THE WATER WHEEL
ISSN 0258-2244
May/June 2014 Volume 13 No 3

CITIZEN SCIENCE: STANDING TOGETHER FOR NATURE

WATER RESEARCH COMMISSION

SASAQS 2014 CONFERENCE | 22-26 JUNE 2014

SOUTHERN AFRICAN SOCIETY OF AQUATIC SCIENTISTS

On behalf of the Southern African Society of Aquatic Scientists, Department of Zoology & Entomology, UFS, and FREE STATE DETEA: Biodiversity Research Division, we invite you to attend the 2014 SASAqS conference to be held at Black Mountain Leisure and Conference Hotel near Thaba Nchu in the central Free State

ACCOMMODATION

AVAILABLE AT BLACK MOUNTAIN LEISURE AND CONFERENCE HOTEL	
Standard Accommodation Bed & Breakfast:	Single R605.00/day
Standard Accommodation Bed & Breakfast:	Sharing R390.00/day
PLEASE MAKE BOOKINGS DIRECTLY AT THE HOTEL	
Remember to state that it is for the SASAqS 2014 conference.	
TEL: 051 871 4200	**FAX: 086 750 3199**
www.blackmountainhotel.co.za	
EMAIL: conference@blackmountainhotel.co.za	

TRADE EXHIBITORS

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

SESSIONS

Categories will include:

- Conservation of Aquatic Ecosystems
- Wetland, Estuarine & Marine Ecology and Management
- Water Availability, Quality and Management
- Ecotoxicology
- Aquatic alien invasions
- Impact of Climate change
- Sustainable utilization of aquatic resources
- Inland fisheries and Aquaculture
- Aquatic Parasitology

PLEASE TAKE NOTE THAT ORAL PRESENTATIONS WILL BE 15 minutes PLUS 5 minutes for questions. **DDD's**, will include a three minute oral presentation, which will be incorporated into the program.

ABSTRACT SUBMISSIONS

- The deadline for submission is 3 March 2014 and you will be notified by 30 March 2014 if your abstract/paper has been accepted. Please submit abstracts electronically on **www.easyabstract.com**

SPECIFICATIONS FOR PRESENTATIONS & DDD's

- Presentation to be generated using PowerPoint software package.
- Windows 8 operating System, Office 2010 will be used.

- The DDD presentation can be done using Office PowerPoint 2013, 2010 and 2007.
- The presentation needs to be done in LANDSCAPE. The screens being used to display the DDD's, are 21 inch touch screens. The screens will be setup in a LANDSCAPE format.
- A maximum of 5 PowerPoint slides will be allowed.
- No PDF presentations will be allowed.
- The DDD's will be displayed on screens in such a way that delegates of the congress can sit down in front of a screen and browse through the DDD presentations at own leisure.

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

PLENARY/KEYNOTE SPEAKERS

- **Dr Danie Vermeulen, Director of the Institute for Groundwater Studies UFS**: His presentation will deal with the very controversial Shale gas development and the sensitive Karoo environment where it is taking place –one of the main questions is whether these two subjects are compatible.
- **Dr John Mendelsohn, Director of RAISON (Research and Information Services of Namibia):** Will present an overview of drainage systems in the central Kalahari Basin, especially the area south of Angola and the Great Equatorial Divide. West to east, these are the Cuvelai, Cunene, Cubango/Okavango, Cuito, Kwando and Zambezi. Some rivers flow west or east to the Atlantic and Indian Oceans, while others end in saltpans or freshwater deltas within the Kalahari Basin. Water in these areas generally have very low mineral concentrations, thus biological productivity is low. Ephemeral flow in certain areas has led to the development of lakes and floodplains that are highly productive.

ROUND TABLE DISCUSSION

- Session I: *Alien invasions in South African Aquatic Systems.* Chair: Prof Jo van As
- Session II: *Inland Fishery Bio-assessment, the Way Forward.* Chair: Dr Gordon O'Brien

2014 YELLOWFISH WORKING GROUP (YWG) CONFERENCE

The YWG conference will be held prior to SASAQS 2014 on Sunday, 22 June 2014, 08:00 - 17:00, also at BMH. For more information on registration, costs involved and to present an oral presentation (15 min + 5min discussion) at the YWG Conference, contact Leon Barkhuizen at **barkhl@dteea.fs.gov.za** or Peter Arderne at **mwardern@mweb.co.za**

PLEASE NOTE THAT NO CORRESPONDENCE OR REGISTRATION FOR THE YWG CONFERENCE SHOULD BE ADDRESSED TO SAVETCON OR THE ORGANIZERS OF SASAqS 2014!

REGISTRATION

All delegates are required to register online at www.savetcon.co.za (Registration for the YWG Conference should be done with Leon Barkhuizen or Peter Arderne.)

Registration includes:

- Abstract book
- Conference bag;
- Tea's/Coffee's;
- Lunches (3); Dinners (3) and Gala event

Registration category	Payment received before 30 April 2014	Payment received after 30 April 2014
SASAqS member	R3 500.00	R3 900.00
SASAqS non-member	R3 800.00	R4 200.00
SASAqS student member	R2 500.00	R2 900.00
SASAqS student non-member	R2 800.00	R3 200.00
Day registration SASAqS member	R1 300.00	-
Day registration SASAqS non-member	R1 500.00	-

PRELIMINARY TIMES OF SESSIONS

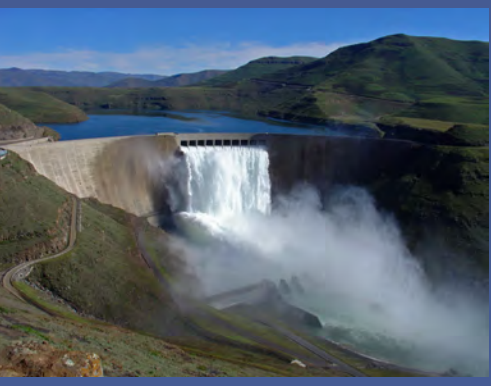
Sunday 22 June 2014	
16h00	Registration
19h00-	Cocktail function (Meet & Greet)
Monday 23 June 2014	
07h00-08h00	Registration - Foyer BMH
08h00-08h15	Welcoming
08h15-10h30	Session 1
10h30-11h00	Tea/Coffee Break
11h00-13h00	Session 2
13h00-14h00	Lunch
14h00-15h45	Session 3
15h45-16h15	Tea/Coffee Break
16h15-18h00	ROUND TABLE 1
19h00 BMH	Evening dinner
Tuesday 24 June 2014	
07h30-8h00	Registration - Foyer BMH
08h00-10h00	Session 4
10h00-10h30	Tea/Coffee Break
10h30-13h00	Session 5
13h00-14h00	Lunch
14h00-15h45	ROUND TABLE 2
15h45-16h15	Tea/Coffee Break
16h15-17h30	Session 6
18h00-19h00	Blue movie
19h00 BMH	Evening dinner
Wednesday 25 June 2014	
08h00-8h30	Registration - Foyer BMH
08h30-10h00	Session 7
10h00-10h30	Tea/Coffee Break
10h30-13h00	Session 8
13h00-14h00	Lunch
14h00-16h00	Session 9
16h00-16h15	Short break
16h00-17h30	AGM
19h00-	Gala dinner
Thursday 26 June 2014	
08h30-10h00	Departure

CONFERENCE SECRETARIAT

SAVETCON event management
Mrs Petrie Vogel - Registration and administration
Tel: +27 (12) 346 0687, Fax: +27(12) 346 2929
Email: petrie@savetcon.co.za

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

2nd Announcement



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

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

CONTENTS

Cover: *Members of the public are playing an imperative role in biodiversity protection in South Africa. See the story on page 10. (Cover photograph of a White-crowned Plover by Drinie van Rensburg)*

Fluid Thoughts

WRC CEO, Dhesigen Naidoo

Can we benefit from a value paradigm shift?

Our recent history has been dominated by a national water dialogue of scarcity, pollution, quality problems and social unrest associated with last mile service delivery.

South Africa's water future is determined by the three faces of the current Malthusian challenge, namely, a growing population, an improving quality of life that is linked with increasing personal water budgets, and a policy determination that relies on water intensive economic growth sectors. This seems to imply that our water scarcity is highly probable.

If we add to this mix the vagaries of climate change and extreme weather events, the scarcity is increasingly assured. The facts as we have them is that using our current water behaviour baseline, tomorrow's South Africa will have less water per capita for personal use and less water per activity for productive use.

Although this analysis is accurate, its narrative is disempowering.

Another perspective can be derived from a different narrative with the same facts. South Africa is indeed water poor, as it has been throughout its recorded history. Our economic pathway is almost inevitably water-intensive as our country has as its mainstay our natural resources and their beneficiation. The couplets of mining and manufacturing; biodiversity and tourism; arable lands and agriculture come to mind.

The goal of universal access to clean water and safe sanitation are non-negotiable based both on the tenets of the Constitution as well as the moral and social compacts of modern democratic South Africa. All of these demands play out in the reality of a finite resource of ever-decreasing quality through continuous use and re-use.

In classical economic terms this defines water in South Africa as a principal determinant of development success. Water is therefore, because of its non-substitutable and irreplaceable nature, a Strategic National Asset. This points to a more empowering paradigm and the change in language has the real possibility of a vector to action.

This shift in emphasis toward the paradigm of a strategic national asset has implications across all the areas of water challenges and opportunities. It most importantly has the potential to change the nature of the dialogue. Let us consider the current debates around shale gas harvesting in the Karoo.

The new narrative is the inter-relationship between two strategic national assets. The first is a much needed new energy source in the form of natural gas for a country that has oil imports as a key driver of our negative trade balance. The second is water in a part of South Africa that is water scarce and has a very high environmental value.

This combination sets the stage to develop protocols and methodologies to derive benefit from the natural gas reserves in a manner that has the possibility of limited negative impacts on the water resource. If we

SCARCITY		STRATEGIC ASSET
Risk	→	Opportunity
Fear	→	Promise
Blame	→	Ownership
Emergency	→	Plan for intervention
Survival	→	Growth possibilities
Cost of remediation	→	Investment in new resources
Unrest	→	Partnership
Reactive	→	Pro-active

Figure 1. *The paradigm of scarcity advises a collection of emotive descriptors in its narrative. A putative sample is presented, all of whom are transformed into a much more empowered, action oriented counterpart in the paradigm of water as a strategic national asset. The opportunities for growth and improvement of quality of life became more apparent as we re-visualise costs of remediation into investment in new water availability.*

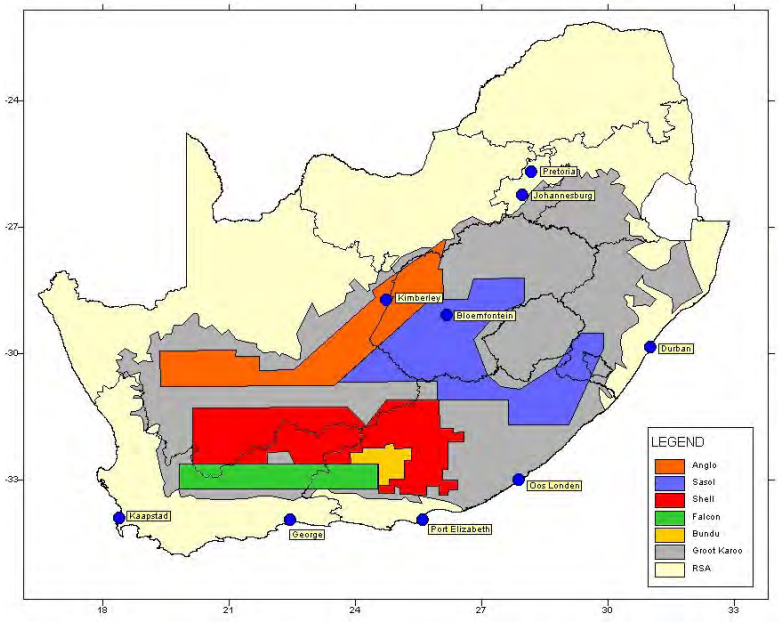


Figure 2. *Current exploration areas and companies involved in hydraulic fracturing in South Africa*

manage to do this, it will enable the South African shale gas exploitation project to become a global best practice and change the international narrative of such endeavours.

The WRC embraces this new paradigm in its strategy. The project portfolio gives effect to the notion of water as a Strategic National Asset from the basic planning regimes of water sensitive design to the mining of freshwater and valuable minerals from acid mine water. The notion can be applied from developing sustainable low/no-water safe sanitation solutions to women-led small scale agriculture initiatives, and from research to empower the notion of ecological infrastructure as a key element of water infrastructure, to novel governance mechanisms to encourage wider empowered participation.

This the WRC does in partnership with South Africa's small but highly productive water R&D community, the dedicated South African water practitioners, the prudent water users and our friends around the global in the quest to ensure the reality of universal access to water and water services.

Water diary

Large dams
June 1-6

The International Commission on Large Dams is holding its 82nd Annual Meeting in Bali, Indonesia, with the theme 'Dams in global environmental challenges'. More than a 1 000 dam experts, engineers, scientists, consultants, and operators, among others, are expected to attend. *Visit: www.icold2014bali.org for more information.*

Water resource management
June 11-12

The Second African Water Symposium titled 'Planning for the future' will be held in conjunction with the 6th Orange River Basin Symposium at the University of the Free State. *For enquiries Tel: (051) 401-2863'Fax: (051) 401-2629; Email: info@africanwatersymposium.co.za or Visit: www.africanwatersymposium.co.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.*

Sediment water science
July 15-18

The International Association for sediment water science (IASWS) brings together and fosters collaborative research and dialogue between earth scientists, biologists, chemists and environmental engineers whose interests pertain to sediment-water interactions in all aquatic systems. Conference themes include the impact of sediments on ecosystem functioning and human health; multiple stressors; scale-dependent connectivity in aquatic systems; technical and methodological advances in sediment-water science; and physical and biochemical processes in sediment systems. *Enquiries: Prof Kate Rowntree; Email: k.rowntree@ru.ac.za or visit: www.iasws2014.co.za for more information.*

World Water
September 21-26

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

Municipal engineering
October 29-31

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

Health and nutrition
November 19-21

The Second International Conference on Health and Nutrition will be held in Rome, Italy. The conference, hosted by the World Health Organisation and the Food and Agriculture Organisation of the United Nations, along with several other parties, will focus on how to address major nutrition challenges over the coming decades. *Visit: http://www.who.int/mediacentre/events/meetings/2014/international-conference-nutrition/en/*

Young water professionals
December 7-10

The 7th International IWA Young Water Professionals Conference will be held in Taipei, Chinese Taiwan. Conference topics include water treatment and management, wastewater treatment and management, water reuse and desalination, energy saving, nutrient removal and recovery, health-related issues, nanotechnologies, sludge management and resource recovery, and wetland and climate change, among others. *Enquiries: Tel: +886-2-33664377; Email: ywp2014@iwahq.org; Visit: www.iwa-ywp7.org*

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*

Water by numbers

11% – The percentage of the population (about 1.4 million households) who do not have sanitation facilities or services, according to a report, *The Quality of Sanitation in South Africa*, presented in Parliament in 2012. The same report says government requires about R44.5-billion to resolve the sanitation crisis.

