THE WATER WHEEL

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New dam to bring relief to Lesotho residents

WATER RESEARCH COMMISSION

SASAQS 2014 CONFERENCE | 22-26 JUNE 2014

SOUTHERN AFRICAN SOCIETY OF AQUATIC SCIENTISTS

On behave of the Southern African Society of Aquatic Scientists; we invite you to attend the 2014 annual conference to be held in the Thaba Nchu district at the Black Mountain Leisure and Conference Hotel (BMH).

The 2014 conference theme is *Sharing and conserving SADC water systems* and will be hosted by the Department of Zoology and Entomology, University of the Free State and the Biodiversity Research Division: Department of Economic Development, Tourism and Environmental Affairs (FS DETEA).

ABSTRACT SUBMISSIONS

The deadline for submission of abstracts is on 3 March 2014, notification if abstract (paper/DDD*) has been accepted will be on 7 April 2014. Please submit abstracts electronically on www.easyabstract.com.

- Abstracts can be submitted for consideration either as oral or DDD presentations. Please adhere closely to the *Instructions to Authors* for conference abstracts.
- Oral presentations: 15 minutes, including few minutes for discussion.
- *Posters as **Digital Data Display**, with three minutes oral presentation. *See information below.*
- Please ensure that e-mail addresses as submitted are correct, as these addresses will be used in all correspondence and acceptance notifications.
- Maximum number of words: 250 for abstracts.
- Late submissions will not be considered

INSTRUCTIONS TO ALL AUTHORS FOR CONFERENCE ABSTRACTS

TITLE OF ABSTRACT, IN CAPITAL LETTERS
Name of author(s), underline presenter if more than one
Address of Author(s), Department, Institution, PO Box, City, Postal code, Country
Email address of corresponding author

All of the above must be centered, 1.5 spacing with no enters between each line with the required information. The abstract must follow after one space, entered. The abstract must have no more than 250 words.

New paragraphs must start on a new line, indented, with no extra spacing between the paragraphs. The font to use is Arial, 12 pt, 1.5 spacing apart. Please do not use references in the abstract. Please justify the text part of the abstract. The margin setting to use is the normal word format, do not adjust the margins to fit the abstract.

IMPORTANT DEADLINES

- Closing date for submission of abstracts: 3 March 2014
- Closing date for early bird registration: 30 April 2014
- Closing date for regular registration: 13 June 2014

DIGITAL DATA DISPLAY

In the past, a static display of printed media (posters) was part of the SASAQS conference, on display for the duration of the conference. For the 2014 conference however, the organizing committee would like to introduce Digital Data Display (eposters, but we prefer DDD's). This concept will allow for the research information to be presented in an electronic format, displayed on various strategically placed plasma screens. The digital data displays will run for the duration of the conference. Instead of information being crammed into a single poster, we urge participants to produce a visually stimulating version of their research consisting of five *power point slides*. The exact format to use in the preparation of the DDD's will be made clear in the second circular.

Besides the above mentioned, all of the DDD participants will be required to do a three-minute presentation, during the allocated sessions.

ROUND TABLE DISCUSSION

The committee decided that time must be allocated for Round Table Discussions. One session will be on *Alien invasion in South African Aquatic systems*.
Participants are invited to submit topics to be dealt with, in the second Round Table slot. Email Liesl van As with your suggestions, who will finalized it with the organizing committee. Vanasll@ufs.ac.za

PRELIMINARY PROGRAMME

Sunday 22 June 2014	
16h00	Registration
19h00-	Cocktail function (Meet & Greet)
Monday 23 June 2014	
8h00-8h30	Registration - Foyer BMH
8h30-10h30	Session 1
10h30-11h00	Tea/Coffee Break
11h00-13h00	Session 2
13h00-14h00	Lunch
14h00-16h00	Session 3
16h00-16h15	Short break
16h15-17h30	DDD presentation 1
19h00 BNH	Evening dinner
Tuesday 24 June 2014	
7h30-8h30	Registration - Foyer BMH
8h30-10h00	Session 4
10h00-10h30	Tea/Coffee Break
10h30-13h00	Round table discussion
13h00-14h00	Lunch
14h00-15h15	DDD presentation 2
15h15-15h30	Short break
15h30-17h30	Session 5
19h00 BMH	Evening dinner
Wednesday 25 June 2014	
8h00-8h30	Registration - Foyer BMH
8h30-10h00	Session 6
10h00-10h30	Tea/Coffee Break
10h30-13h00	Session 7
13h00-14h00	Lunch
14h00-16h00	Round Table Discussion
16h00-17h30	AGM
19h00-	Gala dinner
Thursday 26 June 2014	
8h30-10h00	Departure

REGISTRATION

All delegates are required to register online at www.savetcon.co.za

Registration includes:
Abstract book, Conference bag, Tea's/Coffee's, Lunches (3), Cocktail function (1), Dinners (3) and Gala event.

Registration Category	*Payment received before 30 April 2014	Payment received after 13 June 2014
SASAqS member	3500	
SASAqS Non-member	3800	
SASAqS Student member	2500	
SASAqS Student non-member	2800	
Day Registration		

TRADE EXHIBITORS

Interested companies should contact the Conference secretariat for more information and to book exhibition space.

ACCOMMODATION

Accommodation will be available at the Black Mountain Leisure and Conference Hotel
Standard Accommodation Bed & Breakfast: Single R 605.00/day
Standard Accommodation Bed & Breakfast : Sharing R 390.00/day

PLEASE MAKE BOOKINGS AT THE HOTEL
remember to state that it for the SASAQS 2014 conference.
TEL: 051 87 4200 FAX 086 750 3199
www.blackmountainhotel.co.za
EMAIL: conference@blackmountainhotel.co.za

CONFERENCE SECRETARIAT

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Sharing and conserving SADC water systems

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

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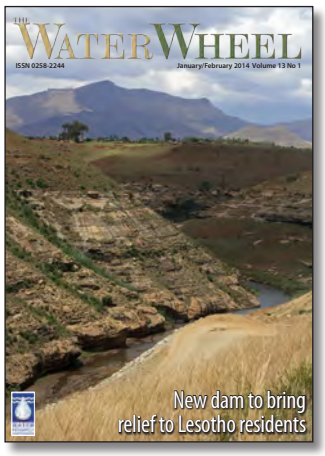


WRC CEO, Dhesigen Naidoo

2014
Twenty years of water research in a democratic South Africa

We herald in 2014, our twentieth anniversary of a free and democratic South Africa, with mixed feelings at the WRC.

We do for the first time for most of us without the Father of our Nation, and arguably one of the greatest human beings in human history, Tata Nelson Mandela, no longer with us. The sadness that continues to tug our heartstrings are however overwhelmed by the will he has stimulated in all of us to continue his life's work of vectoring our endeavours so that the net impact is to expand the frontiers of human dignity.

In those 20 years since 1994, the world has become a remarkably different place. The 1990s were characterised by a unipolar, US-led post-cold war world and a dramatically weakened Russian Federation. The only tangible economic threat to the US's fortunes was a steadily strengthening Euro on the back of a galvanised expanding European Union. There were speeches in UN platforms and other multilateral arenas of the possibility of the African Century characterising the first post-millennial hundred years, but they were generally accepted as part of an aspirational rhetoric of one of the world's forgotten regions.

The 2000s heralded dramatic shifts in the global political economy. The characterisations included:

- A global vulnerability to much more sophisticated terror attacks on the back of an increasing brittle roadmap for the Middle East.
- A global economic slowdown stimulated by tsunami of unsecured debt causing in the US initially, but eventually finding sympathetic, superimposing ripples in Europe and elsewhere.
- The significant rise of economies in the South, in particular China, India and Brazil leading both an economic growth wave and a concomitant shift in the global economic balance.
- Africa has emerged as the continent with the strongest average growth rate, albeit from a lower baseline, but continues to show the promise of sustainability in the growth even while the global recovery remains lukewarm at best.

South Africa has, in this time, been through a rollercoaster ride of divided experiences. The black euphoria of liberation in 1994 combined with the very cautious optimism among white folk was a cocktail that characterised the start of our fledgling democracy. Over time we experienced the galvanising of the South African 'rainbow nation' under the stewardship of Tata, former President Mandela.

In this time there were a series of factors that re-shaped the South African science and technology landscape. The first was the desire to craft a trajectory away from a predominantly resourced-based economy into a knowledge-based economy with significant diversification. The response to this objective was robust with the development of the Science and Technology White Paper following a comprehensive Research and Technology Foresight initiative. This culminated in the 2002 National R&D Strategy, which significantly reorganised and aligned the national science and technology landscape, brought substantive private and public investment into R&D and injected an important optimism into South African science.

The second development was the end of the Apartheid induced isolation. This has had a profound impact in many spheres, the most prominent being the rise of South Africa as a global player in the political and sports domains. We have also quietly made enormous strides in the science and technology arena. We see this as prominent in many ways – the hosting of the world's largest radio-telescope the Square Kilometre Array, the location of the International Centre for Genetic Engineering and Biotechnology in our country and South Africa's acknowledged contributions to big science like the Intergovernmental Panel on Climate Change.

On the research productivity front, A Pouris in his *South African Journal of Science* article 'Science in South Africa: the dawn of a renaissance' observed that between 2000 and 2010 SA's ranking in terms of ISI paper production rose from 35th to 33rd. This was the impact of moving from 3 617 papers published in 2000 to 7 468 papers in 2010. The South African water science community has performed with merit, with South Africa's ranking in water sciences rising to a high of 18th in the world in 2013 while contributing a phenomenal 1.61% of the global share of papers.

This sets a remarkable foundation to go forward. The WRC has developed a 2014 programme that will highlight the achievements of this water R&D community (including all stakeholders) over these 20 years of democracy, create platforms for a very candid critique of our collective performance to date, and of course set the stage to finetune our design going forward. This design will engage the concept of futures planning for water sciences, better mechanisms to ensure the use of scientific knowledge in planning and decision-making at all levels, and, elevating water sciences impact on socio-economic development. This will be our best tribute to the spirit of Madiba as we enable *Amandla Olwazi Kubantu* ('the power of knowledge to the people')!

Letters to the Editor

Reënwater wel lewensvatbaar vir huishoudings

In die *Water Wheel* van September/Oktober 2013 (volume 12 no 5) verskyn 'n artikel 'Rainwater harvest from tanks – Useful yes, but can you drink it?' waarin geskryf word oor die gebruik van reënwater vir huishoudelike gebruik.

Dit is 'n interessante artikel gebaseer op navorsing deur 'n span vanaf Stellenbosch Universiteit by die Kleinmond behuisingskema. Dit is ook veral interessant om te let op die terugvoer van die gebruik van reënwater deur die plaaslike inwoners. Tog skep dit 'n persepsie dat die gebruik van reënwater nie werklik lewensvatbaar is nie.

Ek is woonagtig op Cannon Rocks in die Oos Kaap. Beide Cannon Rocks en Boknesstrand kry hul munisipale water van ondergrondse bronne te Cannon Rocks. Die soutgehalte van die ondergrondse water word nadelig beïnvloed deur veral droogtes. Tans word die water vanaf die boorgate verwerk deur 'n tru-osmose proses.

Voor die inwerkingstelling van die tru-osmose werke, was die water direk gelewer aan beide dorpies vir huishoudelike gebruik. Weens die hoë soutgehalte van die water het die inwoners van beide Cannon Rocks en Boknesstrand hoofsaaklik gebruik gemaak van reënwater. Die gebruik van reënwater vir huishoudelike gebruik is steeds van toepassing by die inwoners.

Ons persoonlike huishouding, soos verreweg die meerderheid van die inwoners, word voorsien deur reënwater ten spyte van die gesuiwerde water deur die tru-osmose werke. Ek is bewus van enkele inwoners wat reeds vir etlike jare al hul munisipale watertoevoerkraan glad nie oopdraai nie. Die gemiddelde reënwater opgaarvermoë van huishuidings in Cannon Rocks en Boknesstrand wissel van 1 500 ℓ tot 2 000 ℓ.

Die persepsie wat die artikel by 'n leser laat, naamlik dat die gebruik van reënwater vir algehele huishuidelike gebruik, nie lewensvatbaar is nie, is na my mening dus nie korrek nie.

Bert Venter, Cannon Rocks

Water diary

Municipal water
January 23-24

The Water Institute of the University of Pretoria (UP) is hosting a knowledge-sharing workshop on the water resources of the City of Tshwane. The purpose of the workshop is to, among others, supply a detailed overview of the water resources of the municipality to a multidisciplinary audience, to showcase the status quo of UP-related water research pertaining to the metro, and to generate awareness and interest in the water resources of the municipality, with the aim of promoting cooperation in the protection and safe utilisation of these fundamental resources. *Enquiries: Matthys Dippenaar, Tel: (012) 420-3117; Email: madip@up.ac.za; Visit: www.up.ac.za/waterup.*

Water treatment
February 10-12

Stellenbosch University is offering a three-day course on water and wastewater treatment, with an introduction to re-use. The course will also look at the application of the theory in practise as well as legislation and operational aspects which should be considered. Presenters are drawn from government, universities, and consulting engineering companies. *Enquiries: Merentia Meyer, Tel: (021) 808-4352; Fax: (021) 808-4351; Email: merentia@sun.ac.za; Visit: www.eng.sun.ac.za*

Gender and water
February 19-21

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

Water loss
March 30 –April 2

The International Water Association Water (IWA) Loss 2014 Conference will be held in Vienna, Austria. This is the sixth event in a series of IWA water loss reduction speciality conferences, following on a successful conference held in the Philippines in 2012. *Enquiries: Conference Secretariat, Email: 2014committee@iwa-waterloss.org; Visit: www.iwa-waterloss.org/2014/cms/*

Civil engineering
April 6-8

The South African Institution of Civil Engineering (SAICE) with its industry partners is hosting the first Civilution Congress at Emperors Palace, Johannesburg. "Civilution is a new era for engineering professionals, motivating engineers of all disciplines to conduct business differently. It is also where engineers play the role of history makers, bringing about transformation, diversity, leadership and evolution in our local and global society and the betterment of the quality of life trough collaboration between communities and government," SAICE says. *Enquiries: Liza Monteiro (Conference secretariat), Tel: (011) 465-0334; Email: liza@confco.co.za; Visit: http://civilutioncongress.com*

Water, energy & climate
May 21-23

The IWA Water, Energy and Climate Conference 2014 will take place in Mexico City, Mexico with the theme 'Solutions for Future Water Security'. The conference is seen as an opportunity to bring together knowledge from across the globe to share experiences and information, enable collaboration and build new partnerships, discussion of cutting edge solutions to the world's water and energy issues, while also addressing approaches to sustainable and effective adaptation throughout the water sector.

Water innovation
May 25-29

The Water Institute of Southern Africa Biennial Conference & Exhibition will be held in Nelspruit. *Enquiries: Jaco Seaman; Tel: (011) 805-3537; Fax: (011) 315-1258; Email: events@wisa.org.za; Visit: www.wisa.org.za*

Aquatic science
June 22-26

The 2014 conference of the Southern African Society of Aquatic Scientists will be held in Thaba Nchu, Free State. *Enquiries: Petrie Vogel; Tel: (012) 346-0687; Fax: (012) 346-2929; Email: petrie@savetcon.co.za; or Visit: www.savetcon.co.za to register.*

Social Science
July 2015

The third World Social Science Forum is set to take place in Durban. The forum is a global event of the International Social Science Council that brings together researchers and stakeholders in international social science cooperation to address topical global issues and future priorities for international social science. The theme for this event is 'Transforming global relations for a just world'. *Visit: www.codesria.org/spip.php?article1674*

National recognition for Water Administration System

Water efficiency system, the Water Administration System (WAS), has been recognised by the Department of Water Affairs during its annual Water Conservation and Water Demand Management (WC/WDM) Sector Awards held in Gauteng earlier this year.

The system, developed by Dr Nico Benadé (pictured) with funding from the Water Research Commission (WRC) to assist irrigation schemes with efficient water management, was awarded the second place in the Agriculture category. Interestingly, the winner in this category was the Lower Olifants River Water User Association, which has successfully implemented WAS to achieve its WC/WDM targets.

WAS is a uniquely a South African integrated management tool for irrigation schemes that delivers water on demand through rivers, canal networks and pipelines. WAS is used for water distribution management and for the calculation of dam and canal operating procedures for a given downstream water demand.

Twelve years of research went into the development of the WAS program, with its main aim to minimise water losses on irrigation schemes. Field measurements have indicated water savings between 10% to 20% on implementing the water release module of the WAS program alone.

The program is currently used by all major irrigation schemes in South Africa, totalling about 148 411 ha. This includes 9 991 abstraction points, with a total water allocation of 1 206.5 million m^3.

"Effective water loss reduction can only be achieved through a comprehensive management system such as WAS," notes Dr Benadé. "All of the irrigation schemes using WAS have reported water savings. At the Loskop, Oranje Riet and Lower Olifants irrigation schemes, for example, the water-supply losses in the canal system have been reduced over a number of years to 20% per year. In general, water losses of 20% and below are considered extremely well for irrigation schemes", he notes.

Dr Gerhard Backeberg, Executive Manager for Water Utilisation in Agriculture at WRC comments: "Over the last 15 years the implementation of WAS on irrigation schemes has practically proven that real water savings through water loss control are achievable. The higher the losses the bigger the opportunities are for savings."

To read more about the impact of the WAS program read the report, *Research impact assessment of the Water Administration System* (**WRC Report No. TT 447/09**) available from Publications (Email: orders@wrc.org.za) or electronically from www.wrc.org.za.

Prominent experienced and young engineers awarded at SANCOLD conference

Both prominent experienced and young engineers were recognised at this year's conference of the South African National Committee on Large Dams (SANCOLD), held at Thaba'Nchu from 5 to 7 November, 2013.

More than 230 delegates attended this year's conference, which had the theme 'Technology for Water and Water Energy in southern Africa', including attendees from Kenya, Lesotho, Namibia and Swaziland.

The highlight of the conference was the presentation of the SANCOLD Award to two prominent dam engineers. The SANCOLD Award is made to prominent person(s) to acknowledge their exceptional contributions to the Committee and/or the dam industry in South Africa.

The first Award went to Dr Chris Oosthuizen (top photograph), a Specialist Engineer in Dam Safety Surveillance and Rehabilitation at the Department of Water Affairs (DWA). Dr Oosthuizen has been the Approved Professional Person for more than 150 DWA dams since 1986, and has been appointed as the dam safety expert for two arch dams in Switzerland since 2000. He is also involved in the monitoring of the dams of the Lesotho Highlands Water Project.

The second recipient of the SANCOLD Award was Mr Willie Croucamp (middle), which has 44 years of service with DWA. He has headed the Dam Safety Office since its inception to 2003. Mr Croucamp promoted the development of clear guidelines for use by Approved Professional Engineers in the execution of tasks defined in the legislation. He also officiated as assessor of the judicial enquiry on the deaths following the failure of two tailings dams in the late 1990s.

Further to the Award, SANCOLD has been encouraging the participation of young engineers in the organisation. As an incentive a prize was awarded to the best paper prepared and presented by a young engineer. This year's recipient was Mfundo Vezi (bottom), a student at the Department of Civil Engineering at the University of Cape Town. He received the award for his paper on 'Dynamic modelling of arch dams in the ambient state'.

