

THE WATER WHEEL

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NEW HYDROPOWER
OPPORTUNITIES
COULD HELP LIGHT SA



SANCOLD ANNUAL CONFERENCE 2014

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***“TOWARDS SUSTAINABLE
DAMS IN SOUTHERN AFRICA”***



SANCOLD

SOUTH AFRICAN NATIONAL COMMITTEE ON LARGE DAMS

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

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>

Follow us on Twitter:

@WaterWheelmag

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: *South Africa might have more hydropower potential than previously thought. Read the article on p 12. Cover illustration by Ralf Broemer.*





A water research and innovation framework for South Africa

The year 2014 represents a year of note for South Africa at the World Water Week to be held in Stockholm in September.

Two parties closely related to the South African water science and technology system have been confirmed as the recipients of its two highest annual awards. Dr John Briscoe, a South African trained in this system, who has been practicing as both an academic and water practitioner around the world, is the 2014 winner of the prestigious Stockholm Water Prize.

In addition, the City of eThekweni, a long-time partner of the Water Research Commission (WRC), has been named by the Stockholm International Water Institute as the winner of the 2014 Industry Award for its innovative record as a water utility. This is a unique double, and if, in addition, the South African entrant to the Stockholm Junior Water Prize manages to walk away with the honours, it would indeed be the first time that any country would have done so. (More about both these awards can be read

elsewhere in this issue).

In addition to these accolades, we know that the South African water science and technology community, in spite of being of modest size and means, is highly productive. The 2013 statistics on the ISI index confirm that in the water resources category, we contribute just more than 1.61% of the global share of papers. This puts South Africa at

number 18 in the world with respect to research output. In addition, our pulse studies also indicate that the water

sector has a higher conversion rate of research into patents when compared to most other sectors.

These are all laudable achievements, but in a country that has a combination of water services and sanitation backlog challenges toward the desired goal of universal sustainable access, wicked problems like non-revenue water and acid mine drainage, dealing with weather and climate change while pursuing a water intensive

economic growth agenda; we need to collectively up the research and innovation contributions to the implementation of the National Development Plan (NDP) in the long term and the five-year plan of the fifth democratic administration in the short term.

The WRC has as core components of its own Corporate Plan the principles of the multiplier effect and

“The South African water science and technology community, in spite of being of modest size and means, is highly productive.”

completing the innovation value chain from research to outcomes and impacts through the WRC Knowledge Tree con-

cept. The WRC has also partnered with the Department of Science and Technology to develop a Water Research, Development and Innovation (RDI) Roadmap to plot South Africa’s potential water technology pathways. This happens at a time when many players in the water industry are also investing in the research and capacity development domain through such interventions as research chairs and learning academies.

This provides the fertile ground to grow a Water Research and Innovation Framework for the country.

The development of the Water Research and Innovation Framework will provide an opportunity for the water sector and its partners to converge the different research agendas into a common vector toward a shared vision for both the future of water science and technology, as well as the future of the South African water industry. The Minister of Water and Sanitation is already starting a new dialogue on the alignment of the sector to better realise the goals of the NDP and a future water prosperous South Africa that could boast sustainable economic growth enabled by water security while simultaneously guaranteeing a dignified quality of life for all through universal safe water and sanitation access. The WRC will begin a process toward the development of a National Research and Innovation Framework in the coming months and will be encouraging all the players in the water sector and our various partners to actively participate in the process.

From the editor...

Thanks to our loyal readers

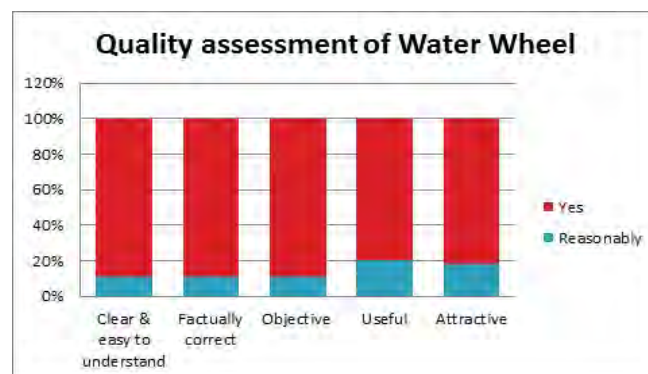
The *Water Wheel* would like to thank all its readers who participated in the recent reader survey. The survey confirmed the magazine's status as the most popular water magazine in South Africa. The survey also confirmed that this magazine remains one of the top knowledge products of the Water Research Commission, its publisher.

What pleasantly surprised *the Water Wheel* editorial team was the way in which the magazine is

shared – 60% of respondents indicated that they share the magazine with colleagues, family and friends.

We were also especially delighted with readers' response to the quality of the magazine. More than 80% of survey respondents indicated that they found *the Water Wheel* clear and easy to understand, factually correct, objective, useful and attractive.

The editorial team pledges to keep up the good work in bringing



you high-quality, well laid out news and information about the South African water and sanitation sector. We will also be looking

to implement some of the wonderful suggestions we received from our readers, so watch this space!

Lani van Vuuren (Editor)

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CSIR researcher elected to prestigious US science organisation

CSIR system ecologist, Dr Bob Scholes, has been elected as a foreign associate to the US National Academy of Science, an honour bestowed upon the world's best scientists as chosen by their peers.

Dr Scholes is well known for his contributions to the fields of global change, ecology and earth observation. With this achievement, he joins the ranks of a small number of elite South African scientists.

According to Thompson ISI, who maintains databases on scientific publications worldwide, Dr Scholes is among the top 1% of environmental scientists worldwide based on citation frequency, publishing widely in his chosen fields. He has a particular interest in the savannas of Africa, and has over 30 years of field experience in many parts of Africa and the world.

The Academy of Science is a non-profit society tasked to provide independent, objective advice to the US government on matters related to science, engineering and medicine. Nearly 500 of its members have won Nobel prizes.

Only 21 foreign associates are elected annually and there is no membership application process. Only Academy members may submit formal nominations of their peers. This is then followed



by an extensive vetting process that results in a final ballot at the Academy's annual meetings.

According to the Academy of Science, members are elected in recognition of their distinguished and continuing achievements in original research. Election to the Academy is regarded as one of the highest honours that a scientist can receive.

"I am blown away and I am humbled. It puts me in the company of internationally respected colleagues. It is a huge honour, both for myself and for South Africa," remarked Dr Scholes of his achievement. "I hope to spread the benefits by helping the South African Academy of Science, of which I am also a member, to reach its full potential."

Source: CSIR

New DWA-WRC partnership aims to build water capacity in South Africa

The Department of Water Affairs and Sanitation (DWAS) and the Water Research Commission (WRC) have signed a Memorandum of Understanding (MoU) appointing the latter as the implementing agent for the new phase of the Framework Programme for Education and Training in Water, also known as FETWater.

The programme, which will run until September 2017, is a joint UNESCO, Belgian and South African knowledge transfer and capacity building programme aimed to improve capacity in integrated water resource management expertise in areas where they are most required.

The end of the second phase, also implemented by the WRC, saw 1 052 professionals in the South African water sector receiving training through the FETWater programme. Concurrently, a vast amount of training material was produced, and two groundwater test sites were developed at the universities of Pretoria and KwaZulu-Natal. The programme places special emphasis on the training needs of women and previously disadvantaged individuals.

The new capacity building needs and requirements that will be considered in Phase III are the advancement of technologies in the water space, climate change and variability, strengthening of the water regulatory system and development of regulatory tools, local government capacity building using water as a catalyst



for economic growth and development, developing stronger inter-governmental relations, specialised skills and knowledge to manage water taking into account the whole value chain.

Phase III will be largely guided by the National Water Resources Strategy 2 (NWRS-2). Addressing participants at the signing ceremony earlier this year, DWAS Acting Director-General, Trevor Balzer (seen in the photograph with WRC CEO, Dhesigen Naidoo), said that FETWater provided a practical expression of the NWRS-2, and to making an impact in terms of capacity in the sector.

Said Naidoo: "The expectation is very high around Phase III, but it fits in well with where we are as a country. Capacity building in general, and scientific training in particular, is at another level of the game to where we were ten years ago. In the science and technology space, the water sector actually performs extraordinarily well."

Reptile Atlas a first for southern Africa

More than 26 authors and seven editors worked for nine years to complete the first reptile atlas for southern Africa. The collaborative 485-page *Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland* was launched earlier this year. The book contains the conservation status of 421 recognised species and subspecies of reptiles for in these three countries.

The University of the Witwatersrand (Wits University), one of the key

collaborators on the project, reports that data about reptiles were sourced from about 400 people and 14 organisations – 135 512 records in total. The bulk came from museums and nature conservation agencies, as well as from private collections, academic institutions and published literature.

According to Prof Graham Alexander from the School of Animal, Plant and Environmental Sciences at Wits University, the Atlas has the most up-to-date

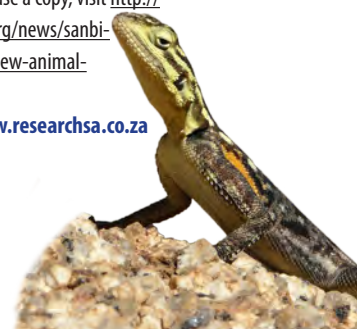
distribution maps (for reptiles) ever produced for the region. "The data in these distribution maps represents all of the available data we have collected since people started studying reptiles in South Africa."

Another important aspect of the project has been the contribution of citizen scientists through the Virtual Museum of the University of Cape Town's Animal Demography Unit. Here the public could submit photographic records of reptiles.

"This citizen science participation has resulted in people focusing on areas where not much collecting has been done in the past. It filled the gaps in distribution maps and identified areas that need more attention," noted Prof Alexander.

For more about the Reptile Atlas and how to purchase a copy, visit <http://www.sanbi.org/news/sanbi-publishes-2-new-animal-publications>.

Source: www.researchsa.co.za



National dam conference a highlight on engineering calendar

The 2014 annual conference of the South African National Committee on Large Dams (SANCOLD), to be held at Birchwood, Gauteng, on 5-7 November, promises to be a highlight on the regional engineering calendar.

The theme for this year's conference is 'Towards sustainable dams in southern Africa'. Dams and their reservoirs need to operate over long periods (even centuries), and long-term sustainability is thus of prime importance. While the main theme is related to sustainable dam development, the conference will also highlight the construction of dams. With large projects such as Phase 2 of the Lesotho Highlands Water Project having been announced, the conference is bound to feature some interesting presentations.

"The construction industry in South Africa needs to have the expertise in dam

construction in order to provide such services in the region, and in Africa, where there is a great need for water resources development," SANCOLD says.

Conference delegates also have the opportunity to attend three technical visits during this year's SANCOLD conference, namely Central Basin acid mine drainage neutralisation plant construction site in Gauteng, the Petra Diamonds Cullinan Mine tailings dam, and the Kareerand Tailings Dam. The site visits aim to highlight the importance of tailings dams as a focus area of SANCOLD and the International Commission of Large Dams of which the South African committee is a member.

- To find out more about the conference contact Lerato Miyen at Tel: (011) 676-3464; Email: secretariat@sancold2014.org.za; or Visit: www.sancold.org.za

New water technologies demonstration programme to help bridge innovation chasm

The Water Research Commission (WRC), in collaboration with the Department of Science & Technology (DST), has established a special programme to pull together the applied research and development and commercialisation stages of the water innovation continuum.

The failure to commercialise research effectively has been termed the 'innovation chasm', referring to the inability of academic research to reach the market as products and services. In other words, South Africa often produces good academic research and small-scale (laboratory level) piloting of new technologies but fails to commercialise.

In order to take research from this early stage to the market, where industry and entrepreneurs will invest in the technologies and where potential users will adopt them, larger scale real-world demonstrations are required to provide proof of technology and effectiveness.

This higher level demonstration is typically costly because large scale plants

need to be built and typically risky because there is no guarantee that the technology will actually work at a larger scale. Despite the costs and risks, demonstrations are important as they can help provide invaluable information for ramping up the technology, improve market awareness and confidence in the product/service, attract potential investors, communicate gaps in research, support evidence-based policy-making, and help technology developers/manufacturers legitimise the performance of their products.

The WTDP will act as an intermediary in the water innovation continuum to facilitate high-level water technology demonstrators, coordinate multi-sectoral partnerships, build networks, and foster knowledge sharing and knowledge transfer to help bridge the gap between water research and the market.

To become part of the programme contact WTDP Manager, Nirvashnee Seetal, at Tel: (012) 330 9010 or Email: nirvashnees@wrc.org.za

Benchmarking: How municipalities assist each other

The Municipal Benchmarking Initiative (MBI), a programme of the Water Research Commission and the South African Local Government Association (SALGA) in association with the Institution of Municipal Engineering in South Africa has made significant strides towards improving water management at the local level since its establishment in 2011.

Globally, benchmarking is recognised as a best practice, practical tool to guide and support effective performance assessment and continuous performance improvement. "The MBI signifies the right direction when it comes to improving water services delivery in South Africa. It is an innovative and inclusive approach to tackling service delivery issues," said SALGA national executive committee member, Pinky Moloi.

According to WRC Executive Manager for Water Use & Waste Management, Jay Bhagwan, specific progress has been made through the initiative in module and material development; municipal engagement, support and events/forums; development of a database and Web tool; business analysis and intelligence as well as business management and leadership.

Water Services Master Classes have been established as peer-learning exchanges designed to bring together senior technical and management staff, experts and professionals on key areas of the water services business. The exchanges are based on a blended learning approach that prioritises interactive discussions and cross-pollination of information

and experiences.

In order to structure peer learning around a specific topic, the establishment of various Working Groups has been encouraged. Furthermore, a well-attended national MBI workshop was held in 2013.

A critical aspect of the current MBI is its 'less is more' approach to benchmarking data collection. Wherever possible, performance indicators do not duplicate information being reported elsewhere against national sectoral objectives. Rather, the benchmarking focuses on core organisational and operational management parameters that are essential for good, sustainable service delivery, while building awareness within municipalities of why they matter.

"We will also vigorously market our initiative to external stakeholders both private and public with a view to sharing ideas and continuously improving water services performance, notes Bhagwan. "After years of pursuing benchmarking in the water services sector in South Africa, it makes me proud of the progress and innovations achieved to date.

The MBI's annual report for 2013 can be downloaded from the WRC website: www.wrc.org.za



International award recognises Durban's innovations in water and sanitation

A part of the Durban municipality, eThekweni Water and Sanitation, has been named the 2014 winner of the Stockholm Industry Water Award (SIWA) for its transformative and inclusive approach to providing water and sanitation services.

"This recognition reflects the work of our whole team over the past 22 years, and is a tremendous honour for all of us," said Neil Macleod, head of the department. "Our greatest achievement has been bringing water and sanitation services to so many poor people and changing their lives."

eThekweni Water and Sanitation was established soon after South Africa's democratisation in 1996. During that time Durban expanded its administrative boundaries to include 3.5 million people, more than a million of them living in poorly serviced rural areas with huge water and sanitation challenges.

In the past 14 years, 1.3 million additional people in the greater Durban have been connected to piped water and 700 000 people have been provided with access to toilets. In respecting the constitutional right to water while maintaining

financial sustainability, access to basic water supply and sanitation is provided at no cost to poor families, while higher levels of services and consumption are charged at full cost.

In addition to successfully providing basic services to a large and diverse population, eThekweni Water and Sanitation is at the forefront of exploring technical and social solutions. According to Macleod, innovation has underpinned the department's work over the last 22 years. Technologies explored have included electronic bailiff units, community ablution blocks, and the construction of 80 000 urine diversion toilets.

Another more recent example has been the department's mini hydropower project: Instead of using pressure reducing valves in pipes running down steep hillsides, the company is installing mini turbines using the excess pressure to generate electricity for the city's low tension grid (a project in partnership with the Water Research Commission and the University of Pretoria). The eThekweni municipality is also pioneering solutions to convert urban wastewater challenges to agricultural opportunities as well as

harvesting rainwater.

The municipal services provider is also looking for new innovations, particularly with regards to sanitation, noted Macleod. "There is a perception that the full flush toilet is the ultimately technology. But we are a water-scarce country that cannot afford to use purified water to flush toilets."

As a result the department is forging research partnerships with organisations such as the Bill and Melinda Gates Foundation and others in search for a 'future toilet technology'. "We are looking for a toilet that can be rolled out to any household, that uses little to no water, that doesn't smell, and is safe to use especially by women and children," said Macleod.