30% – The average percentage of water utilities' operational cost represented by the cost of energy.

0.76% – The percentage of South African gross domestic product (GDP) spent on research, according to a study published by the Human Sciences Research Council. This still falls short of government's target of 1% of GDP.

44% – The percentage increase in newborn survival rates when birth attendants and mothers wash with soap, according to UNICEF.

8% – The percentage of all freshwater drawn worldwide used for energy, according to the UN. In some developed countries, this figure is as high as 40%.

21 – The number of Wetlands of International Importance designated in South Africa. Still, 71% of what remains of the country's wetlands are not protected at all, according to the South African National Biodiversity Institute.

50% – The number of scholarly articles read on screen – as opposed to in hard copy, according to a survey undertaken by the University of Tennessee. However, print readings were generally read with more care.

1 011 – The number of wetlands which have been rehabilitated by Working for Wetlands since 2002. The organisation has invested R725-million to rehabilitate 80 000 ha of wetland area, according to Deputy Minister of Water & Environmental Affairs, Rejoice Mabudafhasi.

Poor water quality putting people's health at risk, says organisation

The lack of compliance with water quality regulations by some South African water services authorities is a clear indication of failing municipal infrastructure and management, according to civil rights organisation AfriForum.

Earlier this year the organisation published its first report on municipal water quality following an initiative to test various sources of public drinking water and outlets of several wastewater treatment facilities. According to AfriForum Head: Environmental Affairs, Julius Kleynhans, local authorities and the media accompanied the test teams across the country in order to ensure the validity of the tests. Water samples were tested by independent accredited laboratories.

According to the AfriForum report, of the 114 municipal drinking water quality tested, 11 municipalities did not comply with drinking water quality standards. In Hertzogville and Delareyville, the tap water was found to contain high concentrations of nitrate (14 mg/100 ml and 12 mg/100 ml respectively), while at Kareedouw, Stormsrivier, Polokwane, Stella, Vryburg, Coligny, and Mafikeng tap water was found to contain E.coli. Standerton's water was found to be safe to drink, although the colour of the water did not comply to drinking water standards.

Of greater concern to AfriForum was the standard of effluent leaving South African municipal sewage treatment works. Of the 43 wastewater treatment works visited, 33 did not comply to standards. "This holds a threat to human health, food security and the environment," said" Kleynhans in a statement.

The results indicated that in some municipalities water was more polluted upstream due to failing infrastructure and untreated sewage pouring out of manholes and pump stations into natural resources. Failing wastewater treatment works were found in metropolitan areas, such as Tshwane, to smaller towns, such as Brits, Klerksdorp, Magaliesburg, and Bela-Bela.

The organisation sent letter to those municipalities who were not compliant and intended further steps in case these municipalities failed to rectify their water quality issues. According to the AfriForum report, the results indicated a need for political will to utilise, maintain, protect, conserve and manage South Africa's resources and infrastructure. "There is a great need for the reviewing of current water services authorities, restructuring of personnel and a thorough investigation into the possibility of privatisation of water and sewerage infrastructure."

The Department of Water Affairs earlier rejected the AfriForum campaign, saying it only focused on water quality analysis which was only a portion of the original Blue and Green Drop audits that the department conducts.

To access the AfriForum report, Visit: https://www.afriforum.co.za/wp-content/uploads/AfriForum-Omgewingsake-Blou-en-Groendruppelveldtog-2014-VERSLAG-ENG.pdf

Renowned SA hydrogeologist passes away

The water research community is still reeling with shock following the sudden death of Prof Gerrit van Tonder (61) of the Institute of Groundwater Studies at the University of the Free State.

Prof van Tonder died on 22 April, apparently of a massive heart attack. A well respected figure in the groundwater community, he had close to 40 years' experience in hydrogeology, with a focus on groundwater management and pollution. He published more than 50 scientific papers in peer-reviewed journals. He was a long-standing funded researcher of the Water Research Commission, partaking in more than 30 Commission projects.

Prior to his death Prof van Tonder focused his efforts on impact research around proposed shale gas mining in the Karoo. He was a peer-review member of the Karoo Water Expert Group, formed under the auspices of the Groundwater Division (GWD) of the Geological Society of South Africa to study the hydrogeology of the Karoo Basin, and a regular speaker at debates around hydraulic fracturing.

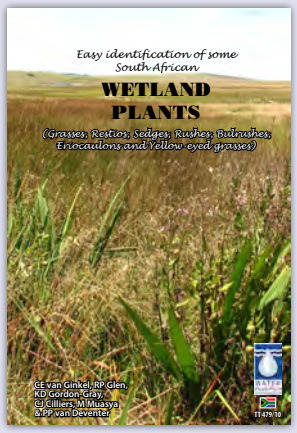
In 2005, he was identified by the Academy of Science of South Africa as the most outstanding groundwater scientist in South Africa. He was also an honorary life member of the GWD. Prof van Tonder leaves behind his wife, Fransie, and children Sanri and Gideon.

Prof van Tonder was a good communicator with a great sense of humour as well as an excellent lecturer whose passionate instructional approaches enabled his students to internalise information and acquire knowledge. He was also a very supportive and resourceful supervisor who always availed time for his master and doctoral students, and demonstrated remarkable patience without compromising excellence.

"The groundwater community is poorer without Prof van Tonder. He was instrumental in developing groundwater hydrology and the capacity we have today. Like so many others, I will miss his engagements on a variety of issues," said WRC Research Manager, Dr Shafick Adams.

New from the WRC

Special price for wetland plant guide

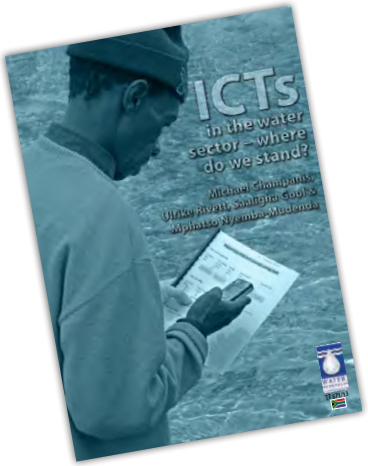


Until 30 June only the field guide, *Easy identification of some South African wetland plants* (**TT 479/10**) is available for R150 only. The guide normally sells for R200. This field guide focuses primarily on obligate wetland plants, paying special attention to grass-like plants. In total, 290 species of plants are covered. The book is printed on high-quality paper and includes many colour photographs and illustrations.

Report No. TT 571/13

ICTs in the water sector – where do we stand? (M Champanis; U Rivett; S Gool & M Nyemba-Mudenda)

Over the last decade information and communications technologies (ICT) systems have become known as a potential solution for developing countries and their information needs. The wide distribution of mobile phones in even the most rural environment has created the suggestion that cellphones are far more than a mere communication tool. The water, sanitation and hygiene (WASH) sector has also seen an increase in ICT applications, mainly for the purpose of improving data collection, information flow between decision-makers and engagement with the wider public. This research project was undertaken to assess the status quote of ICT solutions in South Africa. The aim of the study was to understand in more detail the potential for ICT in the South African water sector, to learn from the successes and failures of existing systems and understand the enablers and barriers for ICT implementations.



Report No. 2089/1/13

User perceptions and levels of satisfaction of water management devices in Cape Town and eThekwini (L Thompson; T Masiya; P Tsolekile De Wet)

Since the onset of democracy, South Africa has experimented with different ways of promoting sustainable water service delivery in urban areas. In the 1990s, there was concern with the need to expand water service delivery to unserviced areas in an environment characterised by non-payment or resistance to payment for water services. Pursuant to these concerns, numerous efforts were made to collect outstanding debts from water users. These included water cutoffs as well as seeking judicial redress. However, these measures met with limited success. As a result, municipalities began to develop novel ways of enforcing payment for services. This resulted, among other alternatives, in the introduction of water management devices. While these devices have been praised as efficient and effective mechanisms in regulating water service delivery, limited studies have been conducted to find out perceptions of the recipients of these devises. This study provided an understanding of user perceptions of the efficacy of water management devices.

Report No. KV 307/13

Discussion paper on the role of water and the water sector in the green economy within the context of the new growth path (D Naidoo; S Moola; H Place)

The benefits of the green economy and the need for more sustainable ways of operating have been very topical in South Africa. The green economy is also prioritised as a key economic driver by Government policy and strategy. All government departments need to develop implementation plans and align their programmes with the job creation imperative. A number of priority programmes were identified that effectively provide practical interventions for the environment sector contribution. If implemented, the programmes will have a significant contribution towards mainstreaming green economy approaches within South Africa to the benefit of the environment, economy and society, promoting growth while reducing pollution and greenhouse gas emissions, minimising waste and inefficient use of natural resources, maintaining biodiversity and strengthening energy security. This discussion paper looks to explore whether the green economy, from a water sector perspective, will effectively assist in achieving the national development and job creation objections as outlined in the New Growth Path.

Report No. 2011/1/13

Application of emulsion liquid membranes in the extraction of rhodium from mining and metal refinery effluent (R Tandlich; CD Luyt; KL Tyalana; F Moyo)

The platinum group metals (PGMs) constitute the backbone of the economy in South Africa. The mining and related metal refinery operations contribute a significant proportion to the gross domestic product and the employment in the country. The emulsion liquid membranes are a relatively old technology which has been successfully used to extract base metals from acidic media. This project set out to investigate the application of emulsion liquid membranes in PGMs from the aqueous by-products of PGM refining. The by-products are generated as side-streams which require storage and processing. Of the PGMs, rhodium is one of the more inert and therefore difficult to extract.

Report No. 1966/1/13

A large-scale study of microbial and physic-chemical quality of selected groundwaters and surface waters in the North West Province, South Africa (CC Bezuidenhout)

Water from the North West Province catchment areas support prosperous gold and platinum mining, manufacturing industries, agriculture and a growing urban and rural population. However, water allocation for the province has almost reached the quota available, based on surface water estimates. Furthermore, there are reports that the source water within the catchment may be exposed to pollution from various sources, but particularly from economic activities. These reports have demonstrated that several surface waters and groundwater are contaminated with faecal matter and some with opportunistic pathogenic bacteria. Further social and economic developments as well as climate change will impact on the anticipated water availability, requirements and quality of water. Baseline data in these categories will be important for long-term planning. However, detailed large water quality studies have not been conducted in the province to date. This study was aimed to address this gap.

Report No. 2093/1/13

Scoping study and research strategy development on currently known and emerging contaminants influencing drinking water quality (H-G Patterton)

The aim of this study was to investigate and identify the most important new substances in drinking water that could be a concern to human health in South

Africa. The specific aims were to complete a comprehensive review of literature on emerging contaminants (ECs); identify the three most critical ECs in South Africa; review current methods to analyse and quantitate ECs in water; complete a national reconnaissance study on the three critical ECs, develop a risk matrix for the three critical ECs; define critical issues that must be addressed regarding ECs and identify knowledge and skill gaps, propose a future research strategy and develop a terms of reference for the research.

Report No. 2170/1/13

Identifying and prioritising water research questions for South Africa (R Siebrits & K Winter)

Limited historical data are available to describe water research in South Africa over the first half of the 20th century. Many authors recognise that this period was dominated by technological developments, breakthrough research and projects in water storage and transfer, and frequently characterised by a positivist approach to nature and development. A new era in water research in South Africa began with the promulgation of the Water Research Act No. 34 of 1971, which led to, among others, the formation of the Water Research Commission. This study commences with the identification of the prevailing paradigms that have influenced the history of water research in South Africa by analysing the publication output over the last four decades, and in identifying research questions proposed by a range of researchers active in the water sector in South Africa.

Report No. 2048/1/13

Development of a groundwater resource assessment methodology for South Africa: Towards a holistic approach (A Allwright; K Witthueser; J Cobbing; S Mallory and T Sawunyama)

This study tested the Mixing Cell method as an additional tool used to quantify the groundwater baseflow volume in South Africa, among others. In light of the persisting lack of understanding of surface water-groundwater interactions, the importance of the groundwater contribution to streamflow and the increasing use of groundwater, a new approach to the quantification of this is proposed.

Report No. TT 578/13

Groundwater governance: A global framework for action (2011-2014). Regional diagnosis for the Sub-Saharan Africa region (E Braune & S Adams)

The information for this diagnostic has come largely from the regional consultation for the sub-Saharan Africa region of the Groundwater Governance: A Framework for Action project, supplemented from other sources to strengthen the interpretation and conclusions. The purpose of the regional consultations is to solicit regional perspectives on the practical application of groundwater governance. This report starts with a brief Africa water resources and socio-economic setting, followed by an assessment of the current state of groundwater governance in the region, including the gaps in this regard. A section on lessons and opportunities to address the gaps forms the basis for a set of conclusions and recommendations.

Report No. KV 320/13

Implementation plan for direct and indirect water re-use for domestic purposes – Sector discussion document (AM van Niekerk & B Schreiner)

The National Strategy for Water Re-use has to date not been broadly communicated and consulted. The aim of this short-term project is to develop a plan to bridge the gap between the strategy and implementation of water re-use for domestic/potable water use in consultation with the Department of Water Affairs and the WRC. The document was informed by a study of international best practices as well as a locally held workshop on water re-use.

Report No. 2076/1/13

Investigating stakeholder engagement cycles and identities within water resource management, using narrative techniques (AG Choles; N Govender; A Vlok)

The WRC-funded research project, undertaken by The Narrative Lab during the course of 2012/13, investigated the social dynamics of stakeholder engagement and volunteerism using narrative techniques at two study sites in the Western Cape, namely the Wilderness and Swartvlei estuaries, which are situated on the Garden Route. In particular, the study aimed to understand why citizens choose to engage with water resource challenges, how they translate the engagement into action and participation, and how such engagement may be cyclical in nature. The study investigated how citizens become and remain engaged in the decision-making regarding the management of the natural resource and to determine a) if they feel they are empowered, b) if they have sufficient knowledge as well as c) guiding principles on how to act or start an active engagement process.

Report No. 2103/1/13

Estimating the marginal value and price elasticity of demand for water in the industrial sector in South Africa: An application and assessment of the marginal productivity approach (A Nahman & W de Lange)

The need for this project has arisen in the context of the National Water Act and its emphasis on demand-side management, specifically, the economic principle of encouraging more efficient water use by means of water pricing. Designing and implementing water pricing strategies for a particular user group requires information on the marginal value of water to that user group, i.e. the increase in economic value generated per unit increase in water use (in order to assess whether there is scope for increasing water prices); as well as the price elasticity of demand. This project estimated the marginal value of industrial water use in South Africa, and the associated price elasticity of demand for water, using a production function approach. Specifically, the marginal productivity approach was used.

Report No. 2014/1/13

Preparation of magnetic nano composite beads and their application to remediation of mine wastewaters

In this project magnetic ion imprinted polymers with high recognition for uranyl and chromium were prepared for the first time. The prepared magnetic ion imprinted polymers were characterised and optimised in the laboratory. They were then applied to wastewaters from acid mine drainage and influent from a wastewater treatment plant.