Wetland society recognition for WRC

The South African Wetland Society has recognised the Water Research Commission (WRC) through its annual National Wetlands Awards in the 'wetland education and skills development' category for the funding and publication of the *WET-Management Series*.

The awards, sponsored by Mondi and held in October, recognises the outstanding contributions and achievements of those doing wetland work while showcasing successful or innovative work by the wetland sector to the public. Other recipients included Craig Cowden and Doug Woods in the 'wetland stewardship' category for successful wetland rehabilitation projects; Dr Heather Malan in the 'wetland science and research' category for a range of wetland research projects and related scientific publications. In addition, a special national award was bestowed on Deputy Minister of Water & Environmental Affairs, Rejoice Mabudafhasi for her efforts in furthering wetland conservation at the highest political levels.

The *WET-Management Series* of wetland rehabilitation tools were developed as part of a comprehensive nine-year research programme on wetland management initiated by the WRC and a range of partners in 2003. The programme examined wetland rehabilitation, wetland health and integrity as well as the sustainable use of wetlands. The series comprises a roadmap, two background documents, eight tools and an evaluation of the success of six individual projects.

New dam on the cards for KZN Hibiscus Coast

A new bulk water development scheme is being planned to relieve water-supply challenges in the Hibiscus Coast of KwaZulu-Natal. The area includes holiday towns such as Port Shepstone, Margate and Hibberdene.

Feasibility studies have been completed for the Ncwabeni off-channel storage dam to be constructed in a tributary of the Umzimkhulu River, with final design and tender completion expected by the end of this year. The dam will augment current supply from the Umzimkhulu Regional Water Supply Scheme, where water is abstracted directly from the river at St Helen's Rock and treated at the Bhobhoyi Water Treatment Works near Port Shepstone. From there the water is distributed to end users, mainly for domestic water-supply purposes.

According to Mari Trümpelmann from consulting engineering firm Aecom SA, the current river flow cannot meet requirements during dry periods, and there is currently no provision for the ecological Reserve. She was speaking at the 2013 conference of the South African National Committee on Large Dams, held at Thaba 'Nchu in the Free State. "Reconciliation studies undertaken over the last decade have confirmed that provision has to be made to maintain the Umzimkhulu River's current good ecological condition as well as to augment the non-regular water supply to Port Shepstone and surrounds."

The current run-of-river yield of the Umzimkhulu River at St Helen's Rock is about 18.3 million m^3/a without consideration of the ecological Reserve. This is already less than the coastal area's current water requirement of 18.5 million m^3/a. To compound the challenge, the regional water-supply scheme's supply area needs to be expanded to include areas that currently do not have an acceptable level of water supply or services. Increased water conservation/water demand management will have to be implemented to reduce the short-term deficit until the dam can deliver water in around 2018.

After various site studies, a site on the Ncwabeni River was settled upon. The off-channel dam was selected to maintain the ecological integrity of the Umzimkhulu River, which is currently one of the few remaining free-flowing rivers in South Africa. "Water from the proposed dam will augment the Umzimkhulu Regional Water Supply Scheme by around 30 million m^3/s, and meet the growing water requirements up to 2040," said Trümpelmann.

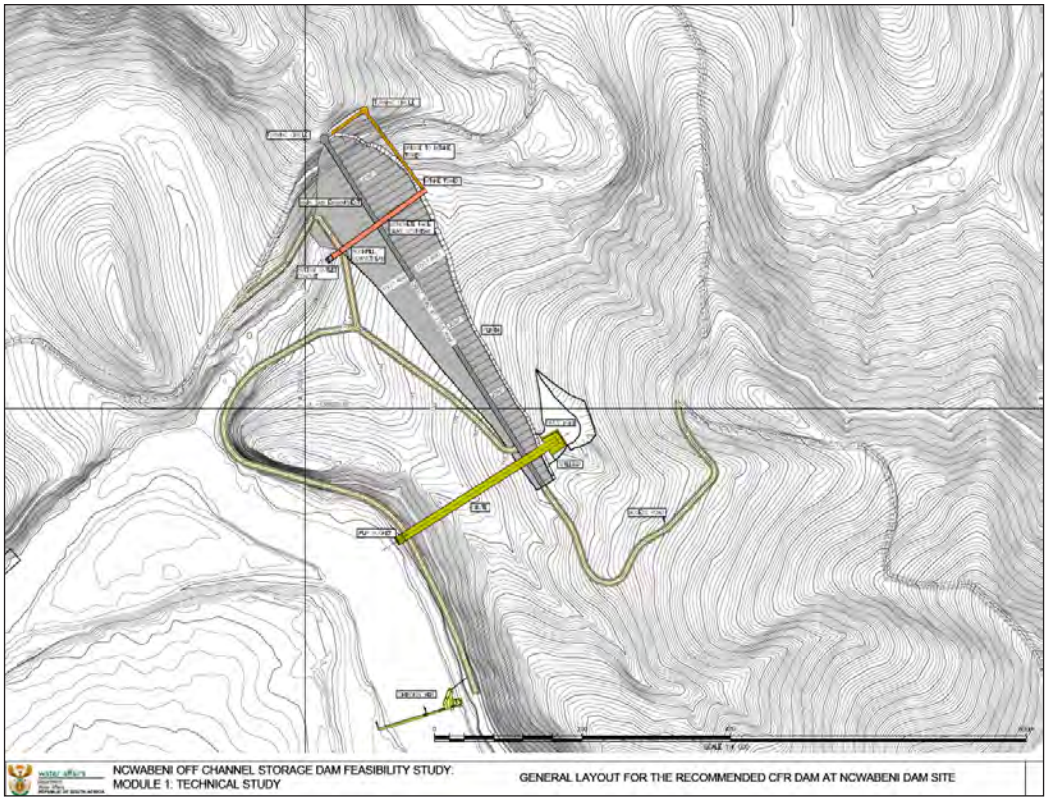
To achieve this yield a dam with a gross storage capacity of 15.5 million m^3 is required. The proposed concrete-faced rockfill dam will be 47 m high, with a side-channel spillway. In addition, a low-level diversion weir is planned to be constructed on the Umzimkhulu River to divert water to the abstraction works from where water will be pumped to fill the dam in the summer months when the flows are greater than the sum of the requirements of the regional water-supply scheme, lawful downstream users and the ecological Reserve. To minimise ecological disrupstions to the Umzimkhulu River, two fishways have been proposed.

Institutional arrangements and financial arrangements for the project are still being finalised. It is hoped to start construction of the new infrastructure by mid-2015.

Characteristics of the proposed Ncwabeni off-channel storage dam

Component	Characteristics
Dam type	Concrete-faced rockfill
Dam height	47 m
Storage capacity (gross)	15.5 million m^3
Spillway type	Side-channel with chute
Outlet	Intake tower with conduit through embankment
Abstraction works pumping rate	0.75 m^3/s

Source: Aecom



Aecom

The general layout of the proposed Ncwabeni off-channel storage dam.

Scientists strike gold in leaves

Eucalyptus trees in the Kalgoorlie region of Western Australia are drawing up gold particles from the earth via their root system and depositing it their leaves and branches.

Scientists from CSIRO made the discovery and have published their findings in the journal *Nature Communications*. "The eucalyptus acts as a hydraulic pump – its roots extend tens of metres into the ground and draw up water containing the gold. As the gold is likely to be toxic to the plant, it is moved to the leaves and branches where it can be released or shed to the ground," explained CSIRO geochemist, Dr Mel Lintern.

The discovery is unlikely to start an old-time gold rush as the 'nuggets' are about one-fifth the diameter of a human hair. However, it could provide a golden opportunity for mineral exploration, as the leaves or soil underneath the trees could indicate gold ore deposits buried up to tens of metres underground and under sediments that are up to 60 million years old.

"The leaves could be used in combination with other tools as a more cost effective and environmentally friendly exploration technique," said Dr Lintern. "By sampling and analysing vegetation for traces of minerals, we may get an idea of what's happening below the surface without the need to drill. It's a more targeted way of searching for minerals that reduces costs and impact on the environment. Eucalyptus trees are so common that this technique could be widely applied across Australia. It could also be used to find other metals such as zinc and copper."

Using CSIRO's Maia detector for x-ray elemental imaging at the Australian Synchrotron, the research team was able to locate and see the gold in the leaves. The Synchrotron produced images depicting the gold, which would otherwise have been untraceable.

Open windows and wash hands to help stop spread of flu, study shows

Families which more frequently ventilate living areas and wash their hands often are less likely to spread flu among one another, according to a study published by Tulane University School of Public Health and Tropical Medicine.

Flu viruses, such as the dreaded H1N1 or swine flu, are easily transferred through close contact, and contaminated hands can serve as vehicles of transmission, explained study leader Sun Wenjie. The study focused on living conditions and behaviour that can influence the spread of flu among members of a household. The researchers compared rates of flu transmission within 54 case households, in which there was a self-quarantined index patient (the first case identified within the group) as well as a secondary case, to disease transmission in 108 control households, each with a self-quarantined first patient and another family member in close contact.

Household density plays a significant role in spreading flu, concluded the researchers. Compared to close contacts living in a single room, the risk of infection of those sharing a room with the index patient was 3.29 times greater, according to the study.

New UNESCO water centre opens in Sweden

The first centre of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) focusing on transboundary water cooperation has been established in Sweden.

The centre will be run by the Stockholm International Water Institute (SIWI) in collaboration with Uppsala University and the University of Gothenburg. This is the 18th UNESCO centre focusing on water-related issues.

"The global population is growing. By 2050 we expect to be nine billion people. However, we are unable to increase the quantity of water resources available to us, noted SIWI CEO, Torgny Holmgren. "Consequently, it is important to ensure we create good cooperation mechanisms around water for the future, and especially in relation to transboundary waters."

Water by numbers

906 – The number of wetlands that have been rehabilitated by Working for Wetlands since 2002. The programme has invested R530-million to secure the health of more than 70 000 ha of wetland area, in the process providing 12 848 employment opportunities.

1818 – The number of arrests made by the Green Scorpions in the last financial year ending March 2013, according to a report released by the Department of Environmental Affairs late last year. The unit managed 70 convictions, with 993 admission of guilt fines paid.

100 – The average number of pupils that have to share a single toilet at over half the high schools in Tembisa, according to non-governmental organisation (NGO) Equal Education. *Mail & Guardian* reports that the NGO audited 11 of the 14 schools in the Johannesburg township, finding that in some schools there were no functioning toilets at all on some days.

270 – The number of full flush toilets installed in the township of Riemvasmaak in Lotus River, according to the City of Cape Town. This is in addition to the approximate 90 toilets that were installed in the area the previous financial year.

20 000 – The estimated number of farmers affected by the current drought in parts of the North West and Northern Cape provinces, parts of the Free State and Limpopo. According to *Beeld* newspaper the drought is one of the worst in South African history.

17% – The water supply deficit South Africa could face in 2030, according to the current supply-demand curve, the Department of Water Affairs reports. The department has launched a 'No Drop' assessment tool to municipalities to reduce water demand and water losses.

New from the WRC

Report No. 1788/1/12

Manual for the rapid ecological Reserve determination of inland wetlands (Version 2.0) (MW Rountree, HL Malan & BC Weston)

This manual provides the technical information (or references to the appropriate methods, where published) for the Rapid level of Reserve determination for wetlands of all types (excluding lakes).

Report No. 1802/1/13

Interaction between aquaculture and water quality in on-farm irrigation dams (K Salie; A Landsdell; N du Buisson; B Snyman; K Holm & L de Wet)

This study served as a second phase of investigations into the impact of fish farming on the water ecology of small farm dams. It was commissioned as a follow-up to the first phase of research in which the fitness-for-use of irrigation dams and canal systems for floating net cage aquaculture and the fitness-for-use of fish farming effluent for irrigation was evaluated. Both these investigations had a positive outcome in relation to the envisaged utilisation of farm dams for fish farming. The second phase encompassed continuing the monitoring and evaluation of a larger sample of Western Cape dams.

Report No. TT 558/13

Alternative technology for stormwater management: The South African guidelines for sustainable drainage systems (N Armitage; M Vice; L Fisher-Jeffes, K Winter; A Spiegel & J Dunstan)

Stormwater management in the urban areas of South Africa has, and continues to predominantly focus on collecting runoff and channelling it to the nearest watercourse. This means that stormwater drainage currently prioritises quantity (flow) management with little or no emphasis on the preservation of the environment. The result has been a significant impact on the environment through resulting erosion, siltation and pollution.

An alternative approach is to consider stormwater as part of the urban water cycle, a strategy increasingly known as water sensitive urban design (WSUD), with the stormwater management component known as sustainable drainage systems. This publication provides guidelines for the implementation of WSUD for both retrofit and greenfield scenarios. Also available as part of this series: *Alternative technology for stormwater management: Sustainable drainage systems – report and South African case studies* (**Report No. 1826/1/13**).

Report No. KV 318/13

Quantifying the impact of WRC-funded research in irrigation scheduling (JB Stevens & PS van Heerden)

The development, improvement and promotion of irrigation scheduling tools over the last four decades through WRC-funded research efforts have been impressive, but this report also highlights challenges to research and development that could have a profound effect on the priorities of WRC research policies and practice in future. This research highlights that the research knowledge will only lead to useful outcomes if emphasis is placed on development, and therefore the innovation process has to be purposefully managed with expertise, time, efforts and funds budget for both research and knowledge brokering.

Report No. 2025/1/13

Structural health monitoring of arch dams using dynamic and static measurements (P Moyo & C Oosthuizen)

The key objective of this project was to develop a holistic approach to structural safety assessment of concrete arch dams, while developing high level manpower in the field of dam safety. Two methodologies, the ambient vibration method (AVM) and the Westergaard method, which is the most commonly adopted approach for dynamic analysis of dams, were tested to establish their applicability in finite element model updating of arch dams based on ambient vibration testing. A significant finding is that the Westergaard method cannot be directly applied to dams with divergent and/or skewed reservoirs. Additionally, the effect of seasonal temperature variations on arch dams was modelled and the results show that it is critical to include temperature effects for dynamic analysis of arch dams. However once the initial thermal stresses have been introduced, the influence of seasonal temperature variations on dynamic characteristics is negligible.

Report No. 1927/1/13

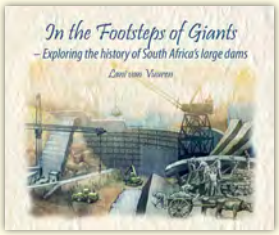
Identifying relationships between soil processes and biodiversity to improve restoration of riparian ecotones invaded by exotic acacias (S Jacobs; M Naude; E Slabbert; O Kambaj; M Fourie; K Esler; K Jacobs; B Mantlana; A Rozanov & D Cowan)

Little information is available on the impact of invasive *Acacia* species in fynbos riparian ecotones on ecosystem function as it pertains to nutrient cycling and soil processes, some of which are central to riparian ecosystem services. The main objective of this project was to investigate the impact of invasive *Acacia mearnsii* on nitrogen, carbon and phosphorous stocks and cycling, as well as its impact on the soil bacterial and fungal community structure within fynbos riparian ecotones and nearby upland areas.

Report No. 1697/1/13

An investigation into the effects of atmospheric deposition on surface water quality in the eastern regions of South Africa (S Lorentz; J Blight; N Snyman; C Bester; L Titshall; O Idowu; M Scholes; C Herold; Y Scorgie; G Kornelius)

The main aim of this preliminary work was to determine if emissions from fossil fuel burning on the Mpumalanga Highveld are likely to increase salinisation of surface water and degrade soil resources. The investigation left researchers with little doubt that the surface water quality in the Mpumalanga Highveld and adjacent areas is decreasing significantly, however, it is less certain that acid gases are the primary cause of this degradation, it was concluded.



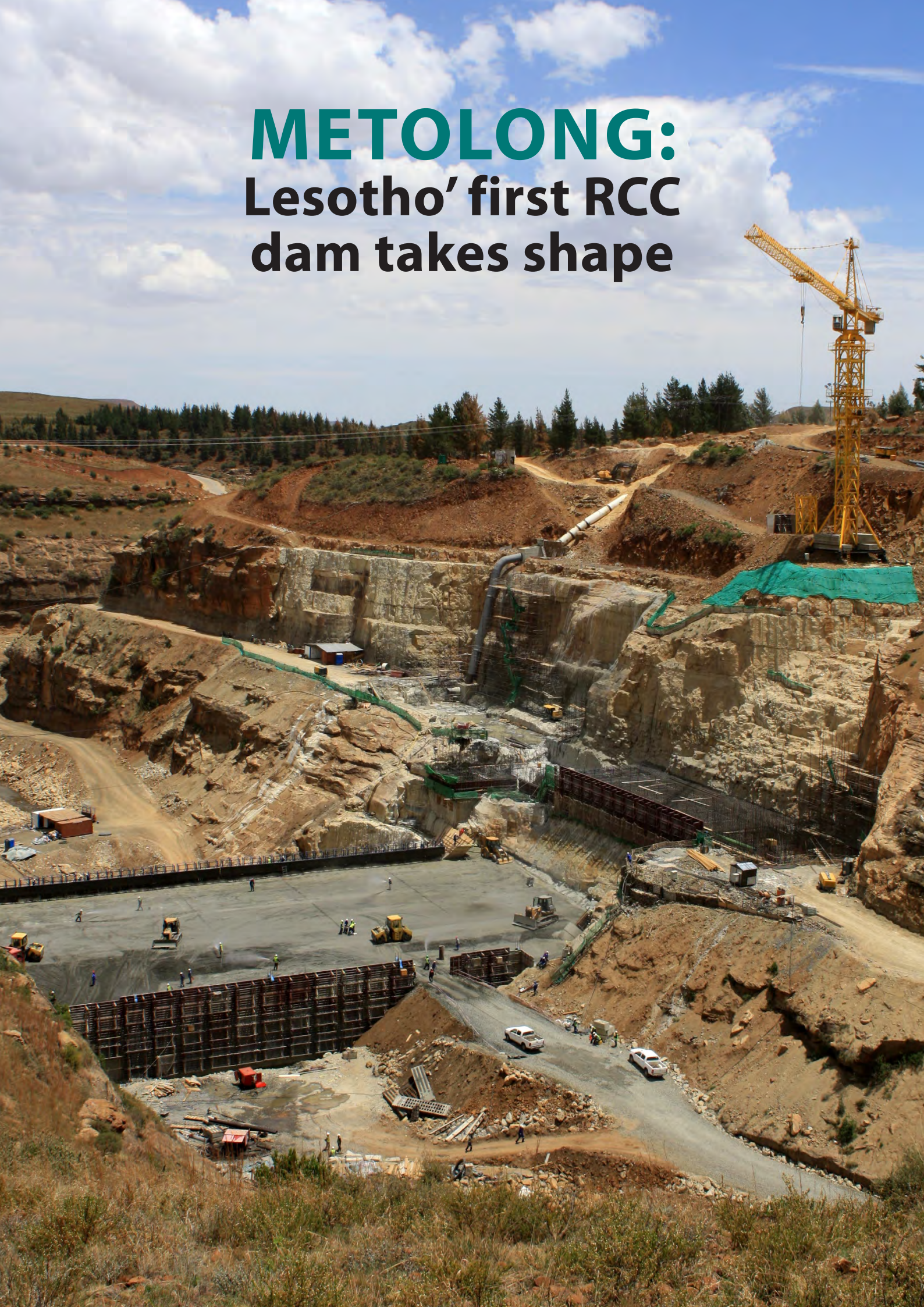
Book on dam history still available

The WRC still has a limited number of copies available of its coffee table book, *In the Footsteps of Giants – Exploring the History of South Africa's large dams*. Featuring 340 glossy pages filled with colour photographs and stories of the country's most iconic water resource development projects, the book takes the reader on a journey through the history of South Africa's largest dams, starting with the traditional attitudes and indigenous knowledge around water resources prior to European settlement and ending with a glimpse into the future of dam building in the country. *Footsteps* explores the reasoning behind the construction of the country's massive water storage structures, the laws that guided their development, and the people and institutions that made them possible. Woven in between are the tales behind some of the country's most iconic dams and dam engineers. This is the first time that such a publication has been on offer for a wider audience in South Africa.

