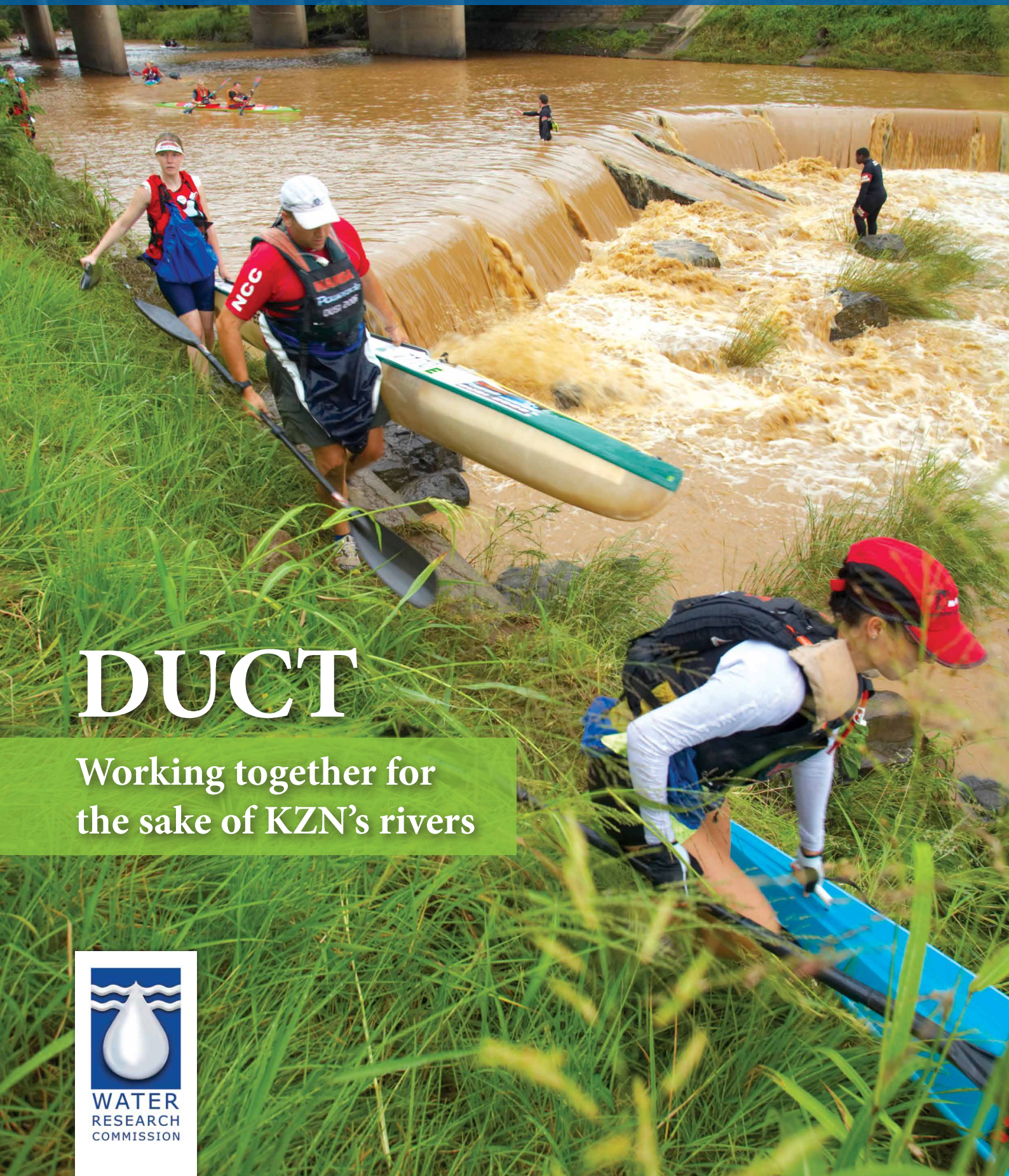
THE
WATER WHEEL

ISSN 0258-2244

March/April 2015 Volume 14 No 2



DUCT

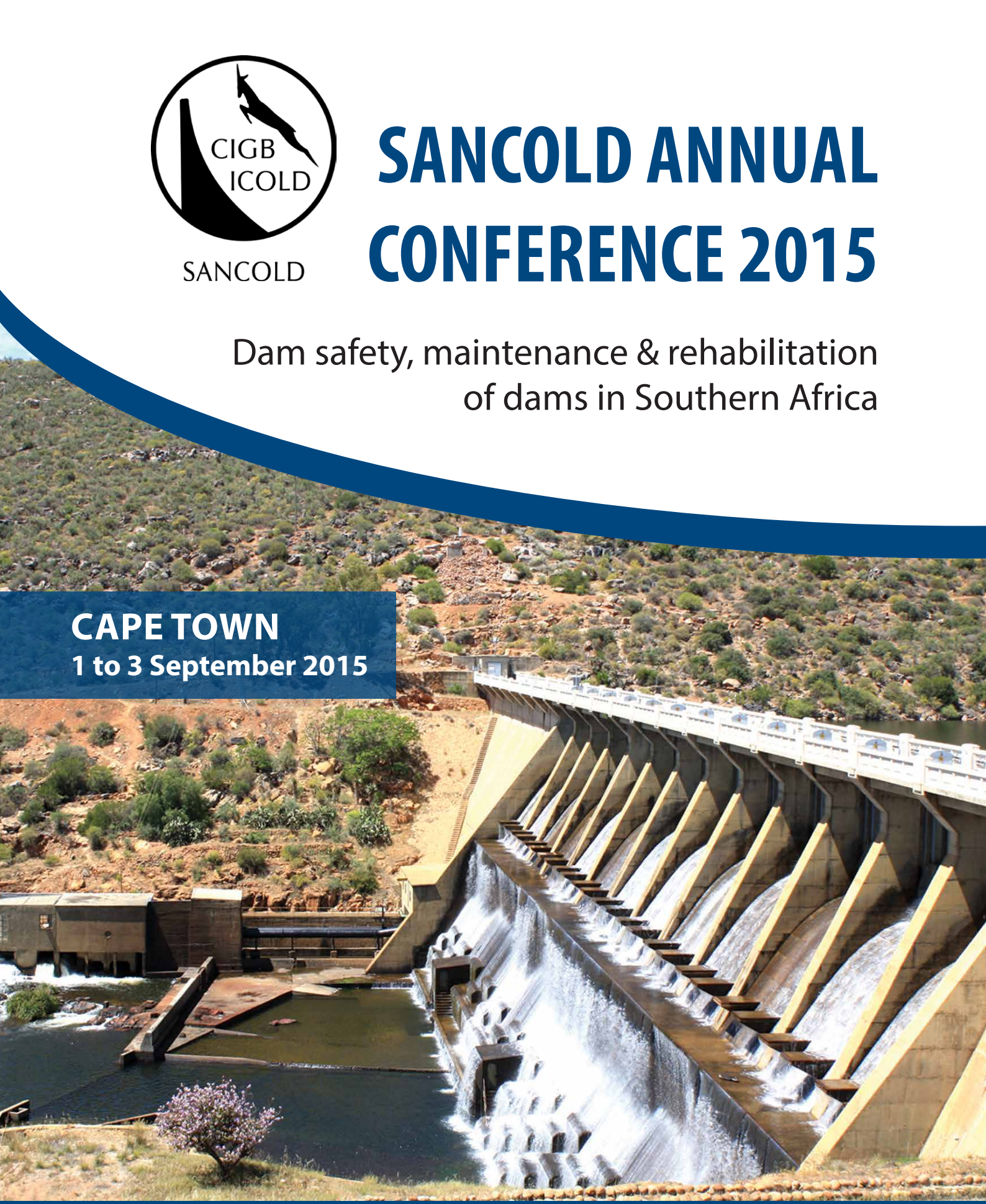
Working together for the sake of KZN's rivers

WATER RESEARCH COMMISSION

SANCOLD

SANCOLD ANNUAL CONFERENCE 2015

Dam safety, maintenance & rehabilitation of dams in Southern Africa



CAPE TOWN
1 to 3 September 2015

Contact Us
Abstracts, papers, technical aspects, exhibition and registration
Ms Nom Buthelezi secretariat@sancold2015.org.za , Tel +27 11 676 3417.

Other matters
SANCOLD Secretary (Paul Roberts) at secretary@sancold.org.za , Tel+27 12 460 9100.

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: Dreamwave Design Solutions,
E-mail: info@dreamwavedesign.co.za

Contents

Cover: *The award-winning Duzi-uMngeni Conservation Trust (DUCT) is illustrating how ordinary citizens can make a difference in the health of their catchments. See story on page 14. Cover photography by Roger de la Harpe/Africa Media Online.*

Fluid Thoughts

WRC CEO, Dhesigen Naidoo

Water and the energy crisis – Impact and solutions

South Africa, like many parts of the world, is in the throes of a very difficult electricity shortage. The impact on our daily lives of now regular load shedding and concomitant disruptions of equipment, machinery and appliances that comprise our toolboxes for functionality at home and at work is high, and frequently tests even the most developed sense of humour.

At a structural level, the water business and our ability to deliver quality water services is highly energy dependent. This is illustrated in Figure 1. To summarise, energy is the critical enabler at every touch-point in the water delivery chain. This begins with energy driven abstraction, either pumping water for irrigation, domestic or industrial purposes from either surface or groundwater to transporting the water to the point of treatment or direct use. This continues with energy powered water treatment for use, and eventually for wastewater treatment post-use. More recently, and more frequently, energy is being used in freshwater production from brackish or sea water through desalination. Energy is the critical input factor that powers water delivery for all uses and in all environments.

A shortage of power has the net effect of compromising the entire water services value chain for the period of its absence. We have seen this having a major impact in South Gauteng recently with the compromise of two major pumps due to an electrical outage triggered by cable theft. The intermittent supply of the energy service also has other potential challenges to both the pumping machinery that have been designed for continuous, uninterrupted operation without unplanned shutdowns, and the corresponding startup surges. In addition, we have to examine the impact of interrupted flow in our pipelines and the impact of the introduction of air pockets to both the flow regimes and the corrosion of the piping infrastructure.

"A shortage of power has the net effect of compromising the entire water services value chain for the period of its absence."

Water is also a major player in the electricity value chain (Figure 1). It has the character of a generator in the form of hydroelectricity and wave power. It is also the critical growth additive in the production of biofuels, and biogas is an important by-product of wastewater treatment. It functions as an energy carrier in steam turbines and functions as a hydraulic tool to unleash energy sources like in the hydraulic fracturing or fracking of shale gas. There is last but by no means least the function of cooling energy generators. The relation between water and energy is an intimate one with the highest level of co-dependency.

In this vein, it is clear to see that water can be a major player in alleviating the energy crisis. Water is a major water use and there is a positive correlation between the amount of water used and its energy demand. An upscaling of our water conservation and demand management (WC/WDM) interventions will have the impact of a lower water consumption and a corresponding decrease in energy demand. The Water Research Commission has in its research portfolio developed a multitude of effective WC/WDM measures and interventions that will realise this impact.

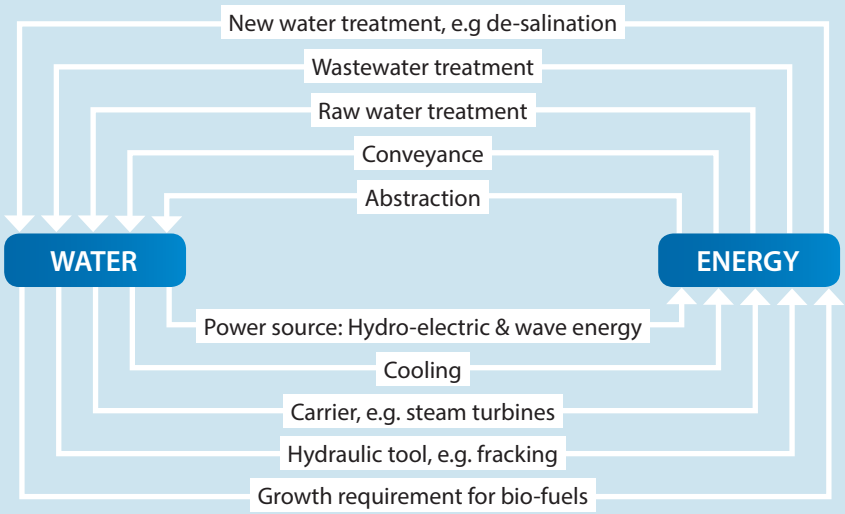
In addition The WRC has published a compendium of case studies of successful WC/WDM interventions that have been used successfully on the ground. These include technical and technological solutions, financial interventions, institutional measures and behavioral changes. An example is the implementation of intelligent pressure regulation in Sebokeng/Evaton which not only achieved a water saving of 33%, but a complementary energy saving of 14 million kWh/year and a Greenhouse Gas emissions reduction of 12 000 t.

This has been complemented with a compilation of best practice in efficient energy use in the water sector. In a country where the current energy demand envelope for wastewater treatment is 200-1800 kWh/Ml and the reticulation energy use is anywhere between 0 and 350 kWh/Ml depending on the situation; the opportunity for greater energy efficiency is large. South Africa's our non-revenue water sits at around 37%, with 25% being in the water leaks domain, the potential for water savings and the related energy saving, therefore, is substantial.

In addition, we are seeing promising results emerging in the WRC portfolio with regard to new micro- and pico-hydroelectricity options utilising the potential energy stored in the water reservoirs in our towns and cities. The WRC teams are working with our partners to get this technology operational in our towns and cities at scale. This may have the potential of water providing a major component of its own reticulation energy needs in the future.

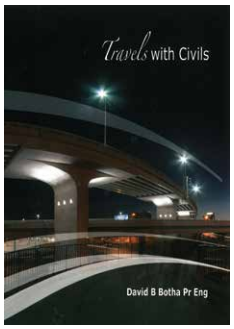
Water conservation and water demand management together with appropriate investments in water based power generation can become a cornerstone of South Africa's future energy security for the water sector and beyond.

Figure 1: The interdependence of water and energy



BOOK REVIEWS:

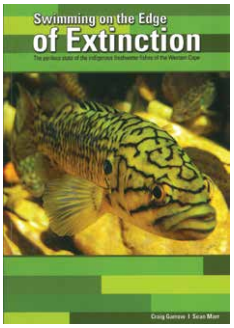
Do you have a new water sector-related book for the Water Wheel to review? Send a copy to The Editor, The Water Wheel, P/Bag X03, Gezina, 0031.