Report No. 1734/1/13

Investigation into methods for the development of a protocol for quantitative assessment of industrial effluents for permitting of discharge to sewer (C Brouckaert; F Mhlanga; A Mashava)

The conceptual basis of this project was to develop a protocol, involving a combination of laboratory testing and process modelling, which would be able to predict the effect of a range of loads of factory effluent on the operation of the treatment plant receiving the effluent, to inform the process of granting a discharge permit. Because of the sustained high impact of textile effluents on several wastewater treatment plants in eThekwini, textile effluents were chosen as the subject of all the investigations.

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

Report No. 1849/1/13

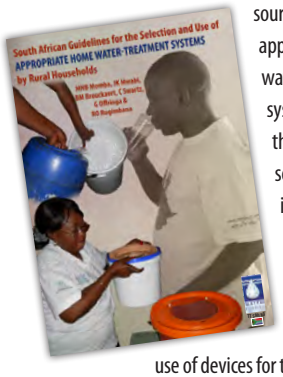
Management of human-induced salinisation in the Berg River catchment and development of criteria for regulating agricultural land use in terms of salt generating capacity (W de Clerq; N Jovanovic; R Bugan; E Mashimbye; T du Toit; A van Niekerk; F Ellis; N Wasserfall; P Botha; T Steudels; J Helmschrot; and W-A Flugel)

The main aims and the specific objectives of this project were to quantify the water and salt balances for a variety of land uses and on-farm management practices in the Berg River catchment; to set up and develop a hydrological model of the Sandspruit catchment for predictions of salt load contributions to the Berg River from different land uses and management practices, and finding the best practice to accommodate land use change in hydrological modelling; and finally to develop guidelines for regulating land use in terms of salt generation capacity, based on the knowledge gained from on-farm experiments and hydrological modelling.

Report No. TT 580/13

South African guidelines for the selection and use of appropriate home water-treatment systems by rural households

In contrast to metropolitan areas, the South African government still faces a number of challenges in delivering safe drinking water to rural communities, in spite of significant progress made in the provision of this basic service since 1994. At least 5 million people still have no access to treated potable water within reasonable distances from their dwellings. A project was commissioned by the WRC to source and investigate appropriate home water-treatment systems, to determine the efficiency of the selected devices in removing contaminants, and to provide guidance on both the selection and use of devices for the production of safe drinking water by rural under local conditions. The guidebook is a result of an extensive literature search, laboratory and field studies, workshop series and a social acceptance study aimed at determining the most important influencers of the social acceptance of home water-treatment technologies as perceived by rural households. A technical report, *Selection and use of home water-treatment systems and devices* (**Report No. 1884/1/13**) is also available.



Report No. TT 583/13

Community engagement in drinking water-supply management: A review (U Rivett; D Taylor; C Chair; B Forlee; M Mrwebi; JP van Belle & W Chigona)

This review emanates from a previous WRC-funded project that investigated the possibility of incentivising community engagement in order to improve drinking water supplies in South Africa. The research is based on the notion that an increase in community engagement, particularly in rural areas, would result in an increased understanding of the current shortcomings of drinking water supplies, an increased understanding of the communication challenges between communities, water service authorities and water service providers, as well as an improved experience of greater transparency and accountability for all stakeholders.

Report No. TT 570/13

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

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

Independent investigation into home-based water purification units

An increasing number of South Africans are purchasing over-the-counted home-based water treatment devices, but do these actually work and are the claims made by the manufacturers true?

A team from the University of Johannesburg set out to independently assess home water treatment devices sold in South Africa for their capacity to provide safe drinking water for domestic, public and occupational use, and to provide guidelines to enable consumers to make informed choices when purchasing these units. The study evaluated the performance capacity of tap-mounted and jug-type purification systems currently available in South Africa. The systems were evaluated for their ability to remove microorganisms under a variety of running conditions. These findings were then compared with the claims made by the manufacturers of the products.

The study confirmed the wide variety of devices in South Africa. According to the researchers, users should pay close attention to the claims made by the manufacturers in their information brochures to ensure that the devices are used correctly. This includes specific flow rates for the faucet-mounted devices, which in most cases do not translate to the normal opening of the tap. Possibly the greatest concern was the fact that all the devices tested as part of the study indicated that the device should only be used with municipal treated tap water that meets SANS241 requirements, raising the question why there would be a need for further treatment of the water.

While an overall general pattern was observed that most of the home water treatment devices tested within this study potentially did improve the water quality in terms of its aesthetic attributes, such as reducing scale, the devices generally tested poorly for taste, odour, heavy metal, and microbiological removal as claimed by the manufacturers.

"Considering that these were the most common claims made by the manufacturers, i.e. that their devices could remove heavy metals and pathogens, as well as improve taste and odour, this is of great concern bearing in mind that their devices did not accomplish what they had claimed," noted the researchers in the final report.

In terms of the microbiological analysis, ultrafiltration and sediment filtration proved to be the most successful for removing bacteria and cysts; however, none of the technologies tested successfully removed viruses. In terms of the physic-chemical analysis most of the manufacturers of home water treatment devices also claimed chlorine removal after treatment – this proved to be true for most of the devices tested.

Several devices successfully neutralised both acidic and alkaline waters while also removing turbidity.

The associated reports, *An independent investigation into the purification capacity of small-scale water purification units supplied in South Africa (Volume I and Volume II)* can be ordered through Publications or accessed via the WRC website.

Citizens indispensable in modern biodiversity protection

Members of the Bot River Estuary Coordinated Waterbird Counts team conduct a waterbird count.

Tygerberg Bird Club

While Water Research Commission (WRC)-funded research projects are typically undertaken by highly qualified experts, the contribution of ordinary citizens to scientific endeavours should not be overlooked. Sue Matthews looks at this increasing trend.

The University of Cape Town's Animal Demography Unit – simply known as the ADU – has been at the forefront of initiatives to involve members of the public in scientific research for more than two decades. Recently, the ADU celebrated the role of its volunteers by declaring the week of 8 – 16 March 'Citizen Science Week'.

"Each data point the ADU's citizen scientists collect is a piece of the jigsaw puzzle of biodiversity," explains ADU Director, Prof Les Underhill, on the unit's website www.adu.org.za. "The ADU's mission is to fit together all the puzzle pieces, so that we can map South Africa's biodiversity through time. We turn the myriad bits of raw data into the kind of information that conservation decisions can be based on."

Here we profile a few of the ways in which citizen scientists are involved in data collection for water-related programmes.

WATERBIRD COUNTS

When the ADU was established in 1991 the acronym stood for Avian Demography Unit, because it developed from the South African Bird Ringing Unit (SAFRING) and the first South African Bird Atlas Project, which ended that year (SABAP2 began in 2007 and passed the 100 000 checklist mark this February). The following year the ADU launched CWAC – the Coordinated Waterbird Counts – to meet South Africa's monitoring obligations in terms of Wetland International's African Waterfowl Census Programme, the Convention on Migratory Species and the Ramsar Convention.

One of the first wetlands to be 'counted' was the Bot River Estuary, outside Hermanus in the south-western Cape. The 20th anniversary of the Bot CWAC was celebrated last July, an achievement that is all the more remarkable given that most of the counters live in the northern suburbs of Cape Town, and have to leave before daylight to get to the site on time. Although a few local birders living in the vicinity of the estuary

take part, the Bot CWAC has always been conducted by the Tygerbird Bird Club and coordinated by one of its members, Mariana Delport, whose family owned property on the estuary's shores.

Nowadays the counts are done twice per year, in mid-summer and mid-winter, in line with the ADU's recommended minimum standard. Impressively, they were done monthly for a four-year period from the beginning of 2003 to the end of 2006, and then quarterly until the end of 2009, in order to monitor the birds' response to breaching of the estuary mouth, which typically occurs at intervals of two to three years.

Doug Harebottle, appointed as the ADU's first full-time CWAC Coordinator in 1999, used the data for a chapter in his PhD thesis on the conservation value of waterbirds and wetlands in South Africa's winter rainfall region. He analysed Bot CWAC data for the period 2002 to 2010 and showed that the freshwater 'lake' conditions experienced after the estuary mouth had been closed for a few years supported more waterfowl, especially red-knobbed coot and yellow-billed duck, while the saline estuarine phase and brackish lagoonal phase supported more waders and shorebirds.

The thesis also includes detailed analyses for four other wetlands, and the acknowledgements section contains high praise for the CWAC teams. "This thesis would not have been possible if it were not for the many CWAC volunteers who gave up (and still give up) their 'Saturday mornings' to spend a few hours counting waterbirds. To do this month after month, year after year takes enormous effort and dedication. I will be forever grateful for their man-hours, turning their observations into useful science and conservation outcomes," wrote Doug.

Apart from providing useful information on waterbird composition, abundance and seasonality, as well as the wetland's conservation importance, his findings were incorporated into the desktop ecological water requirements study for the Bot River Estuary, which will inform management of the catchment and estuary.

The CWAC website lists a number of other potential uses for such data, including:

- Monitoring waterbird population fluctuations and wetland health
- Improving understanding of seasonal movements of waterbirds between wetlands
- Raising awareness of the importance of wetlands as biodiversity hotspots
- Serving as an early warning system for wetland degradation or waterbird population decline.

FROGGING

Another of the ADU's citizen science projects focuses on frog monitoring. In mid-2010 the ADU launched FrogMAP, following on from its seven-year South African Frog Atlas Project (SAFAP) that ended in 2003 and resulted in the publication, *Atlas and Red Data Book of the frogs of South Africa, Lesotho and Swaziland*, the following year. SAFAP data, collected by volunteers as well as professional herpetologists, was primarily in the form of audio recordings of calling frogs, which can be reliably used for identification.

FrogMAP, on the other hand, is one of the ADU's 'virtual museums', in which the specimens are digital photographs in an online database, rather than preserved animals in a display case. Photographs submitted by citizen scientists must be accompanied by information on where and when the animal was observed – there's a built-in Google Map to pinpoint the location for those who don't have access to GPS coordinates – and all species identifications are confirmed by a panel of experts.

Currently the virtual museum contains some 44 000 records, but the majority are from the SAFAP dataset, with only about 5% having been submitted since the launch of FrogMAP. That contribution will hopefully accelerate with the recent initiation of a frog monitoring project in the Hermanus to Gansbaai area of the south-western Cape.

"We're interested in community education and so we've been investigating different educative instruments, citizen science projects being one of them," says Sheraine van Wyk, eco-learning manager at Whale Coast Conservation, the local non-governmental organisation that is driving the project. "We know we have special endemic frogs in this area and that our wetlands are under threat. And at a basic level we all understand that environmental health is vital to our survival and coexistence with

"I will be forever grateful for their man-hours, turning their observations into useful science and conservation outcomes."

Sue Matthews

The unique patterns on a western leopard toad can be used to identify individuals.

Whale Coast Conservation

Sheraine van Wyk with potential citizen scientists at the launch of the Whale Coast Conservation frog monitoring project.

nature. This citizen science project is a way to get members involved and more scientifically oriented, but the end point is greater awareness and knowledge, and the capacity to participate in governance of the ecosystems that surround us.

"At the same time, it's vitally important that scientific rigour is maintained and that the frog monitoring results are dependable and useable, even if limited to a rather simple scientific level."

FrogMAP only gives an indication of the distribution range of a species, but Van Wyk is hoping to collect data on frog numbers, sex ratios and size frequency distribution that could also be useful in assessing population health. "In areas where we have special species, there might be a particular project that is focused more on that frog's conservation. For example, the one in Stanford will be geared towards western leopard toads, and we're very fortunate that a local farmer, Naas Terblanche, has built up considerable knowledge about the species over the years and has been writing articles for the local magazine, so he's created an interest within the community. We'll give people an opportunity to take their interest further, learn more about frogs and get involved in monitoring."

"This sort of project couldn't be done without citizen scientists though – you need people on the ground, because it's just too intensive for a bunch of scientists."

The western leopard toad, *Amietophrynus pantherinus,* is classified as endangered in the latest IUCN Red List assessment because it only occurs in small, isolated patches totalling 440 km ^{2} between the Cape Peninsula and Cape Agulhas. Its habitat has declined as a result of agricultural and urban expansion and associated wetland degradation, and the tadpoles are heavily preyed upon by invasive fish, but the most obvious threat on the Cape Peninsula is car traffic over a few weeks in winter when the toads migrate to and from the breeding ponds at night. The carnage is there for all to see in the morning, commemorated in the Cape Pont Vineyards' Splattered Toad range of wines.

Volunteer groups such as the Toad NUTS (Noordhoek Unpaid Toad Savers) and KirMiTS (Kirstenhof/Muizenberg Toads Savers) in the southern suburbs of Cape Town initially focused on patrolling known road-crossings and 'rescuing' at-risk toads. More recently, under the guidance of the Western Leopard Toad Conservation Committee (WLTCC), which includes representatives from SANBI, Cape Nature, SANParks and City of Cape Town as well as NGOs and volunteer groups, they have also collected data.

Photographs of the toads against a ruler or on graph paper, together with the 'where and when' information, are submitted to the Upload Your Toad node on the iSpot website hosted by SANBI. Each toad's patterns are unique, so computer recognition software can be used to search for matches once the database is sufficiently large, in the long-term yielding information for population demographic estimates.

"Even in the short term, the moment we have data it starts giving us information," says SANBI's Dr Tony Rebelo, who chairs the WLT-CC. "So in the meantime the monitoring will give us data on how long the toads live and how far they move, and as we get more data it will become statistically more powerful. But it takes many years before we can start picking up trends and patterns.

"This sort of project couldn't be done without citizen scientists though – you need people on the ground, because it's just too intensive for a bunch of scientists."

MINISASS

Citizen scientists in the water field are not limited to monitoring our feathered friends or potential Prince Charmings though. They can

also get up close and personal with creepy crawlies in rivers and streams to monitor the health of these aquatic systems, and raise red flags about pollution problems.

MiniSASS (Stream Assessment Scoring System), which uses the composition of macroinvertebrates as an indication of water quality, was originally developed in the 1990s, but with funding from the WRC has been revised in recent years to make it more robust and widely applicable as a monitoring tool. It is based on the more comprehensive SASS5 (South African Scoring System version 5), which relies on over 90 macroinvertebrate classes. MiniSASS uses only 13, but provides a similar end-result in terms of river health status.

The revision was conducted by GroundTruth, an environmental consultancy in Hilton, KwaZulu-Natal, run by Mark Graham, who was one of the original developers of miniSASS, and the new version underwent testing at the WESSA Environmental Centre in nearby Howick by river health practitioners and environmental educators. Subsequently, a new website, www.minisass.org, has been developed by GroundTruth and WESSA, and this incorporates an interactive Google Earth map and database that allows miniSASS users to upload their results and view those submitted by others.

The map reveals that most results uploaded to date are from groups in the vicinity of Durban and Pietermaritzburg, which can be attributed to the proximity of GroundTruth and WESSA and their strong networking in the area. Graham is a board member of the Duzi-uMngeni Conservation Trust (DUCT), a public benefit organisation working with local conservancies and schools in the vicinity of the uMsunduzi and uMngeni rivers, while WESSA is rolling out miniSASS through its Eco-Schools programme.

Louine Boothway, an Eco-Schools node coordinator working on a DUCT-WESSA partnership project, points out that not all miniSASS results are as yet being uploaded to the website, which only went live in October.

Louine Boothway

Learners from Mpophomeni Township, outside Howick, KwaZulu-Natal, conduct a mini-SASS assessment on the uMthinzima stream.