The book is available from the WRC at a price of R150.

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

METOLONG:
Lesotho' first RCC dam takes shape



With Arab funders, South African consultants, a Chinese contractor and a Basotho workforce, the Metolong Dam, currently under construction in Lesotho, is the embodiment of how cosmopolitan water resource development has become. Lani van Vuuren visited the site.

When entering the Metolong Dam site, one is immediately struck by the bilingual signboard outside the gate advertising vacancies – one side English, the other Basotho. It is perhaps symbolic of the challenges of working on an international job site where different cultures – neither of whom speak hardly anything besides their mother tongue – have to work together to build a much needed dam for Lesotho.

Unlike the other large dams in the Mountain Kingdom this one will not be supplying water to South Africa. Lesotho's first roller compacted concrete (RCC) dam is meant to bring welcome relief to the capital of Maseru and surrounding villages of Roma, Mazenod, Morija and Teyateyaneng, which have been suffering severe water shortages in recent years due to rapid urban growth.

Recent studies have shown that current urbanisation rates in Lesotho lie around 5.5%. Moreover, the dynamics of rural water supplies are changing dramatically with the shift to urbanised neighbourhoods. Lesotho has also experienced a boom in export growth through light industries, particularly the textile and apparel sector, which has placed increasing pressure on existing water supplies.

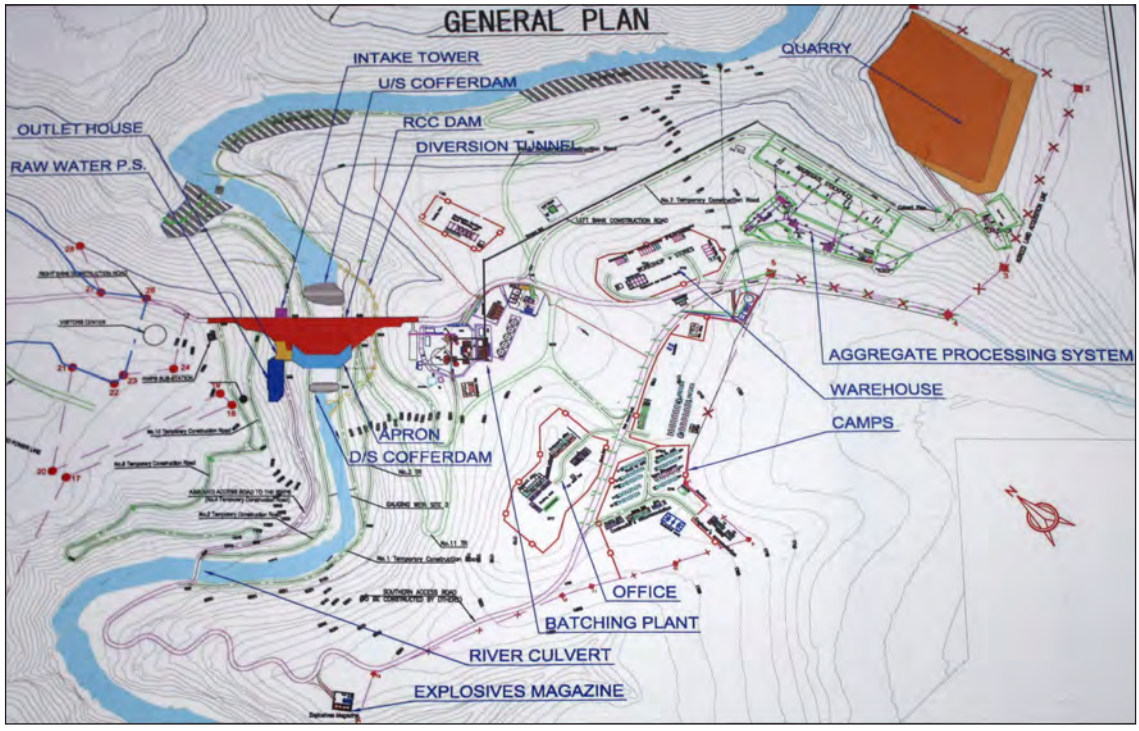
A DAM FOR LESOTHO

The Metolong and associated infrastructure forms part of a broader programme of donor support to improve water and sanitation supply in Lesotho. The dam is being constructed in the South Phuthiatsana River in the lowlands of western Lesotho, about 35 km from Maseru. The river is a tributary of the Caledon River, and sources its water in the highlands of Lesotho. The Metolong Dam and Water Supply Programme, as the project is known, comprises a dam and raw water pump station, associated water treatment works and conveyance systems to support domestic and industrial water supply.

The dam construction is funded by five Middle Eastern funders, namely the Saudi Fund for Development, Kuwait Fund for Arab Economic Development, Arab Bank for Economic Development in Africa, OPEC Fund for International Development and the Abu Dhabi Fund for Development. Additional funders of the larger programme include the South African government, the World Bank, the Millennium Challenge Corporation and the European Investment Bank. The Metolong Authority has been established by the Lesotho government to implement the project.

LOCATION AND DESIGN

South African consulting engineering firm GIBB has been appointed in joint venture with Consolidated Consultants for Engineering and Environment from Jordan to undertake the engineering



Sinohydro

Left: *An upstream view of the Metolong Dam, intake tower, outlet and pump station currently under construction.*

Right: *A general layout of the dam site.*

Lani van Vuuren

Lani van Vuuren

The aggregate processing system has a capacity of 400 t/h. On-site basalt rock is being used as concrete aggregate, while sand is crushed from the basalt stone due to the limited availability of natural sand sources.

A truck waits to be refilled with RCC. Metolong's two batching plants have a total rate capacity of 300 m³/h of RCC and 200 m³/h of conventional concrete.

services of the detailed design, preparation of tender documents for construction and construction supervision of the Metolong Dam. According to Johann Geringer, GIBB Chief Design Engineer: Heavy Engineering Sector, Metolong Dam is located in a deeply-incised gorge. The dam site and type was established during the feasibility study preceding the design stage. The site was determined at a location where it not only offered a sizeable storage capacity for a dam, but also offered a high-lying surrounding topography from where water can be supplied mostly by gravity with the minimum amount of pumping.

"The deep steep-sided gorge and the lack of suitable soils ruled out the possibility of considering embankment-type dams, which left a concrete dam as the only option for the site," Geringer explains. The latter is further enhanced by the presence of suitable concrete aggregate borrow areas being available both on and close to the dam site.

"Since it was important to supply water as early as possible from the dam, fast construction of the dam was a great consideration. This finally culminated in the decision to recommend the construction of a RCC dam."

Several studies were undertaken to optimise the location and design of the dam, including topographical surveys, seismic hazard analysis, hydrological studies, and water quality modelling, among others. Feasibility investigations also included detailed social and environmental studies to mitigate potential impacts of the dam.

Interestingly, a study was also undertaken to determine the potential impacts of climate change on the long-term dam yield of Metolong Dam. This study, undertaken by Jeffares & Green, found it 'highly unlikely' that the available long-term yield of the dam will decrease in the intermediate future (30 to 50 years from now). As a result no adaptation measures

will be required to account for the impacts of climate change on the yield of the dam.

Sedimentation has been found to be more of a threat to the long-term sustainability of the dam. The upstream catchment of the Phuthiatsana River is severely degraded, resulting in extensive erosion due to the high population density and high usage of land. At the time of writing the Lesotho government was investigating catchment management plans to reduce human impacts on the catchment.

Metolong Dam will ultimately be 83 m high with a crest length of 280 m, and a reservoir that can impound up to 63.7 million m^3. The dam will incorporate a 75 m-long, uncontrolled spillway in the central section. The dam has a non-overspill crest width of 7 m.

A popular design feature in South Africa for RCC dams (think of latter constructed dams such as De Hoop), Metolong will also feature a stepped downstream face, which will have a slope of 0.8:1 (H:V). The steps will be constructed 1.2 m high and 0.96 m in width, such that each step is constructed by placing four lifts of RCC each of compacted thickness of 300 mm. The steps on the ogee crest of the spillway will have smaller and varying dimensions to suit the curvature of the spillway cap. The spillway has been designed to pass a flood of 2 000 m^3/s.

Geringer explains that it was difficult to fit an uncontrolled central spillway in the dam that would have the desired discharge capacity within the constraints provided by the narrow gorge. "Various configurations were investigated and a hydraulic model study conducted at Stellenbosch University. The latter confirmed the design with best hydraulic performance to be one that comprises a 75 m-long spillway at the crest followed by a straight chute to finally end on a 20 m-wide flat apron with a width of 45 m and a length of 20 m."

With regards to outlet works, Metolong Dam will have a dry intake tower containing two independent outlet systems to ensure that there is a backup system in case one system is out of operation for either maintenance or failure of some components. The outlet system will comprise two independent 1 200 m-diameter vertical pipes. The intake tower will be situated on the right bank where the lowest intake will be below the 50-year silt level. Geringer notes that the valves of intakes will be sealed off once they become covered with sediment.

The dam design also includes a pump station with an initial pumping capacity of 1.2 m^3/s, to be located on the right bank. The pump station has been designed for five 0.6 m^3/s pumps with variable speed drive motors. For phase 1, three pumps will be installed with two being on duty and one on standby. From the pump station the water will be taken to the 75 Mℓ/day Metolong Water Treatment Works situated on the high ground above the gorge from where the water will be conveyed to Maseru and nearby villages.

DAM CONSTRUCTION

Chinese firm, Sinohydro, one of the contractors on the gigantic Yangtze Three Gorges Project, was appointed to construct the Metolong Dam and pump station in August, 2011. Unfortunately, several delays prevented site establishment to occur shortly thereafter, such as funding shortfalls, challenges in obtaining visas and work permits for the Chinese labour force as well as the contractor's unfamiliarity with local conditions and requirements.

Construction eventually started in 2012, with excavation work for the dam and diversion tunnel commencing in June of that year.

Safety signs dotted around the site remind visitors and employees to be vigilant and stay safe.

Lani van Vuuren

Lani van Vuuren

Above: *A closer view of the RCC laying process. The dam will eventually have a total concrete volume of around 315 000 m³ of which 280 00 m³ will be RCC.*

Below: *Several villages are located around the dam site.*

Excavations were used to remove the weathered and bladed basalt down to sound rock. Excavation in the bladed basalt at the top of the left abutment reportedly proved a difficult exercise to determine a suitable founding level, as the individual rock shards interlock to provide the appearance of a firm founding, but unravel upon the removal of a few interlocking rock shards.

This necessitated the application of shotcrete to the downstream portion of the left abutment excavation to provide stability, prevent fallout of the rock and to provide a safe working area. Once the sandstone horizon was reached, about 20 m to 30 m below the upper basalt, drill and blast methods were employed to excavate the harder intact sandstone rock.

River diversion was accomplished through a 244 m-long tunnel through the sandstone on the left bank. The tunnel will later be plugged with a permanent concrete plug that will prevent water from seeping through it once pressurised. Diversion was achieved in February 2013.

Lani van Vuuren

The contractor employs a single jaw crusher of 400 t/h capacity for aggregate crushing and screening. All drilling is limited to daylight hours in consideration of the three surrounding villages. Crushing and screening operations are, however, performed around the clock as this does not generate excessive noise pollution. Two batching plants, each with a capacity of 150 m³/h are also in use on site.

A major milestone was reached at the dam site on 5 August when the first RCC was placed into the dam foundation. By the end of that month 36 595 m³ of RCC had already been placed to a height of 10 m. At the time of writing, 83 557 m³ RCC had been placed using a fleet of 20 t dump trucks. Interestingly, in order to ensure that the wheels of the trucks were cleaned of contaminants prior to entering onto the freshly placed RCC layer works, a wheel washing station was established about 60 m upstream of the dam. Metolong will eventually have a concrete volume of around 315 000 m³ of which 268 000 m³ is anticipated to be RCC.

The contractor was confident that the halfway mark would be reached around year-end at the start of Lesotho's rainy season to enable impoundment to take place. According to Metolong Dam Coordinator, David Bosshart, it is critical to impound the reservoir during the current rainy season. "Lesotho has a distinct seven-month rainy season in which about 85% of annual rainfall occurs. If we miss this opportunity, there could be an additional seven-month delay waiting for the next rainy season."

In order to impound, the dam should be up about halfway (i.e. 40 m) to be above the intake/outlet pipes. In addition, the lower dam instrumentation, grouting and drainage systems need to be

operational. Workers are currently working in two 12-hour shifts, seven days a week to meet this target. Placing of RCC is routinely exceeding 1 000 m^3 per shift, with the best placing rate for a 24-hour period being 3 179 m^3.

CHALLENGE OF WORKING TOGETHER

Lesotho has a large unskilled and semi-skilled workforce, however, experience in dam construction is limited. Sourcing skilled construction personnel has therefore proved a challenge for the contractor, and on-site training of unskilled personnel has been required.

Unfortunately the problems with unions and labour strikes – now so prevalent in South Africa, have also occurred in Lesotho. In June 2012, the site was marred by violent strikes which left property destroyed and personnel injured. Order was only restored following the personal intervention by Lesotho authorities, and the Chinese Ambassador to Lesotho.

The Metolong Authority has since arranged for the establishment of a satellite site office, however, further unrest occurred in May 2013, which also saw work stoppages. "Although some issues of the labour dissatisfaction still remain to be resolved, the debilitating effect of prolonged strikes by the labour force appears to have been averted," notes Bosshart.

As with all international projects, differences in language and culture play an important part in effective communication. According to GIBB Resident Engineer, Michael Neumann, the site has its fair share of communication problems. "Many of the Chinese expatriates are not conversant in English, while the labour force predominantly speaks Sesotho. In order to bridge the language barrier, extensive use is made of sketches, annotated photographs, daily ad hoc meetings, or even literally taking relevant parties to site and demonstrating what is required."

It is hoped that the team can overcome their differences to complete this necessary infrastructure for Lesotho citizens. The project is expected to be completed in 2015. ❑

General characteristics of the Metolong Dam

Planned year of completion	2015
Purpose	Domestic, industrial
River	Phuthiatsana River
Type	Roller compacted concrete (RCC)
Storage capacity	63.7 million m^3
Wall height above lowest foundation	83 m
Crest length	280 m
Material content of dam wall	315 000 m^3 of which 268 000 m^3 RCC
Type of spillway	Uncontrolled, stepped

Source: GIBB

One of the access roads that have been constructed to the dam site.

Lani van Vuuren

THERE'S SOMETHING IN THE WATER – Research highlights dangers of pollution to irrigation

Chris Kirchhoff/Mediaclubsouthafrica.com

The effects of South Africa's burgeoning population growth, relentless urbanisation and continuous growth of informal settlements, are leaving its mark on two of our most basic needs: water and food. Coupled with concurrent pressure on facilities such as housing and sewage works, a sobering picture has emerged of what increased developmental pressures has put into our water, and is getting on to what we eat as a result. Petro Kotzé investigates.

A recently completed Water Research Commission (WRC)-funded study found conclusively that the quality of the water in some of our rivers used for irrigation are of an unacceptably standard and do not meet World Health Organisation (international) and Department of Water Affairs (national) guidelines for safe irrigation. The study confirmed that pathogenic (bacterial and viral) infestation in certain locations, in particular downstream of informal settlements, is transferred on to the surfaces of irrigated fresh produce on-farm. Some have described this as the potential development of a "bio-chemical time-bomb" in our rivers.

The study has attracted widespread reaction and calls for serious pause to reflect on the situation. "The findings of the WRC on water quality and food safety that were recently released are of great

concern," said Agri SA president Johannes Möller in a release after the results were made public. "The report confirms the organisation's suspicions that river water used for irrigation purposes does not in all instances meet the standards set by the WHO for food safety. Bacterial and viral pollution derived from untreated sewage, in particular, poses a health risk for consumers of vegetables and deciduous fruit irrigated with polluted water."

The national study was led by food scientist Prof Trevor Britz and colleagues from Stellenbosch University, the University of Pretoria, the University of KwaZulu-Natal and the University of Venda. Co-funded by the Department of Agriculture, Forestry and Fisheries and the WRC, the five-year project was launched in 2007 amidst growing concern that South African river water no longer meets exports standards for fresh produce set by the European Union, nor the health standards of local authorities or the WHO.

The main objective of the research was to investigate which bacterial and viral contaminants are found in polluted irrigation water sources. Further, the goal was to highlight their potential risks and carry-over potential to crops cultivated using such water sources. It was argued that this should give an indication whether faecally contaminated water used for irrigation of fresh produce can potentially lead to disease outbreaks.

The national study included rivers such as the Eerste, Plankenbrug, Mosselbank and the Berg Rivers in the Western Cape, the Baynespruit River in KwaZulu-Natal, the Mutshedzi River in Limpopo, the irrigation canal from Loskop Dam and the Olifants and Wilge Rivers in Mpumalanga, Skeerpoort, Moses and Klip Rivers in North West. These rivers are regularly used to irrigate agricultural produce.

"The results of the national study clearly show how unacceptable the standard of many of our rivers are," says Prof Britz. "There is a high risk of exposure to human pathogens when water from the studied rivers is used to irrigate produce that is consumed raw or without any further processing steps."

WHAT DID RESEARCHERS FIND IN THE WATER?

While the quality of the water was not really surprising, the types of organisms that researchers found in it were, says Prof Britz. While they were expecting high concentrations of faecal microorganisms, the occurrence of enteric viruses was unexpected.

Microbial results showed high concentrations of faecal microorganisms with concentrations reaching 10 000 000 cells, which indicate unsanitary conditions. This is ten thousand times higher than the allowed, safe levels set by the WHO and DWA. In particular, the *E. coli* concentrations in most cases exceeded the maximum acceptable guidelines of the WHO and DWA.

Other potential pathogens including *Staphylococcus* (which can lead to food poisoning), *Klebsiella* (respiratory infections), *Listeria* (listeria infections) and *Salmonella* (food poisoning, diarrhoea or kidney failure), intestinal *Enterococcus*, faecal coliforms, commensal and diarrhoeagenic *E. coli*, diarrhoea causing viruses (NoV GI and GII, and HAV), *Cryptosporidium* oocysts (vomiting, diarrhea, abdominal cramps) and *Giardia* cysts were also measured

"There is a high risk of exposure to human pathogens when water from the studied rivers is used to irrigate produce that is consumed raw or without any further processing steps."