The award recognises eThekweni Water and Sanitation to be one of the most progressive utilities in the world. The open approach to experimenting and piloting new solutions across both technical and social aspects of service delivery has made eThekweni a forerunner in the world of utility-run services. One partner comments that "leaders at eThekweni have already been betting on new and



One of the 80 000 urine diversion toilets rolled out by eThekweni Water and Sanitation.



The municipality has provided basic services to 1.3 million additional people.

STOP PRESS: Hydropower project wins Green award

The Water Research Commission's (WRC's) conduit hydropower project, rolled out through partners in Bloemfontein, Pretoria, and Durban, has won a Mail & Guardian Greening the Future Award in the Community Renewable Energy category.

The technology, developed with funding from the WRC by the University of Pretoria, uses excess energy in pressurised conduits to produce clean and renewable hydroelectric power. This solution, known as conduit hydropower, uses micro-turbines installed within the conduit system.

According to the Mail & Guardian, its simplicity is what makes the solution so elegant: "harnessing energy that is already present within the existing infrastructure and that would usually be lost through the use of a pressure valve."

Following a successful trial in Tshwane, the project was expanded to eThekweni and Bloemfontein. At Bloem Water, 96 kW/h of clean energy is being produced from a pressurised conduit and has become the main source of power at the water utility's head office in Pellisier.



The conduit hydropower installation at Bloem Water.

risky approaches to test innovation that will ultimately have a long term benefit for the population, most municipalities refrain from exploring ideas out of the box, focusing on business as usual."

"eThekweni has championed the approach to provide sufficient water to sustain human life, as expressed in the South African constitution, now embedded in national policy. The methods used and results achieved by eThekweni Water and Sanitation serve as a sterling example for the many communities worldwide facing similar challenges," states the SIWA jury in its citation.

- Read the *Water Wheel's* profile on Neil Macleod ('Leading the way with innovation in water and sanitation') in the March/April 2013 issue.

Special day spotlights plight of migratory birds



On 10 May the world celebrated World Migratory Bird Day focused on conserving one of the world's true natural wonders – the spectacular movements of migratory birds along their flyways.

This year's theme focused on migratory birds and tourism.

Thanks to an innovative new project led by the World Tourism Organisation (UNWTO) some of the world's estimated 50 billion migratory birds should soon be able to benefit from sustainable tourism and development. *Destination Flyways*, currently in its preliminary phase, aims to develop sustainable tourism at destinations along the world's migratory bird routes.

Focusing on a selection of eight key sites for migratory birds in Africa, Asia and Europe, the project aims to be a vehicle for both environmental and

socio-economic sustainability, benefiting wildlife, local communities and tourists alike. By providing an adequate framework for sustainable tourism management, diversifying tourism and channelling its revenue back into conservation of the project sites and the communities around them, the initiative will work to safeguard the birds' habitats, while creating job opportunities for local communities along the flyways.

With over one billion international tourists travelling the world every year, generating a global trade income of US\$1.4 trillion, and 9% of global GDP, tourism clearly has an immense

potential to contribute to sustainable development.

"Tourism is an undisputed generator of national wealth, corporate income and local employment. Managed sustainably, it can benefit people and the planet alike," reported UN Secretary-General Ban Ki-moon in a message to the 20th Session of the UNWTO General Assembly.

One of the eight project sites selected for the Destination Flyways project is Lake Natron, in the remote north of Tanzania. Home to 75% of the world's population of Lesser Flamingo, Lake Natron is the only breeding ground for this species in East Africa.

Nanoparticles from dietary supplement drinks could reach environment, say scientists

Nanoparticles are becoming ubiquitous in food packaging, personal care products and are even being added to food directly.

However, the health and environmental effects of these tiny additives have remained largely unknown. A new study now suggests that nanomaterials in food and drinks could interfere with digestive cells and lead to the release of potentially harmful substances to the environment. The report on dietary supplement drinks containing nanoparticles was published in the journal *ACS Sustainable Chemistry & Engineering*.

Robert Reed and colleagues note that food and drink manufacturers use nanoparticles in and on their products for many reasons. In packaging, they can provide strength, control how much air gets in and out, and keep unwanted microbes at bay. As additives to food and drinks, they can prevent caking, deliver nutrients and prevent bacterial growth. But as nanoparticles increase in use, so do concerns over their health and environmental effects. Consumers might absorb some of these materials

through their skin, and inhale and ingest them. What doesn't get digested is passed in urine and faeces to the sewage system. A handful of initial studies on nanomaterials suggest that they could be harmful, but Reed's team wanted to take a closer look.

They tested the effects of eight commercial drinks containing nano-size metal or metal-like particles on human intestinal cells in the lab. The drinks changed the normal organisation and decreased the number of microvilli, finger-like projections on the cells that help digest food. In humans, if such an effect occurs as the drinks pass through the gastrointestinal tract, these materials could lead to poor digestion or diarrhoea, they say. The researchers' analysis of sewage waste containing these particles suggests that much of the nanomaterials from these products are likely making their way back into surface water, where they could potentially cause health problems for aquatic life.

Source: American Chemical Society

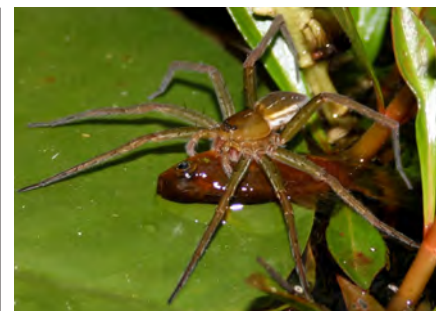
Fish also on spiders' menu

Although viewed by ecologists as the classical predators of insects, researchers have become increasingly aware that spiders are not exclusively insectivorous.

Certain larger-sized species supplement their diet by occasionally catching small fish, a new study shows. The research was undertaken by zoologist and spider expert, Martin Nyffeler from the University of Basel, Switzerland, and Bradley Pusey from the University of Western Australia. The researchers gathered and documented numerous incidents of spiders predating fish from all around the world.

According to their systematic review, spiders from as many as five families have been observed predating on small fish in the wild and three more families contain species that catch fish under laboratory conditions. These so-called semi-aquatic spiders typically dwell at the fringes of shallow freshwater streams, ponds or swamps. These spiders, some of which are capable of swimming, diving and walking on the water surface, have powerful neurotoxins and enzymes that enable them to kill and digest fish that often exceed them in size and weight.

"The finding of such a large diversity of spiders engaging in fish predation is



novel. Our evidence suggests that fish might be an occasional prey item of substantial nutritional importance", says Nyffeler.

Based on this study, naturally occurring fish predation by spiders has been reported from all continents, with the exception of Antarctica. Most incidents have been documented in North America, especially in the wetlands of Florida, where semi-aquatic spiders have often been witnessed catching and eating small freshwater fish such as mosquito fish. In order to catch its prey, the spider will typically anchor its hind legs to a stone or a plant, with its front legs resting on the surface of the water, ready to ambush. The fish will then be dragged to a dry place before the feeding process can begin, which usually lasts several hours.

Source: University of Basel

New from the WRC

Report No. TT 570/13

The use of isotope hydrology to characterise and assess water resources in south(em) Africa (Tamiru Abiye – Editor)

Environmental isotopes are routinely employed worldwide in the study of groundwater and surface water, as they provide unique information on transport and interconnectivity of water resources and reservoirs. The overall contribution of this project was to raise awareness of environmental isotope hydrology as a useful tool in the assessment of water resources at different spatial scale both at local and international level.

Report No. TT 583/13

Community engagement in drinking water-supply management: A review (U Rivett; D Taylor; C Chair; B Forlee; M

Mrwebi; JP van Belle & W Chigona)

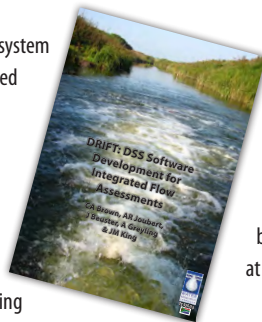
This review emanates from a previous WRC-funded project that investigated the possibility of incentivising community engagement in

order to improve drinking water supplies in South Africa. The research is based on the notion that an increase in community engagement, particularly in rural areas, would result in an increased understanding of the current shortcomings of drinking water supplies, an increased understanding of the communication challenges between communities, water service authorities and water service providers, as well as an improved experience of greater transparency and accountability for all stakeholders.

Report No. TT 575/13

DRIFT: DSS software development for integrated flow assessments (CA Brown; AR Joubert; J Beuster; A Greyling & KM King)
DRIFT or Downstream Response to Imposed Flow Transformations is an environmental flow assessment process that was developed in South Africa. In a previous study, the feasibility of developing a

decision support system (DSS) for integrated flow assessments based on DRIFT was investigated. The aims of this projects were to further develop a DSS for supporting sustainable use of water resources through equal consideration of the ecological, social and economic implications of management options; and to code the DSS for use in any size catchment, from local to international.



Report No. TT 572/13 to TT 574/13

The Shared Rivers Initiative Phase II parts 1-3 (S Pollard; H Biggs; A Rydannykh; D du Toit; A Laporte-Biquit; R Pejan; A Robertson; J Cogger; D Sefatsa; M Emmerson; J Burt & M von Balkom)

The Shared Rivers Initiative is a trans-boundary project that aims to understand and effect change in the implementation of policies and legislations relevant to the wise use of the Lowveld river systems. The final report of Phase 1 of the initiative was published in 2010 (**Report No. TT 477/10**). Phase 2 addressed three different aspects of integrated water resource management raised in Phase 1. They are collective action for improved water resources management, building regulatory competence for addressing unlawful water use, and benefit sharing – understanding the intention of the Reserve and the benefits than an ecosystems goods and services approach provides. The results are discussed in three separate publications (Part 1, Part 2 and Part 3). It is believed that the work presented has the potential to contribute to our knowledge of the policy-science-management-practice interfaces by adopting an integrated approach that seeks to track a policy intent such as environmental water requirements through to outcomes. It seeks to deepen the discourse on environmental water requirements, built on the recognition

that ensuring water for future generations is the basis for a healthy and thriving society. Ensuring both provisioning and regulating services through Reserve compliance provides for benefits that impact on health and at the same time the economy.

Report No. TT 323/13

Scoping study: Energy generation using low head hydro technologies (SJ van Vuuren, M van Dijk & b Barta)

Low head hydropower generation refers to electricity generated from a relatively low pressure head normally found in rivers or irrigation canals, and is applicable to sites with less than 5 m of head. This study illustrated that there is an untapped source of hydropower which should be harnessed. It also reflected that the hidden or unused potential in run-of-river generation; impoundments and irrigation schemes should be seen as priorities. The potential sites where low head hydropower can be installed in South Africa are dams and barrages, rivers, irrigation systems (canals and conduits) and urban areas (such as industrial and urban discharge and stormwater systems).

Report No. TT 577/13

Optimal utilisation of thermal springs in South Africa (J Olivier & N Jonker)

Thermal (hot) springs have been used for religious and/or medicinal purposes for hundreds, if not thousands, of years. Many of these developed into flourishing centres of culture, health and tourism. Although some remained popular over time, many have fallen into disuse. In South Africa, about half of the documented 74+ thermal springs have been developed as family leisure and recreational resorts alone, while the rest remain undeveloped.

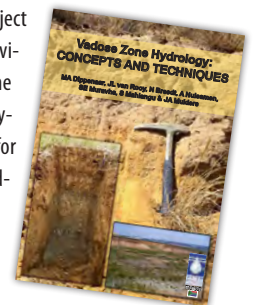


Decisions regarding the viability of alternative and optimal uses of a thermal spring resource are largely based on their physical and chemical characteristics but, apart from research carried out on thermal springs during the early and mid-20th century, little is known about them. The principal aim of this project was to determine the optimal uses of thermal springs in South Africa.

Report No. TT 584/13

Vadose zone hydrology: Concepts and techniques (MA Dippenaar; JL van Rooy; N Breed; A Huisamen; SE Muravha; S Mahlangu & JA Mulders)

This WRC-funded project followed on from previous work outlining the importance of classifying the vadose zone for improved understanding. The study aimed to address the most important vadose zone investigative techniques used by different disciplines, emphasising the intermediate vadose zone and subsurface processes rather than soil moisture measurements, and to incorporate these for the use of other disciplines. The study concludes to say that although vadose zone hydrology is in itself a specialised interdisciplinary field, the applications rely on the requirements of the individual specialists involved in its study. Better dialogue between specialists is the solution rather than a single uniform discipline, and the contributions of all interested disciplines improve the quality of investigations.



Report No. 2091/1/13

Behavioural nudges as a water savings strategy (G Smith & M Visser)

Historically, municipalities have relied largely on tariffs, technical interventions (such as leakage control) and customer education campaigns to manage the demand for water. In recent years, however, municipalities, mainly in the developed world, have begun experimenting

Water diary

Unconventional gas mining

August 18-19

The Groundwater Division of the Geological Society of South Africa and the Mine Water Division of the Water Institute of Southern Africa are hosting a two-day symposium on Unconventional Gas: Just the Facts. *Enquiries: Jacon Seaman, Tel: (011) 805-3537; Fax: (011) 315-1258; Email: events@wisa.org.za; Visit: www.wisa.org.za*

September 1-3

Hydrology

The 17th SANCIAHS National Hydrology Symposium, hosted by the University of Cape Town Institute for Water Studies, will be held in Cape Town. The symposium theme is 'Hydrology in the Anthropocene: Navigating our future research by building on more than 30 years of SANCIAHS achievements'. *Enquiries: Emma Vaughan, Tel: (021) 406 6407; Email: emma.vaughan@uct.ac.za; Visit: www.sanciahs2014.co.za*

Groundwater and mining

September 1-3

The Africa Groundwater Academy will be hosting a course on the 'Application of Modelling in Mines' at the University of the Western Cape. The course will focus on teaching participants how to build flow and transport models, input field data, use zone budget to assess water balance, accumulate mine pollutants transformation, and more. *Visit: www.gwd.org.za for more information.*

Groundwater

September 15-19

The 41st International Congress of the International Association of Hydrogeologists (IAH) will be held in Marrakech, Morocco, with the theme 'Groundwater: Challenges and Strategies'. *Email: contact@iah2014.org or Visit: www.iah2014.org for more information.*

World water

September 21-26

The International Water Association (IWA) is holding its World Water Congress & Exhibition in Lisbon, Portugal. *Visit: www.iwa2014lisbon.org for more information.*

Civil engineering

October 28-31

The 9th World Congress on Engineering Asset Management will be held in Pretoria. Engineering asset management encompasses all types of engineered assets, including built environment, infrastructure, plant, equipment, hardware systems and components. *Visit: <http://2014.wceam.com/> for more information.*

Municipal engineering

October 29-31

The 2014 Conference of the Institute of Municipal Engineering in South Africa (IMESA) will be held at the Durban International Convention Centre, in Durban. *Visit: www.imesa.org.za*

Popular water treatment tool now upgraded

The chemical quality of water can have a major impact on the system storing and conveying the water, and on the use of the water. Waters from underground sources in dolomitic areas, when brought to the surface, in contact with air, may become oversaturated with respect to calcium carbonate, and cause excessive precipitation in storage dams, canals and pipes.

All these waters need to be treated to remove or minimise the various adverse effects. The difficulties with any water are to assess its characteristics and to devise an appropriate treatment to give a non-scaling, non-aggressive, non-corrosive water.

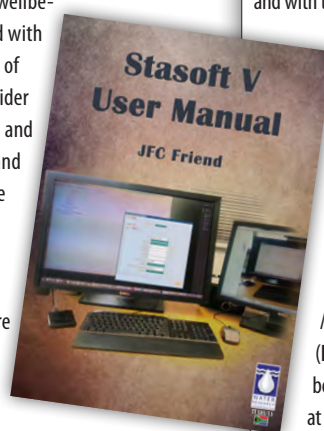
The popular Stasoft software tool was first developed through WRC funding in the 1980s. It provides rapid numerical solutions to characterisations of water and the dosing requirements to obtain the desired chemical water quality for a prescribed input.

The program has been upgraded and enhanced several times over the years. The latest version of the program, Stasoft V, is now available. It was developed to be functional on new operating platforms (Windows 7 and higher).

The program addresses water conditioning problems in aqueous media with a total dissolved solids concentration of up to 15 000 mg/l, and with the carbonate system as the

only weak acid system in solutions. The software addresses a range of chemical conditioning problems likely to arise in the treatment of municipal waters, cooling waters and mining wastewaters.

The *Stasoft V User Manual* and software package (**Report No. TT 585/13**) can be obtained from Publications at no cost.



with strategies that are informed by the field of behavioural economics in order to manage the demand upon their utilities. These strategies have yielded some encouraging results. The attraction of these methods is that they are generally very cheap to deploy, require limited infrastructure and offer few, if any, opportunities for corruption. This study assessed whether there was scope to use feedback, informed by several principles derived from the behavioural economics literature, delivered in the past with the water bill to reduce household water consumption within the City of Cape Town.