Taking South African engineering excellence on the road

Travels with Civils by David B Botha, is the latest publication by the South African Institution of Civil Engineering (SAICE). This colourful publication showcases what engineers have made possible in 110 years of civil engineering excellence in South Africa. Featuring numerous South African landmarks and engineering projects in each province (over 170 in total), the books bears testimony to the ingenuity of civil engineering professionals and celebrates the work and contributions of the South African civil engineering profession. Worth mentioning are the maps and GPS coordinates included with each infrastructure entry, which makes this publication a valuable companion for the local and international engineering-minded tourist. As an added bonus the publication features a free digital copy of the Water Research Commission publication, In the *Footsteps of Giants: Exploring the history of South Africa's large dams*, authored by *Water Wheel* Editor, Lani van Vuuren.

To order a copy of this book, contact the SAICE Bookshop at Tel: (011) 805-5947; Email: angelene@saice.org.za; or Visit: http://saice.org.za/book-store/travels-with-civils



Pointing out the perilous state of our precious indigenous freshwater fish

Swimming on the Edge of Extinction – The Perilous State of the Indigenous Fishes of the Western Cape by Craig Garrow and Sean Marr covers all currently recognised freshwater fish species that are indigenous to the Western Cape. Each species account is illustrated with exceptional photographs of fish in their natural environment together with descriptions of the distribution, biology, status and threats to the species. The book contains descriptions of major river catchments of the Western Cape, each illustrated with maps and photographs of important and picturesque mountain stream habitats. Easy-to-follow chapters summarise the range of threats to the indigenous freshwater fishes of the Western Cape and provide strategies to halt and reverse their decline. It's message is simple but powerful and, the book is bound to interest conservationists, biologists, ecologists, freshwater fisherman and all those who value the beautiful natural environment of the Western Cape. The book will hopefully motivate amateurs, professionals and the person in the street to take action and contribute towards conserving the remaining freshwater fish populations of the province. *Swimming on the Edge* is published by NISC.

To order a copy of this book, Visit: http://www.nisc.co.za/products/49/books/swimming-on-the-edge-of-extinction-the-perilous-state-of-the-indigenous-freshwater-fish-of-the-western-cape.
The book is also available from www.kalahari.com.

Diary

Residuals and biosolids: June 7-10
The Water Environment Federation, together with the International Water Association, is hosting a conference on Residuals and Biosolids in Washington, USA. Visit: www.residualsbiosolids-WEFIWA.org

Aquatic science: June 28 to 2 July
The Southern African Society of Aquatic Scientists will be holding its annual conference at the Champagne Sports Resort, in the Drakensberg, with the theme 'Water resource research, policy and people'. Enquiries: Petrie Vogel (Conference Secretariat); Tel: +27 (0)12) 346-0687; Fax: +27 (0)12) 346-2929; Email: petrie@savetcon.co.za.

Large dams: July 13-20
The 25th Congress of the International Commission on Large Dams will take place in Stavanger, Norway. Visit: www.icoldnorway2015.org

World water: August 23-28
The annual World Water Week will take place in Stockholm, Sweden, as usual.
Visit: www.worldwaterweek.org

Social science: September 13-16
The World Social Science Forum will be held in Durban. A broad range of topics will be discussed under the theme of 'transforming global relations for a just world'. Visit: www.ssf2015.org

Large dams: September 1-3
The South African National Committee on Large Dams (SANCOLD) is hosting its annual conference in Cape Town with the theme 'Dam safety, maintenance and rehabilitation of dams in southern Africa'. Apart from the technical presentations, the conference also includes the SANCOLD Young Engineer's Forum as well as technical site visits to the Clanwilliam and Bulshoek dams, as well as the Table Mountain Dams.
Enquiries: Nom Buthelezi (Conference Secretariat) at Tel: +27 (0)11 676-3417; Email: secretariat@sancold2015.org.za or Visit: www.sancold.org.za

Groundwater: September 21-23
The 14th Groundwater Conference will be held at Muldersdrift with the theme 'From theory to action'. This conference aims to highlight the issue of improving the uptake of existing knowledge and experiences of groundwater in South Africa to assist in solving environmental and societal problems. Email: info@gwd.org.za or Visit: www.gwd.org.za

Municipal engineering: October 28-30
The annual conference of the Institute of Municipal Engineering in Southern Africa will take place at the Grand West Hotel and Casino, in Cape Town. Visit: www.imesa.org.za

Young Water Professionals: November 16-18
The theme for the 4th YWP South African biennial conference, which will be held in Pretoria, is 'Stop talking, start doing'. Conference topics include domestic and municipal water and sanitation; drinking water and bulk water supply; industrial and mine-water; environment water; and capacity building and training.
Enquiries: Jaco Seaman (Conference organiser), Tel: +27 (0)11 805-3537;
Email: events@wisa.org.za;
Visit: www.ywp-za.org/

Large personal historical collection digitally archived at NWU

The North West University's (NWU's) South African Water History Archival Repository (SAWHAR) has reached an enormous milestone with the completion of the Will Alexander Archive in a digital format.

Prof Alexander, for many years a senior engineer at the then Department of Water Affairs and later Professor at the University of Pretoria in 2012 donated to SAWHAR some of his personal papers and documents related to work he had done at the department, along with some academic writings.

The Will Alexander Project archival project started in February 2014, when Willem Lemmer, who had just completed his BA studies at NWU's Potchefstroom campus, was appointed to compile an inventory of the collection. Willem worked under the supervision of Celesté Reynolds, the NWU (Potchefstroom) archivist.

In September, Willem relocated to Vanderbijlpark with a contract to undertake dedicated archival work for SAWHAR. Subsequently, two students, Nadine Smit and Lucky Malekutu, joined the SAWHAR team on a part-time basis. By the end of November 2014, the group had managed to complete more than 22 000 text page scans and 471 photographs of the Alexander Collection. The material is linked to the digital format.

Checking, re-checking and quality assurance took up much of the time in the creation of the digital archive. The Alexander Project is the second and thus far the most comprehensive digital archive to be completed by SAWHAR.

In 2013, Marietjie Joubert compiled the archive of the Standing Committee on Water Supply and Sanitation (SCOWSAS). The documents tell the story of the committee that started operations in the early 1990s and prepared the way for the first policy guidelines to be issued by then Department of Water Affairs and Forestry after South Africa's transition to a multiracial democracy in 1994. The SCOWSAS archive was donated to NWU by social science researcher, Victor Munnik.

SAWHAR is now permanently based in the new library at the Vaal Triangle Campus of NWU. The library was officially opened in 2014.

South Africa welcomes Indian Ocean Rim countries in historic workshop

The Indian Ocean Rim Association (IORA) Water and Sanitation Technology Working Group met for the first time in a workshop held in Gauteng earlier this year.

The WRC played host to representatives from countries such as Oman, France, Tanzania, Bangladesh, Yemen, Indonesia and Australia. Among others, IORA aims to formulate and implement projects for economic cooperation relating to trade facilitation, promotion and liberalisation; promotion of foreign investment and tourism; scientific and technology exchanges; as well as the development of infrastructure and human resources.

The South African workshop discussed a framework for researcher exchanges between member countries, particularly in the water research and development domain. Further it explored opportunities for support and networking in engagements to promote cooperation in water resource management in the member countries.

Support for research and innovation can boost job creation – Naledi Pandor

South Africa's efforts to grow the economy and create jobs through research and innovation topped the agenda at the first Innovation Bridge technology showcase and matchmaking event, held in Pretoria in February.

The first-of-its-kind two-day technology matchmaking event provided an opportunity for local and international technology-based companies, entrepreneurs and financiers to scout for technology solutions and investment opportunities. The event was driven by the Department of Science and Technology (DST) with its partners, the Technology Innovation Agency, the National Intellectual Property Management Office (NIPMO) and the Southern African Research and Innovation Management Association (SARIMA).

During the discussion, the Minister of Science and Technology, Naledi Pandor, said that increasing the number of researchers and enhancing research and innovation skills and outputs could contribute positively to improving South Africa's economy and job creation efforts. "Knowledge is the currency of the global economy. If South Africa wants to continue to compete in the twenty-first century, we must support research and innovation that will generate growth and jobs, now and in the future."

The Innovation Bridge was expected to serve as a key platform to close the gap between research and development (R&D) and the market, contribute to economic competitiveness, and stimulate increased investment in R&D through the creation of an enabling environment for technology exploitation and entrepreneurial partnerships. The inaugural event included policy dialogues, plenary discussions, technology exhibitions and demonstrations with up to 75 technologies from more than 30 publicly funded R&D organisations, including the Water Research Commission.

Source: DST

Engineering institution inaugurates its youngest president ever

The South African Institution of Civil Engineering (SAICE) inaugurated its 2015 President, Malcolm Pautz, at a prestige event in February. Pautz is the youngest ever president since the institution's establishment in 1903.

In his address, Pautz challenged Generation Y engineers to be bold, to have courage, to never be afraid of taking initiative, and to be involved, while judging themselves on self-integrity and accountability. To engineers stemming from the traditionalists and baby boomer eras, the challenge is to listen to the young engineers, to guide and mentor them, and to identify future leaders who will have the task to make the National Development Plan as well as the post 2015 sustainable development goals a reality.

"I have a dream that one day all civil engineers will be judged not by their inheritance, but by their skill and competence, and by the value they create for society. You, the young engineer, need to rise up and ensure that transformation is met on a balanced basis and without hindering economic and social development within the confines of our resources."
- Malcolm Pautz

New grant aims to open access to SA biodiversity knowledge

The Biodiversity Heritage Library Africa (BHL), led by the South African National Biodiversity Institute, has received a US$150 000 grant from the JRS Biodiversity Foundation to enable it to make biodiversity data more accessible across sub-Saharan Africa.

"JRS is proud to support projects that express our mission of enhancing biodiversity knowledge," said JRS Biodiversity Foundation Executive Director, Don Doering. "Online resources for historical and current environmental information can powerfully link scientists to other stakeholders in the quest for sustainable development."

The support is expected to make a treasure trove of historical studies of Africa's biodiversity available to researchers, educators and the public. BHL is a consortium of natural history and botanical libraries that cooperate to digitise the legacy literature of biodiversity held in their collections, and to make that literature available for open access. Though much of the core biodiversity literature from Africa exists in non-African institutions, rich and unique collections of materials reside in the national institutions and universities on the continent.

This project will grow BHL through the collaboration, assessment and digitisation of African collections and by creating a sustainable network of institutions and countries to increase access to biodiversity materials held in sub-Saharan African institutions.

Tackling the lack of sanitation head-on

The Water Research Commission (WRC) has partnered with the Department of Science and Technology (DST) and the Bill and Melinda Gates Foundation to tackle South Africa's sanitation backlog through the use of technological innovations.

The partnership has resulted in the creation of the South African Sanitation Technology Demonstration Programme (SASTEP), which will see innovative, new-generation sanitation technologies developed under the Gates Foundation 'Re-Invent the Toilet' Challenge demonstrated in South Africa.

Under the programme, several district municipalities and schools in critical need of sanitation intervention in the Eastern Cape will host the next generation of toilet systems. These off-grid technologies offer the same convenience as full flush toilets but with less sludge management challenges associated with on-site dry toilets.

Some of the toilets have included plans for menstrual management as part of the design. The Loughborough toilet, for example, can handle and sanitise nappies and menstrual pads through its pressurised cooking treatment unit

Last year a workshop was held in the Eastern Cape with funders and technology developers. This included site visits to potential demonstration sites. The conditions of the schools provided an indication of the challenges generally faced by rural schools in South Africa with regards to sanitation, and what sanitation services and initiatives had been achieved with the support of the local municipality. These included the piloting of WRC-funded low flush toilets as well as toilet blocks assembled from pre-fabricated materials.

Sanitation technology developers fielding questions at the workshop

The workshop ended in Pretoria, where the SASTEP was launched publically, and stakeholders from across the country gathered to engage with the technology developers.

Through this programme and others, the WRC aims to provide technological sanitation innovations that allow for appropriate and sustainable solutions to the country's sanitation challenge.

Workshop confirms that smallholder irrigators require support

The Network on Irrigation Research and Extension for Smallholder Agriculture (NIRESA) took its annual workshop to the Nkomazi Irrigation Scheme late last year. The meeting was attended by around 100 participants from several provinces, including Limpopo, Mpumalanga, and North West.

NIRESA was founded in 1996 to facilitate the exchange of ideas and practices pertaining to smallholder irrigation in South Africa among researchers and advisory agencies operating in different disciplines of agriculture. According to Water Research Commission Research Manager, Dr Sylvester Mpandeli, the organisation aims to build a shared understanding of the priority areas for research and extension and of the activities that are necessary to effectively address the considerable challenges that face smallholder irrigation.

"This is a very good platform for scientists, extension officers and students to exchange ideas, network and also strengthen irrigation activities across the country," notes Dr Mpandeli.

Delegates learnt much about their visit to the Nkomazi Irrigation Scheme, particularly how the farmers struggled with their main weir which was damaged by floods in 1994. Since then efforts to fix this infrastructure have been disappointing.

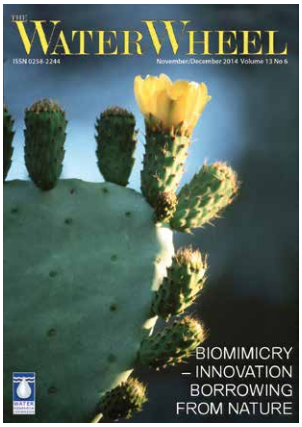
The farmers are getting much assistance from TSgro Company especially in terms of capacity building in the form of training smallholder farmers on leadership issues, through the organisation of information days and farm management, among others, highlighting the need for support for such farmers.

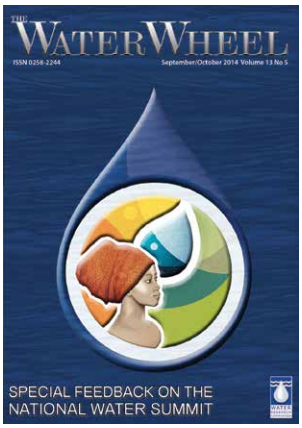
The farmers were also being assisted with a range of other issues, from developing their business plans and getting financial and technical support to assistance with bookkeeping and year-end audits.