Stellenbosch University

Top left: *Tshepo Kikine, a post-graduate student and team member of the WRC project, sampling the Plankenbrug River at Stellenbosch.*

Bottom left: *Nicola Huisamen, a post-graduate student and team member of the WRC project, sampling the Mosselbank River to determine the pollution level.*

Chris Kirchhoff/Mediaclubsouthafrica.com

Eating minimially processed produce, such as those bought at roadside stalls, can pose a risk to consumers.

in many of the rivers. One or more such enteric virus was found in 18% of river water samples and 9% of irrigation canal samples.

From the results it is evident that many of the bacterial, protozoan and virus strains detected in the irrigation water are of clinical importance as they show relatedness to species associated with gastroenteritis in South Africa and other regions of the world. The detection of closely-related strains worldwide is of public health concern as they may be disseminated through a common vehicle such as the international food market.

In the research it was further shown that direct water to produce linkages could be made. It was concluded that species from the surface of produce were present as a result of transfer from the contaminated irrigation water. There can now be no doubt that specific carry-over does take place. The potential of pathogenic organisms being transferred from irrigation water to the surface of fresh produce plus their ability to survive in these unfavourable conditions presents the scenario where consumers unknowingly face a high risk of being infected with harmful organisms when consuming fresh produce.

The study also showed that pathogens like *Listeria monocytogenes* if present in irrigation water will rapidly attach within 30 minutes to fresh produce, and will remain viable for several days. This attachment and survival varies from one vegetable to another. The study also confirmed that chlorine washing is effective in removing up to 3 logs of surface *L. monocytogenes* on spinach and tomatoes but shows very little effectiveness against subsurface *L. monocytogenes*.

Stellenbosch University

A fresh produce sampling site where water from the Berg River is used for irrigation.

Yet, it is important to note that the study also confirmed that there are adequate post-harvest cleaning procedures in place to ensure that these harmful species does not make it to the shop shelf. In other words, if you buy your produce from a reputable retail outlet, you stand little chance of coming in harm's way.

Dr Gerhard Backeberg (WRC Executive Manager: Water Utilisation in Agriculture) also points out that the study did not prove that produce that is exported and sold is a health risk. More results also showed that contamination could also take place after the food has left the farm, during the harvesting, processing and packaging steps.

Yet, while this might put some veggie-lovers at peace, there is still a very real danger of infection for some.

SO, WHO IS AT RISK?

Those at the highest risk of being affected by waterborne diseases are communities that drink water directly from the river without any treatment, and those that use the water for recreation, washing and irrigation methods. In the latter case, eating minimally processed produce, like those bought at roadstalls or other informal retail outlets poses the highest risk. Any potential waterborne diseases are also likely to have the most detrimental effect on those whose immune systems are already weak, says Prof Britz, such as people suffering from HIV/AIDS.

Among those that face the biggest risk are those that live in the very informal settlements that have been fingered as one of the biggest sources of the contamination.

According to the study, one of the major sources of faecal pollution of natural water courses are the many un-serviced informal settlements that have been established near rivers in the last two decades as the process

of urbanisation of poverty stricken rural people gather momentum.

The study continues to say that the other major contributor to the dangerously high levels of pollution in many of the rivers in South Africa is the failing sewage disposal systems of a large number of villages, towns and cities. These systems in total leak huge amounts of raw sewage into the rivers, either from inadequate sanitation in low-income housing areas or from poor maintenance of sewage reticulation systems and inadequate wastewater treatment works.

However, while the situation may seem dire, it is not without solutions.

THE NEXT STEP

While prevention of river and irrigation water pollution is the ultimate solution, cost-effective treatment techniques for irrigation water are needed in the interim. Conventional treatment methods (such as stabilisation ponds, storage reservoirs and slow-sand filtration, among others) have been shown to be effective, but the inclusion and/or use of increasingly cost-effective technologies might exhibit potential.

Treatment options will have to take into consideration the volumes of water to be treated, the range of microbial loads and the efficacy of the treatment technique of different microbes found in the irrigation water, as well as the practicalities, maintenance and operating costs and capital expenses.

A number of follow-up research studies have been launched following the publication of the study results, looking at on-farm, strategies that can be implemented to ensure the safety of fresh produce. The WRC is currently funding two related studies.

According to Dr Backeberg, the first study is investigating different methods that farmers can use to treat their irrigation water on-farm. Different options, including physical treatment through the use of sand filters, chemical treatment and ultraviolet treatment, are being investigated. He says ultraviolet and the combination with filtration systems seems particularly promising.

In turn, the second study is investigating the chain of potential pathogen transmission one step further – from irrigation to fresh produce processing to retail.

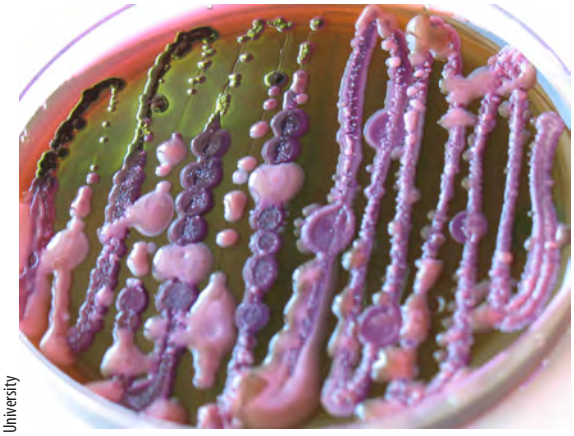
Prof Britz is also involved in another study with the National Research Foundation (NRF) to look at the alteration of the harmful species themselves, and in the process looking for potential solutions from another angle.

Yet overall, "prevention is better than cure," says Prof Britz, who maintains that one of the major solutions is to stop the pollution at source and, he adds, it is everybody's responsibility. Not only must the municipalities help to fix failing sewerage systems, but people must be educated on both how to prevent the situation, and prevent disease through contamination.

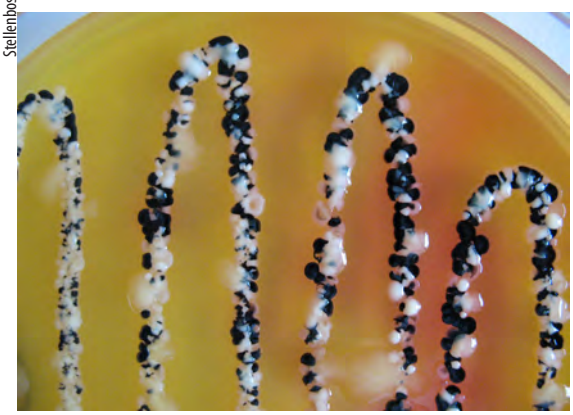
Dr Backeberg reiterates this, saying that the source of the pollution must be fixed at municipal and housing level. This effort must include a combination of governmental departments, such as health, water, agriculture and housing. "The study results have emphasised that everyone must work together," he says.

Dr Backeberg adds that the producers must also be educated and made aware of the problem. "Know where your irrigation water is from," he cautions. Furthermore, he recommends that the best is for commercial farmers to rather not use irrigation methods where the water comes in direct contact with the produce.

When commenting on the research result, Dhesigen Naidoo, CEO of the WRC writes that "We have a collective responsibility to defuse the ticking time-bomb, and the science is also saying that we have the technological solutions at our disposal. The key that starts this engine is the political will at local, provincial and national levels of government."



Stellenbosch University



Chris Kirchhoff/Mediaclubsouthafrica.com

Top: *A kaleidoscope of different bacteria present in faecally polluted river water.*

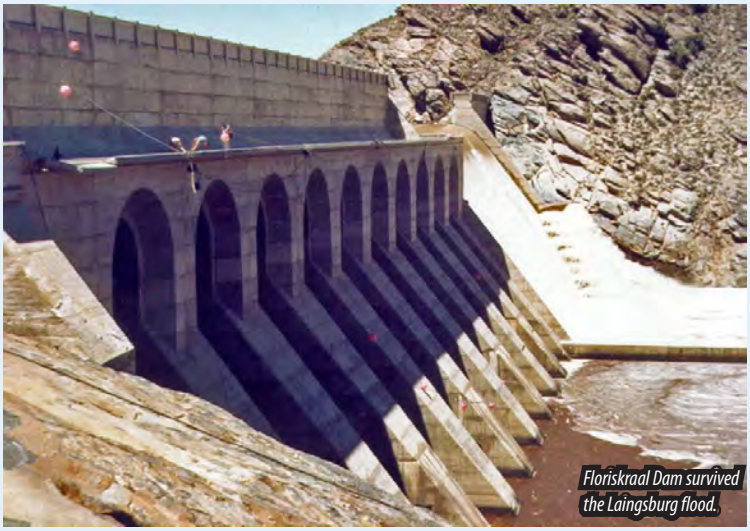
Above: *The black colonies show the presence of* Salmonella *while the white colonies indicate the presence of* Enterobacter *on studied fresh produce samples.*

Left: *The WRC study confirmed that standard post-harvest cleaning procedures ensures that harmful species do not make it to the shop shelf.*

- To access the report, *Quantitative investigation into the link between irrigation water quality and food safety* (**WRC Report No. 1773/1/12 (Volume 1), 1773/2/12 (Volume 2), 1773/3/12 (Volume 3)** or **1773/4/12 (Volume 4)**) contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy. ❑

A WALK DOWN MEMORY LANE:

Remembering the golden years of dam building



Floriskraal Dam survived the Laingsburg flood.

Courtesy Will Alexander

When the young Will Alexander joined the then Irrigation Department in 1950 after completing his engineering degree at the University of the Witwatersrand and serving in the Second World War (WWII) he probably never dreamed that he would be part of the 'golden years' of water resource development in South Africa. The Water Wheel received the following personal account of his first two decades in the water sector, dedicated to former fellow engineer, Robbie Myburgh.

Immediately after WWII, the authorities embarked on a substantial infrastructure development programme, particularly in water supplies, rail and road. Many of the construction staff at all levels were ex-servicemen. As a result, we had a fundamentally different view on life, and our responsibilities.

I returned home from 'Up North' in February 1945, resumed my studies at Witwatersrand University, graduated in 1949, married the girl next door in January 1950, and joined the Department of Irrigation (now Water Affairs) in February. After ten days in the office I was entitled to be transferred as Assistant Engineer to Rooikrans Dam near King William's Town, in the Eastern Cape. For the next 20 years my wife and I were like nomads as we moved from one construction site to another while raising our family.

When we arrived at the site we were treated like members of the family. Back then, each construction site was like a village of temporary houses occupied by the employees and their families. There was also a much greater emphasis on the social aspects. Each site had a tennis court paved with material from the local ant heaps, a jukskei field and, most importantly, a recreation hall. Recreation activities included weekly 'bioscopes' (cinema shows) and monthly recreation activities when funds were collected for the big Christmas party where presents were distributed to all the children. Each activity had a small committee. Staff ranks played no part in these activities. All funds were subject to departmental audit procedures.

ROOIKRANS DAM

The Resident Engineer at Rooikrans Dam was 'Jumbo' Downes – an ex-boxer with cauliflower ears and previously Lieutenant in the 22 Field Park Company, which was our sister company during the war. The dam was a large earth dam that would supply water to King William's Town and the neighbouring Zwelitsha.

My colleague, Anton Wejtko, was in charge of the materials used in the construction of the dam. During WWII he fled from Poland when it was invaded by the Germans and later served in the Polish army in the UK. He had a strong sense of humour. He was later in charge of the department's soils laboratory in Pretoria.

Colin Stegman later took over from Downes, and was more formal in his approach. He did not like the idea of having to walk to my office every time he had something to discuss with me, so he instructed the mechanical foreman to put a bell in my office so that he could ring me. The only bell was one of those huge red fire alarm bells. I stuffed some paper into the bell so that it buzzed instead of clanging. One day the bell did not work. Colin stormed into my office, saw the paper stuffing, and demanded "What is that for?" I told him that the sound of the bell was enough to awaken the dead. His immediate response was "That was exactly what it was intended to do!"

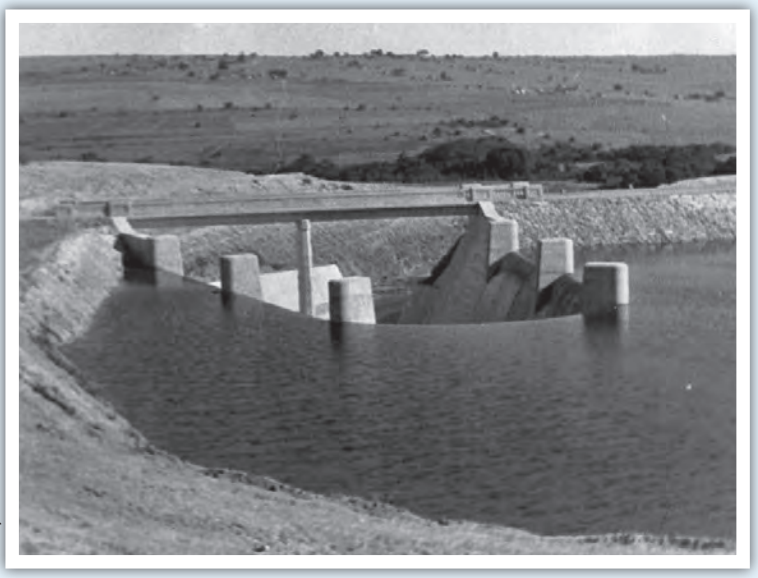
CAPE MIDLANDS CIRCLE

When Rooikrans Dam neared completion I was transferred to the Circle Office in Cradock where Duncan Campbell was the Circle Engineer. At that time soil erosion was rampant in the Cape Midlands. Lake Arthur, which was one of the four major dams in the region, had already silted up, and was in the process of being replaced by another dam further upstream. Large areas were purchased by the State, and taken out of production. The Department of Agriculture designed, constructed and subsidised anti-soil erosion measures while my responsibility in the Circle Office was to design subsidised farm dams and water-supply schemes for irrigation and town water supplies.

In those years civil engineers were fewer in numbers, and of necessity we were jacks of all trades. Where solution methods were not available we had to develop them ourselves. Both the soil conservation works, as well as spillways for farm dams required estimates of design floods for small catchments. These, in turn, required estimates of the short duration rainfall-frequency relationships. I produced maps of the Eastern Cape, which included curves showing corresponding short duration rainfall. It was now possible to determine design rainfall for any position on the map.

The next step was the development of calculation methods for the solution of the rational method as well as the associated Bransby Williams formula for calculating the time of concentration. Slide rulers were too cumbersome for calculations involving powers of numbers, so I developed nomographs for the solution of both equations.

The only instruments required for design flood determination were a school ruler and a pencil. It seemed obvious to me that the runoff coefficient C in the rational method should vary with the return period. It was only much later in my career that I found out that this preceded its use in overseas applications by some ten years.



Courtesy Will Alexander

Side-channel spillway at Rooikrans Dam.

That was in 1954, but somebody higher in the chain of command in the department noticed!

HEAD OFFICE

After three years in Cradock I was transferred to head office in Pretoria under Director, Jan Jordaan. My task was to check and approve for subsidies large municipal water supply and distribution projects. For the only time in my long career I was thoroughly bored, and welcomed my transfer back to construction 18 months later. I was appointed as Assistant Engineer at Floriskraal Dam near Laingsburg. I boarded the train for Laingsburg happily.

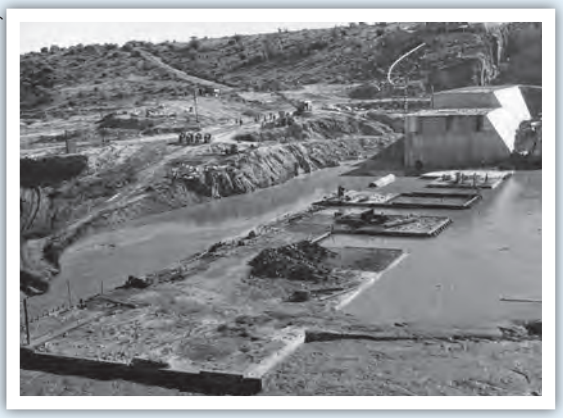
FLORISKRAAL DAM

Morris Selibowitz whom I was to replace met me at the station, and congratulated me. The Resident Engineer had just resigned and I was to take over from him. For the next six months I was the only engineer on the site.

Floriskraal was a large concrete gravity-buttress dam with ten large steel floodgates at riverbed level to reduce the rate of sediment deposition in the dam basin. The construction of the dam was well underway. The senior construction staff were all old hands, some of them had been in

Courtesy Will Alexander

Construction of floodgates at Floriskraal Dam.



Courtesy Will Alexander

Top: *Leeuw Gamka Dam nearing completion.*

Above: *The Erfenis coffer dam overtopped during a flood.*

the department since the Depression years of the 1930s.

My main duties were those of the Assistant Engineer – surveying and setting out, rather than the managerial functions of the Resident Engineer. My first managerial decision was when the earth coffer dam protecting the construction of the downstream apron was overtopped by a minor flood (for the sixth time I was told). I decided to replace it with a crude concrete structure filled and shuttered with large stone 'plums'. It worked because we had no floods after that, and we had some difficulty in breaking it up using explosives when the apron was completed.

The rock used for the coarse aggregate was the local tillite which, when crashed, broke into sharp, elongated fragments. The local sand was also of poor quality. The concrete was volume-batched. All the material was transported to the mixers in cocopans, where Jonas regulated the water added to each batch. The mixed concrete was poured down a zigzag series of chutes to awaiting cocopans below, which were then pushed to the box being filled, where it was compacted by pneumatic vibrators.

I reported that we were having difficulty in meeting the cube strength requirements. Dr Kaplan of the CSIR was sent to visit us, and recommended that we switch to weigh-batching methods, but I preferred to continue relying on Jonas' judgement. In 1981, 25 years later, the dam was put to the test when floods ocurred at Laingsburg. Murphy was very active that day, and everything went wrong that could have gone wrong, but the dam survived any other damage.

The ten floodgates at riverbed level had never been opened since the opening ceremony at the dam. In fact, the dam had only filled on one occasion since then. The flood destroyed most of the town of Laingsburg some 20 km upstream of the dam where more than 100 lives were lost. One of the worst flood disasters in SA history.

The water bailiff was in his boat rescuing people who had been washed into the dam. The flood overtopped the saddle dam and destroyed the power lines from the generator to the gates, which were never opened. The water level continued to rise until it reached a level 4,5 m above the design high flood level, and 2,5 m above the top of the concrete parapets of the non-overspill section of the dam.

The only damage was to the parapets. Jonas must be given a lot of credit for the success. The lesson to be learnt is that practical experience often outweighs technological expertise.

LEEUW GAMKA DAM

As the construction of Floriskraal Dam drew to a close, I transferred the whole organisation to the Leeuw Gamka Dam site near Beaufort West where we were to build a moderately sized earth wall dam upstream of the older dam built by animal drawn equipment in 1918. Before construction could start I had to select the site for the construction camp, plan the township layout, build access roads, houses and works buildings, and install water and electricity supplies and toilet systems.

My Assistant Engineer was Dennis Tidswell. The medical orderly was responsible for treating everything from children's ailments to construction injuries.

The construction of the dam was straightforward and proceeded without incident. There were no instructions or guidelines for optimum excavation and placing of the material, so I bought, studied and applied the procedures in the thick handbook titled '*Moving the earth*'.