Report No. KV 324/13

An adaptable, multi-disciplinary water resource management framework for the Umngeni River basin (S Mitchell; D Hay & C Breen)

We all need water to survive, but for many a water resource provides other benefits. For some it may be recreation and for others a necessary input for production or manufacturing. Our choices affect others. Therefore, a society is required that is informed, is sensitive to, and appreciative of how the state of the water resources and social and economic well-being are interlinked. This project is a first step toward developing an

approach for preparing a 'state of the river basin report' in which river health and societal well-being are linked with the intention of promoting wider appreciation, and why, where and how each one of us should act so that we progress toward a more equitable and sustainable future.

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

Secret of improved energy security may lie in our dams and pipelines



Lani van Vuuren

While load shedding threatens to keep South Africans in the dark this winter, an untapped source of electricity lies unutilised in South Africa's dams and rivers. And while hydropower will not end all of Eskom's woes, it could go a long way towards reducing demand on the national grid. Article by Lani van Vuuren.

There is no doubt that, along with water, energy is the lifeblood of worldwide economic and social development. In South Africa, this blood runs mostly black as 90% of the country's electricity is generated from coal.

Rolling power cuts such as those that hit the entire country at the start of 2008, coupled with skyrocketing electricity prices, have made all citizens aware

of the fact that demand for electricity is grossly outstripping supply. In addition to the construction of additional coal-fired power plants, alternative, renewable energy, must be considered.

As a result of its semi-arid climate South Africa has a vast network of large dams and water distribution infrastructure. According to the South African National Committee on Large Dams, the total storage capacity of the major reservoirs (totalling 252 large dams) currently amounts to about 33 900 million m³ – equal to about 70% of the mean annual runoff from the land surface of the country. In addition, some 3 500 dams with a height greater than 5 m have been registered with the Department of Water Affairs (DWA). Excluding pumped storage facilities, only seven of the country's dams are equipped with hydropower generation plants, the largest being the Gariep hydropower plant situated on the Orange River, which has an operational capacity of 360 MW.

A recently published Water Research Commission funded study undertaken by the University of Pretoria (UP), illustrates how this infrastructure can be retrofitted to provide valuable additional electricity – albeit at a small scale (known as low head hydropower). As stated in the final report, unconventional hydropower development can take place in both rural and urban areas of South Africa. The report discusses the low head energy potential of eight areas: dam releases, run-of-river schemes, irrigation canals, weirs, urban areas (pipelines and stormwater systems), industrial outflows, wastewater treatment plants, and oceans and tidal lagoons.

A LITTLE ELECTRICITY CAN GO A LONG WAY

According to main authors Prof Fanie van Vuuren and Marco van Dijk of the UP Department of Civil Engineering, the potential annual energy output from identified available capacity hidden in existing water infrastructure could produce between 35 and 115 GWh. This is potentially significant given that 100 kW is equivalent to the average energy demand of 65 households in South Africa.

Just by retrofitting 62 of DWA's most suitable dams could reduce the department's overall electricity demand on the national grid by between 170 and 360 GWh a year, the report states. By implementing low head hydropower technology at 20 suitable municipal dams municipal electricity demand could be reduced by between 35 and 50 GWh a year.

“This potential is not necessarily substantial with regard to the contribution to the Eskom national grid, but is significant with regard to the potential reduction in electricity demand on the overloaded national power generation capacity,” the authors say. “In addition to helping Eskom to deliver coal-fired electricity to other needy users, implementing determined low-head hydropower will create various job opportunities in the manufacturing and operation/maintenance economic sectors.”

For water supply utilities (including water user associations and municipalities) introducing enhanced in-house energy generation will alleviate, to some extent, dependency on the already stressed national grid and keep their energy costs down.

Ironically, small hydropower has played a historically significant role in the implementation of electricity projects in South Africa, with the first project being a 300 kW station on Table Mountain in 1895. Early large dams, such as Hartbeespoort Dam, in North West province, and Clanwilliam Dam, in the Western Cape, were originally constructed with hydropower stations.

Unfortunately, many of these small-scale hydropower stations have fallen into disrepair. In many cases they were replaced by Eskom's (at the time) cheap and reliable electricity. In other cases, it was because of poor maintenance and general neglect. The time has now come to revive this technology. Van Vuuren and Van Dijk believe South Africa's possesses the technological know-how to do so.

As part of the WRC project, four irrigation schemes were investigated in detail to determine the potential

Small hydropower has played a historically significant role in the implementation of electricity projects in South Africa, with the first project being a 300 kW station on Table Mountain in 1895.

Estimates of the country-wide potential for low-head hydropower development

Low head hydropower location	Estimated potential (MW)	In existing infrastructure (MW)	Estimated potential “greenfield” conditions (MW)
Small (low-head) dams	5.70	5.70	As per new dams installed
Run-of-river schemes	39.50	17.00	22.50+
Measuring weirs	0.30	0.30	As per new weirs installed
Irrigation schemes	5.50	5.50	No new developments envisaged
Wastewater Treatment Works (WWTW)	2.50	2.50	As per new works and rehab/upgrades
Urban storm water systems	0.10	0.10	Insignificant
Water transfer pipelines and canals	0.65	0.65	As per new transfers and rehab/upgrade
Industrial outfalls	0.25	0.25	As per new industry installed
Subtotal for inland hydropower	54.50	32.00	22.50+
Tidal lagoons and harbours	26.50	As per further research	26.50
Wave energy systems	Unlimited	None	Unlimited

Source: Scoping study: Energy generation using low head hydro technologies

What is low head power generation?

Low head hydropower generation refers to electricity generated from a relatively low pressure head, normally found in rivers or irrigation channels, and is applicable to sites with less than 5 m of head.

for hydropower within existing infrastructure, namely Boegoeberg, Kakamas, Lower Fish and Sundays irrigation schemes. Hydropower potential was identified at all of these schemes, with a scheme such as Boegoeberg having an estimated total of low head hydropower capacity of 623.76 kW, mostly from its main canal and bulk water sluices.

Wastewater treatment works are also viable sources of hydropower due to the high volume of water that generally flows from such facilities. The flow rates at these treatment works are fairly constant so that no dam or

reservoir is required. The project found two opportunities for hydropower generation at these plants – before treatment and at the outflow of the plant.

CLEAN, RENEWABLE ENERGY

Low head hydropower offers various benefits. In addition to being a renewable energy source with high reliability, it uses proven technology, has a long life span (50 years or more), can accommodate flexible operation, has high efficiency, and very low operating and maintenance costs. Preliminary feasibility studies indicate short payback periods, especially when retrofitting onto existing water infrastructure. Another advantage is that hydropower schemes often have more than one purpose. Hydropower through water storage, for example, can assist with flood control and supply water for irrigation or consumption.

Why is this potential only being recognised now? Technologies have improved over the last couple

The Hartbeespoort Dam is estimated to have a hydropower potential of about 5.7 MW.



Lami van Vuuren

of decades, which now allows for the development of previously unfeasible sites. According to Prof van Vuuren, this is coupled with the recent emphasis on the renewable energy sector as well as the high electricity price escalations (> 23% for three years and 8% last year). All of these factors are now working towards making low head hydropower more viable.

REGULATORY CHALLENGES

The implementation of this technology will not come without its challenges. Specific authorisations are required before constructing any hydropower plant. Firstly, permission must be obtained from the owner of the water infrastructure, be it DWA or a municipality. Secondly, a water use licence is required. In general, the generation of hydropower does not consume water or create an additional demand, in which case the only applicable costs are the water use charge.

Developers of low head hydropower will also require a generation licence from the National Energy Regulator of South Africa (NERSA). Lastly, hydropower can be generated for a number of reasons and sold to an array of different people, including private enterprises, local municipalities and Eskom. Whatever the case, a power-purchase agreement must be signed with the authority or purchaser of the electricity under the supervision of NERSA (unless produced for own use).

NEUSBERG WEIR HYDROPOWER DEVELOPMENT

Small-scale hydropower development is becoming a reality in South Africa, with the Neusberg Hydroelectric Power Project project, on the Orange River, already underway. The project, where construction started in 2013, is a run-of-river hydropower station that uses the natural flow and drop in elevation of the Orange River to produce electricity.

The project is being undertaken by Kakamas Hydro Electric Power, a consortium comprised of HydroSA, Hydro Tasmania, Old Mutual and the Kakamas Community Trust. Located 12 km east of Kakamas the project will generate 71.9 GWh of energy per year – enough to provide power to about 5 000 households.

According to the project website, infrastructure includes an offtake weir and 130 m of inlet canal, an inlet structure fitted with a radial gate, 1 400 m of open canal waterway, a reinforced concrete fore-bay structure, a partially buried powerhouse, a 300 m-long tailrace canal, and a 21 km-long transmission line to the Eskom distribution network.

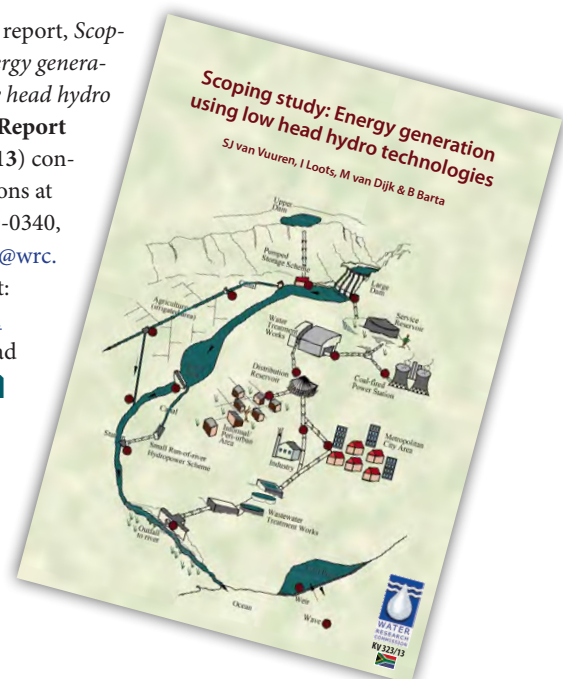
Interestingly, both an environmental authorisation and a water use licence were required for the scheme as it has a significant construction component and water is abstracted from a natural resource.

In order for small-scale hydropower technology to move forward, it would be beneficial if Eskom and local municipalities could join forces and provide easier access to their electricity grids, notes Prof Van Vuuren. “This would allow linking of this ‘base load renewable energy’ to assist in a small way to the total energy demand of the country.”

Although the relative contribution to the grid from low head generation might be seen as minimal, it is believed that the attitude of consumers will be positively influenced by experiencing sensitivity to small-scale development and its potential to have a multiplying effect in the economy.

The available technologies have been introduced to various stakeholders. Also in the pipeline is the establishment of the Hydropower Association of Southern Africa, which will further enhance the status, uptake and implementation of the renewable technology.

- To obtain the report, *Scoping study: Energy generation using low head hydro technologies* (Report No. KV 323/13) contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.



Hydropower through water storage ... can assist with flood control and supply water for irrigation or consumption.

NO FLASH IN THE PAN: How pour flush toilets are driving away SA's sanitation backlog



Maun Water

While the ventilated improved pit (VIP) toilet has become symbolic of basic sanitation in South Africa, with millions of these units being constructed all over the country in the last 20 years, it is the flush toilet that most South Africans aspire to. A new technology developed with funding from the Water Research Commission (WRC) aims to bridge this gap on the sanitation ladder while restoring dignity, privacy and safety to people who have been left behind in the drive towards basic services for all. Article by Lani van Vuuren.

In South Africa, waterborne sanitation is often perceived as a standard representing the equality and dignity to which people aspire – the top of the sanitation ladder. However, considering the cost of constructing such infrastructure for every person and the fact that South Africa is a water-scarce country, providing everyone with a flush toilet is neither attainable nor desirable.

So the humble VIP toilet has become the symbol of basic sanitation in South Africa. While it is certainly a step up from having no access to sanitation at all, imposing a 'one-size-fits-all' solution on households can cause people to reject the technology and thus be unwilling to take care of it.

Moreover, recent studies published by the WRC have highlighted the challenges associated with emptying of VIPs, and the safe disposal of sludge. Many pits ultimately have to be manually emptied – a job that is not only messy and unpleasant, but also dangerous, as sludge typically contains a range of infectious human pathogens.

It is estimated that over 70% of the approximately 2 million VIPs constructed in the last 15 years are now older than five years, and with municipalities reporting that 80% of VIPs require emptying after five to eight years, they may soon be faced with a situation where the gains achieved through basic sanitation delivery are reversed: if pits reach capacity and are not emptied, households will effectively revert to being without sanitation.

Partner in Development's (PID's) David Still is part of a wave of innovators bringing renewed attention to this oft neglected service. He explains the challenges of working in the sanitation sector: "A general problem is that engineers and planners mostly only think in terms of either full waterborne sanitation or VIPs, a kind of binary thinking," notes Still.

"Although both options have their place, they each have their drawbacks. The problem with full waterborne sanitation is that it is very expensive to build and maintain. When sewers or wastewater treatment plants are poorly maintained, as regrettably they too often are, the environmental impact is extremely significant."

On the other end of the scale VIPs, apart from not being as acceptable as waterborne sanitation politically, fill up after a period of time. Users also have the habit of using them for solid waste disposal, especially with the move towards disposable nappies, which makes pits fill up even faster, as well as harder to empty.

POUR FLUSH – A CLIMB UP THE LADDER

An alternative solution was required, says WRC Executive Manager for Water Use & Wastewater Management, Jay Bhagwan. "The WRC recognised the need for an on-site sanitation option which addresses the aspirations of many South Africans for a flush toilet while overcoming the logistical challenges involved with standard sewerage systems, and simultaneously working responsibly within the limits of the country's water resources."

The Commission turned its attention to pour flush toilets, a popular on-site sanitation option in Asian countries. Led by Still, a WRC project, initiated in 2009, investigated the possibility of adapting pour flush sanitation for use by South Africans. Bhagwan explains that a pour flush toilet can be viewed as a significant step up the sanitation ladder from VIPs.

Similar to a full flush toilet, with pour flush sanitation water is poured in by the user rather than coming from a cistern. The system uses significantly less water – only 1-2 litres rather than the 5-7 litres needed for conventional flush toilets. Since it is an on-site sanitation system, there is no complex sewerage and wastewater treatment network required making it much cheaper to install, operate and maintain.

Some changes had to be made to the pour flush toilets usually used in Asia – for one, South Africans prefer to sit rather than squat, so a pedestal had to be provided. The toilets also had to be able to handle anal cleansing material, such as toilet paper or newspaper.

The WRC-PID pour flush toilet is designed to be as simple as possible to avoid parts which can break or block. While looking very similar to a full flush toilet, there is no water tank, cistern, flusher or 'liquefier' (a problematic feature of certain low flush systems which were introduced to South Africa in the last 20 years). Since there is no plumbing no leaks are possible. The toilet is flushed by pouring one or two litres of water into the pan. The pan funnels steeply to a 70 mm-diameter outlet. Greywater can also be used for flushing.

The water seal works just like a regular flush toilet: water is trapped in the bend of the pipe sealing off



Above: The poster created to demonstrate the use of the pour flush toilets to new users.

Below: The prototype pour flush toilet during initial testing.



The pour flush toilet is similar to a conventional waterborne toilet, except that it does not have a cistern.



P10

any smell from the pit coming back up into the toilet. After the water seal, the pipe continues straight to a leach pit. A significant advantage over a VIP toilet is the fact that users cannot use the toilet as a rubbish pit, leaving the resultant sludge essentially free from general household solid waste.

“One of our greatest considerations when funding this development was for a sanitation option that would be safe for women and children to use,” notes Bhagwan. Since there is little smell, the pour flush toilet can be attached to or even located inside a household. Women and children no longer need to fear assault when having to go to the toilet at night. The pour flush toilet can also be used safely by little children – there is no risk of them falling in as with a VIP.

Rather than a conventional sewerage system, the pour flush toilet block is attached to two leach pits. When one leach pit becomes full, then a switch is made to the alternative pit. The full pit is allowed to dry out normally over a period of two to four years and then emptied, ready to be used again once the operational pit reaches its capacity. The leach pits are fully offset from the structure, making them easier to access for maintenance. Studies indicate that the pits have a lifespan of around five years before they need to be emptied.