"With the peri-urban township schools where I work, the learners need to be supported in developing the necessary skills to do miniSASS well enough to be able to post their results, knowing that they are a good reflection of what's happening in that stream," she explains. "I can see that the kids gain in confidence and get a sense of pride in their work when we don't compromise on the results."

"My involvement in this group is extra special for me, because in first world countries citizens involved in science are generally more affluent people volunteering their time. In our situation it's sometimes unemployed or illiterate people who are just really concerned about sewage pollution in their community. They want to put a stop to it and to know what's going on, and they are really excited about miniSASS."

Through its promotion via the national Eco-Schools programme, as well as the Department of Water Affairs' Adopt-a River programme, it is hoped that miniSASS implementation will soon gain momentum.

"It's a wonderful tool," says Boothway,"and it has great potential to involve citizens in painting a picture of the state of rivers in our country." ❑

"It's a wonderful tool, and it has great potential to involve citizens in painting a picture of the state of rivers in our country."

Guy Stubbs/Africa Media Online

Stepping up smallholder agricultural production – What role does water play?

It is generally accepted that in order for smallholder farmers to play a more meaningful role in the economy they must participate in commercial agricultural value chains. But what is the role of water in these value chains and how does this affect the farmers' success? A study, funded by the Water Research Commission (WRC) and led by the Department of Agricultural Economics at the University of the Free State (UFS), investigated. Article by Lani van Vuuren.

The role of agriculture in especially the rural economy is well recognised. According to WRC Executive Manager, Water Utilisation in Agriculture, Dr Gerhard Backeberg, agriculture contributes to economic development and rural livelihoods by providing food products, but also represents a range of opportunities for earning income in production,

processing, distribution and retailing phases of the agriculture value chain. This sector thus provides far more than merely food to rural communities.

Since 1994, the South African government has committed itself to working towards decreasing rural poverty through the implementation of policies that include initiatives to link smallholder farmers to commercial agricultural value chains. The agricultural value chain refers to the chain of activities that farmers and other stakeholders perform to deliver their goods to the end-consumer. Millions of Rands have also been invested on revitalising smallholder irrigation schemes – with mixed success.

According to UFS Senior Lecturer: Agricultural Economics and principal researchers on the WRC project, Dr Henry Jordaan, by participating in agricultural value chains farmers can sell larger volumes of crops at a time, so they can use their available land and other resources more efficiently to produce the maximum amount of crops. Smallholder farmers can also gain access to more effective support services. "Commercial agricultural value chains also include roleplayers who have the necessary skills, expertise and experience that can, through embedded services, help smallholder farmers to produce products that meet the stringent requirements of consumers."

WATER USE ALONG THE VALUE CHAIN

Agricultural water plays a necessary role in increasing productivity. The WRC project analysed selected value chains in commercial and emerging agriculture with specific attention to, among others, mapping of water use at critical points in the value chain; optimisation of water use in the whole value chain; mainstreaming of marginalised participants in the economy; and improving competitiveness in the value chain.

Dr Jordaan explains the importance of this particular study in the South African context: "South Africa is considered to be a water scarce country with a significant amount of competition for water resources. While irrigated agriculture is a major user of freshwater it is also a significant contributor towards meeting food requirements of the local population and provides an environment through which smallholder agriculture

Since 1994, the South African government has committed itself to working towards decreasing rural poverty through the implementation of policies that include initiatives to link smallholder farmers to commercial agricultural value chains.

can contribute towards poverty alleviation."

The results from the analyses of the distribution of water use along the value chains show that the bulk of water is used at farm level to produce food. Since food security is non-negotiable, it is important to produce the required food by using water efficiently. Only the volume of water that is really needed to deliver the required food to consumers for food security should be used – nothing more, notes Dr Jordaan. "Since water is used at different stages of value adding along the value chain, it is important to consider water use along the whole value chain to ensure that water is used efficiently."

Given the role of irrigated agriculture in rural poverty alleviation, smallholder farmers must earn the highest possible return from the freshwater they use. By linking water use along the value chain and the distribution of value along the value chain, it is possibly to identify marketing channels that will allow the smallholder farmer to maximise the financial returns he gets from using irrigation water.

CASE STUDIES

The WRC project focused on three case studies: namely the case of raisin producers at Eksteenskuil, Northern Cape; the case of vegetable producers at Zanyokwe Irrigation Scheme, Eastern Cape, and the case of maize and vegetable producers at Thabina Irrigation Scheme, Limpopo. By involving Masters students who spoke the native language at the respective schemes, the project team could overcome language barriers when interviewing the farmers.

Importantly, the case studies showed that the mere availability of water does not guarantee financial success by smallholder farmers. All the farmers from the three case studies had access to water. The biggest challenge was in the way in which this water was managed. Improper operation and maintenance of water distribution infrastructure was commonplace at the schemes investigated.

"Farmers have to use water in combination with other resources effectively and efficiently to allow them to earn the maximum financial returns from having access to irrigation water in the first place," notes Dr Jordaan. Compliance with best management practices in production is crucially important to achieve this. This includes regular maintenance of water distribution infrastructure. Poor maintenance increases farmers' risk that they will not have water at their farms when required, making it more difficult for them to meet best practices.

The study further showed that there are some smallholder farmers

Guy Stubbs/Africa Media Online

Farmers have to use water in combination with other resources effectively and efficiently to allow them to earn the maximum financial returns from having access to irrigation water in the first place.

who eagerly want to be part of the commercial agricultural value chain – and that there are indeed some farmers who do in fact participate fully. Of the three case studies, the Eksteenskuil farmers seemed most successful as they export their raisins as part of an international fair trade initiative – proving that being resource poor should not necessarily exclude one from participating in lucrative export markets. The vegetable farmers at Zanyokwe sell their produce through various channels, including directly to the community, to wholesalers and to retailers. In turn, the farmers at Thabina sell their produce mostly through informal sellers.

The project team was surprised by levels of innovative and entrepreneurial thinking demonstrated by some of the farmers. "Rather than accepting their fate of being exposed to the challenges that often gets blamed for causing the exclusion of smallholder farmers from participating in commercial agricultural food chains, some of the farmers who participated in the research found ways to get around these challenges."

"Rather than accepting their fate of being exposed to the challenges that often gets blamed for causing the exclusion of smallholder farmers from participating in commercial agricultural food chains, some of the farmers who participated in the research found ways to get around these challenges."

So the Eksteenskuil raisin producers organised themselves into a farmers' cooperative to participate in the fair trade market. The cooperative then created additional institutions (rules and regulations) to help members benefit optimally from communal tractors and implements. At Zanyokwe, a paprika growing project created opportunities even

for farmers who chose not to participate – one farmer told the project team how the paprika farmers used their wages to buy vegetables from his farm.

Unfortunately, it seems smallholder farmers also become easily dependent on outside organisations which get involved in projects aimed at improving the livelihoods of farmers from smallholder irrigation schemes. For example, at Zanyokwe the project team witnessed potato seed going bad while lying in a shed as the farmers waited for training on how to produce the potatoes by the potatoes association.

The dependence on government services was also evident. "During discussions regarding the challenges they face the farmers had long lists of things they wanted government to do for them to help them become more successful, such as give them tractors, give input for production, and find a market for their produce," reports Dr Jordaan. "At the Zanyokwe and Thabina irrigation schemes where there had already been large government intervention, farmers proved willing to wait for government to provide these actions, with only some farmers willing to take the initiative for themselves."

The problem with waiting for government is that when promised services are not provided in time, farmers cannot meet recommended dates for certain actions, such as planting or applying fertilizer, thus failing to comply with best practices and threatening production.

To improve the situation, Dr Jordaan recommends that government should focus on ensuring the effective delivery of services to create and maintain en enabling environment for smallholder farmers and private sector firms within agricultural value chains. In addition, policies should be developed that create a vested interest for private sector firms in the performance of smallholder farmers.

"Then private sector firms, who are key roleplayers in commercial agricultural value chains, and who have ample experience and expertise in the functioning of the particular value chain under consideration, will effectively support smallholder farmers to perform at acceptable levels," maintains Dr Jordaan.

There is a definite space for private companies to become involved in uplifting smallholder agriculture. According to Dr Jordaan, the correct alignment of incentives to attract business development is crucially important for the sustained participation by smallholder farmers in commercial agricultural value chains. "Correctly aligned incentives will get smallholder farmers and private sector firms to use a network approach to get the farmers participating in commercial agricultural value chains. This means farmers using collective action and vertical coordination strategies in an effective manner to improve their business – not just accessing government grants.

"Only the volume of water that is really needed to deliver the required food to consumers for food security should be used – nothing more."

The results from the study show that smallholder farmers have great prospects to increase their production levels. It is believed that the key success factors identified through the study could contribute towards the successful participation of these farmers in agricultural value chains.

Ultimately, however, smallholder farmers' success will depend on their ability to exploit the opportunities provided to them.

More project outcomes and recommendations can be found in the final report, *An economic analysis of the contribution of water use to value chains in agriculture* (**Report No. 1779/1/12**). To obtain a copy of the report 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. ❑

How can smallholder farmers improve their participation in agricultural value chains?

- Don't stare blindly at the challenges that prevent participation – pay attention to finding innovative ways to overcome these challenges and identify all possible support structures that can help implement these actions. This will help farmers exploit profitable opportunities.
- Compliance with best management practices contributes towards the ability of farmers to produce the maximum yield possible at the level of inputs applied and within their existing technology sets.
- Seek ways to improve strategic decision-making skills to improve the effectiveness of day-to-day decision-making. Smallholder farmers' cooperatives should regularly identify the training needs of their members.

'CLOSURE MINING' – Introducing a new concept for environmentally responsible development

Museum Africa_Africa Media Online

In this exclusive article, Prof Anthony Turton of the Centre for Environment, University of the Free State, introduces the concept of 'closure mining' as a solution to the environmental pollution legacy of the mining sector in South Africa.

South Africa is currently facing a challenge from three different drivers, all of which are strategically important. Firstly, we are transitioning into a water deficit situation in which all future economic growth and development will be constrained if we continue with the business as usual approach. Secondly, we are entering a period of our national development in which environmental risks are likely to increase exponentially, in response to various drivers (including the two mentioned here).

Thirdly, we are transitioning from a mining-based national economy to a future, as yet ill-defined beneficiation type of economy, in which the environmental externalities of the

past 120 years of resource extraction will increasingly present as constraints to job creation, social stability and global competitiveness. This opinion piece will unravel this complex bowl of spaghetti by offering a solution in the form of Closure Mining.

THE RISE AND FALL OF GOLD MINING

In all of recorded human history, a staggering 40% of the gold ever produced comes from the Witwatersrand Goldfields. The production cycle of gold is shown in Figure 1.

From this dataset a number of elements are evident. The most important is the steep rate of decline from the peak in 1970, interrupted by a brief respite in 1994/5 as we transitioned to a democracy. More important is the existence of three discreet sub-cycles, each representing different phases of technological development in the industry.

The first phase, peaking in the 1930s, was driven primarily by mechanical engineering as shallow underground operations (< 800 m below surface) were rolled out. The second phase, peaking in 1970, was driven primarily by geophysics capable of understanding the behaviour of rock under extreme pressure at depths of up to 3 000 m below surface. The third phase, peaking in 1995, was driven by improvements in metallurgical processes now capable of recovering residual gold from tailings dams. Working in unison, these three sub-curves generate the overall production cycle, which is now in a phase of dramatic decline, with catastrophic collapse in the near term future all things remaining equal.

STRATEGIC RISKS ARISING FROM THE LEGACY OF MINING

Why should we be concerned about this in the water sector?

The answer to this is complex, so let us try to unravel this bowl of spaghetti. What most non-mining people do not realise is that there are certain fundamentals on which the industry has been predicated. Arguably the most significant of these is that tailings (mine spoil or residue from the extractive process) have been deposited in vast quantities across the landscape.

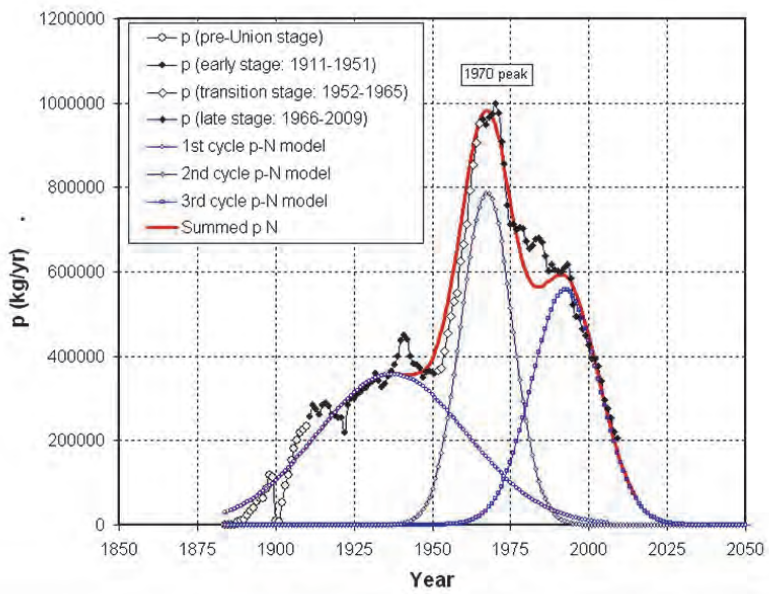


Figure 1
South African gold production life cycle. (Source: GDARD)

When initially deposited more than a century ago, most of these dumps were in the barren Highveld, far away from any human settlement. More importantly, these tailings piles consist of finely milled quartzite with the consistency of talcum powder. As such there is limited structural integrity to the dumps, which consist of a series of outer bunds created by pumping slurry into piles and then allowing that to dry. This creates a progressive ring around the base of the dump, much like a levee constructed to channel a river.

Once this outer levee is dry enough, the inner portion is filled with wet tailings, which slowly dry out as water is either evaporated off the surface or infiltrated into the ground. This process is repeated many times, resulting in the characteristic step-sided flat-topped structures we know today. However – and this is the big risk factor that will increasingly become relevant as the industry collapses – this shape is inherently unstable, so structural stability can only be assured if there is a continuous cash flow to pay for the constant maintenance needed to plug the gaps caused by erosion.

This shape is inherently unstable, so structural stability can only be assured if there is a continuous cash flow to pay for the constant maintenance needed to plug the gaps caused by erosion.

This is the first strategic risk we need to understand. The structural integrity of mine tailings dams is 100% dependent on the continued existence of machinery to maintain the step-sided flat-topped profile. When the machinery goes the dumps simply collapse.

The second fundamental risk that needs to be understood is that these dumps are rich in uranium and a host of heavy metals, all of which are currently bound up in an increasingly unstable structure. For every ton of gold mined since 1886, between 10 and 100 t of uranium has also been brought to surface, depending on the reef band being mined at the time. In fact the combined mine tailings dams in the Witwatersrand Goldfields contain a staggering 430 000 t of uranium in various forms, all about to be released as the dumps start to

Arnaud Thierry Gouegnon/Africa Media Online

Illegal miners or 'Zama Zamas' are becoming an increasing problem in South Africa.

collapse when the last remaining mining companies become insolvent, as they most certainly will in the next decade (unless they do things differently).