THE WATER WHEEL

SUBSCRIPTION

☐ Request ☐ Renewal ☐ Address change





Contact Details

Name: _____

Company: _____

Designation: _____

Postal Address: _____

_____

Tel: _____

Fax: _____

E-mail: _____

What would your like to read more about in the Water Wheel? _____

_____

Would you be willing to pay for the Water Wheel? _____

WATER RESEARCH COMMISSION

The Water Wheel
Tel: +27 (0) 12 330-0340
Fax: +27 (0) 12 331-2565
E-mail: laniv@wrc.org.za /www.wrc.org.za
Physical address: Marumati Building, C/o Frederika & 18th Ave, Rietfontein, Pretoria
Postal address: Private Bag X03, Gezina, 0031

Global News

Water 'a top threat' in next decade

Pressure on freshwater resources may be the main global threat in the next decade, but the world is failing to mitigate the risk and avoid a crisis, according to a survey of leaders from business, government, universities, international organisations and non-governmental organisations by the World Economic Forum (WEF).

Published in the organisation's *Global Risks 2015* report released earlier this year, the survey reveals a belief that water crises pose the greatest risk in terms of global impact. This places it ahead of hazards such as the spread of infectious disease, the failure to adapt to climate change, and interstate conflict.

The WEF defines water crises as a significant decline in freshwater quality and quantity, resulting in damage to human health or economic activity or both. The report points to a study projecting that by 2030 the global demand for water will exceed sustainable supplies by 40%.

Problems will be particularly severe in areas where factors such as urban sprawl make it harder to manage available water resources.

By 2050, the report says, two-thirds of the world's population will live in cities. In countries such as India and regions such as sub-Saharan Africa, urban centres are predicted to expand up to five times.

Margareta Drzeniek-Hanouz, a WEF economist and one of the study authors explained: "As cities become more densely populated, a lack of water infrastructure will have an impact on a higher number of people."

In some cases, freshwater may be unavailable close to the city. "Take Beijing, for example. A canal has been built to supply the city with the appropriate amount of water, which is scarce in the area," noted Drzeniek-Hanouz. "Studies have shown that it would be cheaper to move the whole capital closer to the water than the other way around. There is definitely a direct link between poor urban planning and water stress.

"The WEF survey also examined risk preparedness. Participants were asked to rank progress made in the past ten years to address each risk. The responses suggest that a water crisis, along with extreme weather events and natural disasters, is among the problems the world is least prepared to deal with.

"The report highlights the interconnection between different risk factors such as water, food security and human health," said Drzeniek-Hanouz. "None of them can be addressed in isolation, but all of them are part of an ecosystem of risk that must form the basis of any risk preparedness policy."

To access the *Global Risks 2015* report, Visit: http://www.weforum.org/reports/global-risks-report-2015

Source: SciDev.Net

Tracking fish easier, quicker with new injectable device

Fish no longer need to go under the knife to help researchers understand their movements, thanks to a new injectable tracking device described in the journal, *Scientific Reports*.

The new injectable acoustic fish tag allows researchers to safely and quickly insert the small device into young fish with a syringe similar to those used to treat humans. Injecting the tag, instead of surgically inserting it, is less invasive and enables fish to heal faster, which can also provide more reliable information about fish behaviour.

"Our new tag essentially allows fish to undergo a quick outpatient procedure," explained Zhigun Daniel Deng, a scientist at the US Department of Energy's Pacific Northwest National Laboratory (PNNL). "Tags have been sued to track and evaluate fish movement for decades, but this is the first acoustic transmitter that can be inserted with a simple needle injection."

The Juvenile Salmon Acoustic Telemetry System or JSATS as it is known was originally developed at the request of the US Army Corps of Engineers, which operates dams in the Pacific Northwest. The system's use has since expanded to other fish species, for a variety of waterpower structures, as far as Australia and Brazil.

Tags release quiet beeps that are picked up by receivers placed in rivers, lakes and other water bodies as tagged fish swim by. Receiver data helps researchers map out the precise location of each fish and determine if fish are injured during their travels. That information can help, for example, to make dams more fish-friendly by revising their operations or altering their physical structure.

Source: PNNL

Global conference calls for better inland fisheries management

Inland fisheries – the network of lakes, rivers and streams that provide fish and freshwater to millions across the world – need to be better managed in order to safeguard their contribution to healthy diets and economies, particularly in developing countries.

These are among the key recommendations of international experts at the Global Conference on Inland Fisheries held in Rome earlier this year. During the event leading researchers in the field of fisheries and water management, along with indigenous peoples groups, warned that a dearth of data and sound policies means development decisions fail to take into account adverse impacts on inland fisheries.

Lakes and rivers are an essential source of protein, micronutrients, vitamins and fats for diets, particularly in developing countries, where more than 60 million people rely on them for their livelihood. Some 71 low-income countries currently produce nearly 7 million tons a year, or 80% of global inland captures.

But these water are often impacted by other human needs, including energy creation, tourism and competition for freshwater.

"Inland fisheries provide a valuable but often overlooked source of nutrition and employment around the world," noted Arni M Mathiesen, FAO Assistant DG in the Fisheries in Aquaculture Department. "But to date, the international effort to effectively integrate inland fisheries into the broader development agenda has fallen short of what is needed."

The need for better was one of the issues highlighted. Because most inland fishing activity is small scale, much of it goes unreported and data on the sector is incomplete, meaning its contributions are undervalued in decisions on water management and development.

Research suggests that the harvests from river fisheries that are reported only account for up to 50% of the actual bounty that fisherfolk bring home. Having more and better data will allow decision-makers to make more strategic choices.

Growing urban agriculture boosting food security in cities

Food production globally is taking on an increasingly urban flavour, according to a study by the International Water Management Institute (IWMI).

The study has found that 456 million ha – an area about the size of the European Union – is under cultivation in and around the world's cities – challenging the rural orientation of most agriculture research and development work. The study was published in the November 2014 issue of the journal, *Environmental Research Letters*.

"This is the first study to document the global scale of food production in and around urban settings. It is surprising to see how much the farm is definitely getting closer and closer to the table," said Pay Drechsel, IWMI scientist.

The analysis, a collaboration between IWMI, the University of California-Berkeley, and Stanford University, is the first global assessment to quantify urban croplands and document the resources they consume, namely water, which has both environmental and food safety implications.

According to the authors, their goal was to highlight the role of urban farming in the quest for food security and sustainable development, given the largely rural focus of most agriculture research and policy work. In addition, they wanted to spotlight the starkly different view of urban farming one finds in the developed and developing world.

"We see this dichotomy where urban farming in wealthy countries is praised for reducing emissions and enhancing a green economy, while in developing countries it can be regarded as an inconvenient vestige of rural life that stands in the way of modernisation," Drechsel said. "That's an attitude that needs to change."

The study finds that within cities alone there are about 24 million ha of land under irrigation, and 44 million ha that are rainfed. Going forward, the researchers not the prospect of "irrigated urban croplands playing a larger role in more densely populated and/or increasingly water scarce regions, such as South Asia."

The researchers observe that water usage by urban farms is not just a water recycling opportunity, it can also potentially become a food safety concern. For example, while irrigation allows consumers to get vegetables in the dry season, it also potentially exposes them to pathogens that can be present in the poorly treated water. But the researchers note that food safety issues, while important, can be addressed to maintain the many valuable and underappreciated contributions of urban farms.

To view the original article, Visit: http://iopscience.iop.org/1748-9326/9/11/114002/article

Green infrastructure guide to help address complex challenges of water management

A new Green Infrastructure (GI) guide is set to raise much needed awareness of the benefits of GI solutions for water resources management, according to the United Nations Environment Programme (UNEP).

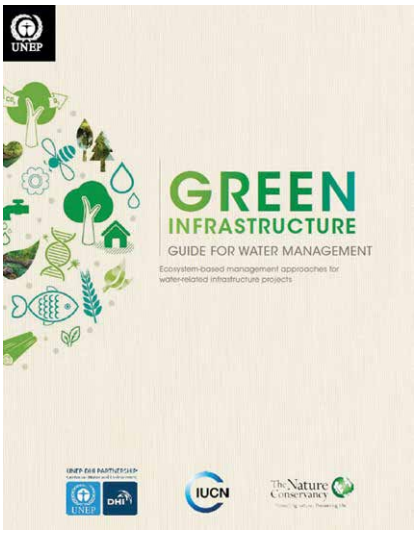
The *Green Infrastructure Guide for Water Management Ecosystem-based Management Approaches for Water-related Infrastructure Projects* is a product of the UNEP-DHI Partnership – Centre on Water and Environment, International Union for Conservation of Nature, the Nature Conservancy and the World Resources Institute. The guide responds to the increasing recognition that GI represents an important opportunity to address the complex challenges of water management.

The publication makes clear that increased efforts to work with GI solutions in water management can result in viable and cost-effective alternatives to greywater infrastructure, as well as support goals across multiple policy areas, including adaptation to climate change.

Examples of GI solutions include constructing wetlands, reconnecting rivers to floodplains, wetland conservation, and introducing flood bypasses, to name but a few. For example, floodplains can reduce flood risk and simultaneously improve water quality, recharge groundwater, support fish and wildlife and provide recreational and tourism benefits.

The capacity of GI to build resilience to climate stocks and variability has also proven to be effective in a multitude of cases around the globe – from conserving mangroves that provide shoreline protection against coastal erosion and storms, to restoring natural floodplains that recharge groundwater and reduce the risk of severe flooding.

The authors of this guide recognise that responses to water challenges are not always a straightforward choice of green vs grey, and that certain water management challenges can benefit from a combination of green and grey infrastructure.



The guide takes the position that the most efficient and cost-effective approach for any given situation must therefore be found by evaluating available options, grey and green, based on their suitability to local hydrology, resource availability and other variables, on a case-by-case basis. The guide concludes with a brief overview of a number of practical tools to support the evaluation of appropriate solutions.

To access the guide, Visit: http://cmsdata.iucn.org/downloads/green_infrastructure_guide.pdf

Source: UNEP

S&T investments needed to hit safe water delivery targets

Dedicated investment in science and technology will be needed to have any chance of reaching the proposed water and sanitation-related Sustainable Development Goals (SDGs) by 2030, delegates at the UN Water conference in Zaragoza, Spain, heard earlier this year.

However, blockages such as corruption, bad governance, poor pay of water facility operators and technicians, broken infrastructure and limited finances prevent existing technologies from being effectively used and hinder the spread of innovation.

"There is a lack of scientific and technical knowledge as well as a lack of the spread of [existing] knowledge," reported Joakim Harlin, a senior water resources advisor at the UN Development Programme (UNDP) and the coordinator of the UN Water working group on SDGs.

Harlin pointed to a need for water technologies that do not require big infrastructure investments. Large projects, such as dams, may not be feasible in the future in places due to water scarcity and a lack of funding.

Sustainable water management has been recognised as an important cross-cutting issue for the 17 SDGs being negotiated to replace the Millennium Development Goals (MDGs) this year. The proposed SDGs include several water-related targets, while the MDGs have just one.

The conference also heard how new technologies are assisting countries with their water issues. In India, for example, satellite-based GPS has helped calculate groundwater resources based on field measurements of water levels, while a mobile phone application in Bangladesh sends text messages to warn local farmers about possible floods.

Another example is the use of satellite imaging to assist water management in Africa, including the TIGER project led by the African Ministers' Council on Water, to consider the status of water resources across many African countries.

Source: SciDev.Net

New reports: March 2015

Report No. TT 587/13

Introducing the wastewater biorefinery concept – A scoping study of poly-glutamic acid production from a Bacillus-rich mixed culture using municipal wastewater (B Verster; Z Madonsela; S Minnaar; B Cohen & STL Harrison)

The nutrient loads in municipal wastewaters are dilute, but add up to significant daily loads because of the massive volumes generated in urban populations. Bioprocessing to reduce these nutrient loads in wastewater while producing a range of byproducts have conventionally included biogas and compost, produced with minimal modification of existing plants. In this project, the broader system needs for such a wastewater biorefinery approach was explored. The specific case of poly (γ-glumatic acid) or γ-PGA production was considered in which the aim was to use the nutrient component of partially treated domestic wastewater for the production of γ-PGA by enriching the microbial ecology for appropriate *Bacillus* species.

Report No. 1881/1/14

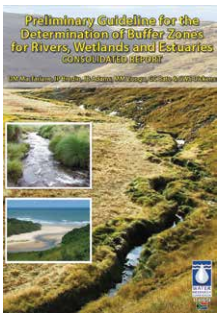
The impact of wastewater irrigation by wineries on soil, crop growth and product quality (PA Myburgh & CL Howell – Editors)

Wine production is an important industry in the Western Cape and the Lower Orange region in the Northern Cape. Wineries produce large volumes of low quality wastewater, particularly during the harvest period. In South Africa, historically most of the winery wastewater has been disposed of to land through irrigation of pastures. However, there are certain secondary environmental pollution risks associated with such irrigation. This WRC project, co-funded by Winetech and the Agricultural Research Council, investigated the sustainable use of winery wastewater for irrigation of vineywards with respect to the effect on soils, vineyard performance and wine quality.

Report No. 1984/1/13

Linking land use to water quality for effective water resource and ecosystem management (J Dabrowski; S Bruton; M Dent; M Graham; T Hill; K Murray; N Rivers-Moore & H van Deventer)

This project is primarily about understanding the influence of land use, in all its forms, on the quality of water in our water resources. This knowledge, if made accessible, has the potential to soundly inform both water quality management and land use management. This will hopefully reverse some of the alarming trends currently apparent in respect of water quality in our rivers, dams and groundwater.



Report No. TT 610/14

Preliminary guideline for the determination of buffer zones for rivers, wetlands and estuaries – Consolidated report (DM Macfarlane, IP Bredin, JB Adams, MM Zungu, GC Bate and CWS Dickens)

Wetlands have been subject to widespread degradation with an estimated 50% of South Africa's wetlands having been destroyed or converted. The need for preventative measures to prevent further degradation of these resources has therefore been highlighted. It is in this context that the establishment of buffer zones to rivers, estuaries and wetlands can play a meaningful role in reducing impacts to aquatic resources and in so doing, protect the range of services that these resources provide to society. This study, through a highly consultative process has developed guidelines to determine appropriate buffer zones for different types of water resources. These zones were tested on a number of case studies and will continue to be refined as implementation proceeds in a learn-by-doing, or adaptive management approach. An eight-step assessment procedure provides the user with a step-by-step approach to determine appropriate buffer zones. The assessment procedure, as well as the management practices that need to be taken into consideration, provide the guidelines for determining and managing appropriate buffer zones.