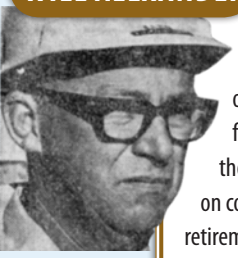
ERFENIS DAM

A year later I was transferred to the construction of Erfenis Dam near Theunissen in the Free State. It was the third-largest dam in South Africa at that time. The local sand was too fine for conventional concrete, and in an innovative solution Chief Design Engineer, Robbie Myburgh, decided to use mortar intrusion concrete. This would be the largest concrete structure using this method anywhere in the world as far as we knew.

The 3,3 m-high boxes were filled with large diameter quarry run crushed stone. The mortar was mixed at the mixer stations and then pumped through long pipelines into the boxes. No artificial cooling was attempted as the stones were in contact with one another and shrinkage was not considered to be a problem.

The method also highlighted some interesting information on the setting properties of cement. Problems were experienced with cement that exhibited a false set soon after mixing. The cement also contained steel 'cylpebs' that were the remnants of large pieces of steel used in the manufacturing process. These wreaked havoc with the high-speed mixing and pumping

MORE ABOUT WILL ALEXANDER



Will Alexander served with the Department of Water Affairs for 34 years from 1950 to 1984. For 19 of those years he was in the field on construction. From 1970 to his retirement in 1984, Will occupied the posts of Chief of the Division of Hydrology and Manager of Scientific Services in the department. He was personally responsible for national water resource management and flood routing during regional droughts and floods. Close to 100 technical reports were printed by the government printer during this period. He also initiated the popular 'Hydro' courses for practitioners starting in 1975. From 1985 to 2000 Will was a professor in the Department of Civil Engineering at the University of Pretoria. From 2000 he has been undertaking research on advanced water resource analyses and the climate change issue.

equipment. The cement manufacturers were cooperative, and both problems were solved.

GAMTOOS CANALS

On the completion of Erfenis Dam I moved to the construction team to Patensie in the Gamtoos River valley near Humansdorp. My colleague Dale Hobbs – also an ex-serviceman – was in charge of the construction of Kouga Dam, while I was in charge of the water distribution project in the Gamtoos Valley down to the Loerie Dam that was to be built as an additional water supply to Port Elizabeth.

William Phillips, son of the famous missionary, built the first tunnel in South Africa at Hankey in 1841. We were soon to follow in his footsteps. I realised that tunnelling through the soft Enon Conglomerate was a more economical option than the originally proposed benched


HERALD
GRIM FLOOD TOLL
Mass drownings in Gamtoos Valley
Dinghy used in Grahamstown rescue
COPTERS GRAB 184 FROM ROOFTOPS

The news headlines during the Gamtoos floods.

canals around the steep side slops.

A sad experience was when a major flood occurred and I ordered the construction teams on the far side of the river to return to the camp across the low-level causeway. One truck with a number of labourers on board ran off the causeway and overturned. Six labourers were drowned in front of my eyes.

ORANGE FISH TUNNEL

We soon picked up speed in the construction of the canals, tunnels and pipelines and had already passed the halfway mark when I was appointed as Departmental Resident Engineer in overall charge of the construction of the 82 km-long Orange Fish Tunnel beneath the continental divide as part of the huge Orange River Project (ORP).

With a few key staff members I set up a small camp on the banks of the Orange River. We were the first to arrive on the site of the ORP, which at that time consisted of two major dams (Gariep and Van der Kloof) and the Orange Fish Tunnel, which was the least visible but the most costly component. Robbie designed both dams and refused to allow the consulting engineers to redesign them.

The possibility of diverting water from the Orange River into the Fish River valley and then into the Sundays River was first proposed in 1928. Contractually, I was in charge of the project. I had spent the previous ten years in the field on large construction projects, and I had more knowledge on all aspects of hydraulic tunnels than the consulting engineers. I was not prepared to accept a passive role of the client's representative on site, and insisted that I be consulted on all implementation aspects.

This caused some strained relationships, particularly with the overseas component of the consortium of consulting engineers. They protested to the Minister but my actions were supported by the Minister and the head of the department. Still, it was not a satisfactory arrangement.

The construction of the tunnel was well on the way to completion and there were few remaining issues that required my intervention when I was transferred on promotion to the Planning Division in Pretoria in 1969.

I thoroughly enjoyed my 34 years in the service of the department, more than half of which were in the field of construction. ❑

DWA

Courtesy Will Alexander

Left: *The Orange Fish Tunnel during excavations.*

Below: *The Alexander children grew up on dam construction schemes.*

OUR FOOD AND AGRICULTURE IN NUMBERS

(DATA REFER TO THE MOST RECENT YEAR AND TO THE WORLD, UNLESS OTHERWISE SPECIFIED.)

POULTRY BIRDS MAKE UP OVER 80% OF ALL LIVESTOCK

AROUND 20 BILLION CHICKENS IN THE WORLD

1.4 BILLION CATTLE IN THE WORLD

CATTLE AND BUFFALOES MAKE UP 6% OF ALL LIVESTOCK

156 MILLION TONNES OF FISH PRODUCED

AQUACULTURE PROVIDES 48% OF FISH FOR HUMAN FOOD

56% OF CHICKENS LIVE IN ASIA

7 BILLION EGGS LAID

THERE ARE OVER 1 BILLION SHEEP IN THE WORLD

SHEEP AND GOATS MAKE UP 7% OF THE WORLD'S LIVESTOCK

4.4 MILLION FISHING VESSELS IN THE WORLD

60% OF FISH TRADE ORIGINATES FROM DEVELOPING COUNTRIES

AGRICULTURE EMITS 5 BILLION TONNES OF CO2 EVERY YEAR

AGRICULTURE AND FORESTRY ACCOUNT FOR 2% OF TOTAL ENERGY USED

80% OF WORLD CULTIVATED AREA IS RAINFED

ANNUAL WATER WITHDRAWAL MORE THAN 3,800 KM^3/YEAR

12% OF THE WORLD'S LAND AREA USED FOR CROP PRODUCTION

38% OF THE WORLD'S LAND USED FOR AGRICULTURE

37 MILLION HECTARES UNDER ORGANIC

FUEL WOOD

70% OF WORLD WATER

2.5% OF THE WORLD'S

22% OF TOTAL AREA

VEGETABLES

AGRICULTURAL
MANAGEMENT WORLDWIDE

SUPPLIES 10%
OF GLOBAL ENERGY NEEDS

WITHDRAWAL IS USED
FOR AGRICULTURE

WATER IS
FRESHWATER

HARVESTED USED FOR
COARSE GRAINS

COVER 1% OF
THE WORLD'S TOTAL
AGRICULTURAL AREA

340 MILLION FEWER
UNDERNOURISHED
BY 2015 TO MEET
WORLD FOOD
SUMMIT TARGET

PREVALENCE OF
UNDERNOURISHMENT
DECREASED
17%
SINCE 1990-92

30%
OF LAND AREA
COVERED BY
FORESTS

ANNUAL
FOREST
LOSS OF
0.11%

GLOBAL EXPORTS OF COFFEE,
TEA, COCOA AND SPICES
ALMOST TRIPLED
BETWEEN 2000-2010

IN 2013 GLOBAL FOOD
IMPORT BILL IS SET TO REACH
1.09 TRILLION US$

MORE THAN
840
MILLION
PEOPLE ARE
UNDERNOURISHED

FISH PROVIDES
17%
OF ANIMAL PROTEIN
INTAKE PER PERSON

400 MILLION TONNES
OF PAPER
CONSUMED ANNUALLY

50% OF PAPER
PRODUCED ANNUALLY
IS RECYCLED

WORLD
IMPORTS OF
WHEAT
AMOUNT TO
147
MILLION TONNES

WORLD PRODUCTION VALUE
OF AGRICULTURE
3.269.457
MILLION US$

RICE
IS THE PRIMARY STAPLE
FOR OVER 1/2
THE WORLD'S POPULATION

147 KG
AVERAGE ANNUAL
FOOD SUPPLY
PER PERSON

368
MILLION TONNES
OF POTATOES
WERE GROWN

69
MILLION TONNES
OF ORANGES
WERE HARVESTED

1 IN 3
PEOPLE WORK
IN AGRICULTURE
WORLDWIDE

SMALLHOLDERS
PRODUCE
80%
OF FOOD CONSUMED
IN DEVELOPING COUNTRIES

MEAT
AVAILABILITY IS
42 KG
PER CAPITA PER YEAR

23.5 KG
SUGAR AND
SWEETENERS
CONSUMED PER
PERSON PER YEAR

107
MILLION TONNES
OF BANANAS
WERE HARVESTED

2.5
BILLION TONNES
OF CEREALS
PRODUCED

60%
OF CHILD
LABOURERS
WORK IN
AGRICULTURE

49.5%
OF THE WORLD
LIVE IN RURAL
AREAS

FAOSTAT.FAO.ORG

Improved groundwater monitoring through GRACE

As part of a project funded by the Water Research Commission (WRC), the Gateway Wellfield at Hermanus was used to test a novel method of groundwater monitoring, using a global positioning system (GPS) to measure minute movements in the land surface above aquifers. Sue Matthews reports.

Umvoto Africa

Dr Chris Hartnady of Umvoto Africa discusses technical details of the cGPS monitoring station at one of the Gateway boreholes with Purdue University's Prof Eric Calais.

SANSA

The TrigNet beacon at the Hermanus Magnetic Observatory .

The project, 'Development and application of Global Navigational Satellite Systems (GNSS) methodology for groundwater resource assessment', was initiated by Umvoto Africa in 2008 as a collaborative study with the then Chief Directorate: Surveys and Mapping (CDSM, now National Geo-spatial Information), Hermanus Magnetic Observatory (HMO, now SANSA Space Science), and the Department of Earth and Atmospheric Sciences at Purdue University in Indiana, USA.

Continuously operating GPS (cGPS) stations were installed at three boreholes in the wellfield with the aim of quantifying any vertical and horizontal surface deformations associated with groundwater abstraction and seasonal rainfall, which would recharge the aquifer. TrigNet, the CDSM's array of permanent cGPS stations distributed throughout the country, was used as the reference system, with the beacon at the HMO serving as the base station.

Dr Chris Hartnady, Research and Technical Director at Umvoto Africa, reports that the project did not yield conclusive results, probably due to a number of unforeseen circumstances. "The project was opportunistic in the sense that we had a wellfield that had just started and was about to go through a testing phase, so we thought it would be a good opportunity to try the technology there. In retrospect – hindsight being the perfect science – it wasn't a good place to do it, mainly because the Gateway Wellfield is so close to the ocean. The potential for saline intrusion with over-pumping meant that we couldn't draw down enough to have a big impact."

"Secondly, we had to retrofit our geodetic monuments onto existing plinths at the boreholes, and although we tried to stabilise them as best we could, there was a noise factor, given that they had not been designed and integrated into the plinths during their construction. There are all kinds of things at the boreholes that could potentially influence them," Dr Hartnady explains.

"Another factor was that initially our idea was to set up our GPS monitoring system during the testing phase of the wellfield and stage various experiments, starting up pumping and then shutting it down at particular times so we could really hone in on responses. What complicated the whole issue was a drought, because in early 2010 Hermanus had reached crisis stage, and was going to be out of water by April, long before the winter rains came. Suddenly there was going to be no testing phase – the wellfield just had to go into production – and we hadn't even fully set up the monitoring stations yet! And of course we then had no experimental control at all over pumping."

Something else that could not possibly have been anticipated to have an effect on the project was the Haiti earthquake. Purdue University's representative on the project, Professor of Geophysics Eric Calais, was seconded to the island state for a year as a United Nations scientific adviser, and had to put the Hermanus project on the backburner.

"His research group helped a lot, and much of the data processing was done with their assistance, but Eric was out of the project," says Dr Hartnady. "In the end it was a nice experiment, and there were a few places where it looked as if things were happening, but to relate any particular little signal in the GPS to a pumping episode was iffy."

Fortunately, the development of the Blossoms Wellfield near Oudtshoorn presents another opportunity to use GPS for groundwater resource monitoring. The wellfield is the culmination of the Deep Artesian Groundwater Exploration for Oudtshoorn Supply (DAGEOS) project, which Umvoto Africa was contracted to lead in April 2000. The project was funded or otherwise supported by the WRC, the Department of Water Affairs (DWA), the Oudtshoorn Municipality and the Development Bank of South Africa.

Here, the wellfield is situated on an anticline of the Peninsula Formation where the top of aquifer is approximately 300 m below the surface at its shallowest point. A network of monitoring boreholes has been established by DWA in the area between the wellfield and the Outeniqua recharge zone, but these only target the upper Skurweberg aquifer used by the local farmers. Drilling down to more than 500 m is just

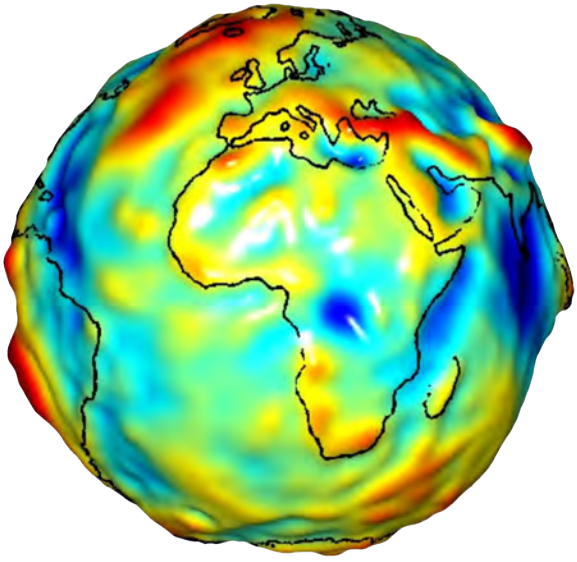
too expensive and logistically difficult for monitoring purposes.

The GPS monitoring method offers a practical alternative, and in this case Umvoto have ensured that the equipment will be sound by incorporating the design and installation of the plinths into the borehole drilling programme.

"Our GPS antennae are keyed into bedrock tens of metres below the surface, so these should be much better geodetic monuments than TrigNet beacons," explains Dr Hartnady. The GPS monitoring will be complemented with satellite remote-sensing using InSAR – interferometric synthetic aperture radar – which can measure centimetre-scale deformations in the land surface at a spatial resolution of 20 m. InSAR has been likened to a 'geodetic camera', used to produce detailed colour images of the Earth's topography.

"Geodetic monitoring is really about precisely measuring positions on the land. InSAR gives an overall picture, but GPS provides calibration at particular sites on the surface, so one reinforces the other, notes Dr Hartnady."

Umvoto will also be collaborating with the Council for GeoScience, which has recently purchased new meters for measuring microgravity. Being able to detect minute variations in gravity caused by differences in subsurface mass (and hence density) allows underground cavities, geological structures and groundwater to be mapped at high resolution, with repeated surveys over time offering the potential to monitor changes.



This visualisation of a gravity model was created with data from the Gravity Recovery and Climate Experiment (GRACE) and shows variations in the gravity field across Africa and Europe. Red shows the areas where gravity is stronger than the standard value and blue reveals areas where gravity is weaker.

In combination, GPS and microgravity monitoring can be used in pumping experiments to measure the compaction of an aquifer and the corresponding surface subsidence, in order to determine skeletal-framework compressibility and specific storage.

"And that's what we're really trying to measure, because ultimately we need to be able to get some quantitative handle on storage and whether it changes spatially, and how the loss of pressure in the artesian aquifer spreads," notes Dr Hartnady.

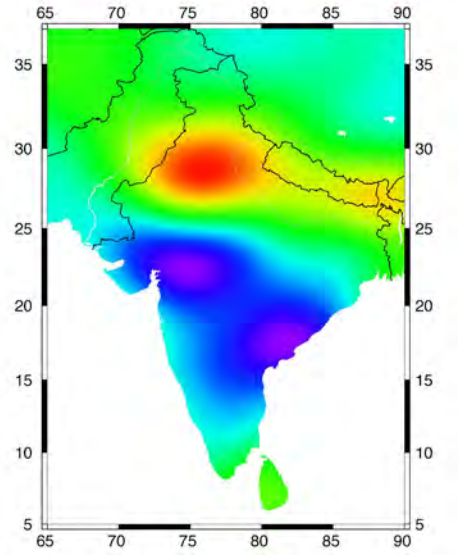
Providing the aquifer host-rock behaves elastically, pressure can generally be restored to its original state by replacing the volume of abstracted water through either artificial or natural recharge. Since test-pumping and free-flow tests have indicated effective elastic behaviour of the confined Peninsula Aquifer in the Klein Karoo, Umvoto have recommended an aquifer management strategy for the Blossoms Wellfield relying on alternating withdrawal and recovery intervals.

Dr Hartnady adds that the microgravity monitoring has broader application too. "Having *in situ* gravity measurements on the ground will link with anything we can tie into GRACE in future."

GRACE is the Gravity Recovery and Climate Experiment, a joint US-German mission that maps variations in the gravity field on a monthly basis, using twin satellites orbiting 220 km apart some 500 km above the Earth. Launched in 2002 with a planned lifespan of five years, the satellites are still collecting and transmitting data, although failing batteries result in periodic power outages. A follow-on mission, GRACE-FO, is planned for 2017.

The data has been used to study global ocean circulation, major earthquakes and glacier ice loss, but has also revealed shocking levels of groundwater depletion in northern India and Pakistan, parts of the Middle East and California's Central Valley.

GRACE quantifies changes in total terrestrial water storage, which includes snow, surface water, groundwater and soil moisture. The most likely source of error in using it to determine groundwater storage is in separating out the soil moisture component, although the latter can be measured using other remote-sensing techniques. It also has limited application to aquifer management at present because the spatial resolution is currently > 150 000 km^2, but it is expected that this will be reduced to < 50 000 km^2 for GRACE-FO.



Groundwater changes in India during 2002-08, with losses in red and gains in blue, based on GRACE satellite observations. The estimated rate of depletion of groundwater in north-western India is 4 cm of water per year, equivalent to a water table decline of 33 cm per year. Increases in groundwater in southern India are due to recent above-average rainfall, whereas rain in north-western India was close to normal during the study period.

"Right now GRACE only works for entire subcontinents and massive basins like the Congo or Amazon, but the follow-on mission with the new satellites has significant potential – not at individual wellfields or even particular artesian basins like the Klein Karoo Basin, but at least as far as the whole of the TMG Aquifer within the southern Cape is concerned," explains Dr Hartnady. "This is something we really look forward to, which is why we're eager to start not only with the GPS and InSAR work, but also to begin to get a handle on the microgravity story."

The initial monitoring will take place over the coming months during testing of the existing production well. However, full commissioning of the Blossoms Wellfield will likely only occur during 2015, once additional production boreholes have been drilled and the pipeline connection to Oudtshoorn completed. ❑

Drakenstein proves small municipalities can save water

The Drakenstein Municipality has earned countrywide respect for its efforts to reduce non-revenue water, boasting one of the lowest water loss percentages in the country. Sue Mattews found out why.