The third strategic risk we need to understand is the presence of uranium, about to be released into the environment in vast quantities, as dumps fall into disrepair and succumb to the erosion forces of wind and water. This is virtually a 100% certainty if we continue on the same trajectory and fail to implement a comprehensive mine closure strategy that simply does not yet exist in any coherent format.

The fourth fundamental risk is that all of the land from Randfontein in the west to Springs in the East that follows the Main Reef is structurally unstable. The reason for this is that a complex array of surface striking reef, roughly adjacent to the Main Reef Road, has all been undermined by historical mining activities, and now increasingly by artisanal miners known as Zama Zamas. We thus has a swathe of land, almost 100 km long and 2 km wide, passing south of the city centre, that is the only land left to develop, but is actually unfit for human habitation because of the absence of structural integrity.

The fifth fundamental risk is that this swathe of land is being settled both formally and informally. A study done in 2011 for Gauteng Department of Agriculture and Rural Development indicated that around 1.6 million people were already living on this land and that number is growing exponentially.

The same study made it clear that doing nothing was an extremely high risk strategy, proposing instead a formal policy that either moved the people from the hazard, or the hazard from the people. This policy has never been formally adopted by the Gauteng legislature, so people are settling on this land in an uncoordinated manner. This is a ticking time bomb.

"Outcome of closure mining is a rehabilitated landscape and functional ecosystem capable of supporting humans and other species."

The sixth risk is that of acid mine drainage (AMD), which we now know is generated mostly on the surface in these tailings dams, infiltrating into the void via multiple ingress points. Work in progress is showing that rain with a pH of 3 is failing on the flat topped tailings dams, triggering the acidification process as the hydroxide coating of the quartzite particle rich in pyrite is oxidised.

AMD is thus closely associated with tailings, but given that these tailings are uranium rich, also becomes a hazard for wind borne dust. The seventh risk is therefore the growing probability of dust-borne fallout of uranium over an as yet ill-defined footprint of land being drained by rivers and wetlands.

The eighth risk rapidly becoming a large blip on the radar screen is that of artisanal miners. As the gold industry collapses, so more Zama

Zamas are being encountered, and it is now probable that there are as many artisanal miners as there are legal miners. Closely associated with this activity is organised crime as explosives are used for ATM bombings and processed gold is swallowed up into sophisticated money laundering syndicates. A recent turf war between two rival Zama Zama gangs in the Florida area saw mass killings underground.

This is a taste of things to come. From an environmental perspective, these artisanal miners use mercury to concentrate their gold and this enters the atmosphere and aquatic ecosystems.

CLOSURE MINING AS A POTENTIAL SOLUTION

Closure mining can be defined as the deliberate long-term planning to optimise all mining-related processes and operations with a view to aligning the final outcome with the broader interests of society, in collaboration with all key stakeholders in a post-mining future, guided by the triple bottom line associated with sustainability reporting. The outcome of closure mining is a rehabilitated landscape and functional ecosystem capable of supporting humans and other species, while mitigating all legacy issues to the extent that they no longer act as constraints on future socio-economic development.

This is nothing more than an adaptive response by the mining industry and is actually in the best interest of society as well. The process is being tested in an experimental sense in the Western Basin and is shown schematically in Figure 2.

In simple terms, the low grade, high-volume tailings recovery is made economically viable by the high grade, low-volume ore from the extraction of surface striking reef. In the process, AMD is neutralised and the landscape is cleared of surface dumps. The void is closed out as are ingress points for water and entry points for artisanal miners. The land is ultimately rehabilitated to a standard that is fit for purpose, which has to be defined through a visioning process, also designed to build consensus about the overall benefit of the process.

As an experiment in progress three constraints have been identified to the successful implementation of this model. These are:

- Absence of a coherent body of technical knowledge to inform the rehabilitation of mine-impacted ecosystems.
- Absence of a post-closure vision capable of driving consensus around the need for rehabilitation and the standard to which rehabilitation needs to comply with.
- Absence of an institutional arrangement capable of engaging the many parties needed for a successful outcome.

CONCLUSION

If the business-as-usual model prevails, then the gold mining industry will collapse in the next decade, with a high level of certainty. This will have a devastating effect on the ecosystems of the Witwatersrand Goldfields, unleashing a deluge of uranium over the landscape, while triggering a wave of illegal mining activity that will be virtually impossible to police or regulate. Increasingly, angry people will turn on the government as their houses succumb to the geotechnical instability associated with construction on undermined land. Closure mining can prevent this, but it can only be done if consensus is built between all parties that the final outcome is indeed desirable for society as a whole.

If adopted as a strategy, then an environmental catastrophe of unprecedented magnitude can be averted. The recent events unfolding in the Western Basin do not bode well for this, however, so the prognosis for success seems tenuous at the time of writing. What we need is leadership of the calibre of the Gene Kranz, Mission Controller for Apollo 13, who said to his team that failure is not an option, when confronted by an unanticipated catastrophe. Should this type of leadership emerge, then Johannesburg need not be called the most uranium contaminated city in the world.

Watch Prof Anthony Turton talk at the TedX Table Mountain event earlier this year: http://youtu.be/VTr0QpOxyWY ❑

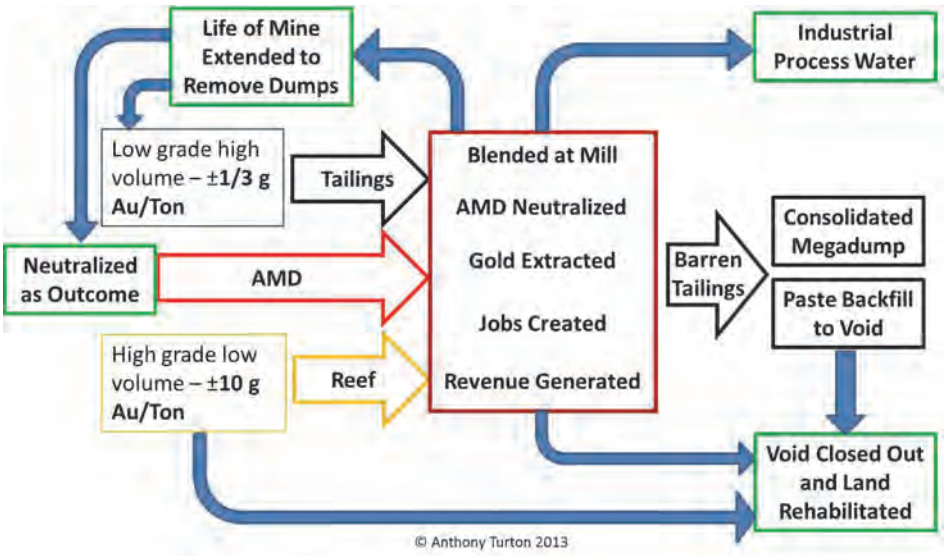


Figure 2
Schematic representation of the concept of closure mining as being refined in the Western Basin.

LARGE-SCALE DESALINATION: What can we learn from Australia?

Wikipedia

Desalination is bound to take off on a large scale in South Africa in the near future as conventional water resources become increasingly scarce. But what can we learn from other countries where this has already happened, such as Australia? This report from Dawid Bosman, TCTA Senior Manager: Advisory Services.

Seawater desalination is an immensely scalable and climate-independent water resource, and is being adopted on a global scale. Around 68 Gigalitres of desalinated water is already being produced each day by nearly 15 000 desalination plants (Imagine a cube of water standing as tall as the Empire State building in New York). This capacity is growing by about 12% each year, which suggests that global water scarcity is growing faster than both the economy and the population.

Large-scale desalination will take off in South Africa within the next few years; our surface water resources are already stretched to capacity in many catchment areas, and are vulnerable to changes in climate. But desalination will be only a part of a collective response to address water security, alongside conventional resources, and a multitude of water reuse, conservation and demand management initiatives. Whereas some dams will still be built or upgraded in years to come, a new breed of water infrastructure project will join the project pipeline: the large-scale desalination plant.

Desalination in South Africa is still in its infancy; the largest plant is a modest 25 Ml/day plant treating mine effluent at eMahlahleni. There are also a few smaller, seawater plants that were built by municipalities along the South Coast, often as an emergency response to prolonged drought conditions. Many of these projects have been characterised by technical design flaws, resulting in costly, premature refurbishments.

The next milestone will be desalination on a far greater scale, of 150 Mℓ/day per day and more, when the large metropolitan municipalities adopt the same technology. As one would expect, such a step-up in scale will bring a significant increase in cost and complexity.

The exact timeline to that milestone is not yet clear, but detailed feasibility studies have been undertaken on project options in Cape Town and Durban, and desalination now features prominently in their water resource planning portfolio. Desalination is also under consideration to treat acidic mine water to a potable standard on the Witwatersrand.

These projects will require a very different approach to project design, procurement and institutional framework, compared to what is the norm for conventional water infrastructure. Looking abroad at projects underway or recently completed, it is apparent that they are extremely complex, and can fail to deliver on early expectations. The question is whether our water sector, with its current resources and competencies, is ready to guide the implementation of a successful, large-scale desalination project?

At the TCTA, we are studying the complexities of the desalination

challenge, and have set out to learn from the experiences of other countries that have gone on this path before us. Our aim is to gain insight that will help us avoid, as far as possible, the costly design and implementation mistakes made elsewhere.

After an initial desktop study, it became clear that Australia presented a very useful field of study. Between 2006 and 2013, they had built six very large sea water desalination plants, primarily as a response to the Millennium Drought, which lasted from 2003 to 2010. The fairly recent completion of the projects meant that the implementation teams and corporate memories were mostly still intact.

And since Australia has a similar energy mix as South Africa, their desalination technology choices would also be similar. Finally, amongst most of the water utilities in Australia, we encountered a willingness to share information.

Our initial enquiries were met by a positive response from three water utilities, who were also project owners. SEQWater in Brisbane invited us to visit their Gold Coast Desalination Plant, SAWater invited us to the Adelaide Desalination Project, then under construction at Port Stanvac, and Water Corporation in Perth invited us to visit their Kwinana Plant, and to attend a presentation on their Southern Desalination Project, then under construction near Binningup.

The lessons from the tour were documented in a TCTA journal, *Building Best Practice in Desalination: Part 2 – Lessons Learned from Large-Scale Projects in Australia*. What follows here are the key points, in a more concise format.

CAPITAL EFFICIENCY IS NOT GUARANTEED

When comparing the capital efficiency of Australian desalination projects against other water-supply projects of similar technology, scale and timeframe, the Australian projects dominate the least capital efficient end of the spectrum, and in absolute terms, some of the Australian projects are 10 to 15 times more expensive than the best performing projects of the same capacity.

A number of factors contribute to this extraordinary capital expense. Firstly, environmental compliance is probably the main reason why the Australian desalination projects are so expensive. Australia has perhaps the toughest standards of environmental protection in the world, and a rather activist society.

Secondary reasons for the high cost would include the alliance procurement model, the unionised local labour force, and the risk premium that projects outside the Gulf market tend to attract, due to the absence of a track record of long-term successful projects.

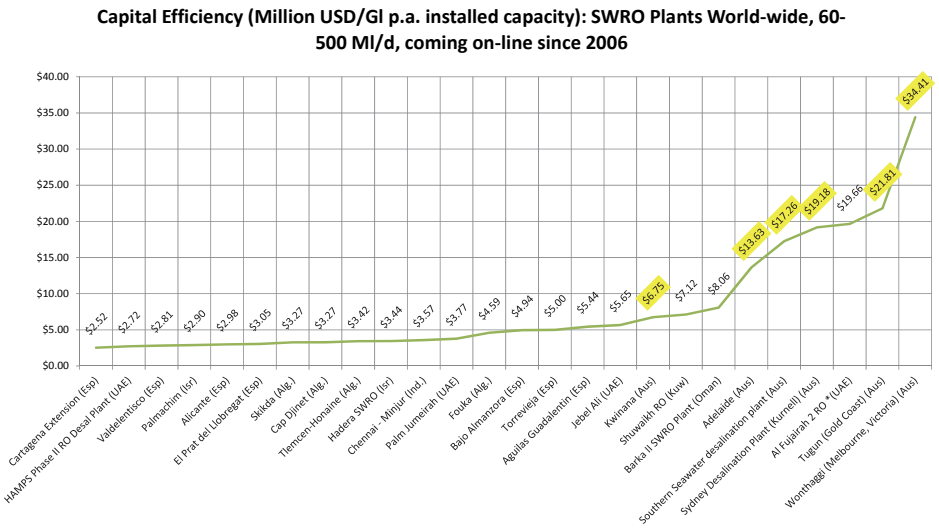


Figure 1
Comparison of Capital Efficiency, XL SWRO Plants, coming on-line since 2006 (DesalData, 2012)

GETTING PROCUREMENT RIGHT: THE ALLIANCE MODEL

Large-scale desalination projects are extremely complex to design, build and operate, and this poses a tough challenge to conventional procurement methods. In the Australian public infrastructure sector, the alliance model of procurement and contracting is widely used. In 2012, alliance contracts represented one third of the total value of public sector infrastructure projects delivered.

The desalination projects we reviewed also went this route, before

Courtesy Dawis Bosman

The TCTA team during their visit to Australia.

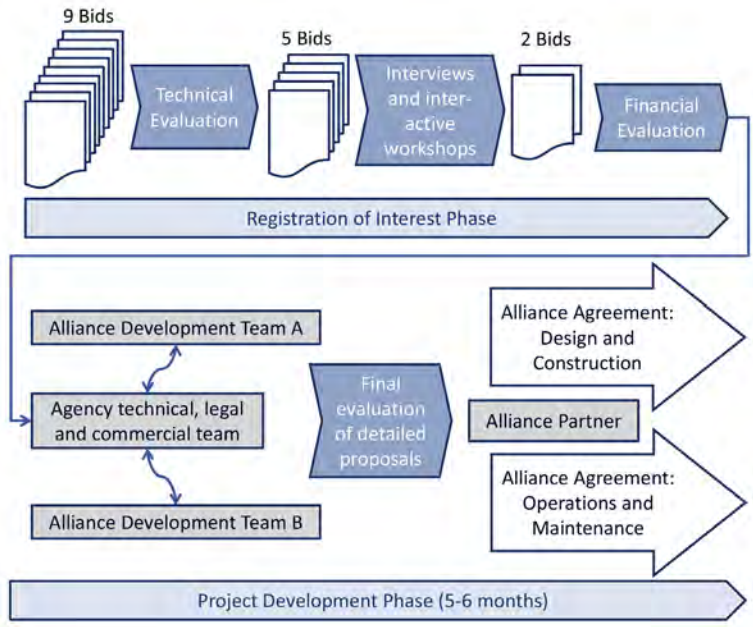


Figure 2
The Alliance Development Process

entering into long-term design-build-operate-maintain (DBOM) contracts. The idea of the alliance approach is to create a project environment where the interests of both the agency and the consortium are aligned, through smart incentives and risk-sharing arrangements, where the risk of avoidable cost overruns are minimised by design. And because the alliance is such an intimate business venture, it is extremely important to select the right partner – not unlike a marriage. Hence a very thorough process of evaluation and elimination is followed.