Report No. 2109/1/14

Development of a toolkit to enable quantitative microbial ecology studies of sulphate reducing and sulphide oxidising systems (RP van Hille; L Motleleng; N van Wyk; R Huddy; M Smart & STL Harrison)

Acid rock drainage (ARD) represents one of the most significant threats to the sustainability of water resources in the northern and eastern regions of South Africa. Large areas are likely to be impacted by the ARD, which can persist for decades or even centuries. There is a need for sustainable remediation systems to address the challenge. Biological treatment systems potentially offer a sustainable alternative to conventional physical and chemical processes. Stable performance of sulphate reducing systems depends on the maintenance of a stable, robust microbial community. Currently, there is a lack of techniques available for the quantitative evaluation of microbial communities in sulphate reducing systems. The development of tools, with a relatively rapid turnaround, to assess the structure of sulphate reducing communities would be valuable in the management of remediation systems based on sulphate reduction. This project aimed to address some of these shortcomings in the management of ARD.

To order any of these reports, contact Publications at Tel: (012) 330 0340, Email: orders@wrc.org.za or Visit: www. wrc.org.za

Rivers and people

Refusing to DUC(T) for cover – how one organisation is making a difference to KZN's rivers

The multi-award winning Duzi uMgeni Conservation Trust (DUCT) is illustrating that South African citizens need not sit back and be silent witnesses to the degradation of the catchments in which they live, but can in fact play in a significant, active role, in reversing this condition. All it takes is some patience, commitment and perseverance.

Article compiled by Lani van Vuuren.

The non-governmental organisation, DUCT, is becoming known to South African households, and not only those that live in the uMngeni and uMsunduzi catchments where the organisation is active. In 2014 DUCT was the winner of the *Mail & Guardian* newspaper's Greening the Future Award in the Community Conservation category. Later that year, the organisation went on to win an Eco-Logic Award in the Water Conservation category.

It is the Dusi Canoe Marathon (which holds to the old fashioned spelling of that river's name) that indirectly inspired the establishment of DUCT. South Africa's premier canoeing event, the Dusi attracts 1 600 paddlers every year with their seconds and supporters and has become part of the culture of the region. Over the years the Dusi has been a crucible for South Africa's top paddlers, several of whom have brought honour to the country by winning titles at the annual World Marathon Canoeing championships, including five times men's winner and reigning champion Hank McGregor.

But it was concern over the deteriorating quality of the uMngeni and uMsunduzi rivers that led a small group of paddlers to establish DUCT ten years ago. "Since the formation of DUCT in 2005 and its official registration in 2006, the organisation has grown to include those who are passionate about river health in this region, not only those with the inclination to mess about in boats," notes DUCT Chair, David Still. Apart from Still the core group of volunteers that founded DUCT and continues to steer its activities includes several water professionals who are well known members of the water research community, including Dr Mark Graham and Professor Colin Everson. Today the organisation has over 300 people on the payroll. In a country where unemployment verges on a national crisis, this is something of which the DUCT board is very proud.

According to Still, rivers reflect a great deal about our values as a society - "Rivers do not lie. If your city does not have a functional waste management system and if too many people do not care what happens to their waste, then

far too much of that waste is going to end up in the river. If your city is not spending enough on the construction, operation and management of its sewage systems, then too much sewage is going to end up in the river. If your landowners – public and private – do not make an active effort to stem and defeat the tide of alien vegetation invading their land, then fairly soon the indigenous vegetation will disappear, with all the attendant consequences."

DUCT functions in different ways. The organisation lobbies for higher priority to be given to any actions and programmes which will improve river health, such as the removal and control of invasive alien plants, the improvement of waste management systems and the implementation of the environmental flow provisions of the National Water Act of 1998. In many instances, it provides skills and manpower to give the effect to those actions and programmes, particularly where there is something new that needs to be tried out or demonstrated.

Further DUCT monitors matters which have a direct bearing on river health, such as sewage pollution, uncontrolled sand mining operations and illegal dumping. The organisation works on raising the public awareness of river health issues through the education of school groups, public campaigns and the use of the media.

Finally, DUCT provides access to a network of highly experienced professionals with relevant skills, and uses these skills to formulate proposals and to manage programmes which are making a difference. The *Water Wheel* highlights four of the organisation's programmes.

River care and alien weed control

One of DUCT's first actions following its establishment was to form a number of River Care Teams to physically clean up the uMngeni and uMsunduzi rivers. A river care team is a group of well trained, well equipped and motivated workers who are based on a particular stretch of river (about 10 km long).

On this stretch their work includes control of invasive alien vegetation, trash collection and removal, prevention of illegal dumping and reporting and sewage or industrial pollution. The number of teams depends a lot on funding, and typically varies between 6 and 14.

A big part of DUCT's current work is controlling alien invasive plants. Aquatic weeds, in particular, spread amazingly fast, doubling the area they infect in as little as ten days (depending on the temperature and nutrient levels in the river). Hyacinth, water lettuce, Kariba weed, azolla, ludgigia and parrots feather are some of the more common aquatic weeds found in the uMngeni and uMsunduzi rivers.

Lotto funding from 2010 to 2013 enabled River Care Teams to make significant inroads with alien invasive plant control over a 100 km zone. With support from the Department of Environmental Affairs DUCT is able to access herbicide for both terrestrial and aquatic work, and has been loaned boats for spraying the aquatic weeds. DUCT further liaises with the South African National Biodiversity Institute (SANBI) to treat emerging weeds, such as Mauritius hemp and Pompom weed.

Invasive alien plants, such as water hyacinth, is a significant challenge in the rivers under DUCT's care.

Since 2006 citizens from all walks of life and hundreds of school children have joined DUCT in removing solid waste from the banks of the uMngeni and Msunduz rivers.

"The organisation has grown to include those who are passionate about river health in this region, not only those with the inclination to mess about in boats."

DUCT is working with authorities to eliminate illegal sand-mining from the catchment.

The confluence of the uMngeni (left) and uMsunduzi rivers.

DUCT's activities also stretch away from the banks of the rivers. It has initiated a pilot programme to improve land care and prevent soil erosion in the upper uMsunduzi catchment, while implementing erosion control measures along other sections of the river. This is done to reduce siltation of the rivers and dams in the catchment.

Monitoring sand mining

Sand for construction will always be needed to feed the growing cities of Pietermaritzburg and Durban, and sand mining is an important party of the valley economy. However, the industry is very poorly regulated and managed and there are many illegal operators. The responsible authorities have to cover the whole province and cannot be everywhere at once.

This is where DUCT can play a role and its support network have a strong presence on the ground, monitoring whether mining operations remain within the limits of their permits and whether in fact they even have permits. "DUCT would like to see the sand mining industry focusing its efforts on the headwaters of dams such as Inanda and Shongweni where sand deposits have accumulated and will further accumulate over time," says Still. "This sand could be designated as green sand, i.e. sand which has been harvested in an ecologically responsible manner, and we would like to see the major industry players insisting on the use of this sand."

DUCT is also lobbying for a special levy to be raised on all sand mining in the valley which will go towards community-based monitoring and rehabilitation work, thus helping to further support the valley economy while simultaneously protecting the environment.

Involving communities

Since 2006 citizens from all walks of life and hundreds of school children, supported by DUCT, have donned rubber gloves and filled countless numbers of bags with solid waste found in the uMngeni and uMsunduzi rivers. The events are timed to coincide with the International Coastal Cleanup day in September.

Initially the focus was on the uMsunduzi River, and partnerships were organised with local schools as well as interested and affected parties, including provincial and local government agencies. Later, the badly polluted tributaries of the Slangspruit and Wilgefontein started to be included, with residents of the historical black urban areas, Imbali and Edendale, participating too. The cleanup has been sponsored by aluminium supplier, Hulamin since its inception, and has grown to include some 40 schools collecting 8 000 bags of refuse.

DUCT also has a schools education programme aimed at raising environmental awareness among youth, facilitating youth action towards rehabilitation and restoration, and encouraging creative expression in caring for our environment, among others. The programme further encourages the concept of communities working together towards the goal of clean and healthy river systems and encourages collaboration with other schools.

> *"The world is run by those who show up. Our job is to show up for the sake of river health so that when the decisions are made and the resources allocated, issues affecting river health are not relegated to the bottom of the list."*

Older community members are also encouraged to participate in river conservation. For example, some people have volunteered their services as 'enviro champs' where they report local environment issues and developments, such as sewage spills, on a monthly basis. At the time of writing there were 20 of these enviro champs. They are paid a small stipend of airtime so they can phone in or SMS through the environmental problems they encounter.

This initiative has been so successful that a municipal decision has been taken to replace certain problem sewers. DUCT also reports that a respectful and cooperative relationship has also developed with the plumbers who repair the problems.

"As part of our turnaround strategy, we have identified credible institutions with whom we have partnered in our quest to pursue our common vision. DUCT fits within that category as we both want to protect and sustain the fragile ecological infrastructure within our area of jurisdiction. We are extremely grateful for this partnership model," notes Sbu Khuzwayo, municipal manager at uMgungundlovu District Municipality.

Sewage monitoring

Water testing in tributaries in the Pietermaritzburg area over the years has indicated ongoing pollution from sewage spills and leaks. In some areas, surcharging manholes have continued unabated for many months, spewing their contents into an already strained river system.

DUCT is about to conclude a three year partnership agreement with the Msunduzi Municipality whereby DUCT will provide an sewer inspection, mapping and monitoring service. Sewage manholes which could impact on the upper uMsunduzi River and its tributaries will be inspected several times each week by dedicated teams. These will be focused specifically on those areas where Umgeni Water's routine weekly sampling results indicate high E.coli counts.

Initially these manholes can be difficult to find, but constant vigilance and sleuthing has uncovered a number of surcharges in overgrown areas previously neglected. On many occasions it has been necessary to carry out house-to-house surveys to ascertain the origins of pollutants, especially when stormwater discharges are involved.

KwaZulu-Natal's main water utility, Umgeni Water, has praise for DUCT's work. "The work done by DUCT is clearly of benefit to our organisation as well as the environment and all those living in the area. We rely on water resources in the uMngeni and uMsunduzi river catchments, and having an independent, suitably skilled, knowledgeable and enthusiastic NGO working to protect those catchments and water resources is reducing risks and enhancing sustainability to those resources, in both quantity and quality," says Steve Terry, water quality scientist at Umgeni Water.

A more recently development has been DUCT's involvement in the Durban Green Corridor, a partnership with eThekwini Municipality. The programme seeks to integrate nature rehabilitation, conservation and environmental awareness, youth development and local economic growth through adventure sport and ecotourism within the uMngeni river valley. The programme is supported by the Department of Water and Sanitation as well as local businesses, sport and environmental organisations.

Despite all the obstacles, the organisation is seeing a difference. For example, as a result of DUCT's interventions serious budgets are being allocated by the relevant authorities for sewer upgrades and upgrades of sewage treatment plants, for invasive alien plant removal and for improved land care in general. The organisation is also seeing more attention being given to catchment health matters, as well as a growing public awareness of the value of South Africa's rivers to society.

"The task of turning around river health in a catchment is massive, for it touches on virtually every aspect of the way we manage our society," notes Still. "It is easy to become overwhelmed and wonder what difference one individual or one organisation – an NGO at that – can possibly make."

Still has a two-fold answer. "That old maxim holds true – the way to climb a mountain is one step at a time. Instead of bemoaning the magnitude of the task, rather get on with it and before long one will look back and see that substantial progress has been made."

The second part of his answer is this. "The world is run by those who show up. Our job is to show up for the sake of river health so that when the decisions are made and the resources allocated, issues affecting river health are not relegated to the bottom of the list."

The DUCT directors and management team snapped after a meeting in 2013.

Alien species management

Alien infested waters – how to solve an unsolvable problem

While South Africa has realised the negative impact of alien invasive fish on its indigenous freshwater fauna curbing the spread of these resourceful creatures has proven difficult. A recently completed study funded by the Water Research Commission (WRC) sought to find some workable solutions.

Article by Sue Matthews.

The vermiculated sailfin catfish, introduced to South Africa via the pet trade, has invaded two rivers in the Richards Bay area.

The eradication of smallmouth bass from the Rondegat River in the Western Cape's Cederberg has demonstrated that eradicating invasive alien fish can indeed be done (see article in *The Water Wheel*, November/December 2012). But should this approach be applied in other areas, with similar success expected?

A recent WRCresearch project collated the lessons learned from a number of local case studies and used them to develop a decision support framework for managing alien fish in South Africa.

The first case study – led by Peter Kimberg of Hydrocynus Consulting – assessed the impacts of largemouth bass *Micropterus salmoides* in the Groot Marico catchment. The catchment has been classified a national Freshwater Priority Area, or FEPA, because it contains fish species of special conservation concern as well as landscape features of special ecological significance, and also because the river's upper reach is the only free-flowing river in the North West Province.

The river rises as springs from a series of dolomitic eyes, discharging into tributaries that flow through deeply incised gorges. The rugged terrain and inaccessible watercourses mean that the fish community has largely been spared the impacts associated with agriculture and other human activities. Nevertheless, one of the 19 indigenous fish species recorded from these upper reaches of the catchment – the endemic Marico barb *Barbus motebensis* – is listed as vulnerable on the IUCN Red List of Threatened Species, largely due to its restricted distributional range and very small area of occupancy.

It is only known from approximately 10 locations in the upper reaches of the Marico and Crocodile rivers, most of which are threatened by water abstraction, seepage from mines or predation by largemouth bass. Two other invasive alien fish species – carp and rainbow trout – have also been recorded in this part of the catchment.

Kimberg and his collaborators sampled 94 sites in the upper catchment during surveys conducted in March and November 2012, using a mix of bank-based visual observation, snorkel transects, backpack electrofishing, seine netting, fyke netting and angling to cater for different habitats and species preferences. They found 14 of the expected 19 indigenous species, as well as largemouth bass and a small number of carp.

In all, 32 largemouth bass were collected at 16 of the 94 sampling sites, primarily in the main stem of the Groot Marico River and the Sterkstroom / Polkadraaispruit tributary. There was also a seemingly isolated population in the Marico eye at the top of Kaaloog se Loop, but otherwise this invader was absent from the tributaries. It had evidently not penetrated into the uppermost reaches of the main stem either.