Sue Matthews

Delegates at the Third Regional African Water Leakage Summit held in August 2013 were clearly impressed with a presentation by Drakenstein Municipality's water services engineer, André Kowalewski, demonstrating their approval with extended applause. The presentation, entitled 'Water demand management and conservation successes since 2000', revealed how non-revenue water in this Western Cape municipality had been reduced from 34% to only 12% over a 13-year period, using a range of interventions. Non-revenue water refers to physical (real) losses through leaks and overflows, and commercial (apparent) losses through meter under-registration, billing errors, theft and unbilled authorised consumption.

The Drakenstein Municipality includes the towns of Paarl and Wellington, as well as the small settlements of Hermon, Gouda and Saron, dotted along the Berg River as it makes its way to the Atlantic Ocean. It is home to approximately 255 000 people, whose water supply is delivered via some 650 km of pipes, 28 reservoirs of 0.8 to 100 Mℓ capacity, and 16 booster pump stations. The decision to implement water demand management interventions in 2000 was taken in light of an average annual growth in demand of 3.5%, high water losses and per capita consumption rates, and the knowledge that the local storage capacity was only enough to sustain Paarl and Wellington for 36 and 28 hours respectively (bulk water supply is from Wemmershoek Dam).

Pressure management was the first aspect to be addressed, because system pressures were excessively high in places, resulting in numerous pipe bursts. Apart from the increased frequency of water leaks, the elevated leak flow rates associated with high pressures and the need for repairs added to the costs.

The two pressure zones in Paarl were increased to six on the advice of GLS Consulting, contracted for hydraulic modelling of the municipality's entire water reticulation network. Seven new pressure reducing valves with hydraulic controllers were installed in 2000 at a capital cost of R2.8-million.

"That cost had been paid back within four and a half months," says Kowalewski. "We've undertaken various interventions to reduce water

losses since then, but pressure management has had the largest impact, accounting for about 80% of our savings."

The other interventions include metering of all unmetered water connections – such as firewater connections, irrigation systems in public parks, and standpipes and toilets in informal areas – as well as refurbishment or replacement of the existing water network, both in reacting to leaks and proactively replacing old pipes.

"You need to look after the assets," stresses Kowalewski. "You have to keep your hand on it all the time, carrying out constant repairs and preventative maintenance."

In the three years up to July 2013 alone, more than 57 km of pipe have been replaced in the Drakenstein area, and three maintenance teams are on standby at all times to ensure that any burst pipes are fixed within eight hours of being reported. Detailed records are kept, which reveal that the average reaction time from reporting a burst pipe to closure of the municipal mains is only 30 minutes, ensuring that water losses are minimised.

The introduction of a rising block tariff scheme in the 2001/2002 financial year has also played a major role in curtailing water demand and encouraging consumers to repair leaks. For the 2012/2013 financial year, for example, water use above 80 kℓ per month was billed at R20.96 per kilolitre, while the 11-30 kℓ rate was only R7.52 (the first 10 kℓ is not tariffed in accordance with the national free basic water policy). Public awareness of the need to conserve water has been raised through leaflets distributed with accounts, waterwise pamphlets, and annual Water Week activities such as exhibits, educational puppet shows, and poster and song competitions.

A more hands-on approach was used amongst the poor community of Saron, where water consumption was an excessive 354 ℓ per person per day. An analysis of the minimum night flow indicated that leaks were the main culprit and so – using a R2 million Water Affairs grant and R500 000 prize – a pilot project was initiated in which a contractor was appointed to liaise with residents through home visits, conduct a plumbing audit, and repair water leaks.

Drakenstein Municipality

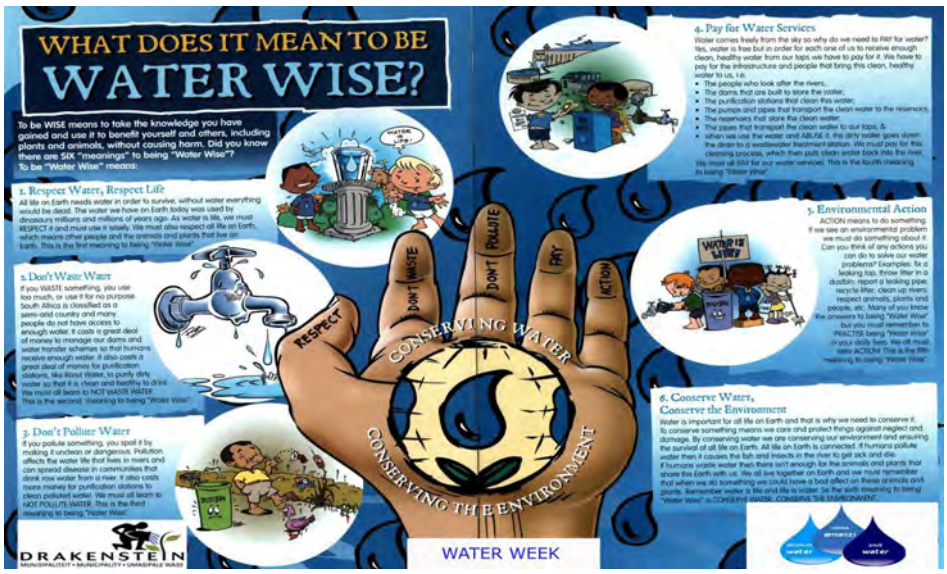
A pressure management installation in Paarl. Pressure management has had the largest impact on reducing Drakenstein's water demand.

A total of 1 413 properties were visited, of which 83.4% had leaks, and repair work included the installation of 1 352 taps and 8 335 metres of pipe. Residents were provided with a pamphlet containing water-saving tips and information on identifying and repairing leaks. The project resulted in a savings of 120 Mℓ for the 2010/2011 financial year, postponing the need for an additional reservoir.

Overall, the water demand management initiatives implemented in the Drakenstein municipal area have saved 158 600 Mℓ of water since 2000, worth some R790-million. The average Infrastructure Leakage Index (ILI) is only 2.1, with Saron the lowest at 1.9. By international standards, an ILI of 1-2 is considered excellent for developed countries, 2-4 is good, 4-8 poor and >8 bad.

Inevitably, finding sufficient funding to sustain the water demand management efforts is one of a number of challenges encountered by the municipality.

"Our capital budget for this year is not enough to keep up with the replacement of old pipes, for



Drakenstein Municipality

One of the posters used to increase awareness of water conservation among municipal constituents.

Drakenstein Municipality

More than 57 km of pipe have been replaced in the Drakenstein area and even more repaired in the last three years.

example," explains Kowalewski. "Vandalism is a huge problem too, because much of the infrastructure we put in the ground, such as fittings and manhole covers, is sold as scrap metal."

Retaining and training skilled personnel is another concern, but Kowalewski is particularly excited about an arrangement made with the FET (Further Education and Training) College in Paarl to offer plumbing courses from 2014, allowing municipal staff as well as local unemployed people that show potential to receive training and earn qualifications, such as the national certificate.

Kowalewski's take-home message to other municipalities wanting to emulate Drakenstein's successes is to keep to the basics, as there is no need to outsource everything to expensive consultants. "Water demand management is not rocket science," he says. "It's simple things you do that make a difference."

In October, the municipality's achievements were recognised at the Water Conservation and Water Demand Management Sector Awards, when Drakenstein was named runner-up in the Local Municipality category. First place went to Gauteng's Emfuleni Municipality, which aims to achieve a 15% water saving through Project Boloka Metsi, co-funded by Sasol and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

At the award ceremony, held at Gallagher Convention Centre in Midrand, Deputy Minister of Water and Environmental Affairs, Rejoice Mabudafhasi, referred to the recent Water Research Commission (WRC) study on non-revenue water conducted by WRP Consulting Engineers, which estimated that South Africa 'loses' 36.8% or 1 580 million m^3 of the water supplied per year, worth some R7-billion. Of this non-revenue water, 25.4% is considered to be losses through physical leakage, and the average ILI value for South African municipalities is a high 6.8.

During her speech, the Deputy Minister noted that the Department of Water Affairs (DWA) has allocated a little over R20-million to the War on Leaks programme, which creates employment and skills development for unemployed youth. These funds will allow for pilot projects in nine district municipalities countrywide, namely West Rand (Gauteng), Kenneth Kaunda (North West Province), Fezile Dabi (Free State), Waterberg (Limpopo), Ehlanzeni (Mpumalanga), Amathole (Eastern Cape), Central Karoo (Western Cape), Amajuba (KwaZulu-Natal) and Pixley ka Serme (Northern Cape).

"Local indigent youth are trained and appointed as 'water conservation warriors' to implement the education and awareness programme as well as the retrofitting and leak repair initiative," she explained. "These water warriors undergo basic training on plumbing, water leak repair and other

The town of Paarl, which falls under the Drakenstein Municipality

skills that would help them to develop small businesses which would service the communities to create more permanent employment."

Another initiative by DWA to encourage municipalities to address the issue of non-revenue water is the No Drop assessment tool, which builds on the success of the Blue Drop and Green Drop schemes for drinking water quality and wastewater services management, respectively. It will be implemented across all municipalities from October 2013 to March 2014, with the results published in the Blue Drop Report of 2014. Future reports will be released every second year to allow municipalities time to implement the recommendations from the previous assessment, ensuring continual improvement.

"No Drop was developed as an incentive-based system to support municipalities on the one hand, but also to show the rest of South Africa what's happening within a particular municipality, not only in terms of non-revenue water but also focusing on water conservation and water demand management," says Paul Herbst, DWA Director for Water Use Efficiency. The idea is to expand upon and verify the research findings of the WRC report on non-revenue water, which was based on usable datasets submitted by only 132 of the 237 local municipalities targeted countrywide.

A significant number of the municipalities could not even provide a system input volume, let alone more detailed information, and very few had a comprehensive water conservation and water demand management strategy that set targets, intervention programmes and budget requirements.

Drakenstein Municipality

The Leliefontein booster pump at Wellington was upgraded as part of Drakenstein's water demand management efforts.

The new Blue Drop score will be made up of five key performance areas for Blue Drop aspects and one – water use efficiency and water loss management – for No Drop, the latter making up only 3% of the overall score. Compliance with 90% of seven criteria is required to be awarded No Drop status. However, the weighting on these criteria, namely strategy, planning and implementation; asset management; technical skills; data credibility; compliance and performance; local regulation and customer care, will shift slightly over the next four cycles. In this first round, criteria that reflect a municipality's understanding of its current situation and performance against compliance-related criteria are prioritised.

"We did a trial run of No Drop in several municipalities, and they were quite satisfied that it is adequately designed to fulfil its role as a supporting tool," says Herbst. "From our side, we're hoping that the No Drop system is taken seriously by the municipalities as an incentive-based system, and that municipalities will start making headway in the implementation of water conservation and water demand management." ❑

Wikipedia

WWW.SXC.HU

What does research have to say about SOUTH AFRICA'S WATER INSTITUTIONS?

It has been 16 years since the promulgation of the National Water Act, which has the decentralisation of water resource management as a core focus. What do we know of these water institutions that are supposed to govern our water resources, and what do we still need to know? This was the focus of a completed research project by the Water Governance Group, a sub-unit of the CSIR Natural Resources and Environment. Article by Nikki Funke, Richard Meissner, Shanna Nienaber and Cebile Ntombela.

South Africa's water institutional landscape has seen some considerable changes since 1994 as a set of new policies replaced the 1956 Water Act. In addition, various non-state stakeholders gradually became involved in water governance, including academics, consultants, communities and scientists. The result was the beginning of a dynamic water governance environment characterised by a move away from centralised to increasingly decentralised water institutions.

This article is based on the results of a CSIR Parliamentary Grant funded project on 'The Architecture and Effectiveness of South Africa's Water Institutions', which aimed to assess the literature published on the subject of legislative water resource management institutions and the planned decentralisation process since the development of South Africa's water policy in 1997. A total of 189 technical reports, government publications (including the National Water Act, White Paper, policy documents and guidelines), working papers, conference papers, conference proceedings, peer-reviewed and popular articles and masters and doctoral theses were identified and assessed. This assessment took account of different trends and themes evident in this body of literature, and also considered what research gaps are present. This gap analysis sets the scene for future research needs on water institutions and also how such research could possibly inform policy development and implementation.

BACKGROUND

The National Water Act refers to water resource management institutions as being either catchment management agencies (CMAs), water user associations (WUAs) or international water management bodies (IWMBs). In October 1999, the government

established 19 water management areas (WMAs) that constitute the entire land area of the Republic. It was planned for every WMA to eventually have a CMA for water resource management and for coordinating the activities of water users and institutions. To date only two CMAs have been established in the Breede and Inkomati WMAs. In the remaining ones water management activities are carried out by the Department of Water Affairs, WUAs, irrigation boards (IBs), catchment forums or a network/platform of various stakeholders or a combination of these.

A key component of South Africa's water institutional landscape is the decentralisation process of water management whereby an increasing number of management responsibilities is supposed to be delegated to more localised levels of governance, for example through the formation of CMAs. The notion of the decentralisation of water management, its institutionalisation and practical implementation, is one of the topics that has featured considerably in the literature.

Research on legislative water resource management entities seems to particularly focus on how these institutions can and should cope with the many challenges that characterise the ever changing water institutional landscape. Research on how to optimise the functioning of these institutions ranges from lessons learned to leadership.

Some interesting research patterns emerged from the assessment of the literature. These were divided into the coverage of water institutions, coverage of different themes that emerged from the literature and authors' scientific or academic background.

LITERATURE COVERAGE OF WATER INSTITUTIONS

As part of the literature review the project team looked at 139 documents covering four types of water institutions: CMAs, IBs, WUAs and IWMBs. Figure 1 indicates the literature coverage of these different types of institutions by percentage. Of the 134 documents reviewed, 86% cover CMAs, followed by 7% for WUAs, 5% for IBs and 3% for IWMBs. Since the promulgation of the National Water Resources Strategy and the National Water Act in 1997 and 1998 respectively, there has been a proliferation of publications on the topic of legislative water resource management institutions, with a prominent focus on CMAs.

One of the gaps that is evident in the research is that only 7% of the research focuses on WUAs and 5% on IBs. This may be a shortcoming in the literature base as in the absence of CMAs, WUAs and IBs perform many of the functions that are supposed to be carried out by CMAs. There are potentially many lessons to be learnt from how WUAs and IBs carry out their operations and how these lessons can benefit CMAs or the water institutional landscape in the absence of CMAs.

In addition, it is interesting to note that only 3% of the literature that was reviewed covers IWMBs. On the one hand this could be seen as a shortcoming because South Africa shares six of its rivers with neighbouring countries, and should therefore focus on joint management of these rivers through IWMBs. On the other hand, it could be assumed that because these IWMBs were developed prior to 1997, it is likely that there has been less of a focus on them since 1997. It is also possible that much of the information around IWMBs is not contained in peer reviewed sources and journals because of the relatively technical and practical issues these institutions deal with. While a large body of transboundary literature in Southern Africa exists that can generally be linked to IWMBs, this literature generally falls outside of the scope of the literature search conducted for this project.

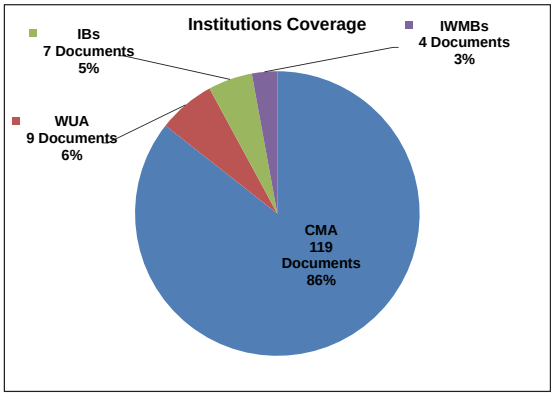


Figure 1: Institution coverage

THEME COVERAGE

Prominent themes that are covered in the literature include adaptive management, challenges/constraints, co-learning/learning organisations, cooperative governance, finances/financial resources, IWRM and stakeholder participation (Figure 2).

Each of these themes is covered and discussed in varying amounts of detail in the literature. From the graph it becomes apparent which themes have been of particular interest to authors. Some of these themes or concepts have also to a large extent become 'buzzwords' which are often referred to as potential solutions for solving the water management challenges faced by South Africa. It is important for water resource managers and government officials not to fall into the trap of making excessive use of concepts such as 'co-learning' and

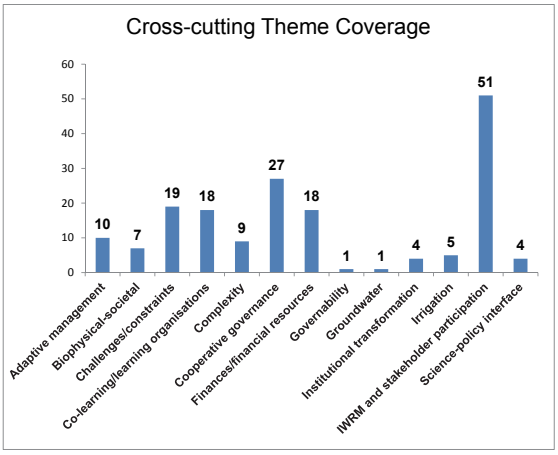


Figure 2: Theme coverage

'strategic adaptive management' without successfully integrating these concepts into the practice of water resource management. Combining different perceptions, models, frameworks and theories could also bring forward different empirical results, conclusions, recommendations as well as a more nuanced understanding of water resource management.

AUTHORS' SCIENTIFIC/ ACADEMIC BACKGROUND

Apart from themes covered by the literature, the study also considered the scientific/academic background of the authors that produce this literature, since their backgrounds are likely to have influenced the methodology and themes that were investigated. The project team identified 37 peer reviewed (influential) publications from the literature set. These included articles published in *Water SA*, research funded by the Water Research Commission (WRC) and the CSIR as well as technical reports by the International Water Management Institute (IWMI). The team therefore excluded government documents (e.g. guidelines and policy documents), working papers, conference papers, masters and doctoral theses and Mark Dent's *CMA Leadership Newsletters*, because these are not peer reviewed. A total of 62 authors were involved in the drafting of these documents (Figure 3). Of these 62 authors, 52 or 84% have a natural science background (e.g. aquatic biology, hydrology or engineering). Only five social scientists (8%) and five economic and business management scientists (8%) were involved with only four as lead authors. The authors' backgrounds were verified by investigating their profiles on their respective institutions' websites.

The predominance of natural scientist authors in the literature suggests an absence of transdisciplinarity in water management. It appears that the complex issue of water resources management is predominantly being approached from one perspective rather than a necessary combination of perspectives. It is important to note here that transdisciplinary research does not mean merging the scientific background of a researcher with another discipline's topic, for example a social scientist applying his/her methodology to analysing a natural scientific problem, e.g. a specific cause of water pollution. Transdisciplinarity also does not equate to scientists from various disciplines forming a research team to study a specific theme.

A case can be made for the use of transdisciplinarity by pointing out that the complexity of societal-environmental problems needs to be understood in a holistic manner, which necessitates knowledge from various traditional disciplines being integrated. Not only is it necessary for a wide variety of disciplines to solve problems together; a broad group of actors from government, academia and civil society also need to be involved. Transdisciplinarity is therefore more than a methodology, concept, philosophy or policy instrument, but can in fact be understood as a state of mind or approach to water governance.

CONCLUSION

In sum, the literature on water resource management institutions may be characterised by a prominent focus on CMAs and by empirical inconclusiveness (from scholarly contributions and anecdotal evidence) regarding their architecture and effectiveness in terms of preserving the ecological reserve.

