gas for heating and cooking and, when passed through a generator, generate electricity.

Thus, this system can operate off the electrical grid, while generating an effluent stream suitable for irrigation in agriculture and cattle rearing. The algae biomass, generated in copious amounts can serve as a bio-fertilizer, a substrate for the anaerobic digester and further is responsible for carbon sequestration, which mitigates carbon dioxide emissions into the environment.

The IAPS also has the potential to decrease the costs involved in capturing more water and alleviating the demand on already strained and untapped environmental water reserves. It further reduces the costs involved in treating more water, most notably in terms of the energy required to harvest the water and to divert it to where it is most required.

THE CONSTRAINTS OF IAPS AS DEPLOYED AT THE BELMONT VALLEY WASTEWATER TREATMENT PLANT

The IAPS at the Belmont Valley wastewater treatment plant was constructed to supplement the remediation capability of the of the trickling filter system deployed by the municipality. Thus, there is a pump that diverts 10% of the incumbent wastewater from the plant into the IAPS. Therefore when the pump is not operational, there is no influent into the IAPS until the pump is running.

The IAPS was designed to remediate wastewater to a secondary level, which has in the past not been emphasised. Thus the IAPS at the Belmont valley wastewater treatment plant does not disinfect to a level compliant with the standards set forth by the Department of Water Affairs (DWA) for discharge into the environment primarily due to the lack of a tertiary treatment component, which should not imply that that the IAPS cannot be designed to generate a specific effluent quality.

Rather, with the addition of a tertiary treatment unit and supplementary UV disinfection/chlorination/flocculation, the effluent from the system can be utilised for domestic purposes like flushing toilets, lawn irrigation, washing cars, showers and in the case of agriculture, irrigation.

Another shortcoming of the present configuration is that the anaerobic digester was not designed for methane harvesting. Had the system been configured to harvest methane, the wastewater treatment plant would be operating off the grid and would concomitantly be better equipped to place itself as a sustainable self-sufficient technology. However future designs could easily amend this shortcoming ensuring that even urban and rural communities would have constant, renewable, reliable and carbon neutral electricity generation as sources of energy like wood and fossil fuels are environmentally and health detrimental.

The current paddlewheel design deployed at the Belmont Valley wastewater treatment plant often disconnects from the shaft resulting in impaired wastewater remediation. This has implications for the quality of water effluent discharged from the IAPS. In actuality at times no effluent is discharged from the system due to a lack of sufficient propulsion from a functional paddlewheel as a result the water in the raceway may stagnate.

Another concern is that the paddlewheel utilises electricity to turn, it would be preferable if it either utilised solar energy or methane gas captured from the in-pond anaerobic digester as once there is a power cut both paddlewheels are not operational resulting in an effluent stream that is partially remediated and not suitable for environmental discharge.

Of greatest concern is that the current raceway design is flawed in that only 50% of the final effluent is remediated. This should have been amended by either doubling the size of the second raceway or adding a third raceway to increase the retention time in the system, which currently results in the final effluent not being suitable for environmental discharge.

The world is edging closer to a scenario where water will have to be recycled and more efficiently utilised in order for sustainable and adequate access for all, most especially as water is a right and not a privilege. Education is vital to ensure that water utilisation and remediation costs are reduced to ensure an adequate supply for all.

Sustainable remediation of wastewater is imperative in a drought prone, water stressed country like South Africa. Technologies like the IAPS carefully considered these ever pertinent needs and comprehensively addressed them by generating a treated water, energy and a biomass suitable for agricultural applications, resulting in a system which can be tailored to suit the regions and the needs of the community where it is deployed, ensuring access to sanitation for all and resulting in reduced preventable sanitation and water contamination related disease incidences.

The system has been shown to be cost-efficient, versatile, deployment ready, sustainable, robust, environmentally safe, sustainable, green and capable of facilitating up-skilling in relatively remote communities. Land is available in South Africa and the climate of conducive for efficient year round remediation. So, why not, this system can serve as the stepping stone for improving the quality of life for all. ❑

Taking on the challenges of AMD through horticulture

Through his dedication to the environment, Alusani Emmanuel Maphorogo, Parks Manager for Johannesburg City Parks, is committed to the development of a remediation and sustainable rehabilitation strategy for a park located in the West Rand of Johannesburg. Maphorogo speaks to Debbie Besseling about his career in horticulture, and how he became involved in the project.