The Marico barb was found to be the most abundant species, with a total of 2329 fish recorded at 54 sites. Tellingly, it was present in all the tributaries except the Sterkstroom / Polkadraaispruit, and in the main stem occurred only upstream of the invaded zone. This diminutive little fish, generally only three to four centimetres long, shares some habitat preferences with largemouth bass, increasing its exposure to the much larger predator. The numbers of other indigenous fish species did not appear to be affected by the invader's presence.

The second case study – headed up by Dr Darragh Woodford, then a postdoctoral researcher at the South African Institute of Aquatic Biodiversity (SAIAB) – investigated the role of the Orange-Fish-Sundays interbasin transfer scheme in facilitating invasion. Completed during the 1970s, the scheme transfers water via an 83 km long tunnel from the Gariep Dam on the Orange River to the Teebus Spruit, which flows into the Great Brak River, a tributary of the Great Fish River.

After being released from the Grassridge Dam, the water travels more than 200 km downstream before some of it is diverted through the Cookhouse tunnel from the Great Fish River into the Little Fish River, and from there to the Darlington Dam on the Sundays River. Releases from the dam provide irrigation water for intensive citrus farming in the Sundays River Valley. An offtake at the Korhaansdrift weir diverts water from the river into a network of concrete canals that supply some 300 irrigation ponds.

Previous research has revealed that the interbasin transfer scheme enabled the introduction of five species of fish beyond their natural range – the smallmouth yellowfish, African sharptooth catfish, Orange River mudfish, banded tilapia and Mozambique tilapia. Invasive alien largemouth bass, carp and mosquitofish have been introduced to the catchment via other pathways, the last two being particularly abundant.

The research team sampled the fish entering the irrigation network during seven field trips throughout 2012, and also conducted a winter and summer survey of 30 irrigation ponds. The river goby *Glossogobius callidus* was found to be the most abundant species entering the network, followed by the mosquitofish, the estuarine round herring – native to the tidal reaches of the river but widespread throughout the system since being introduced to Darlington Dam – and Mozambique tilapia. These four species had also established populations in most of the irrigation ponds. Their success can partly be attributed to reproductive strategies that do not require specific habitats for spawning.

Towards the end of 2012, the research team also conducted surveys in three major tributaries of the Sundays River that flow through the Addo Elephant National Park – the Uie, Wit and Coerney rivers, home to the endangered Eastern Cape redfin *Pseudobarbus afer* and other conservation-worthy indigenous fish. The preceding wet winter had broken a six-year drought in the catchment, when most of these tributaries had dried up and fish were confined to isolated pools. The drought had the effect of eradicating the invasive African sharptooth catfish *Clarias gariepinus* from the Coerney River, because the water hole in which it was recorded was fished to depletion and then evaporated.

It had been presumed that a causeway on the lower Coerney River would prevent catfish in the Sundays River from moving upstream and back into the national park, but the survey showed that this unwelcome guest had somehow returned. Further investigation revealed that the irrigation network has sluices that allow sections of the canal system to be emptied for maintenance purposes, and one of these discharges water into a pool in the Coerney River, several kilometres upstream of the causeway barrier.

"What we tried to do in this project is ensure that if an authority engages in management they can use the framework to do what's feasible, but will also be able to plan against using unrealistic amounts of resources to attempt to solve an unsolvable problem."

Left: Darragh Woodford and assistants sampling fish in the Sundays River catchment.

Right: Darragh Woodford displays an African sharptooth catfish caught in the Sundays River catchment, where an irrigation scheme has allowed the species to invade the Addo Elephant National Park.

A similar scenario has occurred in the Richards Bay area, where the vermiculated sailfin catfish *Pterygoplichthys disjunctivus* was able to spread via the local water transfer infrastructure. The species is native to the Amazon basin, but has become invasive in various other parts of the world. It was presumably imported to South Africa through the pet trade, probably under the guise of a more innocuous look-alike species, but was evidently released by an aquarium owner or allowed to escape from a garden pond, because in 2000 it was reported from a lake near the town of Empangeni.

In 2004 two juvenile specimens were collected from the Mhlathuze River, downstream of the lake, and in 2007 an adult specimen was collected from the adjacent Nseleni River. The two rivers are in separate quaternary catchments but are linked by a pipeline allowing water to be pumped the few kilometres from the Mhlathuze River into Lake Nsezi, which flows into the Nseleni River.

A research team led by Dr Olaf Weyl conducted three surveys on the Nseleni River over a two-year period from 2010 and collected 346 specimens, both juvenile and adult, indicating a well- established and self-sustaining population. Apart from its potential impact on other riverine biota through its algal grazing, the catfish is known to destabilise the banks of rivers and canals as the males excavate burrows for females to lay and guard their eggs. The resulting erosion and siltation has knock-on effects for other species, as well as economic impacts through damage to infrastructure.

The species was included in the Alien and Invasive Species Regulations published in 2014, listed as category 1b in protected areas, indicating that it must be controlled, and category 3 elsewhere, restricting activities that might facilitate its spread to areas where it does not already occur.

In terms of the regulations, management authorities of protected areas, as well as organs of state in all spheres of government, will have to submit Invasive Species Monitoring, Control and Eradication Plans by mid 2016. But how will they decide where to focus their efforts, or select species to be targeted for eradication, rather than only control? Furthermore, the regulations only deal with species that are foreign to South Africa, but indigenous species that have spread through human activities to areas beyond their natural range – known as extralimital species – may also warrant attention.

To assist management authorities in their deliberations, the research team developed a decision support framework to prioritise areas for alien fish eradication efforts by adapting a 'summary of options' flow diagram in the IUCN Global Invasive Species Programme toolkit.

"What we're trying to do through the framework is to say 'where do you really need to manage alien fish', and there are lots of areas that don't require intervention anymore because they've been settled for a long time, and the impacts have already happened," says Dr Weyl, principal scientist at SAIAB.

"Most important is to try to prevent alien fish getting into the last refuges of our native fishes. Headwater streams are number one priorities, and the last defence at the moment is to stop fish being introduced over waterfalls or into areas where they don't already occur."

The decision support framework asks the following questions in sequence:

1. **Is the population established?**
   The research team recommend using the 'unified framework for biological invasions', developed by Blackburn et al. (2011), to assess the invasion status of an alien species in a given area. The population is considered established if there is evidence of successful reproduction at the site. Management of established populations that are not invasive should focus on preventing further spread and mitigating any negative impacts on indigenous, naturally occurring species.

2. **Is the population invasive?**
   Characterising a population as invasive requires evidence of further, unaided spread beyond the point of introduction, and of negative environmental impacts at the site or in other areas where the species has been introduced. Containment is the first priority for management of invasive species, after which control strategies can be considered.

3. **Does the population have socio-economic value?**
   Some invasive fish species are valued as a food source, recreational fishery or pest control agent, increasing the risk of non-compliance with eradication efforts. The socio-economic value of the invasive species should be considered on a site-specific basis, and stakeholder engagement conducted to gain support for management action.

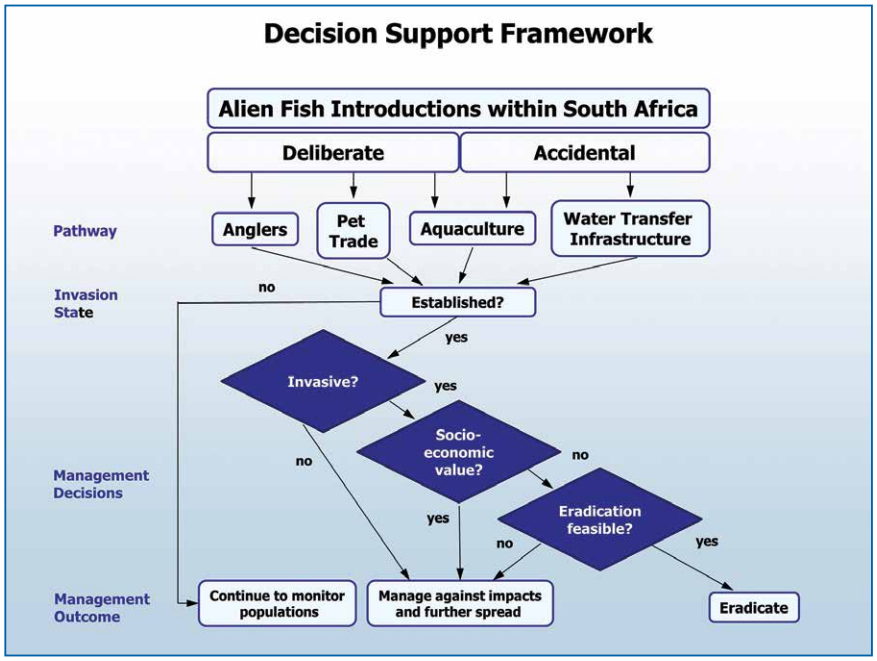
4. **Is eradication feasible?**
   Aspects to be considered when assessing whether eradication efforts are likely to have a successful and sustainable outcome include the size of the target area, the need for barriers to re-invasion, the choice of method, and the availability of resources in terms of funding and skilled human capacity.

Using this framework for the case studies, the research team demonstrated that the small population of largemouth bass in the Marico Eye is an appropriate target for eradication, given its geographic extent and proximity to the sensitive Kaaloog se Loop stream. Piscicides such as rotenone – used so successfully in the Rondegat River – are not an option here because of the conservation value of the indigenous fish community, but the high water clarity makes manual removal by spearfishing quite possible.

In the Sundays River catchment example, alien fish populations within the irrigation network were found to be unmanageable, but the African sharptooth catfish population in the Coerney River could be managed to prevent further spread and mitigate negative impacts. Eradication should not be pursued because the catfish occurs as patchy populations, the presence of endangered Eastern Cape redfin precludes the use of piscicides, and there is no physical barrier in the lower Coerney River to prevent re-invasion. Likewise, eradication of the vermiculated sailfin catfish is not feasible due to the size of the Mhlathuze and Nseleni rivers.

"One really has to guard against misapplying limited resources," says Dr Weyl. "What we tried to do in this project is ensure that if an authority engages in management they can use the framework to do what's feasible, but will also be able to plan against using unrealistic amounts of resources to attempt to solve an unsolvable problem."

"The criteria in the framework can help prevent authorities from spending too much time and effort on things that aren't worthwhile, so that eradications are focused on situations where they are likely to lead to the desired objective."



The decision support framework developed by the project team to assist in managing alien freshwater fish species in South Africa.

Tinus van Vuuren, Water Manager of the Lower Sundays River Water User Association, stands over the discharge pipe that allows water from the irrigation network to spill into the Coerney River, creating a point source for fish invasions.

Olaf Weyl at the Marico Eye, identified as a priority for largemouth bass eradication.

A selection of largemouth bass caught in the main stem Groot Marico River.

To obtain a copy of the report, *Understanding the unintended spread and impact of alien and invasive fish species – development of management guidelines for South African inland water* (**WRC Report No. 2039/1/14**) contact Publications at Tel: (012) 330-0340; Email: orders@wrc.org.za; or Visit: www.wrc.org.za to download a free copy.

Agricultural water management

Water footprints – the story of our fruit and vegetables

We get our water from taps and our fruit and vegetables from the green grocer, but few people realise the tight link between water and the food we eat. Despite the importance of food, most people are unaware of the many challenges to keep producing food for a growing population, especially in an arid country such as South Africa. Water footprinting is not just a new buzzword, it may be a very useful tool that can help us manage our water resources better.

Article by CE le Roux, Michael van der Laan and Mark Gush.

A citrus orchard on Patrysberg Farm in the Olifants -Doorn water management area.

Besides drinking it, producing food is perhaps the most important thing we do with our water. Producing the food we eat uses up to 15 times more water than what we physically use in our houses. In South Africa, irrigation uses about 60% of runoff, and approximately 90% of vegetable and fruit products are grown under irrigation in South Africa, representing a significant fraction of available water.

This dependence on irrigation is of concern due to the vulnerability of water supply in South Africa. While many irrigation schemes make use of groundwater which is an important resource, when more water is being used than recharged, this practice becomes unsustainable. It is very important, therefore, to learn how to increase our water use efficiency and to find ways to produce more 'crop per drop'.

According to the Department of Water and Sanitation, South Africa is facing a number of important challenges in the management of our water resources. In the future, water scarcity will become more of an issue as a result of the ever growing population and economy. Little additional water can be made available from conventional sources and developing alternative sources of water is expensive.

The deterioration of water quality is considered to be the most serious threat to water resources and agriculture is one of the major contributors to this problem. Apart from these uncertainties about future water availability for people, we are also legally required to allow for water required by natural ecosystems, and to be mindful of the potential water impacts associated with climate change.

To address these challenges the Water Research Commission (WRC) is currently funding several water footprint projects, including for important horticultural and field crops, and assessing the usefulness of this information. Research by the University of Pretoria in collaboration with the CSIR is now underway on fruit and vegetable crops in two very interesting regions in South Africa from a water resources perspective.

Citrus in the Olifants-Doorn Water Management Area (WMA)

Economically, after deciduous fruit and vegetables, citrus is the third most important agricultural crop in South Africa, covering approximately 58 000 ha. Citrus is grown in winter and summer rainfall regions of the country, and is the sector that exports the greatest amount of fruit from South Africa, with more than 1.35 million tonnes shipped annually.

The winter rainfall Citrusdal and Clanwilliam area of the Olifants-Doorn Water Management Area (WMA) is no exception as it exports more citrus than any other growing area in South Africa. The WMA is situated north of Cape Town along the West coast. It is a dry, water stressed region, where mean annual rainfall is less than 200 mm, and competition for water is continually increasing.

Due to water scarcity, the area is largely unsuitable for rainfed agriculture, but it has approximately 500 km^2 of irrigated agricultural land. Consequently, agriculture accounts for 87% of the total water use of this WMA.

Irrigation water for citrus and grapes is sourced primarily from the Olifants River, while water for deciduous fruits comes from smaller rivers and farm dams in the higher lying Koue Bokkeveld area. Potatoes grown in the low-lying Sandveld region depend on groundwater for irrigation.

A water footprint assessment estimated that it requires approximately 126 ℓ of water to produce one kilogram of navel oranges. Of this, over 99% was

Grading oranges at a citrus packhouse.