After extensive testing, the first two toilets were installed in Pietermaritzburg in September 2010. They have been in operation since then without problems or blockages. Consequently, a further 20 household demonstration units were built as well as three toilets at a crèche. According to Still, all are working well. For the users of the technology it adequately addressed the wish for a flush toilet.

Moreover, the technology costs considerably less than installing a full flush toilet connected to a sewer or a standard septic tank. In addition, it is not dependent on piped water supply, and can be used even if the water supply is cut off occasionally, as a small amount of water is required and greywater can be used. It is also less complicated than a VIP in terms of installation.

FROM KWAZULU-NATAL TEST TRIALS TO THE WESTERN CAPE

In a follow-up project funded by the WRC and undertaken by Maluti GSM Consulting Engineers, the pour flush toilets were piloted in three high-density settlements in the Western Cape, namely in Klipheuwel informal settlement, Cape Town; the Klein Begin community, Grabouw; and Enkanini informal settlement, Stellenbosch. In the first community the pour flush toilets discharged into soak pits, while in the second community the toilets connected to a biodigester. In Enkanini, the toilets were connected to the municipal sewer. This indicates the versatility of pour flush technology.

A total of 14 toilets were installed. Some of the toilets were for private household use, but in Klein Begin two toilets were constructed for a crèche, while the toilets in Enkanini were constructed for communal use. A significant amount of effort was involved in liaising with the community, partner organisations and municipal officials to explain the technology and receive community endorsement.

The project team reports that the homeowners benefiting from the project took great pride in their new toilets, with the units kept extremely clean throughout the monitoring period. Some neglect and misuse was reported at the communal units in Enkanini, however. Despite this, the toilets continued to work well, to the extent that Stellenbosch Municipality was considering incorporating pour flush into its standard specification for informal settlements.

FROM HOME TO SCHOOL

In order for the technology to work in an institutional setting, such as a school, the pour flush was converted to low flush technology – i.e. a small cistern was added so that users would not need to fill a bucket in order to flush. The low flush toilet developed still uses much less water than

Advantages of pour flush technology

- Unlike a pit latrine pour flush toilets can be built onto a house.
- Unlike conventional waterborne systems, pour and low flush sanitation use only a litre or two for flushing.
- These technologies are cheaper to build than full flush toilets with septic tank and soak pit.
- Because pour flush latrines are often flushed manually using a bucket, greywater can be used for flushing without the need for a piped recycling system.
- The water seal prevents smells and flies, as well as trash and solid waste entering the pits.
- Users cannot use the pit as a receptacle for domestic waste (unless they access the pit separately).
- Pits are smaller, so there is no need for deep excavations. This also allows for easier access and emptying.

an ordinary flush toilet – only around 2.5 litres, although the cistern introduced the risk of leakage. The prototype was piloted in two schools in the Durban area in partnership with eThekwini Municipality, namely Sizimesele Primary School and Thandaza High School.

Apart from drastically improving access to sanitation at the schools the provision of the new toilet blocks created an opportunity to educate teachers and learners about the transmission of disease and how it can be prevented, so motivating them to shift to new behaviours at the same time as the shift to a new sanitation system. Presentations were made at the schools on disease transmission and control as well as how to take care of the new sanitation system.

Still explains that a pour flush or low flush system addresses a number of needs, for example, it provides an on-site flush system which can be installed in many contexts, including rural or crowded communities where laying sewers is not an option. In addition, it provides a competitively priced alternative to the VIP.

ROLLOUT OF TIMBER FRAME SANITATION BLOCKS

Following the successful piloting of the low flush technology in the Durban schools, Still and his team have moved on to a new project for the WRC whereby the possibility of providing timber frame pour flush sanitation blocks for use in schools being tested. Constructing sanitation structures from timber opens up the possibility of a rapid response to the needs of schools facing a sanitation crisis.



Toilet positions are discussions with residents of Enkanini informal settlement.

Safe sanitation for Africa – A Gates Foundation-WRC collaboration

The WRC, through funding from the Bill and Melinda Gates Foundation has established the Sanitation Research Fund for Africa (SRFA).

The fund is a direct result of the gap identified that Africa lags behind in terms of research and innovation (knowledge creation) due to the lack of dedicated sources of funding and support. The SRFA aims to stimulate local competency and capacity in the sanitation sector in the Eastern and Southern African Regions, and to provide solutions based on good scientific evidence related to up-scaling dry sanitation technologies.

To date, 12 research projects have been commissioned from the US\$2.8 million fund.

The first focus area for the projects is pit latrines, used by the majority of Africans. Six research teams from Botswana, Ethiopia, Kenya, Malawi, Uganda and Zambia are evaluating the pit processes in peri-urban areas in their region to gain insight into the mechanisms occurring in pit latrines across a variety of conditions. By improving our scientific understanding of these on-site sanitation systems, they can be better managed.

A second research focus is developing innovative solutions for removing and treating faecal sludge while developing local capacity and competency for faecal sludge management. Six research teams from Malawi, South Africa, Uganda and Zimbabwe are exploring and piloting pit emptying and beneficiation routes for faecal sludge.

Construction of the demonstration pour flush toilet in Klipheuwel.



Maluti Water

Timber frame structures can be prefabricated off site and can also be moved at a later date if needs be.

An assessment was conducted by Mvula Trust of the water and sanitation infrastructure at six schools in the Vhumbedzi, Malamulele central and Lepelle

circuits in Limpopo province. Timber frame sanitation blocks containing pour flush are now being constructed at these schools.

At the time of writing, construction was progressing steadily. The timber is being sourced from the Department of Environmental Affairs' invasive alien plant clearing programme.

Following construction, a trained health and hygiene educator will be appointed at each of the schools while the cleaning staff will be trained in how to effectively sanitise the ablution blocks while protecting themselves from diseases and harmful chemicals. In addition, the cleaning staff will be trained in how to remove blockages.

“If this project is successful, there may be extensive application for timber frame sanitation blocks in informal settlements where sanitation needs are critical, but authorities are opposed to interventions involving brick and mortar,” notes Still.

The WRC-funded pour flush technology has considerable potential for commercialisation, more so following Durban plastics manufacturer Envirosan's investment into the project over the last two years. The company has invested over R2 million in producing an injection moulded plastic pedestal and P-trap that can function as either a low flush or pour flush toilet, and full production is expected by August this year.

Still's hope is that this technology will spread itself through its own logic, with affordable pour flush pedestals becoming available at local plumbing and building supply stores. “If pit emptying is neither affordable, desirable nor practical, VIP owners can simply close them up and retrofit pour flush with offset pits.”

It is believed that this innovation can go a long way towards alleviating South Africa's persisting sanitation backlog.

- To access the related reports, *Piloting and testing the pour flush latrine technology for its applicability in South Africa (WRC Report No 1887/1/12)*, *Developing a low flush latrine for application in public schools (WRC Report No. 2198/1/13)* and *Pour flush trials in the Western Cape (WRC Report No. KV 322/13)* contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; Email: laniv@wrc.org.za or Visit: www.wrc.org.za to download a free copy.



Mpumalanga wetland rehab partnership a win for ecological infrastructure

In one of the most intensively mined areas in South Africa, a unique public-private partnership is illustrating the wonder of nature in mitigating the impact of anthropogenic activity on the country's water systems. Article by Lani van Vuuren.

Dr Paul Oberholster (standing) and Arno de Klerk of CSIR Natural Resources and the Environment during a post-rehabilitation site visit of the Zaalklapspruit wetland.

South Africa's wetlands are arguably its most valuable ecological infrastructure. Not only do these special ecosystems support water resources by purifying water and regulating flows, they also act as sponges that store water and release it slowly, filtering pollutants and reducing the impacts of droughts and floods in the process. Sustaining a rich diversity of faunal and floral species, wetlands also support the economic activities of many rural communities, including the provision of food and fuel.

Wetlands have become South Africa's most threatened ecosystem. Although no comprehensive national survey of wetland loss has been undertaken, studies in several major catchment have revealed that between 35% and 60% of the wetlands, and the benefits they provide, have been lost or severely degraded. It is likely that the extent of wetland loss, due to human activities such as urban and industrial development, as well as agricultural and other poor land management practices, for South Africa as a whole lies within this range.

In the Mpumalanga Highveld – the traditional heart of South Africa's coal industry – wetlands and mining have long been thought to be mutually exclusive. Up to 80% of the country's coal is mined here, often to the detriment of the region's wetlands. This is because wetlands are frequently found in the lowest lying parts of landscapes, which also provide the cheapest and easiest access to coal seams using open-cast techniques. This results in the inevitable destruction of these ecosystems during the mining process. Mining also impacts wetlands in other ways, for example, through the release of polluted mine-water, as well as the diversion of surface water and alterations to groundwater.

SANBI Director: Ecological Infrastructure, John Dini, Coaltech Board member, Henk Lodewijks, and Arno de Klerk and Dr Paul Oberholster of the CSIR discussing the improved functioning of the wetland.



Ironically, current research in the Upper Olifants River catchment, where coal-mining takes place, has shown that wetlands can play an important role in mitigating the impact of polluted water entering the catchment. With the value of wetlands as a natural resource being increasingly realised, regulators are now insisting that mines avoid, minimise and, in some cases, offset, their impacts on wetlands, and internalise the broader socio-economic and environmental costs of wetland loss into their balance sheets. As a result, the coal mining sector has realised that it needs to proactively and systematically address the business risk posed by its impact on wetlands.

This has sparked a partnership between the CSIR, the South African National Biodiversity Institute (SANBI), the Working for Wetlands (WfWET) programme of the Department of Environmental Affairs, the Water Research Commission (WRC) and major coal producers through the Coaltech Research Association to limit and mitigate the sector's impact on the catchment's wetlands. This partnership is currently taking the form of a co-funded, three-year research project under the auspices of Coaltech.

According to the CSIR Natural Resources and the Environment (NRE) researcher, Arno de Klerk, due to the importance of the coal sector to the economy of South Africa it makes more sense to work with the sector towards mutually beneficial solutions rather than to expect the cessation of coal mining in the area altogether.

“The importance of coal as a strategic resource to South Africa cannot be denied. Not only does coal account for the vast majority of the country's energy production, the coal-mining industry also directly employs over 50 000 people. In the absence of large-scale renewable energy developments the expansion of coal-mining activities are bound to continue in the foreseeable future. This makes it important for us to work together to ensure that these activities continue as environmentally responsible as possible.”

IDENTIFICATION OF HIGH RISK WETLANDS

At the time of writing, the project team was in the final stages of developing an atlas that identifies which wetlands are of particularly high value from a biodiversity or ecosystem goods and services perspective in the coalfields of the Mpumalanga Highveld. The project is bringing together, in a user friendly way, the potentially confusing array of biodiversity data that regulators expect mining houses to consider when they are planning

and implementing a mine. This includes data on threatened habitats, special wetland types, threatened species, protected areas, priority areas from the new provincial conservation plan, and sites identified for the expansion of protected areas.

A separate project, funded by the WRC, is refining the mapping of wetlands in Mpumalanga. This revised data is expected to be available later this year, and will improve the quality of data available for decision-makers in the province. “Although site level mapping and confirmation of exact areas will always be required, the refined datasets will significantly improve accuracy and reduce uncertainty in planning processes,” notes de Klerk.

ZAALKLAPSPRUIT WETLAND

Another endeavour stemming from this research partnership is a case study on the rehabilitation of the Zaalklapspruit Wetland system. The main aim of the project is to determine the effectiveness of wetland rehabilitation in restoring the water treatment functions of the wetland (specifically related to mining-related pollutants).

“Wetlands provide more ecosystem services per hectare than any other ecosystem, being sites of intense biogeochemical activity that play an important role in improving water quality,” explains de Klerk. “A wetland consists of various levels of organisations working together, which leads to improved water quality. In order to understand how to improve the functioning of a system, we need to understand how these various levels work together and how rehabilitation can improve them. The knowledge gleaned through this research could assist greatly in restoring the upper Olifants River catchment.”

Finding a suitable site for rehabilitation in the catchment was a challenge in itself. De Klerk explains that the project team required a site that fulfilled a number of different criteria, including the type of wetland, level of impact, rehabilitation feasibility and landowner willingness (since most wetlands are located on farm land). After various site visits, discussions and deliberations the team settled on a site forming part of the Zaalklapspruit Wetland system. Measuring around 139 ha in size, this piece of the Zaalklapspruit Wetland is a naturally un-channelled valley bottom wetland system (a critically endangered wetland type) near Witbank in the upper Olifants River catchment. The wetland is located downstream of coal mines and is subject



One of the concrete structures constructed in the wetland.

Lani van Vuuren

to typical acid mine drainage issues. The water quality through the wetland is generally very poor, having high levels of dissolved metals and low pH.

Before rehabilitation, the ecological integrity of the Zaalklapspruit Wetland system had been severely impacted by agricultural activities, which resulted in a major incised channel running through the centre of the wetland. This channel, together with drainage associated with historic ridge and furrow cultivation in the central area of the wetland caused canalised flow and compromised the wetland’s water quality enhancement function.

The rehabilitation of the Zaalklapspruit wetland has improved its ability to treat polluted water from industrial and mining activities.



Lani van Vuuren

Rehabilitation activities, funded and undertaken by WfWET, focused on restoring the impacted landscape, removing channels, ridges and furrows. This raised the water table, and slowed down the water flow, allowing water to distribute across the width of the wetland again rather than racing through the centre.

Provincial WfWET coordinator for Mpumalanga, André Beetge, explains that rehabilitation was an expensive process involving extensive engineering, including the construction of several broad, low concrete structures, earth berms, and weirs. Due to the acidic and corrosive nature of incoming water flow, the project had to make use of concrete structures rather than the preferable wire gabion structures favoured in wetland rehabilitation. These man-made structures have been designed to be filled up naturally with plants and sediments over time.

IMMEDIATE RESULTS

The Zaalklapspruit Wetland showed almost immediate improvement following its make-over. At the time of writing, the project team had only just started with post-rehabilitation monitoring (after having completed an intensive pre-rehabilitation survey to establish baseline conditions), but



Lami van Vuuren

Following rehabilitation water now moves slower through a larger area of the wetland, rather than through a channel in the centre.

preliminary results were promising. “We have been pleasantly surprised by some of the results. We are already seeing an increase in pH levels in the water flowing through the wetland, as well as a decrease in dissolved metals,” notes de Klerk. “The biggest test now will be to see whether the improved functioning of the wetland is sustainable.”

There is hard work ahead for the project team as they now look deeper into the ecological functioning of the wetland system to determine exactly what and how its biological functions have been altered through rehabilitation. “Above all, we need to determine the sustainability of this improvement,” says CSIR principal researcher, Dr Paul Oberholster. “While this currently falls outside the current duration of the project, we are in discussion with various stakeholders to monitor the wetland for a longer period of time.”

GUIDELINE FOR THE FUTURE

The project team is quick to point out that while wetlands are incredible natural resources they are not ‘miracle workers’ that have unlimited capacity to clear all pollution in a catchment. “An improved wetland, such as Zaalklapspruit, can only do so much in terms of improving water quality. All water users in a catchment have the responsibility to minimise their impacts on the system by ensuring their discharge comply with legal requirements,” says Director for Ecological Infrastructure at SANBI, John Dini. “In an ideal situation a wetland should only be relied upon to do the ‘final polishing’ in terms of water quality, and in this way save downstream municipalities, and industries millions of rands that would otherwise have been spent to treat the water. These types of passive methods are ideal for dealing with smaller-scale impacts, e.g. the many older, ownerless and derelict mines which have fallen by default to the state to deal with where we need lower cost and low maintenance options for dealing with this.”

While it is still early days the project team is hopeful that the case study on the Zaalklapspruit Wetland system will be the poster child for wetlands in terms of how they can be improved, as well as how important they are in a mining-dependent economy, especially when looking to address post-mining landscapes. This is due to the myriad of advantages of these systems, including cost and long-term maintenance in relation to active technological systems that require heavy capital and operating investment, as well as long-term commitment from either government or the private sector to operate. □



The rewetting of the wetland has resulted in the re-establishment of numerous wetland plants.

South Africa's first wetlands offset guideline nearing completion

A new best practice guideline for wetland offsets is nearing completion. Wetland offsets can potentially play an extremely important role in dealing with residual impacts of developments. Residual impacts refer to the inevitable remaining impact (even after rehabilitation) on wetlands, which each development in or near a wetland inevitably has. At present, every development which impacts on a wetland leaves the overall wetland network worse off than before, and less able to support biodiversity and deliver key ecosystem services. Wetland offsets provide a mechanism for dealing with this residual impact through the rehabilitation of other impacted wetlands, and also through protection of other high-quality wetland sites.