Manuel Street Park is situated in the area of Davidsonville, Roodepoort West. The park is in close vicinity to the Princess Dump, a largely unrehabilitated mine dump. Mine run-off contaminates the park frequently. The impact of contaminated mine run-off water flowing through the Manuel Street Park and into the wetland is a great risk, in addition to the dust and water run-off which poses a health and safety risk.

As the area is not fenced, children play in the park and walk through the wetlands to school. There have also been reports in the media of the residents in Davidsonville suffering from severe asthma from air-borne dust from the mine dumps.

In past rainy seasons heavy rains have washed mine tailings through houses in the vicinity. Although there is a boundary wall to protect the houses from dust and run-off, it is just 1.5 m high and does not effectively serve its purpose. Interim precautions have been taken to avoid another flood in the park during heavy rains.

Maphorogo became involved in this project through his current position, where he is responsible for horticultural maintenance at Manuel Street Park, which falls within his geographic area of responsibility. "In 2012 there was an overflow of what was believed to be acid mine drainage (AMD), which caused serious concerns. I then developed an interest in mine tailings remediation and rehabilitation using microbial treatment, landscaping and public needs assessment," he explains.

This project seeks to establish a remediation and rehabilitation strategy for the park. According to Maphorogo, the first stage will involve performing a soil profile analysis, public needs assessment, and finding a good formulation for the mine run-off contaminated soil. Thereafter the results will be analysed and a remediation and rehabilitation strategy will be drafted.

PROPOSED STUDY AT MANUEL STREET PARK

Maphorogo's study includes the investigation of the usefulness of a treatment using a commercially available microbial preparation (Effective Micro-organisms® or EM®) in remediating the soil in Manuel Street Park. EM® is a blend of beneficial microorganisms that exist in nature and can increase the quality, soil structure and productivity of soil and the growth and quality of plants. The product also suppresses germination of weeds and can be used for solving environmental problems such as soil pollution.

The technology was developed by Prof Teruo Hinga in Japan. It basically comprises beneficial bacteria, fungi, lactic acid and molasses. All these are brewed to a formulation which has many uses.

The study will primarily undertake greenhouse trials with samples of soil removed from the park and tested using different treatment protocols. The planned use of microbial preparations is intended to explore a type of low cost environmental biotechnology, which can contribute new solutions to remediation and rehabilitation challenges for contaminated environments. Once the results are analysed and plans put in place, it is envisaged that the study will contribute positively towards the rehabilitation of the park in the long term.

Johannesburg City Parks has other parks that are near unrehabilitated mine tailings that have the same risk of being polluted. The outcomes of this study could be helpful in developing remediation and rehabilitation strategies for these other parks.

A community survey will be conducted to establish how the Davidsonville community use the Manuel Street Park; what their needs are and what their required uses of the local parks are in general. Maphorogo explains that a researcher at Johannesburg City Parks will be conducting the field survey with his assistance. He will analyse the results. "I will be drafting the remediation and rehabilitation plan using the findings of the study, which will meet the requirements for the MSc Horticulture, which I anticipate concluding by December 2014," he comments.

With regards to the remediation and rehabilitation of Manuel Street Park, a remediation plan will be needed to deal with the contaminated soil, and a rehabilitation plan to improve the park once the soil is no longer regarded as toxic.

CURRENT POSITION

In his current position as Parks Manager, Maphorogo has various responsibilities some of which include: weekly site visits, the overall enhancement of customer satisfaction, improving financial management and control, operational systems and the management of operational effectiveness, as well as the improvement of information and knowledge management. Procurement and management of horticulture services

forms an important part of his responsibilities, as does asset management and human capital management.

Compliance with the core delivery mandate and enhancement of service delivery and quality control, as well as the integration of management solutions with corporate strategy are key to the overall objectives. Compliance with legislation including the Municipal Finance Management Act No. 56 of 2003 (MFMA), Public Finance Management Act (PFMA), National Environmental Management Act (NEMA) and the National Water Act (NWA) form an integral part of his function.

The mandate of the Johannesburg City Parks and Zoo is set out in the Shareholder Agreement and is defined as: The provision, preservation and management of open spaces, biodiversity, environmental and conservation services through education, research, direct conservation action and recreation with a focus on the zoo, parks and cemeteries.