After washing, oranges are automatically size-sorted at a citrus packhouse.

attributed to crop evapotranspiration in the orchard, while water used for other purposes like washing the fruit in the pack-house and agrochemical spraying in the orchard made up the balance.

Given the limited water resources in the Olifants-Doorn WMA, such water use is significant and requires careful management. Theoretically, when crops are exported, the water that was used to produce these crops is also exported. This water has been termed 'virtual water'.

We seldom use products that were produced in our backyards, and virtual water is therefore a useful way of remembering the possible impacts our activities have on water resources elsewhere. Virtual water can also be useful on a national level where decisions are being made about where we import our products from and export them to.

"Increasing water scarcity means that water footprinting may become a valuable tool to enable us to manage our water resources better."

In some cases it might be better to import crops from regions with good soils and high rainfall rather than using local scarce water supplies for irrigation. The virtual water concept highlights the importance of balancing the sustainability of local water use to produce the crops against socio-economic benefits gained from exports.

Carrots and broccoli on the Steenkoppies Aquifer

The Steenkoppies Aquifer is located just west of Johannesburg. For thousands of years this water has flowed through a natural outlet called Maloney's Eye and into the Magalies River. Once the water enters the Magalies River, it gives life to vibrant ecosystems and provides irrigation water to a number of downstream farms.

Following the late 1980s, farming began above the Steenkoppies Aquifer itself, irrigating with water from boreholes tapping directly into the aquifer. Water flowing from Maloney's Eye was drastically reduced as a result. This would go on to cause conflict between farmers on the aquifer and downstream users, especially during years of drought.

There's a really good chance that the carrots in your fridge were grown with groundwater pumped from the Steenkoppies Aquifer, as this region is the largest carrot producer in Africa. Again it isn't just the physical water in the carrots that we need to be concerned about. Up to 230 ℓ of water is used to grow a 750 g bag of carrots. That is almost three times the volume of water you would use in the average bath. Additional water is used in cleaning, packaging and distributing the carrots.

On top of that, some of the carrots produced are wasted. Wasting food is like wasting water. Vegetables are being wasted along the entire supply chain from the farmer to the consumer. Most wastage occurs in the hot summer months.

Data from the Tshwane Fresh Produce Market for the year 2012/2013 indicated that an average of about 100 000 kg of carrots from the Steenkoppies Aquifer were wasted at the Market. This represents about 1.5% of all carrots received from the Steenkoppies Aquifer and is expected to be only a small fraction of the total wastage. More perishable crops such as lettuce and strawberries are expected to have even larger losses. One way to reduce impacts on water resources is to prevent food from being wasted unnecessarily.

We often also throw away a big part of the plant, like the leaves that cannot be eaten. If the farmer uses these parts of the plants for making compost or feeding animals, then he gets more productivity out of the water that he used for irrigation. Broccoli is a good example, because it has a significantly high water footprint relative to many other vegetables.

To get one kilogram of broccoli heads a farmer uses up to 1 300 ℓ of water. This is because the broccoli head is very small compared to the rest of the plant. However, farmers on the Steenkoppies Aquifer often use the rest of the plant to make compost for use on future crops, effectively recycling the water used to produce them, so these water savings should ideally be off-set against the water footprint.

So what is water footprinting exactly?

The water footprinting concept originated in response to challenges in water resource management. The Water Footprint Network (WFN) has led the way regarding the methodology of calculating water footprints, originally coming up with the concepts behind blue, green and grey water footprints.

Blue water is the water in dams and rivers and groundwater that anyone can use for any purpose. Green water is rainwater that has infiltrated into the soil and can only be used by plants. Grey water is the volume of clean water needed to dilute the harmful pollutants we put into water.

A total water footprint is the sum of the three colours reported as a volume of water and can be calculated for an entity, region or to produce a product. This network has ensured that the term 'water footprint' has become more mainstream, and a key contribution has been to show global virtual water flows, indicating which countries are net exporters of virtual water and which rely on water used and polluted elsewhere to produce the products they consume.

But some scientists feel that it is irresponsible to report a water footprint

simply as a volume of blue, green and grey water. Whereas greenhouse gas emissions are considered to have the same global impact regardless of where these emissions take place, this is not true for water. The impact of using or polluting a certain volume of water will differ depending on the local conditions where the water is used. Because of this local nature of water, there are so many different scenarios within which a water use must be interpreted before you can understand its full impact.

This makes standardisation for comparative purposes very difficult as, for example, you need to consider the spatial and temporal availability and demand for water. For example, even though 230 ℓ of water for a 750 g bag of carrots seems like a lot, it of course doesn't mean that growing carrots is a bad thing.

However, finding a standard way to calculate a water footprint has not been an easy task, and the international scientific community remains divided on the issue. One reason for this is that different people need different information. A water footprint must help a farmer to reduce the amount of water he uses, a consumer to choose the most environmentally sustainable product and a politician to make sensible water policy decisions.

As a result, ISO Standards for water footprints (ISO 14046:2014) were developed and released in August 2014, aiming to standardise the ways in which people conduct water footprint assessments. The Standard gives very broad and flexible guidelines and includes a few important principles. Water footprints, according to the Standard, must consider the full lifecycle of a product, must include an environmental impact assessment and must preferably be based on scientific evidences. The Standard also has specifications on how water footprints are reported, in order to ensure transparency.

However, the scope of the ISO standard does not include a way to report the results as product labels. Rather than a volume, it is suggested that results be reported as 'water equivalents' (H_2O-e) which gives an indication of the product or activities' impact on water resources. Rather than the utilisation of the grey water footprint concept to estimate impact on water quality, this Standard proposes the use of other mid-point indicators firmly established in Life Cycle Assessment methodology, such as estimating eutrophication potential in 'phosphate-equivalents' in the case of nitrogen and phosphorus pollution from agriculture.

Further complexities in water footprinting in agriculture

Apart from standardising water footprinting for various purposes to reflect local conditions, there are also other complexities. For example, the same crop grown in different seasons will have different water footprints due to variances in growth rates and atmospheric evaporative demand. Crops grown predominantly during the rainy season may also have

Carrots are mechanically harvested on the Steenkoppies Aquifer – representing the largest carrot producing region in Africa.

Following harvest the carrots are washed at the pack-house. This represents a very small fraction of the water use compared to in-field crop evapotranspiration.

high ratios of green to blue water consumption due to higher rainfall during this season.

The importance of doing local studies on water use and yield measurements therefore also becomes clear, as opposed to utilising international, easily available crop factors, for example, from FAO56. Accurate water footprint calculations are dependent on accurate measurements of crop water use/requirements.

However, published crop coefficients used for estimating crop water use in South Africa are still often taken from research studies conducted overseas, and may not be representative for local conditions.

Furthermore, the coefficients are crude estimates in that they only have initial season, mid-season and end-season values, linked by straight lines representing growth stage periods. This is not entirely realistic compared to the curved and fluctuating crop coefficient curves for most crops, when derived from observed data. To get the best water footprint estimates, crop water use information should be based on field observations.

Then of course equally important is the impact on water quality, arising through the cultivation of land and the use of agrochemicals such as pesticides and nitrogen fertilisers. This is even more difficult to quantify than water use, and the scientific community are currently devising approaches to quantify this using different levels of complexity depending on what data are available.

Potential of water footprinting

Despite all these challenges in standardising and refining water footprinting methodologies, the concept has the potential to really improve water resource management. Water footprint accounting intends to address environmental as well as socio-economic issues. Analogous to carbon footprinting, it aims to provide a metric on the impact of our products or activities on our water resources, especially when calculated impact along the entire production chain.

Many studies in the past have focussed on improving water use efficiency at the farm level, but water footprinting also aims to inform consumers, water resource managers and policy makers. Water resource managers have found themselves overwhelmed by complex questions about when and where water is available, when and where it is needed and how the use of water impacts our societies and ecosystems. Water footprint accounting aims to simplify the complexity of catchment hydrological cycles and water use dynamics.

And water footprinting can also contribute to improved water resource management on a farm level. More often than not farmers over irrigate their lands to reduce any risk of the crop being water-stressed, and water footprinting can potentially play an important role to prevent this. Water footprints are currently being calculated for a range of fruit, vegetable and field crops in South Africa, and these footprints can serve as benchmarks for farmers, potentially revealing inefficient use of water. This, in turn, allows savings in electricity due to reduced pumping, and fertiliser due to reduced leaching losses. It will also have longer term sustainability benefits for the environment and society.

So what does this mean for South African farmers

Increasing water scarcity means that water footprinting may become a valuable tool to enable us to manage our water resources better. Consumers are also demanding more information on the products they consume. If the WRC projects to estimate the water footprint of common fruit, vegetable and field crops and the growing interest in water footprints leads to an emphasis on refining water use estimates and reducing impact on water resources, then this will be a positive development.

Even though a farmer cannot change the amount of water his carrots or citrus need, he can reduce the impacts of growing crops with good management. Water footprinting can provide the necessary information to do that. Maximising the use of rainfall during the growing season reduces the need to use blue water from dams, rivers and aquifers, making it available to other users. For example, in the Steenkoppies aquifer, in contrast to Olifants-Doorn, there is greater opportunity to make use of green water by not over-irrigating. Reducing the volumes of water we irrigate has multiple benefits for the environment. A farmer can also ensure that water distribution and irrigation infrastructure is in good condition so as to minimise transmission losses.

Once water footprint accounting has developed to a point where we can label food, we as consumers will be able to make more informed decisions. Until that day we as consumers can already have a positive influence by reducing the food we throw away. This can be done through better planning and preserving food, but also through buying food that is grown locally.

The further we are from the farm, the more food is wasted on its way to us. And of course our backyards are the ultimate local source of vegetables which can be watered with water from the bathtub or a rainwater harvesting tank. But most importantly, we must try to become more aware of the stories of the food we eat. As consumers who vote with our money, we are one of the most powerful role players that can drive changes from poor use of water resources and prevent the associated impacts.

Water and the environment

Monitoring the ecological success of wetland rehabilitation

Millions of Rand have been spent on rehabilitating South Africa's wetland and regaining some of their ecological services. But is it working? Petro Kotzé visited the monitoring project at Kamiesberg Working for Wetlands.

Petro Kotze

Both the integral role that wetlands play and their endangered status are well known. In South Africa, rehabilitation of wetlands is mostly run under the South African National Biodiversity Institute (SANBI) programme, Working for Wetlands. Their primary focus is wetland rehabilitation, but the protection, rehabilitation and sustainable use of those wetlands are simultaneously entrenched within their core aims.

Concurrently, the project is a vehicle for poverty reduction through job creation and skills development amongst vulnerable and marginalised groups, and forms part of the governmental Expanded Public Works Programme (EPWP). This programme seeks to draw significant numbers of unemployed into the productive sector of the economy, gaining skills while they work and increasing their capacity to earn income.

As such, the programme is aligned to South Africa's progressive 1998 National Water Act, which is based on the principle of managing water resources for environmentally sustainable social and economic benefit. The Act also recognises that water reserves are required for both basic human needs and the protection of aquatic ecosystems.

The success of the programme in training an employing people is well documented. In his recent State of the Nation address, President Jacob Zuma said that 60 000 job opportunities are to be created by environmental programmes such as Working on Wetlands, Working on Waste, Working for Water and Working for Fire in the next financial year.

While it has been easy enough to keep tabs on the amount of jobs created, the benefits of rehabilitation to the environment has been decidedly more difficult to quantify. Monitoring the immediate ecological outcomes of rehabilitation has mostly been based on best professional opinion, says Heidi Nieuwoudt, SANBI Working for Wetlands Programme coordinator for the Western and Northern Cape. "Few rehabilitation sites have been monitored to measure the extent of success and failure in terms of pre-determined objectives set for rehabilitation efforts," she says. While Working for Wetlands acknowledges this as a critical component to rehabilitation, this need could not be met for all sites due to budget constraints.

Now, a monitoring team has been developed as part of the Kamiesberg Working for Wetlands project, located in the Northern Cape. Team members are from neighbouring communities and were previously unemployed,

while management of the project is shared by Conservation South Africa (CSA) and South African National Parks, which co-selected eight wetlands for monitoring.

The initiative has drawn some valuable ideas and lessons from a Working for Wetlands wise use initiative at the Makuya wetland, Limpopo province, which piloted the involvement of community monitors, and is being implemented by the Association for Water and Rural Development (AWARD).

First, a look at the ideal state of a wetland

The scope for rehabilitation of drained wetlands in urban areas is very limited, and as such rehabilitation efforts are mostly focused on wetlands that were once used as farmlands but are now abandoned for cultivation, says wetland ecologist Dr Donovan Kotze (Research Fellow at the University of KwaZulu-Natal). Mostly, these wetlands would historically have been drained, and the artificial drainage channels are still present.

"This gives us the opportunity to reinstate the historic, pre-conversion wetland area while at the same time, a farmer does not have to forgo land," he says. Yet, due to a lack of historic data the original state of the wetland is not known with precision. "We need infer based on current indicators," says Dr Kotze.

Sometimes, historic aerial photographs can assists but often farming activities started before the earliest available photographs. We can infer, for example, that flow used to be spread through the wetland because the area doesn't have a natural channel, notes Dr Kotze. "Now, the farmer has dug what is usually a straight artificial channel, and we judge the effectiveness of rehabilitation in terms of how effectively we have blocked this."

"You can see if the interventions are obviously not working, but without before and after data it's quite difficult to measure your success conclusively," Dr Kotze explains further. This challenge forms the backbone of the monitoring efforts at Kamiesberg. "We will have at least a year's worth of data before rehabilitation starts."

There are three wetlands in the Kamiesberg that are forming the basis of the monitoring project, namely Xharas, Schaaprivier and Natpad.

Xharas is very much a system that naturally lacks a clearly defined channel. During wet seasons flow is spread out over the wetland. However, a large portion of the wetland has a straight, artificial drainage channel. The wetland was cultivated until five or ten years ago, but the farmer no longer intends to cultivate it anymore. Therefore, it presents the opportunity to plug the furrow and reinstate a naturally diffused flow. Because a portion of the wetland has not been drained, there is a reference site in addition to the data of the state of the wetland before and after interventions, that will be collected.

According to Nieuwoudt, "Xharas's structure will be built in a year, and we view this as the 'mother ship' for monitoring. We've already done the first level monitoring and the team is continuing with their monthly baseline data gathering. We will thus have a relatively good data set before implementation.