The alliance-forming process happens in two phases: The registration of interest (ROI) and the project development phase (PDP). During the ROI phase, consortia are invited to submit their qualifications, proposed personnel and cost estimate for the project development phase (PDP). The bids would contain separate technical and financial envelopes.

"Large-scale desalination projects are extremely complex to design, build and operate, and this poses a tough challenge to conventional procurement methods."

After a technical evaluation, the field of bidders would be narrowed down. Then follows interviews and interactive workshops, after which only two bidders would be selected for the PDP-phase. The financial bids are then opened to ensure that cost estimates are within a predetermined range.

The PDP phase extends over a period of five to six months, during which time the agency will second key personnel to each of the bidding teams, and conduct a continuous evaluation through weekly progress meetings and workshops. This produces two detailed, competing proposals, in whose accuracy the agency will have a high degree of confidence, containing the following:

- Designs completed to about 30-40%;
- All technical and financial risks identified;
- Detailed capital and operating cost estimates;
- Risk and reward mechanisms negotiated.

In the final evaluation, the two proposals are evaluated using criteria that include life-cycle cost, culture, capability and commitment. Then follows a thorough commercial, technical and qualitative evaluation, after which one consortium is appointed as the alliance partner, and thereby chosen to design, construct, operate and maintain the plant in an alliance with the agency.

The alliance model is a fundamental departure from conventional methods of procurement and contracting. Competition for the bid extends quite far into project design. This is costly and time-consuming, and hence the agency reimburses the losing bidder for expenses incurred. This makes it a very expensive procurement process. Yet the advantage is that a long-term partnership on a very complex, strategic and expensive undertaking, is entered into on a well-informed basis.

Clearly, the alliance approach requires a very mature professional environment.

SITE SELECTION

Site selection is an extremely important decision-point in the design of the project, as the choice will determine the efficiencies and risks that will characterise the plant over its entire lifespan. As a result, site selection is typically preceded by an in-depth investigation into the project requirements, and the degree to which alternative sites will address those needs. Costs and benefits of each site parameter are quantified, as well as the timeframe in which it will occur, and the Net Present Value (NPV) calculated. Allowing for key considerations that could not be quantified, the site with the lowest NPV would usually be selected.

A previously disturbed site can be attractive, as it often presents a lower environmental hurdle. The Binningup site had been used as a stone quarry before, and this eased some environmental concerns. However, the prior use of the site may also be a negative; at the Tugun site (Gold Coast), the site had been previously been used as a landfill, which aggravated the ill effects of

sub-standard civil works, resulting in contaminated groundwater ingress into the intake and outlet shafts, and unwanted Methane releases on-site.

A potential site may not have clear access to the beach (the Tugun site has an airport and residential area between itself and the beach), or disturbance of the beach may be restricted due to environmental or social sensitivity. In these instances, the designers may have no choice but to select a tunnel design for the marine intake and outlet. This would add hugely to the cost of the entire project.

The rapid dispersal of brine (the highly saline waste from the desalination process) in sea water, as well as a slow flow-rate of feed water at the intake, are both key design objectives of the marine structures, due to environmental concerns. Whereas the intake flow-rate could largely be achieved through clever design, brine dispersal is very much reliant upon the sustained flow of off-shore currents, which is of course site-specific.

Some plants are more susceptible to brine dispersal problems than others; the Kwinana plant is perhaps the most intensely monitored plant in the world, due to its location within the environmentally sensitive and relatively still Cockburn Sound. During 2008, the desalination plant had to be shut down twice due to insufficient brine dispersal. A site with restricted or inconsistent ocean currents could lead to permitting delays, onerous monitoring requirements and the enforcement of periodic plant shut-downs, all resulting in reduced operational efficiency.

ACHIEVING VALUE FOR MONEY

Despite the Australian projects being probably the most expensive in the world as a group, it became clear that, amongst themselves, they achieved varying degrees of success, in terms of value for money. The term 'value for money' in this instance, refers to the best economic outcome over the project lifespan, and has two key components:

- Capital Efficiency: The ratio of capital outlay over yield, measured in $ million per gigalitre of water produced per annum.
- Operational Efficiency: The ratio of operating cost over yield, measured in $ million per gigalitre of water produced per annum.

Within the Australian cohort, a range of capital and operational efficiencies were achieved, which indicates that some projects had achieved better economic results than others – Figure 3 illustrates the benchmarks.

Whereas there are a multitude of factors that would contribute to a project's performance in this comparison, the following observations may explain some of the differences:

- The Victorian project is located on a site with very high levels of environmental sensitivity, which required extensive landscaping to cover the entire plant, even on the roofs, to mitigate the impact and obtain approval.
- The Gold Coast project was beset with engineering and site-related challenges, probably more so than any of the other projects.
- The later projects (Southern and Adelaide, completed in 2012) appear to perform better than the earlier projects, which suggests that some learning had transferred between projects, which resulted in greater efficiency in procurement, site selection and technology choice.

Lani van Vuuren

The Emalahleni Water Reclamation plant, which treats polluted mine-water to potable quality, has one of the largest desalination installations in South Africa.

The above spread of benchmarking values again underlines the importance of carefully considered project design, site selection, alliance partner selection and efficient execution. These broad areas of risk are significant determinants of the capital and operational efficiencies of a project, over the long term. Furthermore, it should be an on-going aim to draw on the learning experiences of projects that had gone before, and in doing so reduce the probability of repeating mistakes.

Finally, it is worth noting that even in the relatively robust institutional environment of Australia's federal and state governments, not all the challenges of the desalination build programme were anticipated, and some expensive lessons were learned, despite efforts to pre-empt them. ❑

Figure 3
Benchmarking Capital and Operational Efficiency.

	Installed Daily Capacity	Installed Annual Capacity	Capital Cost	Capital Efficiency	Operating cost per annum	Operating Efficiency
Desalination project:	MLD (Megalitre per day)	GLA (Gigalitre per annum)	AUD million	AUD million / GLA	AUD million	AUD million / GLA
Victorian	435	146	5500	37.74	600	4.11
Gold Coast	125	42	1200	28.66		
Sydney	250	84	1900	22.69	258	3.07
Southern	140	47	955	20.36		
Adelaide	300	101	1824	18.15	129.9	1.29

Why is there an ecological reserve?

Although the concept of an 'ecological reserve' aimed at maintaining the ecological integrity of our water resources is now well known in water management circles, surprisingly little has been published about why such a reserve is necessary. This overview by Dr David le Maitre explores the rationale behind the ecological reserve, and links this to the concepts of ecosystem services and ecological infrastructure.

Many articles and reports refer to the ecological reserve but they mostly deal with what it is, how to estimate it, and how to implement it in practice. Not to why it is there. The concept of ecological infrastructure is explicitly linked to ecosystem services. But a recent article on that topic (see the *Water Wheel* July/August 2013) does not clearly link ecological infrastructure with the ecological reserve.

There seem to be no discussions of the concept which are generally or widely accessible to people. All the information is in documents that are typically only read by hydrologists and aquatic ecologists. This is quite surprising because a fundamental principle like this, which requires that water is set aside to meet its requirements (and basic human needs) before any other considerations, should surely be based on strong arguments?

So, how did the concept of an ecological reserve become a fundamental provision in the National Water Act of 1998? The ecological flow requirements introduced in the 1980s, and the explicit recognition that aquatic ecosystems should be protected because of their critical role in maintaining and improving water quality, both set precedents. The role of ecosystems in regulating water quality led the drafters of the Water Law Principles in 1996 and the 1997 Water Policy to recognise that maintaining water quality required maintaining the entire ecosystem which led naturally to the idea of resource quality and to the ecological reserve.

Another important factor was the need to fulfil the requirements of the Constitution and the fundamental principles of the water law finalised in 1996. The Constitution's Bill of Rights gives all South Africans the right *to an environment that is not harmful to their health or well-being*, as well as the right to have the *environment protected for the benefit of present and future generations*. Clearly, if we allow people's water supplies to become so contaminated they are harmful, then we have failed to fulfil that right.

The Constitution also provides for access to sufficient food and water, a right which was recognised by the provision of water for basic human needs in the reserve. It was a natural step from this line of thought to the principle that: *The quantity, quality and reliability of water required to maintain the ecological functions on which humans depend shall be reserved so that the human use of water does not individually or cumulatively compromise the long-term sustainability of aquatic and associated ecosystems.* This principle makes it crystal clear that the reserve is about maintaining ecological functions **on which humans depend** and, therefore, explicitly links the reserve to ecosystem services.

People have also been manipulating ecosystem and the services they

provide to increase the benefit to us for thousands of years. For example, growing crops like vegetables involves capturing and modifying ecological processes to favour food production. There are indications that our use of ecosystem services is approaching and in some cases exceeding the capacity of the ecological infrastructure to deliver the necessary level of services. These limits apply both globally and locally and affect everyone.

We have seen these limits coming to light across South Africa, where many of our river systems have been so badly damaged by the pollutants that flow into them – sewage, industrial wastewater, acid mine drainage, return flow from agriculture – that they are hazardous to all life downstream. This situation has been aggravated by the fact that we also take out large volumes of water, not leaving enough to dilute the inflows and sustain the ecosystems that could assimilate the pollutants. Some impacts can and should be corrected quickly such as industrial pollution and dysfunctional wastewater treatment plants. Others will take longer to 'fix' and will be very expensive, much more expensive than if we had dealt with them when they first became evident.

An ecosystem service perspective tells us that the question is not how much water can we remove from a water source (e.g. a river) without compromising its ecology, it is how much and of what quality is needed to ensure that a given water source's ecosystem is able to continue supplying us with the same amount and quality of water in the future. And to understand this we have to view the water source as a system from which people benefit, at a particular site, as well as downstream and upstream.

Most of those benefits are sustained by regulatory services and the ecological infrastructure that supports them. There services regulate water quality and quantity and, therefore, the provision of water for us to use. So, how do these regulating services actually work? How does an ecosystem regulate the flow of water?

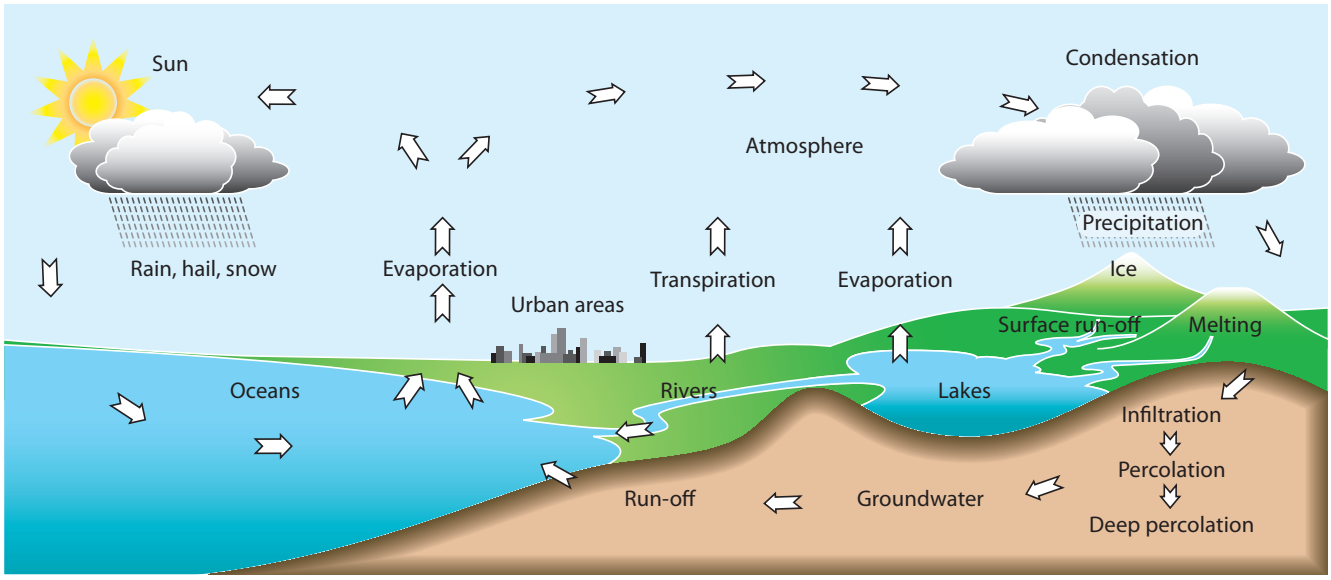
The best way to understand this is to follow the paths taken by water in the water cycle (see Figure below).

The regulation of flows is often seen as applying only to the movements of water from rainfall into rivers, often via groundwater, and back into the oceans. However, the vegetation that covers most of the land plays critical roles in the composition of the gases in the atmosphere (together with the plankton in the ocean) and the energy balance of the planet – how much sunlight is absorbed and reflected. Transpiration by plants also plays a critical role because water evaporation absorbs a lot of energy.

Vegetation and animals also protect, stabilise and maintain the porousness of soils which is important because the porousness determines how much rainfall infiltrates into, and moves through, the soil and how much runs off over the surface. Land degradation generally reduces vegetation cover, exposing the soil and reducing its porousness, increasing the runoff and facilitating soil erosion. This creates negative feedbacks which lead to further degradation. The eroded soil lands-up in rivers and is carried downstream to fill-up dams and clog estuaries.

Well-managed vegetation typically maintains high infiltration rates which are important because this limits how much rain water flows rapidly overland to reach rivers and how much filters more slowly through to sustain flows during dry seasons and droughts. When lots of water flows overland the rivers tend to produce floods which can do considerable damage.

Land degradation therefore tends to increase the risk of flooding downstream. At the same time, the reduced infiltration leaves less water for plant growth, which can reduce fodder and crop production in dry years and droughts. The reduced dry season



The water cycle.

Courtesy David le Maitre

Water quality regulation is a vital and critical service, especially for the poor who often live in highly degraded environments.

flows can also adversely affect aquatic ecosystems, reducing their biodiversity and resilience and compounding the effects of the higher sediment loads entering the river systems.

These impacts are important because the aquatic organisms, including those that live in or on the sediments in the river bed and banks or on the rock surfaces, play a critical role in regulating water quality. As rivers flow from their mountain sources to the sea, the rates of flow and river channel form changes. Headwater streams typically are narrow, slope steeply and flow rapidly over rock, boulder and pebble beds and have narrow strips of riverine vegetation.

In the more gently sloping middle slopes they tend to broaden, flow more slowly, accumulate more sediments, widen and have wider floodplains. One the lower slopes and plains the flow slows even more, sediments accumulate to form the entire river bed, its course meanders and it tends to form multiple channels. On the highveld even headwater streams are gently sloping.

All the way down a river there is continual interchange of water between the water on the and in its bed and banks and water is also taken up by the riverine, floodplain and wetland vegetation. This interchange is very important because it brings the substances in the water into close contact with the organisms living in or on the sediments and rocks and the roots of the riverine and wetland plants. The organisms and plant roots absorb these substances.

The microorganisms, in particular, are very effective at this and also at taking up chemical pollutants and breaking them down to harmless chemical compounds. The types of sediments also play a role. Sediments with a high proportion of clays can absorb large quantities of phosphorus because it binds chemically to the clay minerals. The coarse white sands of the Cape rivers are less effective as the clay content is low but can transmit larger volumes of water.