FARMING AND HORTICULTURE

Maphorogo grew up in a family of people who are passionate about the environment. "My mother, Selina, has worked tirelessly towards addressing the problem of food security and health in Limpopo Province since the 1970s. My father, William, has been a farmer all his life. He was raised by his grandfather, Mukondeleli, who was also a farmer.

I have farming and horticulture flowing in my blood, and growing up around people who are passionate has influenced me to appreciate nature and give back to what we – humankind – have taken from nature," reiterates Maphorogo.

When he matriculated in 1997, he chose to study horticulture as a career, and since then has enjoyed each and every level of studying and work. "I was also motivated by my mentor and godmother, Dr Erika Sutter, who worked as a botanist and an ophthalmologist," he comments.

CAREER HISTORY

In 2001, Maphorogo graduated with a National Diploma in Horticulture from Technikon Natal (now Durban University of Technology). In 2002 he worked as a general worker at Leitch Landscapes in Durban where he completed his experiential training. In 2003 he was employed by Real Landscapes as a supervisor of the maintenance team. From the period 2004 to 2007 he worked as a horticulturist at eThekwini Municipality, and later progressed to Senior Horticulturist.

"I have done many short courses to enhance my skills such as health and safety, project management, BS OHSAS 18001, permaculture, herbarium techniques, performance management and public administration," he comments. From June 2007 to date he has worked for Johannesburg City Parks.

In 2012, Maphorogo graduated with a BTech degree in Horticulture from UNISA. He is currently busy with his thesis towards a Master of Science in Horticulture at the same university. "My ambition is to also complete a PhD in Environmental Science and LLB Environmental Law," he states.

CAREER MILESTONES

Maphorogo discusses the milestones of his career: "In 2004, I was selected on a skills exchange programme between eThekwini Municipality and the Leeds City Council, London, England. The same year I established new contacts with Stadtgärtnerei in Basel Switzerland where I undertook further training in horticulture. I was also part of the team (training) on artificial pollination for *Encephalartos woodii*, which was a special project for the Durban Botanical Gardens in that it is one of the rarest in the world, being extinct in the wild.

"In 2004, I got my 15 minutes of fame when I was interviewed by BBC for the gardening programme and as a build-up to the Royal Horticultural Society Chelsea Flower Show 2004. I am part of the Gauteng Institute of Environment and Recreation Management (IERM) Branch, chairing a sub-committee on Environment and Conservation."

Alusani Emmanuel Maphorogo (centre) with two of the awards he received during the Johannesburg City Parks Environmental Awards in 2009.

ACHIEVEMENTS

Maphorogo highlights some of the most significant accomplishments of his career: "In 2001 I received a Bronze Award from the National Examination Board for Horticulture. In 2004, I was fortunate to be part of the team that went to Leeds City Council for a period of four months for training. This provided me with the opportunity of gaining physical experience and to enhance my managerial skills, whilst gaining knowledge of the wide range of systems and procedures.

"I was involved in the construction of an exhibition at the Royal Horticultural Society Chelsea Flower Show. The garden won a Bronze Award at that exhibition. The design of this garden entitled: *From Freedom to the Future,* was inspired by the life of Nelson Mandela in fighting oppression of the black majority by the white minority, and how the rainbow nation was formed," he comments proudly.

At Johannesburg City Parks, Maphorogo has received various recognitions, including the Managing Director's Achievers Award of Excellence, for his work in landscaping projects. More recently he received the Nyamuofhe Achievement Award for the achievement of a B.Tech in Horticulture from the Ramaphosa Family Trust, another of his fine accomplishments. ❑

WATER Kidz

Aqualibrium – Celebrating SA's young water achievers

A team of scholars from a school in the East Rand of Johannesburg are the proud winners of Aqualibrium, the South African Institution of Civil Engineering (SAICE)-Water Research Commission (WRC) Schools Water Competition 2013. Debbie Besseling took the opportunity to speak to the pupils and their teacher about their significant achievement.

SAICE Outreach Officer, Marie Ashpole, with Eqinisweni Secondary School teacher, Deborah Ramachela.

All photographs courtesy SAICE

The 2013 Aqualibrium champions, Tyson Chuma (18), Rudzani Mnisi (18) and Thulani Ndlovu (17) attend Eqinisweni Secondary School in Ivory Park, Midrand. They won the competition with just 60 penalty points – a truly exceptional score.