In light of the fact that so few CMAs have gotten off the ground, the question arises as to how catchment management is functioning in the absence of CMAs. What functions are WUA, catchment forums and other actors performing in the absence of CMAs and what lessons

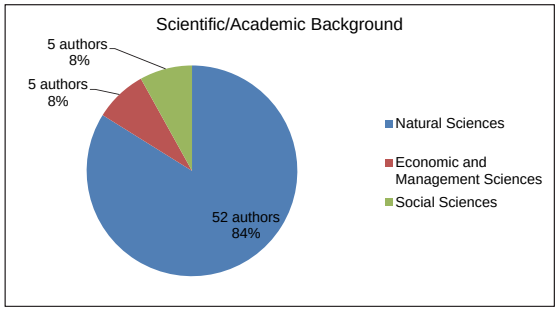


Figure 3: Authors' scientific/academic background

can be learned from how these functions are being carried out? Is it not feasible to have a viable mix of state institutions and non-state actor networks that could perform the functions of a CMA in its place?

A further challenge is that scientists in South Africa who write about water institutions have not engaged substantially with issues of co-production of knowledge, knowledge transfer and knowledge uptake. Often articles implicitly suggest that research findings could be useful to policy-makers, but not enough attention is paid to understanding the complexities of policy-making and the science and policy context.

Finally, social scientists might contribute to advance the understanding of water resources management as part of a research framework that steers away from the practice of propagating buzzword concepts or panaceas without successfully applying these. Examples of concepts and theories from the social sciences include governability, agential power, politics, and governance without government, interest groups, hydro-normative commensalism, hydro-social contract, meta-governance, social constructivism and securitisation.

- For more information, also read the article by Meissner, Funke, Nienaber and Ntombela entitled '*The Status Quo of Research on South Africa's Water Management Institutions: What do we know and where to from here?*' published in the October/ November 2013 edition of *Water SA* (Visit: www.wrc.org.za). ❑

Taking action to save SA's precious indigenous fishes

Habitat destruction, competition and predation by alien fish species threaten the survival of a number of indigenous freshwater fish in South Africa. One of the success stories in freshwater resources conservation is the Yellowfish Working Group (YWG). Article compiled by Deidré West.

Established in 1997, the YWG is a shared responsibility between anglers and conservationists. The group is managed by the Federation of Southern African Flyfishers (FOSAF), which also finances its running costs while underwriting the costs of its projects. Its mission is to 'promote the long-term conservation needs of yellowfish as a flagship group within their natural habitats through sustainable utilisation practices and as a means to create an awareness of their conservation with the relevant decision-makers'.

Basically, the YWG is an 'interest group' comprised of people concerned about the conservation status of the nine species of indigenous yellowfish. Involvement is exclusively on a voluntary basis. Since the establishment of the YWG, fly-fishing resources have been virtually doubled, and the group has continued to be an excellent example of what cooperation between conservationists and recreational anglers can achieve.

But what makes yellowfish and their survival so important? Yellowfish belong to the large cyprinid family, and are the largest, scaled freshwater fish in South Africa. Six of the nine species (genus *Labeobarbus*) are true yellowfishes, while the other three species (genus *Barbus*) are related species.

Yellowfish species are sensitive to habitat degradation and environmental change, and are consequently becoming scarce in many of the rivers in which they naturally occur. Three of the nine species are already classified as threatened or vulnerable.

Recently, the YWG has shifted its focus from the need to popularise flyfishing for yellows in a sustainable manner to placing a greater emphasis on research and the need to combat the real threats to habitat degradation and pollution. An increasing threat is that of hybridisation due to the increasing demand for yellowfish for stocking purposes, mainly because it has become such a sought-after angling fish.

In response the YWG has undertaken a genetic study, starting with work on the two species occurring in the Orange-Vaal system. In collaboration with the Water Research Commission, the group has also published the *State of the Yellowfishes of South Africa 2007* (**WRC Report No. TT 302/07**). This report can be downloaded directly from the WRC website or ordered in hard copy at Email: orders@wrc.org.za.

The YWG hosts an annual conference during which aquatic scientists and ichthyologists from across the country gather to present their research. This year, the conference will be held at the Black Mountain Leisure and Conference Centre, in the Free State, on 22 June, a day before the conference of the Southern African Society of Aquatic Scientists (SASAqS), as many members of the YWG are also members of SASAqS. To enquiry about the conference contact Leon Barkhuizen at Email: barkhl@dteea.fs.gov.za. Those interested in supporting the YWG can contact the secretary, Peter Arderne at Tel: (011) 882-3051 or Email: mwardern@mweb.co.za. ❑

Balancing the business of energy and water

As an organisation that constantly strives to limit increases in water consumption and contribute to sustainable water use, Eskom has indicated its commitment to improving the way in which South Africa's water resources are managed. Eskom's Nandha Govender provides insight into how this is being achieved. Article by Debbie Besseling.

With a track record of some 15 years at Eskom, Govender joined the organisation's Generation Division's Primary Energy, Water Supply Department in 1998 as a mechanical engineer. Today, he is the Acting General Manager: Operations, under the group's Commercial and Technology: Primary Energy Division, where he is responsible for integrated planning and operations of primary energy resources such as coal, water and limestone. In this role he provides general management of the coal supply, water supply, logistics operations as well as environmental and technical services; a position that he enthusiastically describes as having a new challenge every day and an opportunity to learn something new.

According to Govender, one of the major challenges for the organisation is the security of water supply to its power stations in the long term. "This is a major area of focus for us. We have existing and new power stations that last anywhere between 50 and 60 years and it is very important to ensure that water is available to sustain these power stations. Secondly, to ensure proper planning, and that water resources and infrastructure planning is done to make sure that we deliver water to the power stations for the life of the power stations. We are competing for limited resources. We as Eskom have to go beyond our own interests. The idea, which is part of our strategy, is that in the course of doing our business, we have to find ways and means of reducing our water footprint, and managing our current water resources so that others will have access to it as well."

Eskom Holdings SOC Limited is a large consumer of fresh water, accounting for approximately 2-3% of the country's total water consumption annually. Eskom power stations run constantly, supplying in excess of 95% of South Africa's electrical energy and more than half of the electricity used on the African continent.

Govender adds: "It is expected that Eskom's water usage will increase over the next 10 years due to the return to service of older wet-cooled power stations and the introduction of new power stations. However, with the introduction of more dry-cooled stations, diversification of the energy mix and energy and water efficiency measures, Eskom's relative and absolute water consumption will improve considerably by 2030."

Eskom has several overarching environmental objectives relevant to addressing the water challenges, namely avoiding harm to the natural environment; reducing freshwater usage; eliminating liquid effluent discharges through effective water management processes and the re-use of mine-water; and minimising the impact of its activities on groundwater resources.

ABOUT NANDHA GOVENDER

- **Professional registration:** Engineering Council of SA
- **Other memberships:** Certified Director- Institute of Directors; National Society of Black Engineers
- **Academic qualification:** Bachelor of Science (Mechanical Engineering), University of Durban Westville, 1995
- **First job:** Apprentice diesel mechanic
- **Own personal vision:** I am the light and from one light many can be lit
- **Likes:** Education in human values
- **Dislikes:** Wastage of electricity and water taps left running
- **Currently reading:** *Intuitive Listening: How Intuition Talks Through You* by Christiane Northrup and Mona Lisa Schulz.

ACHIEVING OBJECTIVES THROUGH INNOVATION

Eskom has achieved significant water saving objectives through

the implementation of various projects over the past two decades. One major innovation has been dry cooling. To date, 17 of the newest Eskom coal-fired power generation units (at Grootvlei, Matimba, Kendal and Majuba) have been installed with dry-cooling systems. Water consumption from these units is 15 times lower when compared to conventional wet-cooled units.

In addition, a policy decision has been made to implement dry-cooling technology at all new coal-fired power plants. Thus Medupi and Kusile will be equipped with dry-cooling technology. Figure 1 illustrates the positive impact of water usage following the introduction of dry-cooled large six pack power stations during the period of 1983 to 1993. It is anticipated that this will further improve with the commissioning of the world's largest dry-cooled power stations, Medupi and Kusile, which are currently under construction.

The second water-saving project relates to diversification of Eskom's water mix. Through the reuse of treated mine-water from its coal suppliers and treated sewage recovery the power company has managed to reduce its freshwater usage. To reduce the intake of freshwater at Tutuka and Lethabo power stations, mine-water is being sourced from nearby tied collieries, desalinated and used to augment the freshwater supply. The total volume of mine-water recovered to Tutuka and Lethabo is approximately 8 million m^3/a.

Eskom has also increased its use of desalination plants. A desalination plant is already in place at Tutuka Power Station to utilise excess mine-water from its tied coal colliery. An additional project, to be completed at the end of the financial year, aims to manage the resultant brine with the construction of a brine pond.

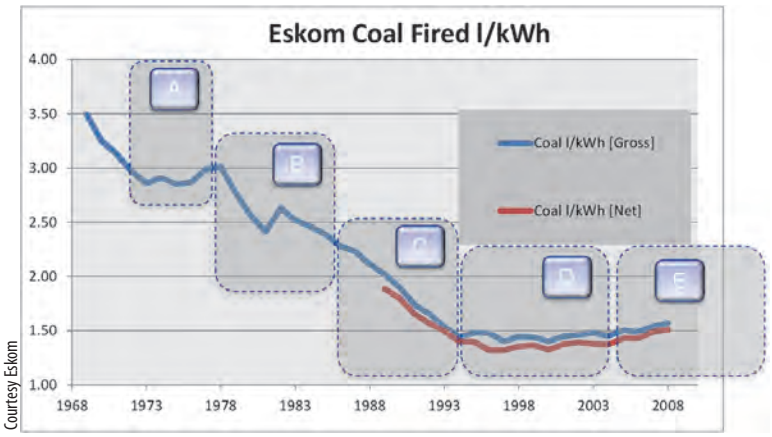
Furthermore, there is a project underway for the development of a large-scale desalinisation plant to treat and use mine-water at Kriel and Matla power stations from the tied coal collieries. The project is currently in the feasibility phase. The estimated time for the operation of the plant will be in the next three to four years. There is a temporary desalination plant in place, with plans to build a permanent plant at Lethabo Power Station for the use of mine-water from its tied coal colliery.

Sewage is also treated and re-used. Most of Eskom's coal-fired power stations (10 of the 13 stations) treat and recover sewage water for use in their operations. The total amount of sewage water reuse is approximately 5 million m^3/a.

A further innovation is Eskom's implementation of a Water Accounting Framework (WAF) directive. The objective of the WAF is to facilitate sound water and effluent management by prescribing minimum requirements for the monitoring, accounting and reporting of water use at the organisation's power stations. Stations have identified major streams, and plans are underway to install flow meters at strategic points as part of the technical plans to be implemented over a period of three years to ensure full compliance to the directive.

Eskom also sets water-use targets in terms of litres of water used per unit of electricity produced for each power station every year. The water targets are linked to the Eskom Sustainability Index. The targets are benchmarked against historical as well as designed water consumption for each type of plant.

All power stations have water use performance targets that are set and monitored on a monthly basis and reviewed each year. The target setting is based on the station design and technology, water use performance, water quality and statistical/regression analysis of each power station. Eskom achieved its best overall water use performance



Courtesy Eskom

***Figure 1** - Eskom's water use per unit of energy over the last 40 years.*

Eskom accounts for up to 3% of South Africa's total water consumption.


Courtesy Eskom

Courtesy Eskom

An aerial view of Matimba Power Station, one of Eskom's dry-cooling stations.

WHERE DOES ESKOM USE ITS WATER?

- At the coal-fired stations, water is used to generate the steam that drives the turbines to generate electricity, and for cooling purposes
- Water is used to drive the turbines to generate electricity at its hydro power and pumped storage schemes
- Most power stations treat raw water to produce potable water for certain processes and to supply the nearby communities and coal collieries for domestic purposes
- Sea water is used for cooling purposes at Koeberg Nuclear Power Station
- Construction and commissioning activities at its new power station build sites
- Production of the demineralised water as make-up water for the steam cycle
- Hydraulic conveyance of ash to the ash dams
- Dust suppression
- Scrubbing of flue gases where flue gas desulphurisation is employed

of 1.34 ℓ/kWh in the 2012 financial year against a target of 1.35 ℓ/kWh.

As a strategic water user Eskom is committed to being proactive in establishing water management procedures and initiatives to protect water resources and promote conservation and judicious use of water in support of the national policy. A Memorandum of Understanding (MoU) has been signed between Eskom and the Department of Water Affairs to promote, encourage and support good water management practices in areas of Water Conservation and Water Demand Management (WCWDM) within the power generation sector.

WORLD WATER WEEK IN STOCKHOLM

Towards the end of last year, Govender attended World Water Week in Stockholm, Sweden, where he gave a presentation on the South African Strategic Water Partners Network (SWPN-SA), focusing on a case study entitled 'Partnership on Effluent and Wastewater Treatment'. This highlighted one of the key focus areas of the SWPN-SA, whose overall objective is to reduce the 17% water resources demand gap by 2030, as well as in severely stressed catchments whose water balance is in deficit.

The SWPN-SA has formed three working groups which focus on the following:

- Working group on Water Efficiency and Leakage Reduction: Focus on water use efficiency, reducing water losses and water wastage in the Municipal Sector. Group led by Nestle (South Africa) and Sasol;
- Working group on Agriculture and Supply Chain water: Focus on Agricultural Supply Chain and irrigated agriculture, led by Coca Cola (South Africa);
- Working group on Effluent and Waste Water Management: Huge potential for increasing reuse of waste water at the coast as well as in inland systems. Focus on mine-water and municipal effluent treatment, led by Eskom and Johannesburg Water.

The SWPN-SA is a water management partnership between government, the private sector and civil society.

GREATEST MILESTONE OF CAREER

Govender relates the greatest milestone of his career: "I was appointed to the Governing Board of the first catchment management agency (CMA) to be established in the country. I was part of a group of governing board members who represented a wide stakeholder and user base. I was representing the Industry, Power Generation and Mining seat on the Board. The experience itself, of creating a new institution, was a huge learning experience, in terms of being able to contribute my wisdom, expertise and knowledge that I had acquired from the water sector and also from being in the employ of Eskom," says Govender. ❑

Looking back: A 100 years after Lewis walks the Orange

On 12 December it was exactly 101 years since Dr Alfred Dale Lewis, former Director of the Irrigation Department (as the Department of Water Affairs was known in 1912) completed his epic journey along the lower end of the Orange River.

This was not just a casual stroll. The water engineer's aim was to explore the lower reaches of South Africa's largest rivers for the possibilities of irrigation. Decades later Dr Lewis' vision would be fulfilled when the Gariep and Vanderkloof dams, along with the Orange-Fish Tunnel were constructed.

"There can hardly be a true South African and certainly no irrigation engineer, with a soul so dead that he can contemplate our greatest river tearing down to the ocean through a vast area of country which is thirsty for water, without feeling that some great effort should be made to design and carry out irrigation works for the Orange River which would rival those famous works of other great rivers in the world," Dr Lewis wrote in 2012.

His journey started on 24 November 2012. He first travelled by horse-drawn cart from Kenhardt to Pella mission station. It was one of the hottest years on record and the country was suffering from a great drought. By the time Lewis reached Pella on 27 November two of his horses had died.

From this point onwards it turned out to be impossible to follow the river even on horseback, so Lewis decided to complete the journey – a distance of over 400 km – on foot. For 16 days he travelled alone beside the river, over rough terrain, carrying all his gear. Temperatures reached 41°C in the shade in some places.

He sometimes managed to procure the services of carriers from Khoi villages dotted along the landscape to help him with his load (in his final report Lewis writes how he had to 'bribe' these men with tea and tobacco). When his food ran out he procured goats for slaughter from the passing villages.

Through all of this he kept his sense of humour. Managing to procure a riding ox for a while, Lewis writes how comfortable it is to ride "the only body part tiring being the arm from slogging." He reached the Orange River Mouth on 12 December, and the detailed report he prepared shortly thereafter served as the main information source for planning for many years.

Source: In the Footsteps of Giants – Exploring the history of South Africa's large dams

The detailed report he prepared shortly thereafter served as the main information source for planning for many years.

Ralf Broemer

AD Lewis' journey along the lower Orange River.

Drinie van Rensburg

LOWER ORANGE RIVER FORUM – Maintaining South Africa's largest river

The Lower Orange River Forum (LORF) is a working example of how citizens are working together with government and non-government organisations to protect South Africa's valuable water resources. Article submitted by Peter Ramollo of the Northern Cape Department of Environment and Nature Conservation.

Originating in the Kingdom of Lesotho, the Orange River is the longest river in South Africa, and is shared among four countries, namely South Africa, Lesotho, Botswana and Namibia. It is a source of water for agricultural and domestic use, while the river itself supports various aquatic organisms both within its own catchment and those of other catchments in the Eastern Cape through inter-basin transfer schemes.

For the arid Northern Cape the Orange River, along with its main tributary, the Vaal River, is an artery of life. However, urbanisation, industrial and mining developments as well as pollution are placing increasing strain on this important resource.

The Orange River is regulated through several weirs and some of the country's largest dams, including the Gariep and Vanderkloof dams, which are used for electricity generation, flood regulation and agricultural activities. As a result, the former variable river flow has become more regulated. This has facilitated the establishment of breeding sites for the agricultural pest black fly, which causes great economic losses to livestock farming and tourism in the Northern Cape.

The LORF was established in 2003 after an outbreak of toxic blue-green algae (cyanobacteria) that resulted in massive fish kills in the Orange River. The initial objective of the forum was to engage with water users along the river and provide them with relevant information

regarding issues affecting the river system. Since then the forum has grown, attracting various stakeholders and specialists on water management and conservation.

Last year, an event was held in October in Upington, where several scientists and other specialists presented information on various topics, such as biomonitoring and water resource planning. This forum gives a platform to communities, farmers and scientists dependent on the river to develop measures together to safeguard the river.

There are various developments underway in the province, such as renewable energy plants, which are expected to place an even bigger pressure on water supply. All the weirs are earmarked for hydropower energy generation, and there are also plans to build more weirs for hydropower stations within the river system.

Due to existing river regulation less water is reaching the Orange River Mouth estuary, a wetland of international importance. This is because the water released from the Vanderkloof Dam takes up to six weeks to reach the mouth. Due to this and other environmental factors, the saltmarshes that harboured the bird populations for which the mouth was awarded Ramsard status, have collapsed.

If the custodian of South Africa's water resources, namely the Department of Water Affairs, is to succumb to pressures to approve water use for the increasing developments underway in the province, it might lead to a water shortage within the Northern Cape or lead to extreme capital expenses to ensure that the available water can be cleared from pollution.

The riparian zone of the Orange River is dominated by mixed woody vegetation, such as buffalo thorn, wild olive, indigenous wild tamarisk, sweet thorn, cape willow, karee trees and reeds that stabilise the bank and prevent bank erosion and degradation. On the other hand, invasive alien vegetation, such as wild tobacco, castor oil bush, Mexican poppy and mesquite has created impenetrable thickets along the Orange River banks in areas like Onseepkans, Pelladrift, Goodhouse and Vioolsdrift.