Industry and regulators in South Africa have recognised that, although offsets may be extremely useful in terms of compensating for residual, permanent impacts of development activities on biodiversity and ecosystem services; it is necessary to approach them with due caution and consistency, and from a strong scientific foundation. Further, they need to be applied in a way which is practical and realistic for industry to implement.

Therefore, the wetland offset guideline has been compiled by SANBI in partnership with the Department of Water Affairs, with additional support from Coaltech and the WRC through the project focusing on limiting and mitigating the impact of coal mines on wetlands.

The guidelines address the range of issues necessary to ensure that offsets are applied in a way which factors in the full range of social and environmental costs arising from the permanent loss of the ecological infrastructure, biodiversity assets and the ecosystem services affected by development activities.

The goal of wetland offsets is to achieve no net loss with respect to the following: water resources (focusing on the importance of wetlands for supporting water resource management objectives, as well as people's use and cultural values associated with wetlands); ecosystem and habitat objectives (especially in terms of meeting national and local objectives for habitat protection and avoiding worsening of ecosystem threat status); and species of special concern (particularly threatened, rare or keystone wetland species).

The guideline emphasises that wetland offsets are applied as the last stage in the mitigation hierarchy and are only aimed at mitigating or compensating for residual impacts of project development on the environment after all reasonable options for avoiding, reducing and remediating impacts have been exhausted.

The guideline also emphasises that the use of wetland offset does not change the decision-making process on whether a development should go ahead or not. Projects with unacceptably large impacts on a wetland should still not be allowed, and the use of offsets will not change the decision-making process. All offsets do is allow the residual impact of developments to be compensated for, and hence avoid the slow and inevitable degradation of the wetland system.

Once published, the guidelines will set clear standards and approaches and serve as a formal starting point for the development of sensible, practical, implementable and fair offset projects which deliver optimum benefits to industry, society and the environment in terms of dealing with residual impacts on wetlands. It is anticipated that the guidelines will be formally adopted by DWA later in the year, and will be equally applicable for regulatory processes carried out by the Department of Environmental Affairs and its provincial counterparts, under the National Environmental Management Act.



Lani van Vuuren



The fishway at Leopard Creek, Kruger National Park, was recently upgraded.

Spare a thought for our MIGRATING FISH

The annual sardine run on the South African South Coast is not the only fish migration taking place around South Africa. Many freshwater species also require free passage, particularly from breeding spots in estuaries to habitats inland. Petro Kotzé reports on World Fish Migration Day held on 24 May to raise awareness of the need for fish to be free.

Humans have manipulated rivers for their own use for thousands of years. Dams provide water for cities, irrigation to grow crops while generating power for industry and mining. In South Africa, we have been manipulating our waterways with artificial structures since the seventeenth century. Indeed, the country is one of the leading dam-builders in the world. South Africa's estimated 500 large dams hold back millions of litres of water, enabling activities that would otherwise have been near impossible in a semi-arid climate.

Dam construction started slowing down here in the 1970s, in part because there was a growing realisation that the benefits also came with a price – often to the river environment. One area of concern was,

and still is, our migratory fish and invertebrate species. Barriers to migration in rivers, such as bridges, weirs and dams, are considered a major factor responsible for the reduction in numbers and range of many such species throughout the country. Locally, we have about 100 indigenous freshwater fish species that undertake annual migrations to reach better feeding grounds, avoid unfavourable conditions and to improve breeding success.

If they are not able to do this, they could breed at the wrong time of the year, or not at all. This could leave the eggs and larvae in an unfavourable or unprotected environment, where they can become easy prey to predators. In turn, this could lead to a decrease in numbers or, eventually, to the species disappearing completely.

As the understanding of fish biology developed, countries started to react to environmental degradation and species loss. The challenge of river restoration, including the rehabilitation of our fish stocks, was launched. Since the 1970s and 1980s, there has been a worldwide increase and interest and research on promoting the free passage of aquatic organisms in river.

One of the most recent initiatives has been the launch of the world's first World Fish Migration Day, celebrated on 24 May.

CREATING AWARENESS OF THE PLIGHT OF OUR MIGRATING FISH

The day aims to “promote greater awareness of the global importance of freshwater migratory fish and free flowing rivers.” The concept is the brainchild of Dutch aquatic ecologist, Dr Herman Wanningen and a number of international organisations, including the WWF in the Netherlands, the Nature Conservancy in the United States and the IUCN SSC/Wetlands International Freshwater Fish Specialist Group and Wanningen Water Consult with LINKit consult.

Aquatic Health specialist, Dr Kerry Brink, of the WFMD partnership, explains that it is the first of its kind worldwide. The idea to develop the day started in June last year, and momentum started to build after the website went live in October. “From there it just grew and grew.” Eventually, over 250 events across the globe took place to mark the occasion.

Brink explains that the main aim of the day is to create awareness, through a variety of events suitable for the whole family. Few people know what the impact of a dam really is to the aquatic environment,

“For fish migration you need to have a connected river, which is free flowing without constructions blocking the way.”

Dr Andrew Deacon demonstrating a fish and its swimming capabilities to onlookers.



Petro Kotzé



A Tilapia found in a fishway in the Kruger National Park, its tail probably nipped off by a tigerfish.

she notes. “There is a misconception that there are only benefits to dams, but there are, in fact, also many disadvantages. The debate surrounding the construction of dams is quite complicated, but you have to be aware that you cannot just build a dam and there will only be positive results.”

The crux of the day is captured in the theme, *Connecting fish, rivers and people*. “For fish migration you need to have a connected river, which is free flowing without constructions blocking the way,” says Brink. “The ideal is a river that is free-flowing from its source to the sea. Then we are trying to connect people to these ideas and concepts”, she says.

The Lower Sabie gauging weir fish ladder. Here the pros and cons of a conventional fish ladder were explained by Drs Piet Kotze and Andrew Deacon.

Another part of the aim is to let people know that there are other alternatives to restore the movement of fish, if the physical construction cannot be removed. These include fishways, fish ladders or



fish passes – structures placed on or around constructed barriers such as dams or weirs to give the fish an opportunity to migrate.

With the help of over 150 organisations, celebrations and events was organised for World Fish Migration Day in the hundreds of participating locations worldwide, commencing in New Zealand and, following the sun, finishing as it set in Hawaii. Brink says the main event, held in Amsterdam, included a press conference and message from the Dutch minister of environmental affairs, and a tour of a fishway. Other international events included picnics next to rivers, a march in Ethiopia, workshops and presentations.

In Warsaw, a training conference with a political debate was organised with a number of satellite events that took place across the country and broadcast live. In turn, WWF in Italy organised a conference to provide scientific information, techniques and encourage project proposals to address issues of hydrogeological management, minimising environmental impacts and requalifying the ecosystem. This event was preceded by the opening of the largest fish ladder in Europe.

It is hoped that the international day would bring global attention to the need to ensure that natural river networks remain connected and, where they are fragmented, to ensure that they are restored wherever possible, in order to achieve healthy fish populations and productive rivers.

In South Africa, the day was celebrated in the Kruger National Park, and focused on some of the fishways that have been constructed in this park's rivers.

A LOCAL LOOK AT FISHWAYS

For the occasion, consultant, Dr Andrew Deacon, who spent most of his career as the park's freshwater ecologist, organised a tour of some of the park's fishways, including the Leopard Creek fish ladder, the Lower Sabie gauging weir fishway, the Lower Sabie Dam bridge, which has a near-natural fishway, and the Kruger Gate gauging weir. Deacon says that there are currently around 13 fishways in this park, the first of which was constructed on the Engelhard Dam in 1971, providing the only migration route for aquatic organisms over the 667.7 m long dam wall with its 329 m long spillway.

An innovative fishway design

Through the years, as fishway designs improved, a number of constraints have been identified. These include that many lack effectiveness because of poor placement of the entrance, that they cater mainly for large fish; that the fishway pools are often too short with excessive turbulence levels and a lack of maintenance.

An innovative fishway design, developed by hydraulics engineer, Dr Jan Rossouw with the support of the WRC, is the Twin Channel Vertical Slot. Very flat slopes are usually required for fishways, which have to accommodate a wide variety of fish. Flat, sloping fishways are expensive, and difficult to fit into a barrier.

These constraints can be overcome by placing two fishways in a barrier: one, with small drops between small pools, aimed at small fish; and the other aimed at larger fish, able to cope with larger drops and requiring larger pools. The large variation in water levels often experienced in South African rivers is adequately accommodated by adopting a vertical slot fishways design. The TwinChannel Vertical Slot Fishway allows the passage of fish of a wide range in size and swimming ability from very weak to very strong.


Some of the fishways were found to be blocked by debris, and in need of some maintenance – a reflection of the state of many fishways in the country. In 2008, for example, it was reported that there were about 57 fishways in South Africa, of which about 42 were functional to some degree.

South Africa has a long history with the development of fishways, improving designs as time went by. Initially, fishways were designed to cater for strong-swimming adult salmonids. This proved ineffective for passing juveniles or smaller fish species. When these limitations were noticed, it resulted in renewed research on the topic both locally and internationally, in order to develop designs that would allow for all necessary migratory fish to pass through. Today, there are improved fishway designs that successfully pass a wide variety of fish and other aquatic migratory species.

Locally, support took off after the then Department of Water Affairs and Forestry (DWAF) recognised the need to determine fishway requirements in South African conditions and species, and to develop optimal, cost-effective fishway design criteria for South African rivers. Performance evaluation and the know-how to maintain them correctly were also identified as of importance. This resulted in a series of research projects, funded by the Water Research Commission (WRC) to address such issues, resulting in comprehensive guidelines for the planning, design and operation of fishways in South Africa.

While the success of fishways is still hard to put into concrete figures, they are doing the job. According to Dr Deacon, when his team first started constructing fishways in Kruger, their biggest proof of success, like elsewhere in the country, was simply seeing the fish physically move through to their breeding grounds.

As for future plans for the international celebration, the goal-post has been moved further ahead. The partnership has come up with a letter of intent, says Brink, which they hope to get participants and organisations (most specialists and organisations in the areas of fish migration and conservation) to sign, in order to formalise their commitment to work towards collaborate and network to disseminate knowledge. The letter of intent will be used to cement the future of the international day. The first step is to tell people the facts, says Brink, and then the information can be disseminated to higher levels, hopefully to decision and policy makers.

- To stay up to date with any activities, visit <http://www.worldfishmigrationday.com/> and the 'World Fish Migration Day 2014' facebook page. 

“Today, there are improved fishway designs that successfully pass a wide variety of fish and other aquatic migratory species.”

Fish sampled in the Kruger Gate fishway put in an aquarium temporarily as part of the World Fish Migration Day demonstration.



Petro Kotzé



Gavin Lawson

LET THEM FLOW – new guidelines urge stronger action to protect urban rivers

The Water Research Commission (WRC) is throwing its weight behind efforts to rehabilitate degraded rivers in South Africa by funding the development of various 'how to' guidelines, technical manuals and policy briefs. The latest set of tools, aimed at the country's urban rivers, was launched at a special event earlier this year. Article by Sue Matthews.

Speaking at the launch of the guideline document *Tools to determine enforcement-driven rehabilitation objectives on urban river reaches*, WRC CEO Dhesigen Naidoo said: "What the WRC wants to do as our contribution are projects like this one, giving rise to support materials that can be used by

authorities and the rest of us who care about our rivers to fix them up in the right and responsible way."

He was addressing a gathering of people who had shown just how much they care about rivers by getting cold, wet and tired for the sake of raising awareness about the state of urban waterways. These were the intrepid souls who had taken part in this year's Peninsula Paddle on a day when the Cape of Storms was threatening to unleash galeforce winds and torrential rain. They had started out in pitch darkness at the mouth of Zandvlei, at Muizenberg on the False Bay coast, and had paddled, portaged or dragged their canoes across the Cape Peninsula to the mouth of the Salt River on the Table Bay coast. The full distance of the traverse is some 27 km, but a section had to be skipped this year due to the impending bad weather.

The event was held on 8 June – the Sunday after World Environment Day – and was organised by Dr Kevin Winter of the University of Cape Town’s Department of Environmental and Geographical Science. He was one of four people who undertook the first Peninsula Paddle in 2010, and has noticed the improved condition of some parts of the waterway network since then.

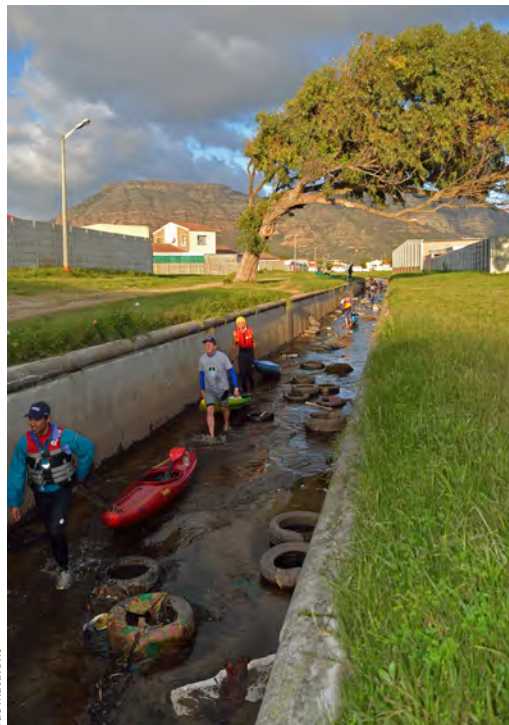
This can be attributed to the Kader Asmal River-Cleaning Project, launched by the City of Cape Town in 2011, which uses Expanded Public Works Programme funding to employ people to remove litter, control invasive weeds and plant indigenous vegetation. Civil society groups, such as the Zandvlei Trust, Princess Vlei Forum and Friends of the Liesbeek, are also actively involved in caring for the city’s waterways – hence the theme of Peninsula Paddle 2014: ‘celebrating citizen action’.

More than 70 people joined in to paddle some, or all, of the route this year, while others acted as support crew or supervised environmental education activities along the way. For the first time, the WRC also entered a team. Once off the water, the paddlers assembled at the nearby Milnerton Canoe Club, where they were able to have a hot shower and revive themselves with soup and sandwiches.

It was here that the launch of the urban river rehabilitation guidelines took place. Author Samantha (Sam) Braid, from consulting engineering firm Aurecon, explained that the guidelines are specifically focussed on enforced rehabilitation, when a regulatory body issues an Administrative Notice – such as a directive, compliance notice or court order – instructing a perpetrator to rehabilitate a river reach to remedy an illegal or non-compliant activity and the resulting disturbance. Often, the interaction doesn’t involve much more than that.

“A study done by the national Department of Environment Affairs found there’s a reluctance amongst the environmental authorities to give compliance advice to people who have been caught out in the enforcement process, because they’re scared of being held liable for inappropriate advice,” she said.

In terms of the Promotion of Administrative Justice Act (PAJA), enforcement officials are accountable for their decision-making, yet there is a bewildering array of legislation relating to watercourses, with numerous overlaps in the jurisdiction of different institutions and spheres of government. The officials only have a mandate to operate within the jurisdiction of their ‘own’ legislation, and their



Sue Matthews

Peninsula Paddle organiser, Kevin Winter (in grey shirt) and other participants drag their canoes through a canal littered with discarded tyres and other rubbish.

heavy caseload means that coordination with other enforcement institutions is severely lacking. Furthermore, many of the officials have a background in law rather than ecological sciences, so their capability of assessing the impacts of contraventions on ecosystem functioning is inadequate – and a high staff turnover results in the continual loss of knowledge and experience gained on the job.

“What this means is that when enforcement is done, it’s very limited to the actual administration,” said Braid. “You needed to get your EIA or water use licence or whatever approval was required before you proceeded with your activity, and that’s what the

The WRC team who participated in the Peninsula Paddle are Reshmili Lutchman, Bonani Madikizela, Adriaan Taljaard, Sudhir Pillay, Inga Jacobs and Thobile Gebashe.



Karen Watkins

Natalie Newman (on the right) and friends pull their canoes through the Steenberg Canal, which passes through the poorest areas of the Peninsula Paddle route. Newman served on the steering committee for the WRC project on enforcement-driven rehabilitation of urban rivers, and helped test the guidelines during their development.