The Aqualibrium competition was launched ten years ago as SAICE and Rand Water celebrated a hundred years of existence. The competition was devised by Prof Kobus van Zyl and students from the then University of Johannesburg.

Using a grid and a set of plastic pipes and buckets, the competition practically illustrates how water distribution systems bring safe and clean drinking water to the people of South Africa. Learners are given insight into the practical application of the processes and the intricacies involved in the design of water distribution networks as well as the actual water delivery to households.

According to SAICE Outreach Officer, Marie Ashpole, who has been involved in the event since its inception: "The teams are tasked to design a model water distribution network to distribute three litres of water equally between three points on the grid using two different diameter pipes and connection pieces. They are then judged on how well they execute the task – working on a penalty points system. They have a period of about an hour in which to design, build and operate their network."

Regional competitions were held across the country whereafter the finalists gathered at the SciBono Discovery Centre in Johannesburg to compete for the title of ultimate winner. While the team from Eqinisweni took first place, the second place when to the team from Diamantveld Hoërskool from Kimberley, followed by joint third-place winners, Hoërskool DF Malan from Cape Town and Mfesane Senior Secondary School from Port Elizabeth. The three winning teams shared the prize money totalling just over R17 000.

Main sponsor of the competition, the WRC, is committed to the success of young learners who are dedicated in the fields of mathematics and science. SAICE and the WRC have taken the responsibility of spreading the news that more capacity is required to ensure that water is used wisely, that infrastructure is maintained and that new infrastructure is created to provide potable water to those without water. The competition is used as a platform to introduce the water sector as a potential career choice to young people.

Commenting on behalf of the WRC, Lani van Vuuren says that this competition further strengthens government's initiatives aimed at encouraging learners to take Mathematics and Science at school and to follow a career as a science or civil engineering professional. Only in this way can we assure that the quality of life of all South Africans will be better in future!

THE TEACHER BEHIND THE WINNING TEAM

Teacher Deborah Ramachela, accompanied the winning team to the finals. She could hardly contain her excitement at their win. She shared some insight into the capabilities of her pupils, describing them as very dedicated learners with good morals, values, tolerance, as well as being disciplined in terms of their studies.

Tyson is rather shy, hardworking, committed, focused, respectful, disciplined, dedicated, participative and extroverted. Rudzani is studying mathematics, physical sciences and life sciences. She is hard-working, dedicated, committed, participative, full of respect, focused and disciplined. Thulani is studying mathematics, physical sciences and life sciences. He is shy, hard-working, dedicated, participative, committed, focused, respectful and a self-disciplined learner.

According to the team, participating in (and winning) the competition was a great experience. They attribute their success to their positive attitude, their hard work and their support of each other. They advise future competitors to do some basic research on how to design water distribution systems, and to think logically and stay focused.

Commenting on her role and involvement in the competition, Ramachela says she was involved in guiding and facilitating the programme at school, and provided support and motivation to her learners so that they could strive to achieve the best results.

According to Ramachela, the qualities that in her opinion are essential requirements for pupils entering the competition include being committed, available and dedicated to their school work. "Then everything is possible and achievable, because this is all about thinking logically and being able to do the necessary planning," she says.

Ramachela is an educator in the Commercial Department at Eqinisweni Secondary School. She teaches Accounting and Economics and is head of the Grade 9 group. She has a B.Ed and is studying towards a B.Ed Hons second year at the University of Johannesburg.

"I have been a teacher for more than 13 years. What I like most about teaching is that I have been able to change many learners' lives, and I feel as if this is my calling. I dedicate my time to the learners so that they can be exposed to the reality of life, with the help of the department and my family," she says proudly.

On discussing the challenges faced as a teacher at Eqinisweni Secondary School, Ramachela comments that the environment that the learners are constantly facing is challenging, because many of them come from very disadvantaged families. A number of pupils are from single parent families, but this doesn't stop them from achieving. The importance of dedicated teachers cannot be reiterated enough. Encouraging and motivating learners to participate in extra mural activities is a fundamental aspect of the overall learning process.