The mesquite especially grows faster than indigenous vegetation, therefore using more water, which ultimately leads to groundwater depletion. Thought it is difficult to completely eradicate invasive alien plants, LORF calls on communities to assist the government in controlling these invasive species as water availability is everybody's concern.

Though the LORF is committed to ensuring that South Africa's main artery of life does not get reduced into a vein the reality is that the Orange River will remain stressed in the foreseeable future, driven by anthropogenic impacts such as urbanisation, increasing agricultural and mining activities, and pollution from various sources.

Without water all forms of life is threatened so it is up to the residents living adjacent to the Orange River to help protect it. Citizens are asked to report any pollution, such as sewage running into the river, to relevant local and government authorities. If the authorities fail to act, communities should consider taking legal action against the polluters. In this way, they will be protecting their health and well-being as outlined in section 24 of the Bill of Rights. ❑

Without water all forms of life is threatened so it is up to the residents living adjacent to the Orange River to help protect it.

New desalination plant to keep 'Diamond of the West Coast' shining

Much has been done during the project to keep the Lamberts Bay coastline as undisturbed as possible.

Veolia

Lamberts Bay, on the West Coast, has become the latest in a steadily growing number of South African towns opting to augment their conventional water supply through seawater desalination. Lani van Vuuren reports.

Situated some 280 km north of Cape Town, Lamberts Bay, nicknamed the 'diamond of the West Coast', has developed from a small fishing village into a popular holiday town. The town has a population of around 40 000, which swells significantly during the peak holiday season. Lamberts Bay falls under the Cederberg Municipality.

Lamberts Bay has traditionally obtained its water from groundwater sources, with six production boreholes located 15 km south of the town. A reconciliation study published by the Department of Water Affairs (DWA) in 2011 revealed that the town is abstracting significantly more from the boreholes than what is sustainable, causing water levels to decline at an 'alarming rate'.

The DWA study also indicated that seasonal quality variation is apparent, with worsening of the water quality occurring in the summer months when there is little recharge. This has caused the primary coastal aquifer, Lower Wadrif well-field, to become under risk of seawater intrusion from exploitation of groundwater in this area.

DESALINATION PLANT

Following the evaluation of various options (including the drilling of additional boreholes and the construction of a pipeline from Clanwilliam Dam) Cederberg Municipality made the decision to augment Lamberts Bay's water supply through the addition of a seawater desalination plant. Veolia Water Solutions & Technologies South Africa was awarded the multimillion Rand contract in 2012 to provide the plant, which uses reverse osmosis (RO) technology to treat the seawater to potable standard.

The plant has been located next to the existing Lamberts Bay water treatment works, about 800 m from the coast (so as to have the lowest possible visual impact on the coastline). The close location to existing infrastructure also allows easier tie-in of the desalination plant to the Lamberts Bay distribution network. While the plant will have an initial capacity of 1.7 Mℓ/day, the infrastructure has been so designed to allow capacity increase up to 5 Mℓ/day in future.

Abrie Wessels, Veolia Regional General Manager: Cape, explains how the plant will operate "Seawater is sourced from beach wells located 3 km southwest from the plant site. This will provide a relatively clean

source of feed water to the pre-treatment phase." Where the pipeline has disturbed the natural vegetation, rehabilitation has been undertaken.

Pre-treatment will comprise shock chlorination of the feed pipeline, coagulation, filtration by down-flow dual-media filters, anti-scalant addition and cartridge filtration. The pre-treatment process removes particles and organic material in preparation for treatment by RO membranes.

During the RO phase, the salt water is forced through semi-permeable membranes, which retain salts and other impurities, allowing freshwater to permeate. Once desalinated, the water will be stabilised with limestone and carbon dioxide, and fed into the town's existing freshwater network.

The plant layout is based on the initial provision of 2 RO modules, each with a capacity of 850 m^3/day. Veolia's manufacturing division in Spain supplied the plant's standard compact seawater desalination skids.

SAVING ENERGY

Desalination is an inherently energy-intensive process compared to conventional water treatment. To reduce energy use the Lamberts Bay plant has been equipped with energy recovery pressure exchangers to recover the residual energy of the brine stream. This energy will be used in conjunction with a booster pump to boost a portion of the feed pressure to the membranes.

Wessels further explains that the backwash water from the dual-media filters and limestone filters will be collected separately, the solids removed and the sludge discharged to municipal drying beds. "This upgrades the quality of the wastewater (brine) produced by the plant."

"For the brine outfall, marine mapping was undertaken, divers sent into the ocean and sandy areas of lowest impact identified," explains Wessels. "The brine outfall goes out into the ocean at 150 m, and monitoring of the effect of the brine will be undertaken once the plant is fully operational."

CLOSE TO COMPLETION

Construction of the desalination plant has been completed, with cold commissioning having been concluded in November 2013. At the time of writing, the construction of the brine return pipeline was being finalised to enable final commissioning to take place. The plant is expected to come online during the second quarter of 2014.

Interestingly, the Lambert's Bay contract follows the success of six other desalination plants installed by Veolia along the Cape coastline since 2009 (Cannon Rocks, Bushman's River Mouth, Knysna, Plettenberg Bay, Mossel Bay and Saldanha), with a combined desalination capacity of approximately 25 million litres per day.

Wessels sees a promising future for desalination going forward. "Desalination – both of seawater and brackish water – will have a blossoming period in the next few years, with the increased demand on limited water resources, together with the increased contamination load of freshwater resources with industrial pollutants and municipal waste. Membranes used for desalination promises a clean water source, both for industrial and municipal applications, with a reliable quality.

"With capital costs and operating expenses of desalination plants becoming more economical, and the increases in penalties for wastewater discharge and the increases in municipal water costs, desalination is becoming an increasingly attractive option for generating additional water supply." ❑

"Desalination is becoming an increasingly attractive option for generating additional water supply."

Veolia

The new Lamberts Bay seawater desalination plant.

WATER Kidz

Wild about wetlands

On 2 February South Africa joins the world to celebrate World Wetlands Day. This is the day that the Ramsar Convention was signed for the first time back in 1971 when several countries promised to take care of their wetlands. This year's theme is 'Wetlands and agriculture: partners for growth'.

Why this theme? People have been using wetlands for thousands of years to plant their crops and graze their animals – think of the ancient Egyptians using the Nile floodplain, for example. Today, around 2.5 billion people depend directly on agriculture, forestry, fishing and hunting for their livelihoods. Agriculture is also an important economic activity, providing important income and jobs in many countries, including South Africa.

Wetlands provide food and other agricultural products, such as fuel and fibre directly through agricultural production activities that take place in them, such as rice paddies, coastal grazing marshes, planting in flooded areas (called recession agriculture) and aquaculture (fish farming) in large floodplains, as well as cropping of small seasonal wetlands. Wetlands also support agriculture indirectly, for example, by providing fertile soils and reliable supplies of good quality wetlands.

Unfortunately, we have not been as good to our wetlands as they have been to us. In many countries around the world, including South Africa, up to half of wetlands have been lost mainly because of bad agricultural practices. As populations grow and more people need to be fed, more wetlands are threatened.

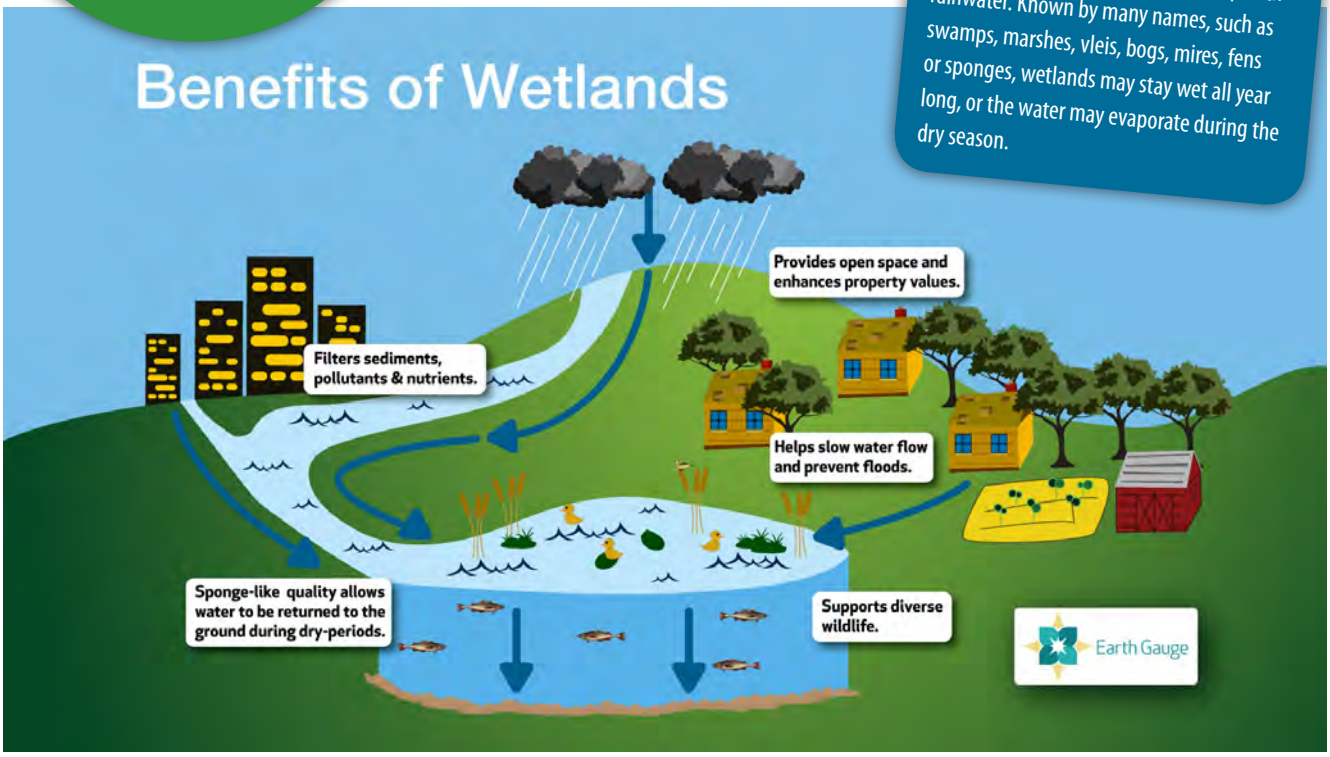
This needs to be prevented. Not only are wetlands important habitats for a range of plants and animals, they provide important functions to humans as well. Wetlands improve water quality, and regulate streamflow. They also house plants that are used for medicinal or cultural purposes. In addition, wetlands provide benefits to people through provision of grazing, direct water abstraction, and the production of fibre and animal protein. In many rural areas in South Africa, people make use of their local wetlands to grow traditional crops such as amadumbe to feed their families. For some people wetlands have spiritual or aesthetic value, while others use them for recreational purposes (think, for example, of South Africa's iconic tourist

What is Ramsar?

The Convention on Wetlands of International Importance, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the cooperation for the conservation and wise use of wetlands. South Africa is currently one of 168 signatories to the convention.

What is a wetland?

Wetlands are areas where standing water covers the soil or an area where the ground is very wet. Wetlands are not connected to the ocean, and can be found along the boundaries of streams, lakes, ponds or even in large shallow holes that fill up with rainwater. Known by many names, such as swamps, marshes, vleis, bogs, mires, fens or sponges, wetlands may stay wet all year long, or the water may evaporate during the dry season.



Source: www.earthgauge.net

Wetlands provide an important home to many animals and plants.

www.sxc.hu

wetland, iSimangaliso Wetland Park, which was the country's first World Heritage site).

There are many ways in which poorly managed agriculture can negatively impact wetlands. When wetlands are drained and converted to cropland many of their benefits are lost. Drained wetlands are less effective at regulating streamflow (which could lead to floods) and purifying water, because the drainage channels speed up the movement of water through the wetland. Drainage also increases the danger of erosion by concentrating water flow, and so increasing the erosive power of the water.

In many areas of South Africa wetlands are burnt to improve the grazing value for livestock by removing old dead material and for other reasons. This can also be harmful to wetlands, destroying many important plants and animals.

When dams are built for irrigation purposes this may increase river flows or water levels due to dam releases and changes the timing and pattern of river flows (i.e. where before the river was dry in winter there might now be water flow). This can damage the natural character of wetlands. Other impacts come from intensive agriculture, which often leads to increased loads of pollutants, such as pesticides, fertilisers, antibiotics and disinfectants. Not only do these affect the character of wetlands, they also have impacts on human health and the quality of drinking water supplied from wetlands.

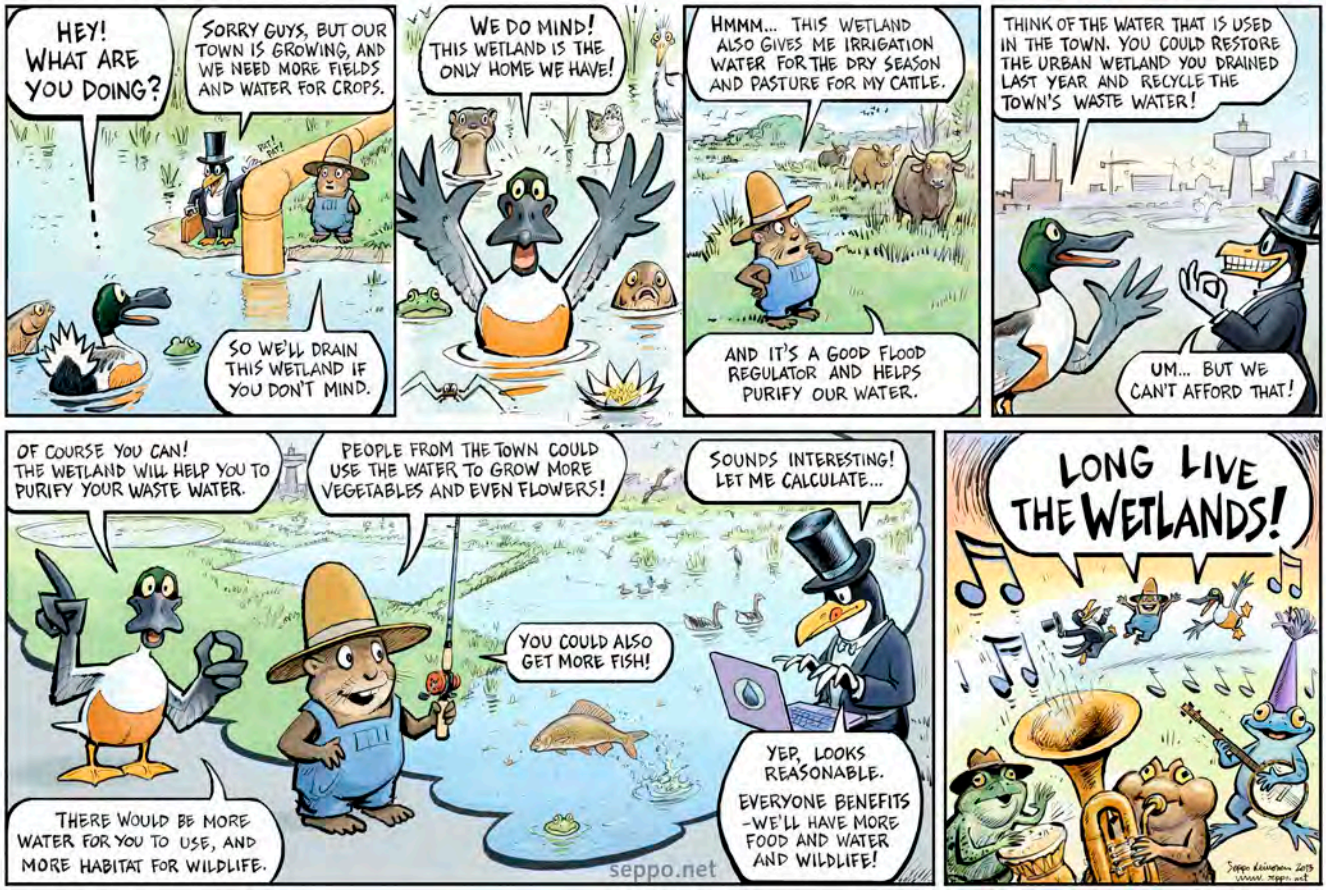
What can you do to protect your wetlands?

- Keep lawns and driveways free of pet waste, fertilisers, and motor oil. These pollutants can wash into storm drains and eventually reach a wetland.
- Choose indigenous species when planting trees, shrubs and flowers to prevent alien invasive species from growing in wetlands.
- Use non-toxic products for household cleaning and lawn and garden care.
- If you grow tired of your exotic pet do not release it into the wild where it can harm local wildlife.
- Volunteer to help monitor or restore wetlands in your area.

There are many laws in South Africa that help protect wetlands. Communities must come together to protect and restore their wetlands. If we look after our wetlands they will keep looking after us. ❑

FOOD, WATER AND WETLANDS

www.ramsar.org



Source: Ramsar

Large dams conference draws record crowd

More than 230 people attended this year's conference of the South African National Committee on Large Dams (SANCOLD) held at Thaba'Nchu, in the Free State, late last year. The theme for the 2013 event was 'Technology for Water and Water Energy in Southern Africa'. Commenting on the theme of the conference, SANCOLD Chair, Danie Badenhorst, said: "The sustainable development of renewable resources with environmental stewardship is of great importance in Africa as we seek to strengthen and maintain our critical water-supply infrastructure. In South Africa we have 3 500 dams with a height of more than 5 m that deliver a broad array of benefits, including water and power supply, flood risk management, water quality, recreation, sedimentation control and other benefits to the country's citizens." Badenhorst was encouraged by the record attendance at the conference as well as the high quality of papers delivered (47 in total). "The papers delivered at the conference covered a variety of aspects, including planning, hydrology, hydraulics, environmental aspects, geotechnical and structural engineering, as well as dam safety. The high number of attendees and the interesting contributions show that there is a need for SANCOLD, and a need for our regular conferences where we can share dam engineering experiences and knowledge."

All photographs by Lani van Vuuren

Keynote speaker, Dr George Annandale, gave a thought-provoking address on sustainable water supply and climate change.

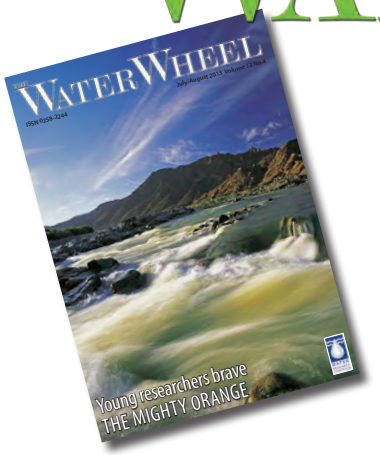
Shirley Ntotole, Zac Prins, Shenaaz Hoosen and Boitumelo Seake, all from the Department of Water Affairs (DWA).

SANCOLD President, Danie Badenhorst with Mike Neumann and Johann Geringer of GIBB.

Molola Mosome, Leepile Motlagomang, Khethikwe Khomo and Rodney Siwelane, all from DWA.

Seef Rademeyer from DWA, Andrew Tanner from Aurecon, and SANCOLD Secretary, Dr Paul Roberts.

THE WATER WHEEL



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

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

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.

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