Research has found that wetland and river ecosystems can even cope with, and purify acid main drainage. As water moves through these sediments it loses oxygen which is important because different kinds of organisms, particularly bacteria, thrive under these low or no oxygen conditions and are capable of absorbing and breaking down different kinds of pollutants. As rivers change from their headwaters to the estuary they can offer different kinds and amounts of water quality regulation (i.e. purification) services.

Healthy rivers and wetlands, therefore, play a vital, unnoticed and essentially invisible role in delivering water we can safely use for drinking, washing, irrigating crops, processing minerals from mines. It would cost a lot of money to replace these services. If water purification plants had to be built and maintained to achieve the same levels of water purification the costs would run to billions of Rand – huge amounts of money we could otherwise have spent on houses, schools, or creating jobs.

We have also physically modified many rivers by converting them into canals to get rid of the stormwater, often to protect buildings and other structures that should never have been built there in the first place. Far more damaging and pervasive though are the habitual, and illegal, bulldozing of river channels and the clearing of riverine and floodplain vegetation so that fields and other things can go right up to the river bank.

There is a lot of research which clearly shows that those strips of riverine vegetation play a critical role in buffering the riverine ecosystems

Courtesy David le Maitre

Eroded soil lands-up in rivers and is carried downstream. This river should be clear, but has a high sediment load due to erosion.

from the effects of activities on the adjacent land. Even a 30 m strip can make a substantial difference. Commercial forestry companies have adopted environmental guidelines which do not allow them to plant their trees up to the edge of the river or wetland. The distance is determined by inspecting the soil for signs of seasonal or permanent water logging. The rationale is that trees planted close to wetlands or rivers use far more water than those away from wet or waterlogged soils. But there is another important benefit which is that tree planting and felling activities are also kept out of these areas with their fragile soils.

Unfortunately, the same cannot be said of agricultural fields which often extend well into floodplains and livestock which are allowed free access to these areas. They do so despite regulations which state that permission is required for cultivation within 10 m of the flood area of a water course, in the floodplain or in wetlands.

The effects of unwise cultivation are exacerbated by the intensive use of fertilisers, pesticides and herbicides in the cultivated land. Some of these substances end up directly in the river or are transported there when rainwater runs over the surface. When the cultivated lands are irrigated, some of the irrigation and rainwater is not used by the crop and filters down into the soil to end up in the groundwater. The groundwater then flows downslope until it discharges into a river as return flow.

The soils and soil organisms do absorb and break-down some of the substances *en route*, but some is transported with the groundwater and ends up in the rivers. The Green Drop initiative and its findings have highlighted the direct impact of discharges from dysfunctional wastewater treatment plants on water quality, both chemical and microbial. These discharges also have an indirect effect by exceeding the water quality regulation capacity of the riverine and wetland ecosystems. The same applies to other direct discharges of industrial wastes and outflows of acid mine water.

More subtle but no less significant damage is caused by acid mine drainage via groundwater. There are many routes by which pollutants enter our rivers and wetlands and most are not easily seen. The variety of substances is huge and we know very little about how they mix when in the water. The organisms living in river and wetland ecosystems can also reduce the quantities of infectious organisms in the water. Some, like the *Escherichia coli* bacterium are quickly neutralised because they do not live for long out of the body but others are attacked and controlled.

Thus the abundance of many disease causing and transmitting organisms is regulated by other organisms in ecosystems. The operation of these regulatory systems is not well understood but they are believed to play a critical role in limiting disease outbreaks and protecting human health. All this should make it very clear that water quality regulation is a vital and critical service, especially for the poor who often live in highly degraded environments and cannot afford the protective measures available to the wealthy.

Should we be surprised by the poor state of the water in our rivers and wetlands? I would argue that we should actually be surprised by the fact that these ecosystems continue to deliver services despite all we have done to degrade them, either deliberately or through neglect. Even ones that seem to be damaged beyond repair have surprised us by their ability to recover when given even half a chance. We need to acknowledge the wisdom of those who recognised the immense value of these ecosystem services and included the ecological reserve in water policies and legislation to protect them for us. Each of us needs to do our best to ensure that our wetlands and rivers are respected and protected. ❑

SOURCES OF USEFUL INFORMATION

- Department of Water Affairs policy documents: http://www.dwaf.gov.za/Documents/default.aspx?type=policy
- The African Water Page (http://www.africanwater.org/) has many useful links including copies of the 1996 Fundamental principles of the Water Law and the 1997 Water Policy White Paper
- MacKay, H. 2000. Moving Towards Sustainability: The ecological Reserve and its role in implementation of South Africa's water policy www.africanwater.org/ecosystems_and_water_law.PDF
- Ecosystem services: http://en.wikipedia.org/wiki/Ecosystem_services
- Folke et al. 2009. Planetary boundaries: exploring the safe operating space for humanity. Ecology and Society 14(2): 32. (http://www.ecologyandsociety.org/vol14/iss2/art32/)
- Van Wyk, E, Breen, CM, Roux, DJ, Rogers, KH, Sherwill, T and van Wilgen, BW (2006) The Ecological Reserve: Towards a common understanding for river management in South Africa. *Water SA* **32**, 403-409.

Courtesy David le Maitre

Cows drinking from a river affected by dysfunctional wastewater treatment.

Water service delivery challenges – What role for water demand management?

Pippa Hetherington/Africa Media Online

Water conservation and water demand management (WC/WDM) initiatives have much to offer in terms of curbing South Africa's municipal water service delivery challenges, argues Jeremiah Mutamba of the TCTA.

Water is a precious yet scarce resource in South Africa. The recent countrywide protests for improved water (and other) services bear clear testimony of the deep-seated and potentially explosive water supply challenges that South Africa face. In extreme cases, lives have been lost and relations broken, as communities lost patience on waiting for reliable supply of the essential resource – water.

From across the country communities have taken to the streets to express their frustration on the lack of clean, safe and sustainable water supplies. While a number of these vexing challenges are due to capacity challenges, one cannot deny that some have a lot to do with the scarcity of the precious resource. This article looks at the South African water service delivery challenges in the lenses of resource availability as well as managerial and operational capacity in the country. The article also attempts to reconcile these challenges with the opportunities that water conservation and demand management initiatives could offer to rescue troubled communities.

HISTORICAL CONTEXT

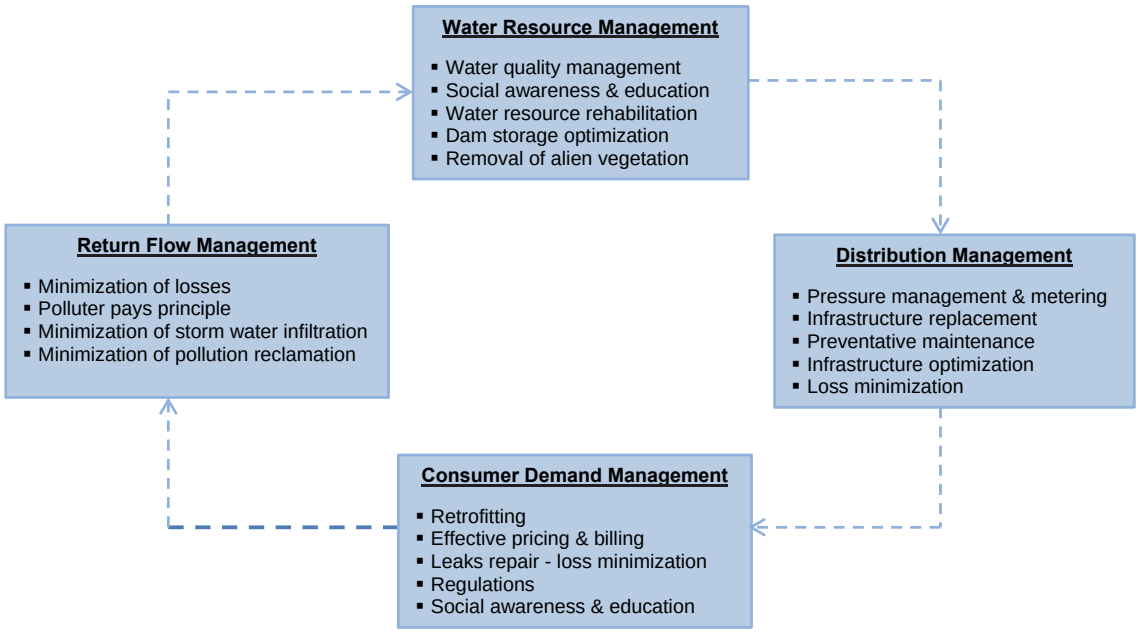
South Africa has a long history of inequitable water policy. Following the country's democratisation in 1994, the South African government embarked on an ambitious programme to address historical inequalities and, in particular, to eradicate water supply and sanitation backlogs. These initiatives were underpinned by the development of sound policy and legislation – the principle pieces of legislation being the White Paper on National Water Policy of 1997, the National Water Services Act and the National Water Act (NWA), promulgated in 1998.

These pieces of legislation, together with supporting frameworks like the National Water Resources Strategy of 2004 (revised in 2013), and the National Water Conservation and Demand Management Strategy, redefined the South Africa water landscape – ushering a new era full of hope and expectations. The NWA, widely regarded as the most progressive pieces of legislation, recognises water as a basic human right and puts emphasis on sustainability, equitable access, and efficient use.

Courtesy of the new policies, it is reported that South Africa reduced its water services backlog from 41% in 1994 to 12% in 2009 and an estimated 5% currently. Also, South Africa achieved its Millennium Development Goal of halving, "by the year 2015... the proportion of people who are unable to reach or to afford safe drinking water" in 2005. Given the widely acclaimed water policy and the reported impeccable progress on redressing historical inequalities in water supply, one would least expect to see the violent water-related protests that have been recently witnessed across the country.

To fully grasp South Africa's water issues, it is essential to delineate the

In some cases water scarcity is due to natural or physical scarcity while in the majority of problem cases it is due to human or managerial factors.



Adapted from Mwiinga *et al.*, 2008

Figure 1: *Components and elements of WCDM.*

sources of the prevailing water scarcity. Of course, in some cases water scarcity is due to natural or physical scarcity while in the majority of problem cases it is due to human or managerial factors. Water services providers (WSPs) often struggle to balance growing water demand with the limited [water] resources. As in other places, South African water demand is propelled by population growth, industrial development, expanding agriculture irrigation requirements, and a general increase in per capita water requirements due to improving lifestyles.

Traditionally, WSPs resorted to searching for and developing new water resources each time demand is close to exceeding existing supplies – approaches better known as supply-side water management. Supply-side approaches mainly involve design and development of new water infrastructure (e.g. dams, inter-basin transfer schemes, groundwater abstraction schemes, desalination plants, etc).

These approaches appeal and are subject to resource availability and are not forever sustainable, particularly in the South African context were most utilisable surface water resources have been allocated and/or developed. A second water resource management tier, critical to sustainable water supply but is often afforded less attention, is the principle of water conservation and demand management (WC/WDM).

"WC/WDM can create harmonised communities through carefully crafted and strategically implemented social awareness and education campaigns targeted at community level."

WATER DEMAND MANAGEMENT

WC/WDM appeals to and fosters efficient utilisation of the available resource. WC/WDM refers to the minimisation of water loss through efficient control of water supply and demand. The principle encompasses two sets of water management strategies, namely strategies for curtailing growth in the amount of water used [water demand management], and approaches to limit the loss or wastage of water and enhances the care and protection of water resources [water conservation]. By and large, WC/WDM approaches focus on improving water use efficiency and promoting sustainable development.

WC/WDM offers a number of tangible benefits. These benefits include: more efficient use of existing resources, cost savings to customers who pay only for received than water lost in distribution, consistent water supply, deferment of costly new water infrastructure, energy savings through deferred of large pumping facilities, improved water quality, and increased revenues for WSPs. In the context of current protests, WC/WDM can also be a vehicle for promoting socio-political objectives, such as equity and gender issues as well as creating harmonised and peaceful communities.

WC/WDM can create harmonised communities through carefully crafted and strategically implemented social awareness and education campaigns targeted at community level. The campaigns can incorporate basic water management principles, procedures to report water losses in communities (e.g. pipe bursts and difficult to detect leakages), home-level demand management approaches, as well as engendering a sense of community ownership of water assets through empowerment approaches. Such approaches also help reduce the levels of vandalism of communal water infrastructure.

APPLICATION OF WC/WDM CONCEPTS

Although WC/WDM offer attractive benefits and South Africa seem to have adopted the concepts in principle, their application have not been optimal. This sad scenario is best reflected in the level of non-revenue water (NRW) – a proxy/indicator for water use efficiency. Internationally, NRW between 5% and 15% is considered acceptable. In comparison, the national average NRW for South Africa is about 35%.

Some communities have NRW much higher than the national average. Classical examples include Mbombela Local Municipality (40-70%), Maquassi Local Municipality (45% - now reduced to 35%), and Emfuleni Local Municipality (49%). Such high levels of NRW are characterised by considerable leakages and unpaid for water bills. According to a report published by the Water Research Commission in 2012, although targets for reducing water loss have been set, activities at municipal level for realising these goals have been limited – mainly due to lack of planning and not fully understanding the potential benefits of WC/WDM. From the few examples of localised high NRW and the significantly high national average, it is clear that that there are still huge gaps and opportunities to optimise WC/WDM principles in South Africa.

Traditionally, increasing water demand has been met with the expansion of bulk water supply infrastructure.

OPPORTUNITIES FOR WC/WDM

In view of the recent water challenges, the related countrywide unrest and the broad water conservation and demand management principles, it is observable that there are opportunities for WC/WDM to help address some of the challenges. In this context water conservation approaches can leveraged to:

- ***Improve water scarcity awareness campaign:*** The crisis provides a great opportunity to, through social awareness and education programs reach out to communities and inform them of the scarcity of water in South Africa as well as the importance of frugal water management and utilisation.
- ***Promote broader stakeholder involvement:*** Stakeholder engagement forms a key element of integrated water resources management and WC/WDM. The crisis situation, though volatile at times, offers a platform for intense stakeholder engagement with an interested audience. Often, stakeholder engagements attract low attention and interest from residence. However, with the prevailing challenges community interest and attention are likely to be high – creating a conducive environment for heightened collaboration. The spin-off of such an approach is improving trust between the stakeholders and the water service providers.
- ***Reduce non-revenue water:*** Having driven home the points of water scarcity and collaborative management stated above, WSPs have a good chance of implementing water loss reduction initiatives in collaboration with the communities. Initiatives that can be promoted through community support include: water-wise gardening (e.g. grey water reuse) water harvesting, reporting of leakages and burst pipes, as well as reporting of unlawful connections.

In addition, the crisis offers WSPs with the chance to motivate for adequate budgets to carry-out water conservation and demand management initiatives – activities that are often relegated to the bottom of the normal budget transactions as they viewed as less fancy. The water protests could effectively catapult WC/WDM to high priority interventions by WSPs as WC/WDM initiatives are cheaper, simpler, and faster to implement compared to conventional measures.

TTCTA

CONCLUSIONS AND RECOMMENDATIONS

Although South Africa has legislation and a water policy that give due credence to WC/WDM, its application has not been effective and optimal. However, there are tangible opportunities for improved application of WC/WDM measures – with potential positive outcomes. It can also be concluded that WCDM approaches have a fitting role in addressing some of the recent water-related challenges.