Often the teachers and students work under difficult circumstances, Ramachela comments that one must have dedication, commitment, as well as love and passion for what you are doing in order to achieve success. ❑

***Above**: Winners of the SAICE-WRC Aqualibrium competition, Rudzani Mnisi, Thulani Ndlovu and Tyson Chuma from Eqinisweni Secondary School (kneeling) with their teacher, Deborah Ramachela and her daughter, SAICE CEO, Manglin Pillay, SAICE President, Peter Kleynhans, and Lani van Vuuren from the WRC.*

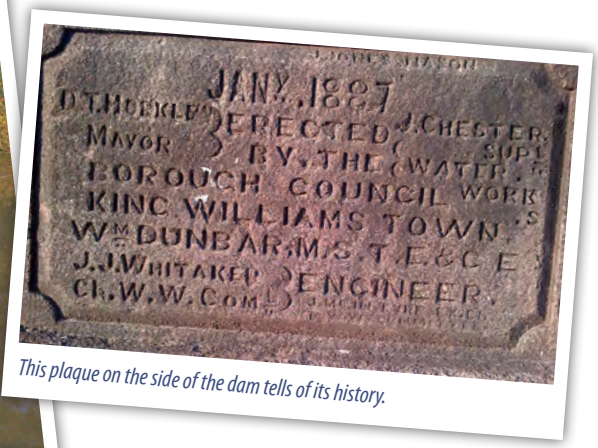
***Below**: The learners from Eqinisweni Secondary School at work during the finals of the SAIC-WRC Aqualibrium competition. From left: Rudzani Mnisi, Thulani Ndlovu and Tyson Chuma.*

Lake Dunbar – The failed dam of King

When looking at the demure Dunbar Lake, located 5 km outside King William's Town on the Buffalo River, one can hardly believe that it was once meant to be the main water supply to the Eastern Cape town. What started as a mission station later became a military settlement, with the first town council appointed in 1861. Mission founder, John Brownlee, was the first to cut a furrow (about 2 miles in length) from the river to supply the mission station with water. When the military moved in they took over the furrow. Despite the proximity of the Buffalo River, water supply to the young King William's Town was often erratic. With the appointment of Borough Engineer, William Dunbar, in 1881 it was hoped the situation would change. Dunbar was enthusiastic that he could not only improve the town's water supply, but improve its economic situation as well. He envisaged a series of locks on the Buffalo River so that boats could sail up to the forests and timber could be 'floated downstream'. However, his dam was severely criticised since its final cost turned out to be three times the original estimate of £4 000. Its water also turned out to be muddy and unsuitable. The dam was finally completed in 1888. In the end, Dunbar was criticised so much he chose to resign (he subsequently went to work for the Johannesburg Waterworks Company). Lake Dunbar did not turn out to be the end of King William's Town's water woes, but for a while it was a popular boating spot – that is until a severe flood washed away the boathouse in the 1890s. In 1900 it was stated that Lake Dunbar would remain a 'white elephant' unless its water was piped to town. Pipe-laying started in 1903 and the pipeline was in use until about 1970. The dam was superseded by Maden Dam in 1910.

- With thanks to Clint Lentz and www.bassfishing.co.za for information and photographs.

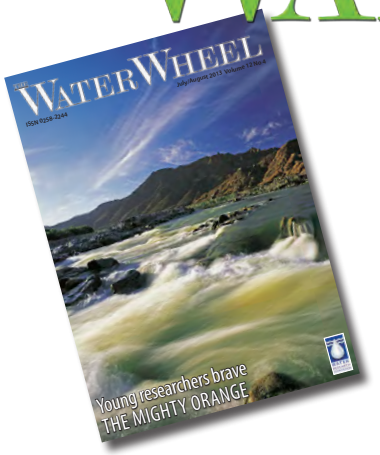
Lake Dunbar is still a spot for bass fishing.



This plaque on the side of the dam tells of its history.

Dunbar's dam originally held about 9 Mℓ of water.

THE WATER WHEEL



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The Water Reasearch Commission not only endeavours to ensure that its commissioned research remains real and relevant to the country's water scene, but that the knowledge generated from this research contributes positively to uplifting South African communities, reducing inequality and growing our economy while safeguarding our natural resources. The WRC supports sustainable development through research funding, knowledge creation and dissemination.

The knowledge generated by the by the WRC generates new products and services for economic development, it informs policy and decision making, it provides sustainable development solutions, it contributes to transformation and redress, it empowers communities and it leads various dialogues in the water and science sectors.

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