Natpad is similar to Xharas, but it currently has the added impact of very intensive grazing. The rehabilitation plan involves working closely with the livestock owner who has agreed that the area will be allowed to recover for the next few years. This wetland's structures will be built in two years but in the meantime they continuing with the gathering of baseline data there, explains Nieuwoudt.

There are a number of key impacts to address at Schaaprivier. Gully erosion in the wetland is eating its way into an area of intact, natural wetland. The purpose

Gully profiles are taken twice a year for every monitoring point during the dry season.

The team taking livestock counts. Afterwards, they discuss losses or new arrivals with the owner or herder and document the reasons.

National Wetlands Award

The Kamiesberg Working for Wetlands monitoring team's efforts have been so successful that they were recently nominated, together with CSA, in the category 'Wetland Education and Skills Development' at the 2014 National Wetlands Awards. Nieuwoudt says they will also aim for the 'Wetland Science and Research' category at this year's wetland awards due to the amount of baseline data that they have contributed to research.

Source: www.sanbi.org

of rehabilitation would be to halt that. Erosion in Schaaprivier wetland has been aggravated by increased surface runoff from the uplands that feed it, and rehabilitation efforts are focused on the causes of the erosion. "Some of the areas are well outside of the wetland and interventions are specifically designed to slow down and promote infiltration and vegetation cover," notes Dr Kotze. "It's not so much bringing back a wetland area, but rather the prevention of more degradation."

According to Nieuwoudt, Schaaprivier's structures are currently being finalised, so they should be able to make a comparison by 2016. Yet, she points out that the information will still be limited because they don't have a long data set.

The five remaining wetlands are mainly monitored for the impact of livestock in collaboration with CSA. While there is not a direct link to the rehabilitation work done by Working for Wetlands, two of the wetlands have been fenced off from the livestock in order to let the wetlands 'rest'. "Here we can pick up noticeable visual changes but we will need at least two years' data to verify this," says Nieuwoudt.

Monitoring the state of a wetland

The project's monitoring framework is divided into three levels. The top level is the most complicated and entails in-depth monitoring, and needs to be done by an experienced person or wetland ecologist. The second level is based on Wet-Health and can be done by a person with good knowledge. The third level is the base level. Laymen can be trained to do this work, and this is where the Kamiesberg ground-team fits in.

The project started out as a pilot over four months to test the viability of full implementation. A formal training programme was facilitated to equip the ground-team to implement a number of monitoring techniques.

"Some of the areas are well outside of the wetland and interventions are specifically designed to slow down and promote infiltration and vegetation cover. It's not so much bringing back a wetland area, but rather the prevention of more degradation."

Firstly, they are monitoring measuring wells, enabling them to document the rise and fall of the water table in the wetland. They take a measurement every two weeks to get a seasonal picture. "The challenge is that these systems are highly seasonal," says Dr Kotze. "Naturally it changes considerably across seasons and the ideal would be to have data over five or ten years."

Furthermore, rainfall is measured and fixed-point photos taken across the system, in part to monitor vegetation change.

Erosion is measured with the use of erosion profiles and erosion pins. The first allows for the profile of the valley floor to be drawn, by taking vertical measurements every 20 cm, from a fixed horizontal transect line. Over time, the profiles will indicate change in the landscape. Erosion pins, again, are used in areas where sheet erosion is expected and indicates if there is more or less soil.

In the Kamiesberg, the focus of the monitoring is not only on the immediate ecological outcomes of the rehabilitation interventions (like re-instating the water table of the wetland and halting the advance of erosion head-cuts) but also on the use of the wetland for livestock grazing. "We recognise that livestock is probably the principle current impact on the wetlands," says Dr Kotze.

It is agreed that in order for rehabilitation to be sustainable in the long term it must be very closely aligned with the continued use of the wetland for this purpose. As such, the team was also taught how to monitor livestock on the wetlands, particularly in close collaboration with CSA.

According to Dr Kotze, this is one of the aspects that highlight the holistic approach that the project is following.

"The ground-team is working really hard," adds Nieuwoudt, "and they are now monitoring eight wetlands and 43 stock posts monthly."

The top level monitoring is mostly done by Nieuwoudt and Kotze. They have set up 2 m x 2 m monitoring plots to survey vegetation at Xharas and Schaaprivier.

Dr Kotze says that they are interested in vegetation cover and species composition, as well as the functional groups that the species belong to. "For example, we are interested to see if there is a shift, and to what extent, from terrestrial annuals to wetland (hydric) perennials." Improved vegetation cover and composition would then be an indication of an improved soil saturation condition.

Implementation of data and final thoughts

Lessons learnt from the project could inform the development of a national programme to monitor and evaluate the ecological effectiveness of Working for Wetlands, says Nieuwoudt. In the meantime, the first monitoring team will also start in Ratelrivier close to the Agulhas National Park in the Western Cape at the end of February.

Yet, the exercise at Kamiesberg has not been without its challenges. It's a small team working with limited resources. This is a particular challenge when it comes to the top level monitoring, where expert knowledge is called for.

Dr Kotze notes that they are hoping that there are some individuals, part of the ground team, who can be trained to eventually do this. He adds that this is part of their vision – to give community members the opportunity to gain this expertise knowledge.

Another challenge is the intensive attention the monitoring calls for. The system is hugely dependent on the monitors, and cannot run by itself. For example, some "creative research" was called for when livestock decided that the poles planted for the gully profiles, which need to be fixed in the same position over time, are the ideal rubbing posts. "We're still on a learning curve" Dr Kotze admits.

Furthermore, it is a challenge to involve individuals with no scientific knowledge in the gathering off rigorous data, he says. "What we do hope to do is really look at what extent this model can be applied across the country." He admits that it could perhaps not be a model that can be applied everywhere, but that it is encouraging to see that the programme is opening up opportunities beyond the physical labour most often called for from EPWP beneficiaries.

Significantly, data from the programme is being fed into another research project (funded by the WRC) that will be looking at the long-term and short-term social and ecological outcomes of rehabilitation work.

Another big challenge that's so often overlooked is that the monitoring starts out and there are many good intentions, but after the initial data is collected it's not carried through to evaluation and reflection on management or rehabilitation. "In this project we've thought pretty hard about this and tried to coordinate implementation of the findings," says Kotze. He says they made sure that the data they are collecting feeds into the needs of the WRC research project.

A dipwell is installed, by first drilling a hole with an auger and sinking a dipwell into it for long-term monitoring of the water table.

Fixed point photography: Photos are taken in four wind directions, from the same point. Information on the specific point is indicated with the small, black board.

Climate change

Climate change will affect profitability of SA farms differently, says SU researcher

Climate change will affect the profit margins of farms throughout South Africa differently. Much depends on how rainfall, temperature and the subsequent need for irrigation change the yield and quality of the produce being farmed with in specific regions. So says agricultural economist Dr Hamman Oosthuizen, who used farms in Hoedspruit, Carolina, Moorreesburg and Vredendal as case studies for his doctoral research at Stellenbosch University. The study combines efforts of researchers from three South African universities.

Article by Engela Duvenage.

Dr Oosthuizen's research formed part of a Water Research Commission (WRC) project on "Adaptive interventions in agriculture to reduce vulnerability of different farming systems to climate change in South Africa' (WRC project number K5/1882//4). The research is co-funded by the Department of Agriculture, Forestry and Fisheries and investigates the impact of how climate change will impact agriculture, and assesses the vulnerability of crops, rangelands, farming households and enterprises. It also endeavours to identify and suggest appropriate adaptive techniques and practices to use in selected catchments and farming areas.

Dr Oosthuizen teamed up with climatologists and hydrologists from two South African universities to develop relevant data driven models on which to base his projections. His modelling study is one of the end results of a much broader initiative involving data and models from the Climate Systems Analysis Group (CSAG) from University of Cape Town (UCT) and the Centre for Water Resources Research at the University of KwaZulu-Natal (UKZN).

"It is a given that the agricultural sector is vulnerable to climate change, both physically and economically, as concluded by various studies, local and abroad," explains Dr Oosthuizen.

Dr Hamman Oosthuizen was one of the researchers on a WRC project aimed at understanding how climate change will impact agriculture.

Projects for the Hoedspruit area are that citrus farmers can expect their profits to shrink along with seasonal shifts in rainfall.

"We therefore set out to find out just how climate change will be influencing farming endeavours and profitability at farm level in certain areas of South Africa."

"The impact of such financial vulnerability goes beyond the farm gate, because many livelihoods in rural areas are dependent on the agricultural industry, by one way or the other," adds Dr Oosthuizen, whose findings have already been presented at international conferences in China, Mexico and Belgium. A paper detailing the Hoedspruit case study was published in the International Water Association's Water, Energy and Climate (WEC) conference proceedings.

Dr Oosthuizen believes the new integrated Crop Critical Climate Threshold (CCCT) modelling technique he developed can be applied to any agricultural production region in South Africa or elsewhere in Africa for which climate and hydrological models and accurate input data are available. It combines climatic, hydrological and economic models into an integrated climate change model that determines how climate change will influence the financial vulnerability of farming systems at farm level.

The four selected case study areas under investigation are largely representative of dryland and irrigation farming for both summer and winter rainfall regions in South Africa.

"It is a given that the agricultural sector is vulnerable to climate change, both physically and economically, as concluded by various studies, local and abroad. We therefore set out to find out just how climate change will be influencing farming endeavours and profitability at farm level in certain areas of South Africa."

Projections for the Hoedspruit area

Results from Dr Oosthuizen's assessment of the Hoedspruit area show that local mango and citrus farmers can expect their profits to shrink along with seasonal shifts in rainfall and an increase in average temperature. Farmers with high debt ratios will be more financially vulnerable than those with low debt levels.

Farmers might see quality losses and a reduced fruit set, while the need to irrigate will increase. Irrigation water comes mostly from the Blydepoort Dam where the water supply from the dam's catchment areas seems to be relatively assured.

"The erection of shade netting as an adaptation strategy will reduce financial vulnerability to climate change in the Hoedspruit area," is Dr Oosthuizen's advice. "The capital cost of these structures is, however, high and it may not be affordable to all farmers. In order for the investment to be economic viable and financially feasible, all aspects of management should be at a high level. Gradual implementation over a period of time will also contribute to the feasibility of implementing the shade netting adaptation strategy."

Farmers also need to effectively manage their irrigation systems and conserve soil water while cultivar breeding should focus to increase natural heat resistance."

Vredendal area

Vredendal in the Western Cape's winter rainfall area is a water stressed region where water supply is never certain. Based on Dr Oosthuizen's modelling results, farmers should prepare for a decrease in grape yield and an increase in the need to irrigate. Changing climates may require farmers to plant cultivars that are more tolerant towards projected climate change.

Shade nets may reduce the impact of climate change on yield and the quality of table grapes. Soil preparation and site selection for future plantings are crucial in order to ensure optimum production. Improved soil water management can improve profitability.

Moorreesburg areas

Dryland grain farming dominates the Moorreesburg area in the Western Cape's winter rainfall area. Pastures and small livestock are also kept to produce mutton and wool. No major changes in yield are expected for the intermediate future.

Dr Oosthuizen emphasizes that the models he used show that crop rotation and use of conservation agriculture techniques will enhance profitability and sustainability.

Carolina area

Dryland farming dominates the local agricultural endeavours around Carolina, in Mpumalanga's summer rainfall area. Maize, soybeans, sugar beans, mutton and beef production are the main enterprises.

The models show that local farmers can expect an increase in yield over the long term. This goes hand in hand with increased temperature and increased rainfall. Dr Oosthuizen warns that although all indicators point to increased profitability, the models he used cannot project extreme events such as floods or the impact of pests and diseases.

"It will do Carolina farmers good to follow a 'no regrets' strategy that involves crop rotation and conservation agricultural practices," he advises. "This will have a positive impact on profitability."

How was the research done?

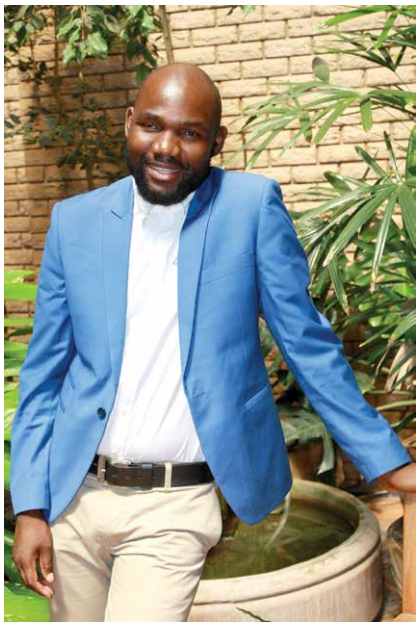
Dr Oosthuizen first based his crop yield modelling on climatic data sets made available by the Climate Systems Analysis Group (CSAG) of the University of Cape Town. These data sets were also used to project future dam levels, the availability of irrigation water and future crop irrigation requirements. During the modelling phase a new technique, the Crop Critical Climate Threshold (CCCT) technique, was developed to enable the researchers to model crop yield and quality under different climate sets.

Shade nets, such as these, may reduce the impact of climate change on yield and the quality of table grapes.

Water personality

Every child deserves to have hope and ambition

Young water professional, Nakampe Modike, has not only managed to overcome difficulties in his own life to have a successful career, he is also helping to create a new generation of young people working in the water sector. Lani van Vuuren spoke to him.



Nakampe Modike

Hailing from humble beginnings, 32-year-old Nakampe has achieved more than many men his age. Yet, when meeting this tall, shy, yet calmly confident young man, one could mistake him for just another young, up-and-coming water professional.

This would be grossly underestimating a man who is, through his non-profit organisation, African Hands for Youth, inspiring and leading a generation of young people who would otherwise have little to aspire to. Not only is he giving them back their hopes and dreams of an education and a career, he is turning these dreams into reality.

Young people from rural backgrounds, like himself. Nakampe grew up in Relela village, outside Tzaneen in rural Limpopo, in the house of his grandparents. Ambitious from an early age he realised that the only way to improve his circumstances was through education. "I wasn't a straight A student, but I was determined to learn wherever and whenever I could."

So much was his determination that he once attended four schools at the same time. "I would attend my local high school (Kgwe Kgwe High School) in the morning until 14h00, then join a study group from another school in the afternoons. When yet another high school offered extra classes I was there, and during the winter months I attending the winter school of a fourth high school," Nakampe explains.