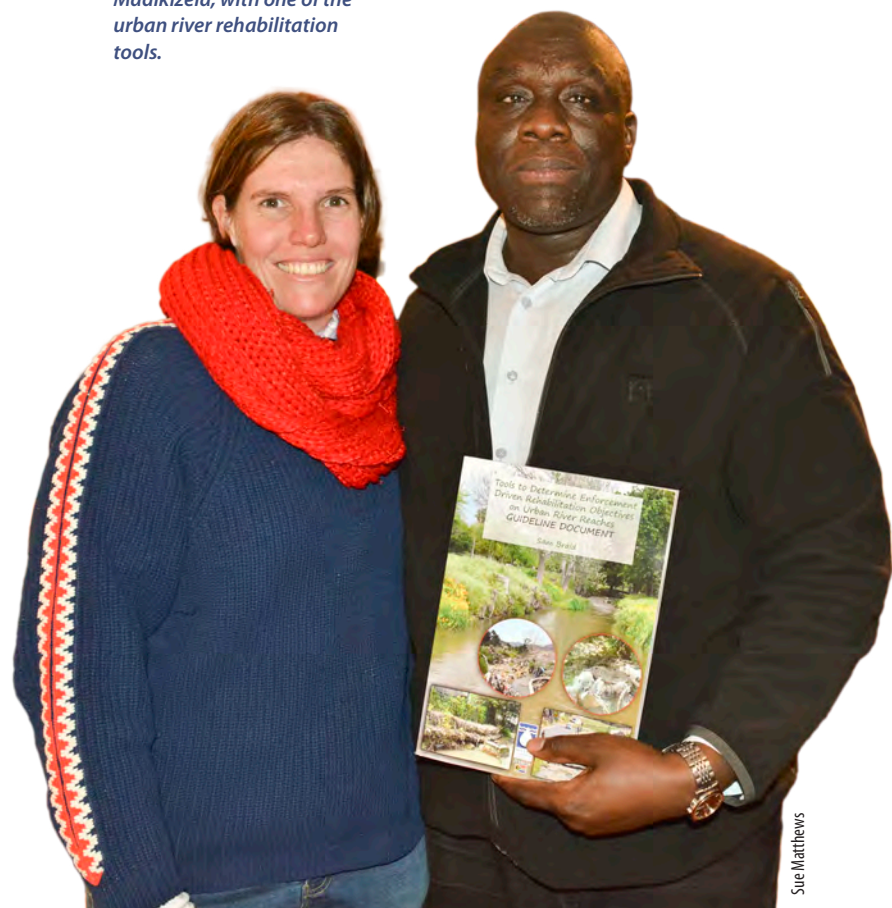
Sue Matthews

focus is on – never mind the ecological degradation that happens to our rivers as a result of those illegal activities.”

The new guidelines will help ensure that the enforcement process involves more than this ‘legal box-ticking’. As part of the research, which was conducted for her PhD, Braid developed three tools – a legislation search tool, a site assessment form and a dashboard tool, all available on a CD accompanying the comprehensive guideline document.

The first of these, the legislation search tool, is a searchable database of national environmental legislation related to rivers. It extracts other sections of legislation that may be relevant or overlap, and the institution responsible for that legislation. This will assist enforcement officials in identifying other stakeholders, especially other government departments, that need to be informed of the enforcement process,

Project leader Samantha Braid and WRC Research Manager, Bonani Madikizela, with one of the urban river rehabilitation tools.



Sue Matthews

and also ensure that the requirements of the enforcement action are compliant with adjacent legislation.

“The second tool – the site assessment form – is to help officials when they go out to do an inspection on site,” explained Braid. “It’s a little questionnaire system that helps keep a record of the site, especially if there are changes in personnel, but also so that when you go back to do a follow-up site inspection you can see if there have been any changes to the site, based on your original site assessment form.”

The form includes a checklist of listed activities that are observed or have taken place on the site, as well as a suite of indicators that must be considered for the active channel of the river and both flood banks. The indicators are grouped as follows:

- Site description – land use, ground cover, height of vertical banks, channel substrate description, riverine vegetation composition
- Site character – erosion on the site, percentage invasive vegetation, continuity of riverine zone, dumping in the river channel, litter in the river channel
- Erosion and armouring – macro-channel bank erosion, extent of erosion on s-bends, bank armouring, active channel bed erosion
- Hydrology indicators – state of discharge outlets, canalisation / channelling, levees / flood prevention banks, abstraction, impoundments, culverts and bridges, flood debris
- Water quality indicators – colour, odour, clarity, water temperature, foam, pH, oily sheen, nutrients, oxygen, indication of life
- Discharge quality – colour, odour, pH, temperature, foam, oily sheen.

The site assessment form contains simple measures and descriptions for each indicator. In the case of the indicator ‘active channel bed erosion’, for example, the choice is between none (no bed erosion), degradation (some incision of the active channel) or channelling (> 1m deep incision of the active channel). Any additional information, such as the site layout diagram, photos or notes can be attached to the form to provide a comprehensive record.

Once back in the office, the official enters all the information on the site assessment form into the spreadsheet of the dashboard tool – and *Voilà!* Displayed on the computer screen in front of them is a graphic representation of the impacts at the site. A summary graph shows the extent of negative impacts on seven riverine functions – flood attenuation, sediment trapping, habitat provision, carbon storage, water quality, aesthetic/recreational use and subsistence/cultural use

– for both the active channel and each bank. Below it is a colourful dashboard graph illustrating the degree to which these impacts on riverine functions can be attributed to alien infestation, site clearing, infilling/impeding/dumping, erosion/excavation, discharge, abstraction, impoundment, diverting, structures, channelling/levees and bank stabilising.

Using these results, the official can request a rehabilitation plan that is tailor-made to address the identified impacts at the site. The request should specify the riverine functions to be rehabilitated and any necessary specialist studies, as well as the need for an environmental management plan and monitoring programme.

The site assessment form and dashboard tool were tested in the field by enforcement officials in both Gauteng and the Western Cape, to allow their adjustment for the typical capability of enforcement officials and to ensure that they are suited to a range of site characteristics. These test exercises are included in the guideline document as case studies.

Natalie Newman, a senior environmental professional with the City of Cape Town, served on the reference committee for Braid's research project and was one of the officials who tested the tools. She feels that they provide a consistent approach to enforcement, and have a potentially wider application than their intended use.

“While these are enforcement tools, it was apparent on site that they could easily be adapted for use in determining what proactive actions are required when planning rehabilitation and restoration projects,” she said. “The legislative search tool is also incredibly useful as it not only allows an enforcer to determine applicable contraventions, but could also be used as a pre-planning tool. It can guide a person in determining what legislation needs to be investigated, based on the activities being undertaken.”

WRC Research Manager, Bonani Madikizela, noted that the guidelines draw on experiences across the globe, as Braid had consulted widely and made presentations at international workshops. “The next step will be to develop them further and make them policy,” he said. “We want to influence the policy for fixing our country's waterways as much as possible.”

He added that another WRC project currently underway will expand the scope of this research beyond the rehabilitation of urban rivers. Involving a number of researchers from different organisations, with Dr Liz Day as project leader, it will focus



Sue Matthews


primarily on physical interventions such as bank reshaping and erosion protection structures, but also address water quality improvement, implementation of appropriate flow regimes and the removal of invasive alien fish. The deliverables include a technical manual and a rehabilitation guideline, the aim of which is to guide decision-makers to make informed choices and consider options, trade-offs and consequences.

WRC Executive Manager: Corporate Services, Reshmili Lutchman, on the highly polluted Black River approaching the end of the Peninsula Paddle, as storm clouds gather over Devil's Peak.

The final slot on the programme for the launch of the urban river rehabilitation guidelines was reserved for Dr Andrew Gordon, representing the Department of Water Affairs.

“The launch of these guidelines gives me an opportunity to say that Water Affairs greatly appreciates the research that private organisations like consulting companies and institutions of higher learning undertake into the understanding and management of our water resources,” he said. “This research is very practical and useful in helping us do our job.”

“I'd also like to acknowledge the WRC in the excellent job they do in taking funding and channelling it into topics that feed into the department's mandate.”

- To order the guides, *Tools to determine enforcement driven objectives on urban river reaches main report (WRC Report No. TT 593/14)* and/or guideline document (TT 594/14) contact publications at Tel: (012) 330-0340, email: orders@wrc.org.za or download a free copy at www.wrc.org.za 



From detrimental to desks – How one factory is putting alien plants to good use



Debbie Besseling

Invasive alien plants are a major threat to South Africa's biodiversity and the country's natural capital. The government's invasive alien plant clearing programme has achieved great success over the years, but what to do with all the plants and trees that are removed? The Heidelberg Eco-Furniture Factory is providing the answer by turning removed alien invasive plants into practical school desks while providing the local community with much needed jobs. Debbie Besseling paid them a visit.

According to the World Conservation Union, invasive alien species are the second most significant threat to biodiversity, after habitat loss. In their new ecosystems, invasive alien species become predators, competitors, hybridisers, and diseases of our native and domesticated plants and animals.

Close to 200 non-native plants have been declared 'invasive species' in South Africa. These invader plants have a substantial negative effect on ecosystem functioning and the capacity of ecosystems to deliver sustainable services. What is especially concerning is these plants' ability to affect South Africa's water resources, especially when they invade riverbanks.

In 1995, the government started the Working for Water (WfW) programme. The programme is aimed at removing intrusive alien plants which use much more water than our indigenous vegetation. In extreme cases, these alien plants outgrow our

indigenous plants to the point of wiping them out.

The programme operates in all nine provinces and is run by the Department of Environmental Affairs, which partners with other departments and private companies. The programme also contributes to job creation for local communities, which includes processing the plant material that has been harvested.

To date, the WfW programme has cleared invasive alien plants on over 2½ million hectares of land. Some of this wood can be used for value-added products, and for the production of energy.

The Eco-Furniture Factory project involves the harvesting of free standing invasive alien trees, such as the blue gum, poplar and pine species. These trees are used for the manufacturing of school desks, benches, and other pieces of furniture, as well as coffins. Currently, the project is targeting alien invasive trees that are within a 100 km radius of the factory, which incorporates the areas of Nigel, Heidelberg, and the Vaal Dam area, mainly on state-owned land.

Mill Manager, Boitumelo Rampeng, has worked at the factory since its inception in October 2012. She is responsible for the harvesting, wet mill and dry mill operations, which cover the entire manufacturing process.

Rampeng explains the various phases and the jobs created in each process: "The harvesting process involves the felling of free standing trees through chainsaw operations. This function provides jobs for chainsaw operators. The wet mill process involves the canting and planking of logs. This provides job opportunities

to work on different machines and items of equipment. Thereafter the planks are stacked in solar kilns for the drying process to take place. In the dry mill process, the actual manufacturing of the school desks is undertaken, which make use of numerous machines – laminating wheel, thicknessers, cross cuts and rip saws, sanding, finishing and spraying.”

In terms of securing orders that will ensure the sustainability of the production line, the Eco-Furniture Factory currently has an order from the Department of Basic Education (DBE) to deliver a total of 70 000 desks. Of this order, 22 800 desks have already been delivered to Mthatha in the Eastern Cape, and a further 24 500 to schools in the North West province. The remainder of the order is for schools in the Eastern Cape.

It is estimated that there is a shortage of some 6 million school desks in the South African educational system. This makes the desks manufactured by the factory in high demand. The high-quality, durable, steel-framed desks with wooden seats and tops manufactured by the Eco-Furniture Factory are offered at affordable and competitive prices.

CHALLENGES

The factory has been operational since September 2013. Rampeng discusses some of the challenges of getting the factory operational and how it has expanded since its establishment. “When the order was received from the DBE, not all the required machines and manufacturing equipment were in place and therefore it placed some pressure on the production line. In order to ensure the end product of high quality desks, providing the necessary training to skill the workers, all of whom were previously unemployed and unskilled, was also challenging. In terms of administration, following the required procurement procedures can be a lengthy process.”

The Eco-Furniture Programme has addressed issues of unemployment and poverty in the local community with the employment of some 208 people, including management. Rampeng points out that the project also focuses on the development of small, medium & micro enterprises, and makes use of local suppliers and contractors.

FUTURE PLANS

On discussing the future plans for the factory, Rampeng says that they aim to increase the factory’s production capacity to 4 000 desks per month, and to simultaneously increase

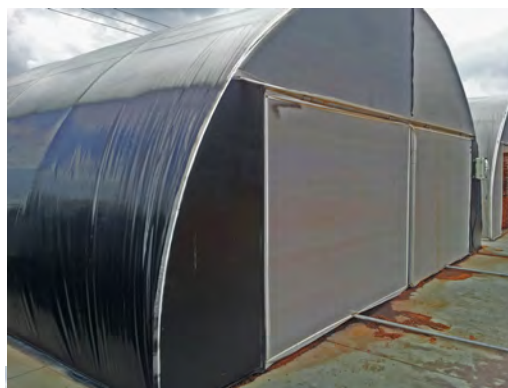
the number of jobs to a minimum of 250. There are also other opportunities in terms of the value added industry options.

Rampeng explains that eco-coffins are another area of focus at the Heidelberg Eco-Furniture factory. Several simple sizes and designs of eco-coffins have been created for this initiative. The coffins will be sold and distributed to non-government charity organisations and faith-based initiatives involved in social responsibility programmes.

The Eco-Furniture Programme is funded through Department of Environmental Affairs’ Natural Resource Management programme (NRMP), an Expanded Public Works Programme, and is in partnership with the Working for Water (WfW) programme. From 2014 the programme is partly funded by the Jobs Fund administered through the Development Bank of Southern Africa. Overall it is implemented through the South African National Parks.

Another similar factory is being established in Ga-Rankuwa. Rampeng will be joining the team at this site from 1 July 2014. With the expertise that she has acquired at the Heidelberg operation, she will make a significant contribution to the new venture. □

It is estimated that there is a shortage of some 6 million school desks in the South African educational system. This makes the desks manufactured by the factory in high demand.



Debbie Besseling

Top: One of the solar kilns at the factory.

Above: Part of the trunk of an alien tree being prepared for the manufacturing process.



How do we improve synchronisation between LAND AND WATER REFORM?

A completed study initiated, managed and funded by the Water Research Commission (WRC) and led by the CSIR is delving into the successes of land reform and water allocation reform in the Maruleng local municipal area. Article by Karen Nortje, Nikki Funke and Willem de Lange.

South Africa has an evident 'dual-economy' agricultural sector on the one side consisting of large-scale mechanised commercial farmers and small-scale, resource poor subsistence farmers at the other. Currently, approximately 95% of the national agricultural output (traded in formal markets) is produced by 5% of South African farmers, who can be characterised as large-scale commercial. In addition, since 1994, the government has been implementing its land reform policy aimed at alleviating the political and economic inequalities that are a legacy of South Africa's past.

One of the major challenges associated with the government's objective to transfer land to black farmers has been to minimise productivity losses during the land reform process and thus avoid possible food security risks to the country. This has,

however, proved to be quite challenging as beneficiaries of the land reform process have struggled to maintain the comparatively high productivity levels of commercial agriculture. Consequently, several support programmes have been rolled out to support productivity-related challenges in the agricultural sector, yet insufficient attention seems to have been paid to addressing the challenges related to effective water utilisation in agriculture.

In parallel to the land reform process, the water reform process has also been underway, with one of its central pillars being the Water Allocation Reform Strategy of 2008. Water allocation reform (WAR) aims to provide water for subsistence farming or for sustaining basic livelihoods, and to start a development path of commercial and competitive water use in support of Broad Based Black Economic Empowerment (BBBEE). Compulsory licensing is a key part of the WAR programme, and allows for water currently allocated to users to be re-allocated to historically disadvantaged individuals. All commercial water users must now register their water use and will have to apply for a water use licence.

The alignment of these two processes has, however, not run smoothly. There is still a weak link

between land reform, agricultural support and water resource provision despite several trans-sectoral programmes that are in place. In South Africa, many land reform farms have failed because of water not being available for production. The synchronisation between water allocation and land reform programmes in irrigation areas, therefore, has to be improved. This challenge falls against a background where the scarcity of water resources in South Africa is on the increase due to various socio-economic and climate change related pressures.

In an attempt to engage with the need to align water and land reform initiatives in irrigated areas that have been subject to the land reform process in order to promote productivity, the WRC conceptualised a research project (K5/1958/4: Investigation of water conservation in food value chains by beneficiaries of water allocation reform and land reform programmes in South Africa) to investigate water

conservation in food value chains by beneficiaries of water allocation reform and land reform programmes in South Africa.

A CSIR multi-disciplinary team commenced with this four-year project in 2010, incorporating multiple levels of stakeholder input into the data pool that underpins the project's findings and analysis and making use of a qualitative research methodology. The project's stakeholders are mostly located within the Maruleng Local Municipal Area and include emerging farmers who are beneficiaries of the land reform process, strategic partners to emerging farmers, and institutional representatives from: the Maruleng Local Municipality, the Lower Blyde Water User Association (WUA), the Moletete Communal Property Association (CPA), the Makhutswe CPA, the Department of Agriculture and Forestry (DAFF) extension officers and Lepelle Northern Water.