But once he passed matric he didn't know where to go. Overhearing his old study friends talk about Pretoria, he decided that this was going to be his destination. His family managed to raise R500, and armed with a small bag of clothes, his matric certificate, his ID document and a 2 kg bucket of achar (a farewell gift from his mother) he boarded the bus to Pretoria – a city he had only heard of before then.

By chance, he ended up at the Tshwane University of Technology. Here he queued for days in order to obtain financial support from the National Student Financial Aid Scheme, often sleeping on the floor. He enrolled in the first course that accepted him – Water Care. To supplement his funding, he worked as a security guard in his spare time.

His first job was as an operator at a sewage treatment plant. His career took several turns from there, and today he works as an audit specialist: water treatment in the internal audit department of Rand Water, where he analyses the potential risks of Africa's largest water utility.

Is he happy that fate brought him to the water sector? "Working in the water sector is not a career it is a calling," says Nakampe. "In other sectors the goal is profit, but in the water sector the aim is so much more – adding to the quality of life of a person by providing regular access to good quality water. If you do not give your best you could be putting someone's health – even their life – in jeopardy. That is a great responsibility."

Now successful in his own life, the harrowing experience Nakampe had to undergo as a school leaver never left him. Just as they often lack access to basic services, such as water, sanitation and healthcare, South Africa's rural communities also suffer from a dearth of information, he notes. "I had no idea of the career options available to me,

and no guidance was offered in terms of applying to university or for a bursary or even what awaited me once I got onto that campus."

African Hands for Youth

Nakampe is determined to change this situation. Even as a student he started taking university applications and course brochures home to the learners at his old high school so that they would be better informed than he was. "I didn't want them to go through the same ordeal as I had." When he was a process controller at the wastewater treatment works in Roossenekal, in Limpopo, he gave tours to local school children of the works. It was also here that his passion for career guidance started.

This eventually led to the birth of African Hands for Youth. Initially, the focus was to provide learners with access to university and bursary applications forms, but later the organisation extended its services to share information on careers, water and sanitation with learners. The organisation works mainly in the Motupa and Modjadji educational Circuits Limpopo, however, repeated requests from other rural areas will see it expanding its reach this year to provinces such as North West and KwaZulu-Natal.

Learners are not only told about the career opportunities available to them, they are also assisted in making the right subject choice. When Nakampe found out that many learners were not choosing mathematics as a subject as they lacked access to math sets and calculators, he arranged sponsorship from the Rand Water Foundation. Other organisations, such as the Water Institute of Southern Africa, have assisted in providing water bottles so the learners can stay hydrated on the long walk to school.

Right tools for the job

Nakampe's paths first crossed with the Water Research Commission a few years ago. Since then, he has become one of the main beneficiaries of the Commission's educational materials, including the *Water Wheel* Water Kidz edition, water cycle posters, and the *Water@Work Career Guide*.

It is the career guide that has got Nakampe especially excited. "I have seen many career guides in my time, but none so comprehensive. The WRC's career guide includes everything, from which subjects to choose to study for a certain career to detailed information about bursaries and tertiary institutions, even FET colleges!"

> *"There is nothing that motivates a child like a student number."*

In 2014, it was through African Hands for Youth that the WRC launched its comic book, *The Thirsty Three*, at Morutsi Primary School, in Limpopo. Two thousand graphic novels, along with other education material, were distributed to the children that day.

Through their efforts, the organisation has reached more than 7 000 learners to date. Nakampe's organisation has been so successful that it has managed to raise not only school attendance but also the matric pass rate in the Motupa circuit from 47% to 68% in the last two years. The mathematics pass rate has increased from 21% in 2011 to 39% in 2013, while the physical sciences pass rate has increased from 29% to 46% during the same period. "There is nothing that motivates a child like a student number," says Nakampe. "Once the learners have been provided with assistance in applying for tertiary education they have something to work for."

Nakampe is particularly proud of the fact that five learners have now gone on to study various engineering and technical water degrees at university and universities of technology as a direct result of the intervention of African Hands of Youth. But the need for further support is significant. "These children are now earning the grades, and being accepted for further study, but obtaining the necessary funding for them to further their studies is difficult, as there is just not financial support for students to go around," notes Nakampe. Much of the funding comes from his own pocket, and he has even gone so far and taking a student into his own home.

Nakampe calls on particularly the water and engineering fraternities to invest in the capacity building of South Africa's scarce skills. "Imagine if these children can become engineers and technicians and go back to their communities – what a difference they would make."

African Hands for Youth has an ambitious vision. "We want to see the youth in rural schools having the same dreams and aspirations as their counterparts in urban areas. Why must they be left behind, just because they were born in a different part of South Africa?"

To find out more about African Hands for Youth's activities, visit their Facebook page, https://www.facebook.com/africanhands4youth?fref=ts, their web page, http://ah4youth.org.za or contact Nakampe Modike at Email: nakampe@ah4youth.org.za

Nakampe and his organisation, African Hands for Youth have reached over 7000 rural children to date.

Water KIDZ

A drop of water can save your life

Every year, people around the world celebrate World Water Day on 22 March. This year the theme is 'Water and Sustainable Development'.

Water is at the core of sustainable development. This means that we need to protect our water resources and manage them so that we can grow our cities and towns while making sure that we all have enough water to go around. But it is not just our factories and farmers that need water.

Water is also essential to human health. The human body can last weeks without food, but only days without water. This means that water is essential to our survival. Did you know that a mere 2% drop in our body's water supply can trigger signs of dehydration like fuzzy short-term memory, trouble with basic mathematics and difficulty focusing on smaller print? (Are you having trouble reading this? Drink up!)

As for the human body, on average it is made up of 50-65% water. Babies have the highest percentage of water – newborns are 78% water! Every day, every person needs access to safe water for drinking, cooking and personal hygiene. According to the World Health Organisation, every person needs at least seven-and-a-half litres of water every day to meet most of their requirements like drinking and washing.

Water is important to the mechanics of the human body. The body cannot work without it, just as a car cannot run without petrol and oil. In fact, all the cell and organ functions that make up our entire anatomy and physiology depend on water for their functioning.

Water serves as a lubricant in digestion and almost all other body processes. The water in our saliva helps facilitate chewing and swallowing, ensuring that food will slide easily down the oesophagus. Water also lubricates of joints and cartilages.

Water also keeps us healthy in other ways. By washing our hands regularly, for example, before eating and after going to the toilet, is one of the best ways to remove germs, avoid getting sick, and prevent the spread of germs to others. Up to one trillion germs can live in one gram of poop.

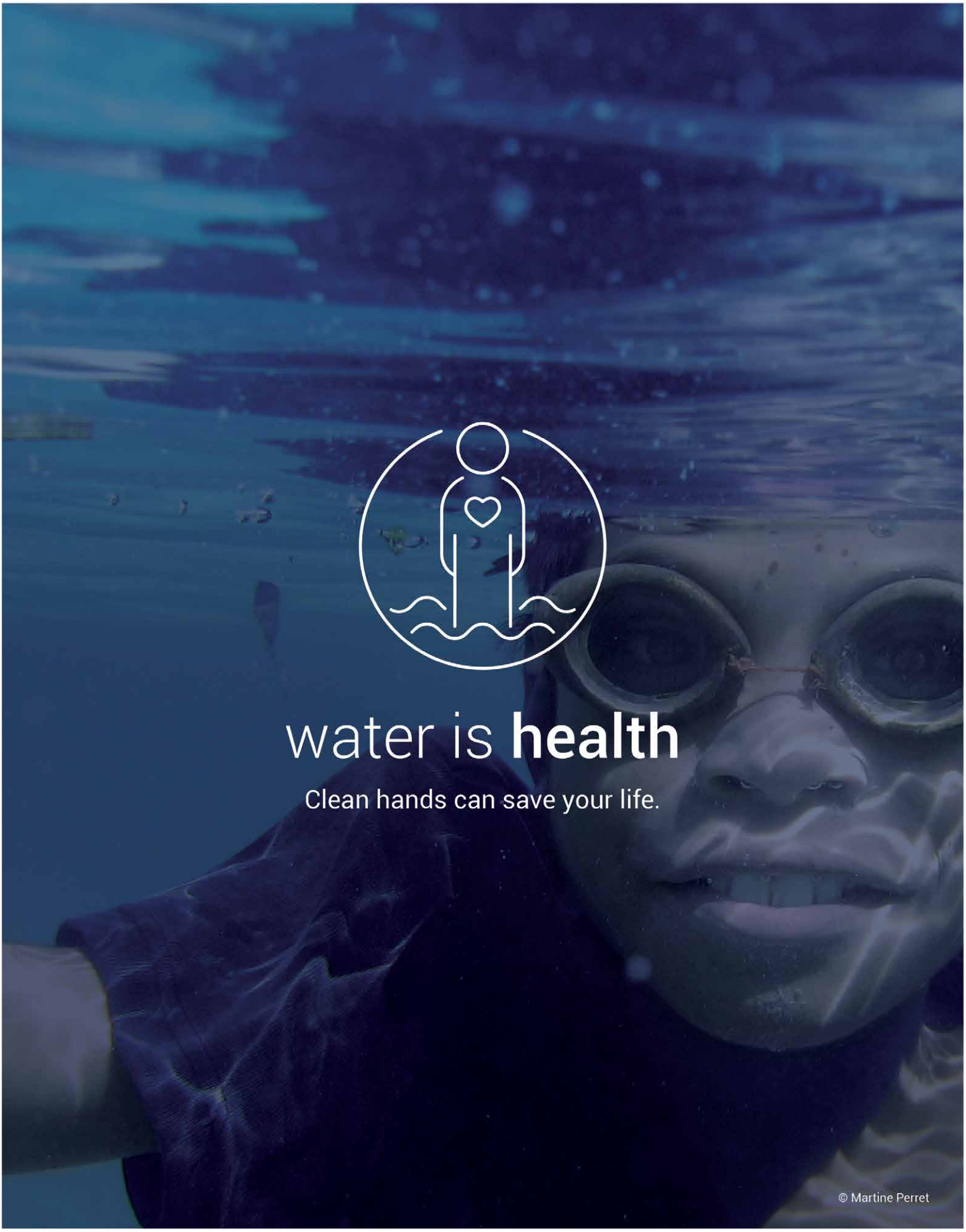
By washing our hands regularly we can reduce the number of people getting sick with diarrhoea in our families and communities by up to a third. We can also prevent a quarter of people getting sick with illnesses such as cold and flu. Handwashing also saves time and money – by not getting sick and spreading illness to others, you will spend more time in school and less time in the doctor's office (that will save your parents money too).

Lather, rinse, repeat – when should you wash your hands?

- After going to the bathroom
- After changing a baby's diapers
- After blowing or wiping your nose
- After covering your mouth/nose when you cough or sneeze
- After playing with your pets
- After touching burns, cuts or sores
- After handling dirty dishes or utensils
- After being around someone who is sick
- After taking out the garbage

Where can I learn more?

- To learn more about World Water Day, Visit: http://www.unwater.org/worldwaterday/
- Project WET has created a wonderful resource for teachers about the importance of water to health. Visit: http://projectwet.org/what-we-do/international/wash



UN WATER
22 MARCH
WORLD WATER DAY 2015
WATER AND SUSTAINABLE DEVELOPMENT

#WaterIs Health

New guidelines launched towards water-friendlier cities

In February more than a 100 delegates gathered in the heart of Sandton to share in the launch of two Water Research Commission (WRC) guidelines aimed at water sensitive urban design. Water sensitive urban design is defined as an approach towards urban planning and design that integrates land and water planning and management into urban design. This approach involves various disciplines of engineering, social, economic and environmental sciences, while recognising water as a scarce, finite and vulnerable resource. Special international keynote speaker, Prof Ana Deletic, of the Cooperative Research Centre for Water Sensitive Cities at Monash University, in Australia, explained some of the benefits of this approach, while Prof Neil Armitage, head of the Urban Water Management Department at the University of Cape Town officially launched the WRC reports. There was also a panel discussion with various speakers debating the benefits and challenges of implementing water-sensitive urban design in South Africa.

(All photographs by Lani van Vuuren)

Speakers at the event were Dr Inga Jacobs-Mata (WRC), Dhesigen Naidoo (WRC), Dr Valerie Naidoo (WRC), Prof Ana Deletic (Monash University), Prof Neil Armitage (University of Cape Town), Jane Eagle (Johannesburg Metro), Mercedes Mathebula (City of Tshwane), Sithole Mbanga (South Africa Cities Network), John Dini (South African National Biodiversity Institute).

Prof Neil Armitage of the University of the Cape Town with the two WRC guidelines on water sensitive design.

More than a 100 delegates from various disciplines and institutions attended the event.

Prof Ana Deletic of Monash University in Australia was the keynote speaker at the event.

wader

WATER TECHNOLOGIES DEMONSTRATION PROGRAMME

A KEYSTONE FOR WATER TECHNOLOGY INNOVATION

VISION

To bridge the gap between water research and the market to achieve a connected water innovation system that delivers socio-economic benefits for South Africa.

The WAter Technologies DEmonstration ProgRamme (WADER) aims to bridge the gap between the R&D and commercialisation stages of the water innovation continuum by moving technologies out of the laboratories and proving them in real-world, test situations.

By coordinating the demonstration of water technologies in operational environments, WADER aims to increase the adoption of appropriate technologies and enhance the water innovation value chain. High-level demonstrations will serve to assess the technical, social, economic, regulatory and environmental attributes of the technologies. Each technology demonstrator will entail multi-player collaborations and a strong technology transfer component i.e. the transfer of skills, knowledge, methodologies, etc. to academia, government, business and civil society.

WADER WILL

• Collaborate • Coordinate demonstrations • Inform • Connect stakeholders • Assess and showcase technologies

WADER WILL NOT

• Provide funding • Endorse technologies • Accredit/certify technologies, individuals and/or organisations • Generate standards • Commercialise technologies

science & technology
Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA

WATER RESEARCH COMMISSION

www.wader.org.za
Tel: +27 12 330 0340 | Tel: +27 12 330 9010 (direct)

A partnership between the Department of Science and Technology and the Water Research Commission

DEEPLY ROOTED IN SOUTH AFRICAN WATER SOCIETY

www.wrc.org.za

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

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

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

WATER RESEARCH COMMISSION

THE POWER OF KNOWLEDGE TO THE PEOPLE