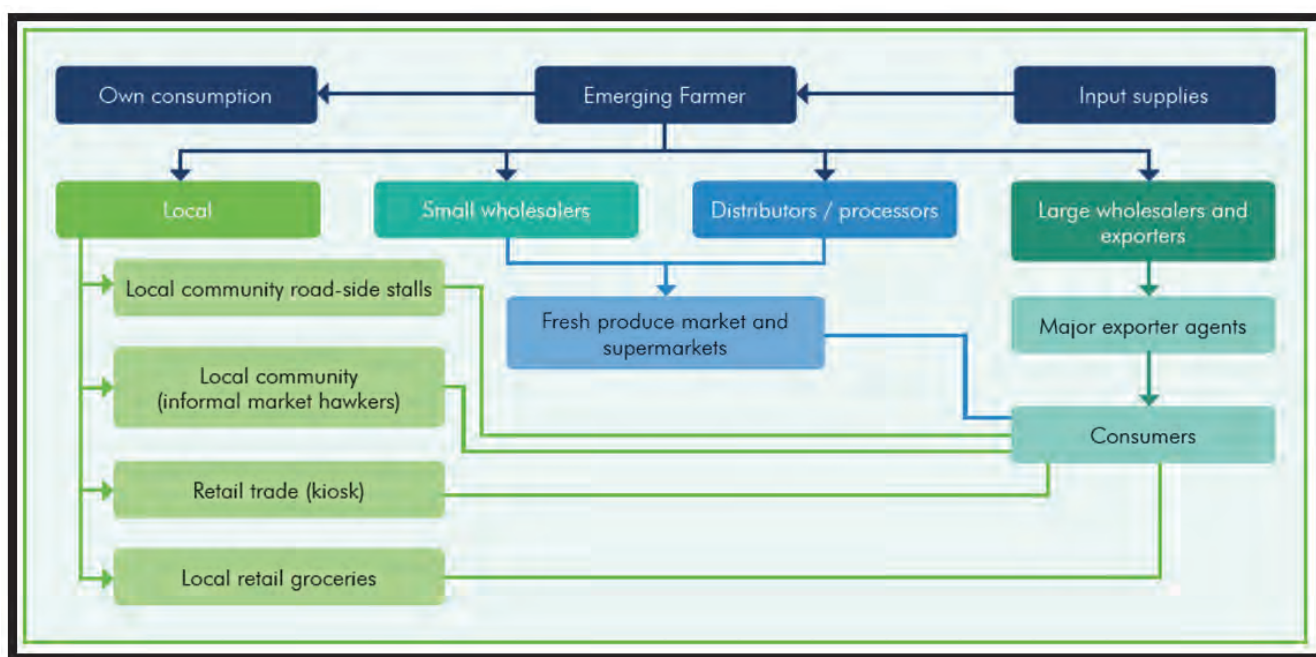
The project has resulted in a number of

Figure 1 (right): Types of emerging farmers

Figure 2 (below): Food value chain for emerging farmers in the Maruleng Municipal Area.

Type 1	The 'really' big players Generally identified as large-scale commercial farmers who do not need to be in a strategic partnership
Type 2	The big players in training Generally identified as large-scale commercial farmers who still need to be in a strategic partnership
Type 3	The entrepreneurs Generally identified as small-scale commercial farmers with aspirations to grow their farming business
Type 4	The transitioners Generally identified as subsistence farmers well on their way to becoming commercial farmers
Type 5	The wishful thinkers Generally identified as subsistence farmers with vague aspirations to become commercial
Type 6	The survivalists Generally identified as subsistence farmers with no aspirations to become commercial

CSIR



CSIR

interesting findings and key messages that could potentially be valuable inputs to South Africa's land reform and water allocation reform initiatives. One of the key deliverables of this project has been a set of three guide books aimed at emerging farmers, agricultural extension officers and policy advisors working in the Department of Rural Development and Land Reform (DRDLR) as well as DAFF.

Each of the guide books is therefore aimed at a different target audience and targets some of the perceived knowledge needs of that particular audience, as established during the course of the research. The contents of the guide books centre on the key themes of the research project: water allocation and land reform, water conservation and food value chains.

What are the key messages coming out of this WRC project? Firstly, it has to be noted that not all beneficiaries of the land reform process aspire to be farmers, let alone commercial farmers. The research has revealed the existence of a diversity of contexts, objectives and aspirations across the range of individuals that have benefitted from the land reform process. As a result, different support strategies are needed for different types of beneficiaries.

It should also be noted that given that support programmes related to water allocation reform and land reform aim to change human behaviour (e.g. to improve water conservation), the design phase of such programmes should systematically account for the culture, norms and traditions of target groupings within the target community within which this behaviour change is supposed to occur.

Furthermore, and this is promising for the future of agriculture in South Africa, the project team found strong evidence of individual entrepreneurs

with commercial aspirations who have the ability to do insightful planning and are determined to be self-reliant and financially sustainable, even in the face of adversity and harsh economic circumstances. However, these individuals were in the minority, with most beneficiaries not displaying such characteristics. In fact, for many land reform beneficiaries it is enough to have a garden that supports their day-to-day needs, or at most provides enough for them to sell a few vegetables at the local market.

In order to make sense of the different kinds of farmers that had been identified during the research, the project team developed a typology (classification framework) of emerging farmers for the case study area. The typology defines attributes according to which each type of emerging farmer can be discussed. The attributes chosen for this typology speak directly to the need to categorise farmers in a way that facilitates an assessment of their ability to conserve water and of their position on the economic trajectory from subsistence to commercial.

The project team identified six basic types of emerging farmers in their typology. This typology has been included in the guide book for policy advisors in order to illustrate the existence of different kinds of emerging farmers. An explanation of the different kinds of emerging farmers that were identified is followed by reflections on how these insights could be used by policy advisors in their day-to-day decision-making: It is clear from our research that not all beneficiaries of water allocation and land reform have the will, the determination, the resources or the ability to take on full scale commercial farming, and all the positives and negatives that it entails.

Beneficiaries need to be made aware of what is required to successfully manage a commercial farming enterprise and need to be given the opportunity to decide whether they want to follow this route. At the same time, if beneficiaries do not want to become full-scale commercial farmers, they need to be given alternatives. These alternatives may involve commercial farming at a smaller scale, or they may involve activities other than farming. This is also an important message for policy advisors to take note of.

A second key message from the project relates to how different groups interpret the concept of "water conservation". One of the biggest problems that the project team identified in its research is that emerging farmers and extension officers are uncertain about what water conservation actually means and what it implies. This is also a major theme that is addressed in the guide books for emerging farmers and extension officers in the case study area.

The primary focus of the guide books on the issue of water conservation ties in with the need for

If land reform beneficiaries do not want to become full-scale commercial farmers, they need to be given alternatives, the research found.



Lani van Vuuren

emerging farmers to use their water as effectively and efficiently as possible in order to maximise their position in existing food value chains and new food value chains. For the purposes of this research, water conservation is interpreted as “doing things right” to conserve water, i.e. making use of the right kind of irrigation (e.g. flood irrigation, drip irrigation etc.) and agricultural practices (e.g. mulching, wind rows, tillage) for the specific kind of farming activities that beneficiaries engage in. Furthermore, water conservation is interpreted as “doing things the right way”.

In other words, if a farmer is using a specific kind of irrigation or agricultural technique, they need to make sure that they are applying the technique correctly and that water is not wasted when they do so. For example, being water use efficient means using only as much water as needed to grow healthy crops, and no more. The guide book for emerging farmers looks at why water conservation is important, how farmers can know if they are practicing water conservation, how they can become better at water conservation and how they can share their knowledge about water conservation with other farmers. The guide book for extension officers is based on the same content, but focuses on how extension officers can assist emerging farmers in improving their water conservation practices.

A third key message from the project team’s research relates to the ability of emerging farmers to progress along the food value chain. Emerging farmers face a range of challenges when it comes to their farming operations. For instance, many of the farmers do not have record keeping systems, and therefore find it difficult to estimate how much water they use and whether they practice water conservation. Financial resources are also a big problem, with many farmers not being able to source the capital to invest in tractors, farming implements and irrigation infrastructure and only making enough to pay their farm labourers and keep their farms going.

Finally, many of the emerging farmers do not have the know-how and experience to run a farm and expressed a need for mentors and or sustainable strategic partnership relationships. The challenges listed above are often the reason why farmers find themselves “stuck” in a particular position within a food value chain and are not easily able to progress along the value chain. For the purpose of these guide books, the project team identified a food value chain that is representative of the Maruleng Municipal Area within which the research was conducted. In the

guide book for emerging farmers, the project team identifies how the current positions of most emerging farmers in this food value chain are problematic, and discusses some of the steps that could be taken to assist emerging farmers to participate more fully in the food value chain and also to move along it.

Lastly, this research has highlighted that much still has to be done to align land reform and water allocation reform. This has also been clear from the project’s case study area, where water allocation reform has not been nearly as prominent or influential as the land reform process. In fact, water allocation reform has for the most part been non-existent with the majority of beneficiaries not having any knowledge of water allocation reform processes in their area.

The level of knowledge regarding the quantity of water used, licensing and water use authorisation, financial support for resource poor farmers and efficiency practices has also been found to be extremely low. During the

project team’s research, it became evident that not a single farmer from the irrigation schemes the project focused on had a water use licence in place. In the case of the CPAs, very few farmers knew about water use licensing and it was only the management structure of the CPAs that was aware of water allocation and water use licensing.

In conclusion, this research has shown the importance of “thinking out of the box” when it comes to the future of South Africa’s land reform and water allocation reform processes. It is critical to be aware of the fact that not all land reform beneficiaries are the same nor want the same things, but that instead beneficiaries are individuals with varying interests and ambitions. These are important nuances that need to be taken into account as the land reform process is interrogated and adapted in a bid to improve its rate of success.

From the project team’s analysis of water conservation-related issues in the Maruleng Municipal Area, it also became evident that it is important for this kind of research to take into account the needs of stakeholders and to address these as far as the project allows. This means doing a needs analysis and, based on this, designing research outputs that are directly relevant to the needs expressed by the project’s stakeholders. Introducing new insights into existing policy processes as well as focusing on the needs of stakeholders and addressing these as far as possible are key ways of improving the impact of such a project. □

“Not all beneficiaries of water allocation and land reform have the will, the determination, the resources or the ability to take on full-scale commercial farming.”



The day the Vaal flowed backwards

The Vaal River in Mpumalanga.

Lant van Vuuren

Thirty years ago, while the country found itself in the grips of a crippling drought, South Africa's water engineers achieved an incredible feat – they reversed the flow of the Vaal River.

South Africa's first large-scale water transfer schemes were undertaken almost exclusively to meet the growing need for electricity. Eskom saw its power stations double in capacity between 1954 and 1955. New power stations had to be constructed to meet the country's insatiable hunger for electricity and Eskom initially focused on the Eastern Transvaal (Mpumalanga) because of its rich coal reserves. However, electricity generation requires water in addition to coal, and so Eskom also started consulting with the Department of Water Affairs (DWA) to gain access to the necessary water supplies.

The Komati and Usutu-Vaal schemes were designed in such a way that most of the power stations could receive water from alternative sources during emergency situations. For example, the Matla and Kriel power stations can receive water from either the Usutu pipeline or the Usutu-Vaal water lead. The system's inherent flexibility proved its worth in the early 1980s.

In the autumn of 1983 South Africa was faced with an economic catastrophe – the projected demand of most of the country's power stations and of Sasol II and III showed that by September, before the normal onset of the rainy season in that area, the five dams of the Komati and the Usutu, as well as the Grootdraai Dam on the Vaal, would run dry. This would be an unthinkable situation, as 80% of the country's total electricity output is dependent on the availability of water in the Usutu-Vaal-Komati system.

The DWA faced a dire situation. Although the Vaal Dam itself was also virtually empty (it was only 38% full) there was the water that was pumped from the Thukela River into Sterkfontein Dam [via the Thukela Vaal scheme] in reserve. This could be let out by gravity to the Vaal Dam, but how to get it from the vicinity of Villiers from where it could be distributed via the Usutu-Vaal link project?

The department had but 20 weeks in which to implement a project to transport some 1 million m³/day over a distance of 90 km (at its shortest). A conventional pipeline of some 2 m in diameter and pumping station would not be feasible in such a short time. The only solution was the one that was subsequently adopted, namely constructing a chain of seven temporary earthen weirs in the Vaal River, each with a pumping station at its downstream toe.

Said to be the brainchild of geologist David George, who was a consultant for DWA at that time, this effectively amounted to putting the Vaal River in reverse. The Vaal River's water was, in turn, supplemented by water from the Thukela-Vaal scheme. In this way, the Komati, Usutu, Vaal and Thukela rivers were connected to keep the 'energy heart' of the country beating.

The Grootdraai Emergency Scheme was approved by Parliament on 18 April, 1983. Work started on the scheme the very next day. This scheme is quite remarkable that, apart from a few aerial photographs and 1:50 000 maps, there were no detailed survey data available, and there was no time for geological or detailed design investigations. Everything had to be done on site as the project progressed.


More than a 1 000 DWA workers laboured on the project day and night. In addition, more than 40 contractors were employed on various aspects of the scheme. The seven weirs that had to be built ranged in height from 8,7 m to around 13,5 m and were placed in such a way that the reservoir formed by each weir would stretch to the toe of the weir upstream of it. Two of the weirs were constructed in the Vaal Dam basin. The total distance along which the water had to be transported was 208 km at a static height difference of 61,5 m between the Vaal and Grootdraai dams. Although engineered by DWA, the scheme was constructed in close collaboration with Eskom and Sasol who, as the main users requiring this water, were responsible for the financing of this project. Eskom also supplied and installed all the necessary pumps.

By 26 July all seven weirs had been completed, and by 18 August the pipelines were finished. The scheme became operational on 18 September, 12

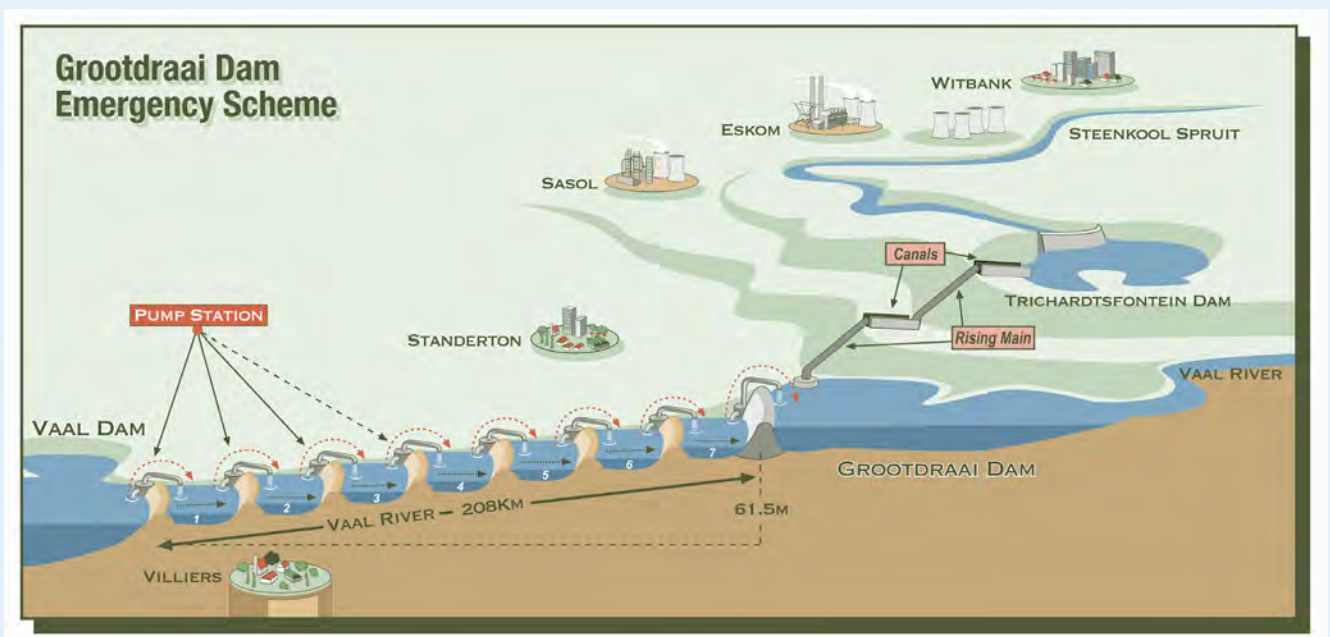
days before the deadline. As it turns out the pumps were not required for a long time because shortly after the onset of the rainy season, heavy rains restored dam levels to normal – ironically, some of the weirs were damaged by the resulting floods. The scheme received an award for the Most Outstanding Civil Engineering Achievement of 1983 from the South African Institution of Civil Engineers.

The scheme was one of the most adrenaline producing schemes ever constructed by water engineers in South Africa. Former Minister of Water Affairs Sarel Hayward related in a department newsletter how a group of dignitaries visited the site via helicopter to check on its progress. Upon landing they were greeted by Resident Engineer Adam Botha who, after showing them around briefly for 15 minutes, coolly informed them that he had no more time to spend with them as he had work to do!

When the scheme was inaugurated the same Botha and his team decided to present the minister with a gift. The speeches were made, the obligatory buttons were pushed, but when Botha had to hand over his gift he was so overwhelmed he could not get out a word. Hayward stepped forward to shake Botha's hand. He had just thanked the engineer when his eyes too started welling up with tears! "So there we stood both with tears in our eyes and all we could do was look at each other. I hope the audience understood," said Hayward of what he called "his most tearful speech".

- This article has been an extract from the book, *In the Footsteps of Giants – Exploring the History of South Africa's Large Dams*, available from the Water Research Commission at a cost of R150. 

The Grootdraai Emergency Scheme. This scheme effectively reversed the flow of the Vaal River.





A toast to South Africa's latest Stockholm Water Prize winner

South African born John Briscoe, the Gordon McKay Professor of the Practice of Environmental Engineering and Environmental Health at Harvard University, has been named the 2014 Stockholm Water Prize Laureate for his unmatched contributions to global and local water management. Debbie Besseling looks at his remarkable achievements that led him to being awarded this 'Nobel prize for water'.

Prof Briscoe joined the faculty of Harvard University in 2009. It was a return journey for him, as he completed his PhD in environmental engineering at the same university in 1976 (he completed his BSc in civil engineering at the University of Cape Town in 1969). At Harvard, he is mainly responsible for managing the Harvard Water Security Initiative. According to its website, the initiative strives to help build water-secure countries, an ambitious aim it strives for through 'focused programmes of interdisciplinary research'.

Prof Briscoe also serves on the faculty of the School of Engineering and Applied Sciences, School of Public Health and Kennedy School of Government. He teaches undergraduate and graduate courses on water management and development. Not all academics like this part of the job, but to Prof Briscoe it is a privilege to have young bright people with whom to interact.

CAREER HISTORY

Throughout his career Prof Briscoe has focused on the issues of water, other natural resources and economic development. He has worked as an engineer in the government water management agencies of South Africa and Mozambique; and as an epidemiologist at the Cholera Research Centre in Bangladesh.

His colourful career history includes positions at the universities of Harvard and North Carolina; the Cholera Research Laboratory (now the International Centre for Diarrhoeal Diseases Research); the Oxford Committee for Famine Relief (better known as OXFAM) as well as the premier development agency, the World Bank, where he worked in a variety of

research, operational, policy and management roles.

In his 20-year career at the World Bank, Prof Briscoe held high-level technical positions, including the position as the Bank's Senior Water Advisor, as well as managerial positions including Country Director for Brazil, with the World Bank's largest borrower. Briscoe's role in developing the governance and strategy of the World Bank is the subject of a chapter in the definitive recent history of the Bank, by Sebastian Mallaby, entitled: *The World's Banker* (Penguin, 2006).

It is in Chapter Thirteen - Back to the Future, where Briscoe's early career is highlighted as well as the significant role that he played in the industry and water management. "In 1976, a young idealist called John Briscoe arrived in Bangladesh. He had left the oppressive atmosphere of his native South Africa; he had earned a PhD at Harvard; now he was coming to live in a village. He chose a place called Fatepur, which was perched upon an island that was surrounded by the tentacles of the world's second-largest river system. Life in Fatepur was miserable. For four months of each year, the village was under several meters of water. The houses were perched on mud plinths, and even in the dry season the nearest market was an hour away by boat..."

"During this time Briscoe had heard of a proposal to build an embankment around Fatepur, he was convinced that no good would come of it. He concluded after interviewing families across all social strata that the rising value of land resulting from the embankment would merely encourage powerful families to grab it."

During the 1960s and 70s the World Bank had moved from building physical capital to building human capital. Two decades later, Briscoe was working for the World Bank in Washington and, in 1998,

he returned to Fatepur. According to the book, Briscoe witnessed that substantial transformation had taken place, which to many was attributed to the embankment that had been built during the 1980s. What was evident was that the poor had shared in this progress. The poorest residents had now been given the opportunity to work as farm labourers.

“The World Bank under Jim Wolfensohn had moved away from infrastructure. It wanted to focus directly on poor people. It did not want to be guilty of harming the environment and it wanted to make peace with the NGOs. Everything pushed it to stay out of controversial infrastructure projects.”

Prof Briscoe says that he is very privileged to have been involved in formulating the World Bank’s Water Strategy, which brings developing countries into positions of setting policies within the World Bank.

When asked about the world’s most pressing water issue, Prof Briscoe says the following: “Water is a very local issue in many ways. You have such different realities even within one country, let alone between countries. That being said you have to look at every water reality in its natural, historical and political complexity – and all of these are different.”

Honing in on the water issues of the developing world, Prof Briscoe sees the challenge of many of these countries to still build the water platform for growth, i.e. to build the infrastructure and institutions necessary to get hydropower, reliable water for agriculture, reliable water for cities. The other great challenge is managing water’s variability. “In a sense this has always been water’s great challenge. How do you deal with the extremes of floods and droughts? This requires both good infrastructure and institutions.”

ACCOLADES


On discussing some of his recent accolades Briscoe highlights his nomination in 2011 by Harvard students for the Joseph Levenson Prize “to recognise exceptional teaching of undergraduates”, in 2012 the Marquand Award for “exceptional advising and counselling of Harvard students” and in 2013 the Star Prize for “exceptional mentoring of students”. In 2012 he was awarded a Hauser Grant for Innovation in Learning and Teaching from Harvard University.

His latest accolade, the Stockholm Water Prize, is a global award presented annually by the Stockholm International Water Institute to an individual, organisation or institution for outstanding water-related achievements. Over the past two decades, Stockholm Water Prize Laureates have come from across the world and represented a wide range of professions, disciplines and activities in the field of water.

In its citation, the Stockholm Water Prize Committee states that Professor John Briscoe “has combined world-class research with policy implementation and practice to improve the development and management of water resources as well as access to safe drinking water and sanitation.”

Prof Briscoe attributes the award to his life that has been filled with opportunity. “From my native South Africa, the United States, in all the countries I’ve worked around the world. I’ve had incredible mentors who have guided me through my career which has been a very important part of it. The award is recognition of a class of people who work on water, people who are both practitioners, who have one foot in the world of practice and another foot in the world of thinking and formulating policy. The award is recognition of those many friends, colleagues and mentors within this space.”

Prof Briscoe is the second South African to win the Stockholm Water Prize. Former Minister of Water Affairs & Forestry, Kader Asmal, won the prize in 2000 for his leadership in establishing the National Water Act and bringing safe water to millions of South Africans who before had been without.

- Watch the video interview of the Stockholm International Water Institute with Prof Briscoe here: <http://www.siwi.org/prizes/stockholmwaterprize/laureates/2014-2/> 

A quick look at the life of John Briscoe

Born: Brakpan, South Africa

Languages: English, Afrikaans, Bengali, Portuguese, and Spanish

Education:

1965 to 1969: BSc (first class honours) in Civil Engineering, University of Cape Town.

1970 to 1972: MS in Environmental Engineering, Harvard University.

1972 to 1976: PhD in Environmental Engineering, Harvard University.

Major field: Water Resources Engineering; Minor fields: economics and demography.

Membership of professional boards and societies

- Founding member of the major global water partnerships, which include: the World Water Council, the Global Water Partnership and the World Commission on Dams.
- Served for six years on the Water Science and Technology Board of the National Research Council.
- Member of the International Water Association’s Council of Distinguished Water Professionals.
- Member of the United Nations Environment Programme (UNEP) Advisory Board on Water.
- Member of the Murray Darling Basin Authority Advisory Council.
- Member of the World Economic Forum (Davos) Global Agenda Council on Water.

THE VAAL RIVER – South Africa's water workhorse



The Vaal River is often described as the hardest working river in South Africa. But what does this mean? And why is this river so important to the country?

Major dams and weirs on the Vaal River

- Grootdraai Dam
- Vaal Dam
- Vaal Barrage
- Bloemhof Dam
- Vaalharts Weir
- Douglas Weir

The Vaal River (named after its naturally dull brown-grey colour) is the second-largest river in South Africa, after the Orange River, into which it flows. The 1 200 km-long river crosses a number of provinces, namely Gauteng, the Free State, Mpumalanga and the Northern Cape.

The Vaal River starts in the eastern Highveld plains, in the vicinity of Ermelo, in Mpumalanga. The river then flows westward on a long course, without rapids or waterfalls, broadening into a large river. While it is a major river it is still a tributary as it does not reach the sea, but instead joins the Orange River at Douglas, in the Northern Cape.

The Vaal River might not be large by international standards (it is about the 129th largest river in the world) it is large by South African standards. Yet it does not run constantly, which means that in winter it has much less water than it has in the rainy season. For this reason large dams have had to be constructed on the river to

ensure a steady water supply to all those people and industries dependent on water from the river.

In earlier times, many little dams were built to irrigate farms. These dams were the forerunners of the great barrages and dams which today control the river on which Gauteng and the surrounding industrial areas depend so heavily. One of the first large schemes to be built on the Vaal River was the Vaal Barrage. This dam, situated about 70 km from Johannesburg was finished in 1923. This dam has a capacity of 63 million litres.

The Suikerbosrant, Klip, and Rietspruit rivers that feed into the Vaal River Barrage Reservoir flow from industrial and heavily populated areas such as Johannesburg, Vereeniging and Sasolburg. This reservoir was used to supply water to the Witwatersrand but no longer does so because the quality of its water is deteriorating due to pollution, says Rand Water. However, this reservoir, which is managed by Rand Water, is still used for many recreational

activities, such as boating, skiing, fishing, swimming and many holiday resorts have grown up on its banks.

The biggest dam on the Vaal River is the Vaal Dam. This dam was built in 1938. While it was the biggest dam to be built in South Africa at the time, it was constructed almost entirely by hand by hundreds of workers. These workers lived and worked at the dam in special construction villages, which had everything from housing, to canteens to an entertainment complex.

The Vaal Dam has been raised twice. In the early 1950s the wall was raised by 6.1 m enabling it to store 2 188 million m³. Then it was raised again in 1985 by another 3.5 m. This increased the volume of the dam to 2 575 million m³. The dam has a surface area of 321 km² and an average depth of 22.5 m.

According to Rand Water, the main water supplier to Gauteng, even though the Vaal Dam is only the fourth-largest dam

in South Africa today, it is still the most important dam in the country because of its role as the primary supplier of water to the economic heartland of South Africa. The water from the Vaal River supplies water to all of the most important industries in South Africa situated around Pretoria and Johannesburg. These industrial areas produce more than 50% of South Africa's wealth as well as more than 80% of the country's electricity requirements – more than 50% of all the electricity supplied in South Africa. From the Vaal River water is also supplied to some of the largest gold and platinum mines in the world, as well as many of the world's largest coal reserves.

Further down the Vaal Dam and Vaal Barrage there is the Bloemhof Dam. This dam has a surface area of 232 km². At Christiana there is a complex series of canals which takes the water to about 1 200 farms in one of the largest irrigation schemes in the southern Hemisphere. This is the Vaalharts Irrigation Scheme. At Douglas, in the Northern Cape, the Vaal River meets the Orange River. The Orange River, which has its origin in Lesotho, then continues westward and eventually flows into the Atlantic Ocean at Alexander Bay.



Above: Map showing the Vaal River.

Below: The Vaal Barrage.

Even these dams have not been enough to supply the increasing need for water. Water now gets 'imported' from KwaZulu-Natal to the Vaal Dam from the Thukela-Vaal Transfer Scheme and as far as Lesotho from the Lesotho Highlands Development Project.

The Vaal River is not only the hardest working river in South Africa because of all the people and industries it supports, it also has to deal with a lot of pollution, like wastewater treatment plants, runoff from mines, industries and agriculture. Organisations like Rand Water and Save the Vaal Environment work to improve conditions in the catchment of the Vaal River and so improve the quality of water that enters the river. □



Did you know?

The Vaal River get its name from the muddy colour of its water, with 'Vaal' meaning 'grey water'. The name is translated from the Khoikhoi name of the river, which is *Heigariiep*.



Many people enjoy the Vaal Dam from a recreational point of view.

Sources

- www.southafrica.net/zalen/articles/entry/article-southafrica.net-vaal-river
- <http://www.randwater.co.za/corporateresponsibility/www/pages/waterorigin.aspx>
- http://www.ewisa.co.za/misc/RiverVaal/VAALRiver_Geology%20.htm
- <https://www.youtube.com/watch?v=lgHYsa-D8tk&list=PLOz2OX6evpWMZyKDK3s7YtHEVSd5VQ9K0> (a video from The Citizen newspaper of the Vaal Dam with its sluices open)
- <http://www.eoearth.org/view/article/228145/>

Thousands flock to Nelspruit water conference

Nearly 2 000 delegates attended this year's Water Institute of Southern Africa (WISA) biennial conference held in Nelspruit earlier this year. The venue was quite unusual, being the Mbombela Stadium. This was the first time that this conference – a highlight on

the water calendar – was held in Mpumalanga. Speaking at the gala dinner, WISA CEO, Lester Goldman, said the organisation's vision remained clear: "We want promote innovations beyond the technical. We want to see innovations to solve the capacity and training challenges ahead.

Solving South Africa's water challenges is predicated on innovation. We wish to increase our assistance to struggling municipalities and increase awareness of WISA as an ally and a resource. Finally, we want to return to a culture of excellence instead of mediocrity."



Thembi Masilela and Lethabo Ramashala from the Department of Water Affairs, along with Mosima Tele from ERWAT taking a closer look at one of the Water Research Commission's new reports.

All photographs by Lani van Vuuren



The Water Research Commission exhibition stand remained as popular as ever.



The friendly staff from Merck are Reggie Reddy, Colleen Petersen, Melanie May, Gurado Symms and Mark Ockhuis.



Poppie Sera, Mxolisi Scwebu and Ntandose Gamede, all from Rand Water.



Pulane Matsoso, Nondumiso Mckteka and Koketso Leballo from the Department of Water Affairs.

SOUTH AFRICAN NATIONAL WATER GAME

A competition to find out what you think about water issues in South Africa

Are you able to wisely develop a catchment? YOU CAN WIN!

WHAT

Enter the national competition sponsored by the Water Research Commission (WRC) & the German Federal Ministry of Education and Research (BMBF), and stand a chance to win many prizes. Prizes include a R5,000 first prize, R3,000 second prize, and a third prize of R2,000. In addition over R20,000 worth of cell phone airtime and a trip for four to a SANPARKS game reserve can be won while playing the game.

WHY

Water resource challenges are on the rise. Climate change adds to the rising challenges. There is a growing need to raise awareness and build capacity around water management to solve these issues. With the Water Game you will see about the conflicts and trade-offs that exist in a real catchment (Middle Olifants) by experiencing them through meaningful play. Also, the game will enable the WRC to understand your thoughts related to water issues in South Africa. By playing this game, individuals will better understand the needs and perspectives of all the stakeholders involved in integrated water resource management, as well as the value that ecosystems provide. Find out more about MOSA - Integrated Water Resources Management in the Middle Olifants South Africa, the BMBF-funded project behind the game on: www.iwrm-southafrica.com.

WHEN

Competition start date: **Friday 18th July**. End date: 18th August. (2014)

WHERE

On the web: Go to www.watergame.co.za
(THE SITE WILL GO LIVE ON 18TH JULY, 12 PM)

WHAT DO YOU NEED:

A computer running on a Windows operating system,
An internet browser (Internet Explorer, Firefox, etc.), Internet connectivity,
A web player will be installed in the beginning of the game.

TO PRACTICE:

Try out the game already today at <http://mosa.aquarepublica.com>



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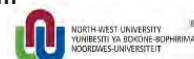
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DEEPLY ROOTED IN SOUTH AFRICAN WATER SOCIETY

www.wrc.org.za

The Water Research 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.

The WRC Vision is to have highly informed water decision-making through science and technology at all levels, in all stakeholder groups, and innovative water solutions through research and development for South Africa, Africa and the world.

FOLLOW US ON



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