It should be acknowledged though that, given the explosive and tense nature of the current relationship between WSPs and communities, calculated approaches should be applied – with the potential outcomes of the interventions clearly and honestly explained to manage expectations. In the main, WC/WDM approaches have the potential to build grounded understanding of water supply and resources management among communities and officials as well as giving birth to a harmonious collaborative working environment in the sector.

- **Article references available on request** ❑

Climate change adaptation: How will we feed people in 2050?

While the latest report from the Intergovernmental Panel on Climate Change (IPCC) indicates that the effects of global warming are already occurring on all continents, few sectors are prepared for the risks that this change brings. Yacob Beletse, Senior Researcher in modelling crop water relations at the Agricultural Research Council (ARC)-Roodeplaat reports on local efforts to help southern African farmers prosper despite a shifting climate.

Most scientists agree that the climate change and concomitant rising temperatures we are currently experiencing is a result of anthropogenic activities, notably the release of greenhouse gases, which include carbon dioxide, nitrous oxide, methane and water vapour. While actions to reduce global greenhouse gas emissions are critical, communities also need to prepare or adapt to unavoidable climate change impacts. Adaptation can take the form of changes in policy, management, technology and behaviour that reduces negative impacts or exploits opportunities.

The ability of society to adapt to the challenges (and opportunities) presented by climate change is, however, limited by several factors. Education levels, access to information and access to capital depend on the economic pathway (i.e. government policy) followed to get to that point. Climate change is therefore expected to affect different communities in different ways depending on location, terrain, land use patterns, social networks, infrastructure, planning capacity, institutional, political and financial realities when they select their own adaptation measures.

DETERMINING THE IMPACT OF CLIMATE CHANGE ON FOOD PRODUCTION IN SOUTHERN AFRICA

The potential impacts of climate change on southern Africa's agricultural sector are well researched and documented. Evidence shows that annual rainfall trends in the southern regions of South Africa are likely to decrease moderately, resulting in increased inter-annual rainfall variability and more intense and widespread drought. On the other hand, rainfall projections over the rest of southern Africa remain uncertain. Farmers will be required to adapt to these extreme conditions.

Temperatures over South Africa are increasing. An analysis of minimum and maximum temperature trends indicate that the region is getting warmer by about 2-3°C. This concurs with those IPCC headlines and scale of changes. We can now say with more confidence that this is expected to lead to decreased water availability in rivers due to increased evaporation, coupled with shifts in the timing and volumes of rainfall. Thus, water scarcity is highly likely in some areas. The impact on the agricultural sector could be exacerbated further by changes in land use, poor land-use management and political imperatives of improving households' access to water, which places more pressure on available water resources.

It is clear, therefore, that climate change potentially has serious repercussions for the agricultural sector, particularly food crops and livestock production, both spatially and temporally. The questions South African authorities now wish to answer is 'how seriously will climate change affect our food production?' and 'what can be done about it?'

THE CHALLENGE OF UNCERTAINTY

A number of scientists in the region have already unveiled methodologies for assessing climate change impacts on agriculture towards the development of adaptation strategies. One of the key challenges, however, is the uncertainty of future impacts, as the conclusion is derived from the complex interaction of various factors, such as biological, economic, policy and social interactions that determine farmers' production each season.

Crop, climate and economic models coupled together are usually used to project future food production and assess the potential impact of climate change. In the last three decades, global climate circulation models (GCMs), crop models and economic models have been used to assess the impacts of climate change on the production and prices of food crops.

Weaknesses identified from previous climate change impact assessments include limited model inter-comparison and multi-model assessment. Furthermore, methods used to date are neither well suited to assess socio-economic impacts of climate change nor adaptation potential. Previous assessments failed to represent the heterogeneity and technological detail essential to the analysis of adaptation while others examined the impacts of climate change on crop yield linking to economic models but not to risk of hunger.

"If the agricultural sector continues with 'business as usual' sufficient food production for the region will remain a pipe dream."

Courtesy ARC

Crop modellers interact during a training workshop on crop multi-models in India earlier this year.

MULTI-INSTITUTIONAL PROJECT

This has raised the need in southern Africa to capture these complex biophysical and socio-economic heterogeneities and so improve our understanding of agricultural impacts of climate change at national and regional scales using consistent methods and protocols of multi model comparison. A diverse team of climate, crop, economic and information technology research scientists are answering this need through a global network called AgMIP (Agricultural Model Inter Comparison and Improvement Project). Its aim is to evaluate the impacts of climate change on food production and economic status of farmers.

A current project under this network is titled the Southern Africa Agricultural Model Intercomparison and Improvement Project (SAAMIIPP). This project involves 10 institutions, 12 researchers and six post-graduate students. The southern African institutions involved in the project include the ARC (who is coordinating the project), the universities of Cape Town and Free State, South African Sugar Research Institute, Human Sciences Research Council, Polytechnic of Namibia, National University of Lesotho, Botswana College of Agriculture, and Swaziland Meteorological Services.

The project is being supported by researchers at the University of Florida, National Aeronautics and Space Administration (NASA), Columbia University as well as Oregon State University in the United States.

The ultimate objective of the project is to estimate regional-scale food production for different future periods and development scenarios, identify field-level adaptation strategies and evaluate economic impacts of climate change on commercial and small-scale farming systems. In addition, the project is aiming to build capacity across the disciplines of climate, crop and economic modelling in the region.

To date, the project has organised six workshops across southern Africa and engaged in several international workshops and training to develop methodologies on integrated climate change impact assessment. The concepts developed during the workshops and training sessions have been applied to predict meaningful climate change impact assessments as a case study in southern Africa.

As maize is the main staple crop in southern Africa, SAAMIIP has assessed the impacts of expected climate change at district level on maize production. In this first attempt, the team focused on the Free State province and, more specifically, on the Bethlehem district of South Africa. The project investigated questions around the sensitivity of commercial-scale maize production to climate change; the impact of climate change on future maize production; and benefits of adaptation to climate change in the district.

A new approach that was considered in this case study was to separate the biophysical and socio-economic components of climate change. This means similar key economic drivers were considered, but the factors were assembled in a manner that allows more flexibility and easier cross-disciplinary research. For example, the future agricultural pathway for South Africa was envisaged as positive and with low adaptation challenges. It was further assumed that South Africa would follow a more positive economic development pathway in line with the National Development Plan, Vision 2030 (National Planning Commission, 2012) characterised by higher rates of economic growth, increased agricultural technology development and use; and increased access to productive commercial agricultural land.

In addition, increased investments in implementing agricultural and land reform policies provide a positive environment for increased agricultural productivity and production for commodities such as maize. Improved economic performance and associated reductions in poverty enhances social cohesion and facilitates investments in commercial agricultural production.

Courtesy ARC

The southern African crop, livestock, climate and economic modelling team.

SHOULD WE CONTINUE WITH BUSINESS AS USUAL?

The term 'business as usual' refers here to socio-economic and agro-climatic conditions of the recent past. Formally, there will not be significant change of socio-economic growth and agro-climatic conditions in the future, and it is expected that it will remain similar to conditions experienced from 1980 to 2010.

The study into the sensitivity of the Bethlehem maize industry to projected changes in climate is

indicative of just how severe these changes could affect the southern African agricultural sector. Analyses indicate that maize yield in this region will decrease by 9% to 28% as a result of changes in climate. Furthermore, about 60% of farmers will be negatively affected as a result of climate change by 2050. At the same time farmers' per capita income is expected to decrease by 27% to 61% as a result of climate change.

The predicted impact on climate change on poverty indicates small increases in poverty levels ranging from 0.25% to 3.79%. Thus, the overall results of the analysis, which used five different climate scenarios, show that maize production will substantially affected by climate change should there be no adaptation. Business as usual is therefore not an option.

WHAT ARE THE BENEFITS OF ADAPTATION?

Project future changes in climate may mean that farmers will need to modify their maize production in order to either maintain current yield or exploit future conditions in order to increase production. These so-called adaptation methods may include changes in field management planting/harvest dates, choice of cultivars, row-spacing, planting depth, application of fertilisers and pesticides, and irrigation schedules, among others.

Thus, if the Bethlehem farmers manage to change the way they grow their maize through adaptation, then only 33-48% of farmers be negatively affected as a result of climate changes. So adaptation will help reduce the negative impacts of future climate change.

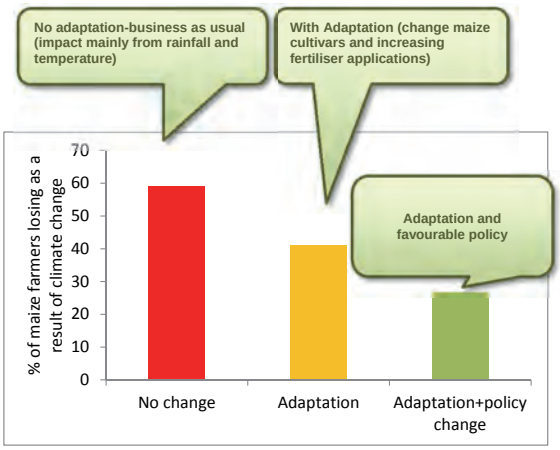
CLIMATE CHANGE WITH ADAPTATION AND FAVOURABLE POLICY

With the introduction of favourable policy together with adaptation, the agricultural sector's vulnerability to climate change can be further reduced. This particular study showed that implementing both will result in only 24-32% of growers being impacted negatively by climate change. Thus policy and social changes reduce the number of those impacted by 54%.

In short, if the agricultural sector continues with 'business as usual' sufficient food production for the region will remain a pipe dream. If, on the other hand, we adapt to new varieties, new technology, socio-economic conditions and policies change favourably towards farming conditions, food security challenges may reduce amid changing climatic conditions.

The question now is how can we introduce farming system changes to the region and so reduce climate change's potentially disastrous impact on food production, and how can we ensure favourable policies and socio-economic conditions and so improve the agricultural sector's resilience to the effects of climate change.

In conclusion, climate change is predicted to have serious implications on food production if appropriate adaptation measures, favourable policy and mitigation is not implemented. The SAAMIIP has a further vision to bring scientists in the region together to work with stakeholders in affecting these changes.



Projections of percentage of maize farmers losing due to climate change.

The project's current work has enhanced southern African capability to response to climate change by building scientific and technical capacity, advancing scientific knowledge, and linking scientific community and stakeholders. The team plans to expand such investigations in different main food producing districts to investigate the inclusion of other adaptations strategies, such as early and late maturing crops, diversification of farming systems (including alternative crops), ecosystem-based adaptation, sustainable land management (such as rainwater harvesting), organic and inorganic fertilisation.

- To find out more about SAAMIIP contact Yacob Beletse at
  Tel: 012 841 9890/9637 or
  Email: BeletseY@arc.agric.za ❑

Courtesy ARC

The SAAMIIP project involves 10 institutions, 12 researchers and six post-graduate students, all geared towards stealing the southern African agricultural sector to the impacts of climate change.

Exploring the relationship between water, energy and food

The term 'water-energy-food' nexus is increasingly being bandied about in global discussions on sustainability. In this article, Research Manager and coordinator of the Water Research Commission's water-energy-food nexus programme, Dr Sylvester Mpandeli, shares some information about the Commission's work in this field.

The WRC water-energy-food flagship programme or Lighthouse was first introduced last year. Lighthouses are transdisciplinary, multidepartmental and inter-institutional mega-projects examining priority water issues across the innovation value chain.

Individually, food, energy and water are all vital for a sustainable future. However, these resources are also mutually connected or linked. So energy, for example requires water, often in large volumes for fuel production, mining, hydropower and power plant cooling. On the other hand, energy is needed for pumping, treatment and distribution of water as well as the collection, treatment and safe discharge of wastewater. In turn, both energy and water resources are required to produce food.

Figure 1 shows that the water sector is heavily stressed compared to the energy and agriculture sectors. According to the National Water Resources Strategy 2 of the Department of Water Affairs, more than 60% of South Africa's fresh surface water is used by irrigated agriculture. However, while irrigated agriculture is the country's largest water user, the sector is also expected to contribute significantly towards poverty alleviation in the country through job creation, increased economic activity in rural areas and also sustaining natural resources management.

Previously, water, energy and food issues were championed independently, however, since the Bonn 2011 Nexus Conference in Germany several organisations have argued that there is a need to drive the water-energy-food nexus across the globe. This call has also been heeded by the WRC. Figure 1 strongly shows that water, energy and food issues are inextricably interlinked. This has given rise to a growing need for integrated natural resource management as suggested by several experts.

WHY DOES THE WRC NEED A NEXUS APPROACH?

Several studies indicate that improved water, energy and food security can be achieved through a nexus approached – an approach that integrates management and governance across sectors and scales. Some of these studies further indicate that a nexus approach can also support the transition to a Green Economy, which aims among other things, at resource use efficiency and greater policy coherence.

However, given the increasing interconnectedness across sectors and in space and time, a reduction of negative economic, social and environmental externalities can increase overall resource use efficiency, provide additional benefits and also secure the human rights to water and food. Conventional policy and decision – making in 'silos' therefore needs to give way to an approach that reduces trade-off and builds synergies across sectors – a nexus approach. The business as usual is no longer an option.

COLLABORATION AND PARTNERSHIP WITH OTHER KEY STAKEHOLDERS

There is a growing recognition by several organisations including the WRC, Shell, WWF, Department

of Energy (DoE), Department of Water Affairs (DWA), Eskom and others that saving water saves energy. The WRC is not running the water-energy-food nexus in isolation. This initiative takes cognisance of the completed and ongoing projects across all the key strategic areas within the WRC.

In the WRC key strategic area dealing with water utilisation in agriculture there are ongoing projects that are directly addressing water-energy-food nexus issues. These include a project on water use of cropping systems adapted to bio-climatic regions in South Africa and suitable for biofuel production. Another project is looking to improve livestock carrying capacity with rainwater harvesting while conserving grasslands and generating biogas from manure. A third project is aimed at optimising electricity cost for sustainable irrigation water use.

South African energy efficiency initiatives offer exciting opportunities for delivering significant water savings. Likewise, energy savings can be realised through water efficiency initiatives. Saving water also reduces carbon emissions by saving energy otherwise generated to move and treat water.

Water-energy-food nexus initiatives would also take cognisance of alternative sources of energy, including hydroelectric, solar power, and wind power. Through its nexus Lighthouse programme the WRC would identify key strategic partners to champion this issue in line with national priorities.

Since it started its water-energy-food nexus initiative, the WRC has already identified are few research gaps. This includes the need for a better understanding of the linkages between water, energy, land and food or agriculture. Also required is more knowledge of the linkages between water, energy and food and the risks of climate change on water availability and energy supply. Thirdly, research is required on advanced technologies that save energy and water. Lastly, partnerships are required between government and private sector that move research and development from bench-scale to implementation.

It is important to note that some of these research gaps will be addressed by current studies conducted by WWF, Shell (scenario team) and University of Cape Town and also by new projects that the WRC is intending to drive during the 2014/15 financial year. It is hoped that these initiatives will go a long way towards ensuring a better water, energy and food future for South Africa. ❑

"Water, energy and food issues are inextricably interlinked has given rise to a growing need for integrated natural resource management."

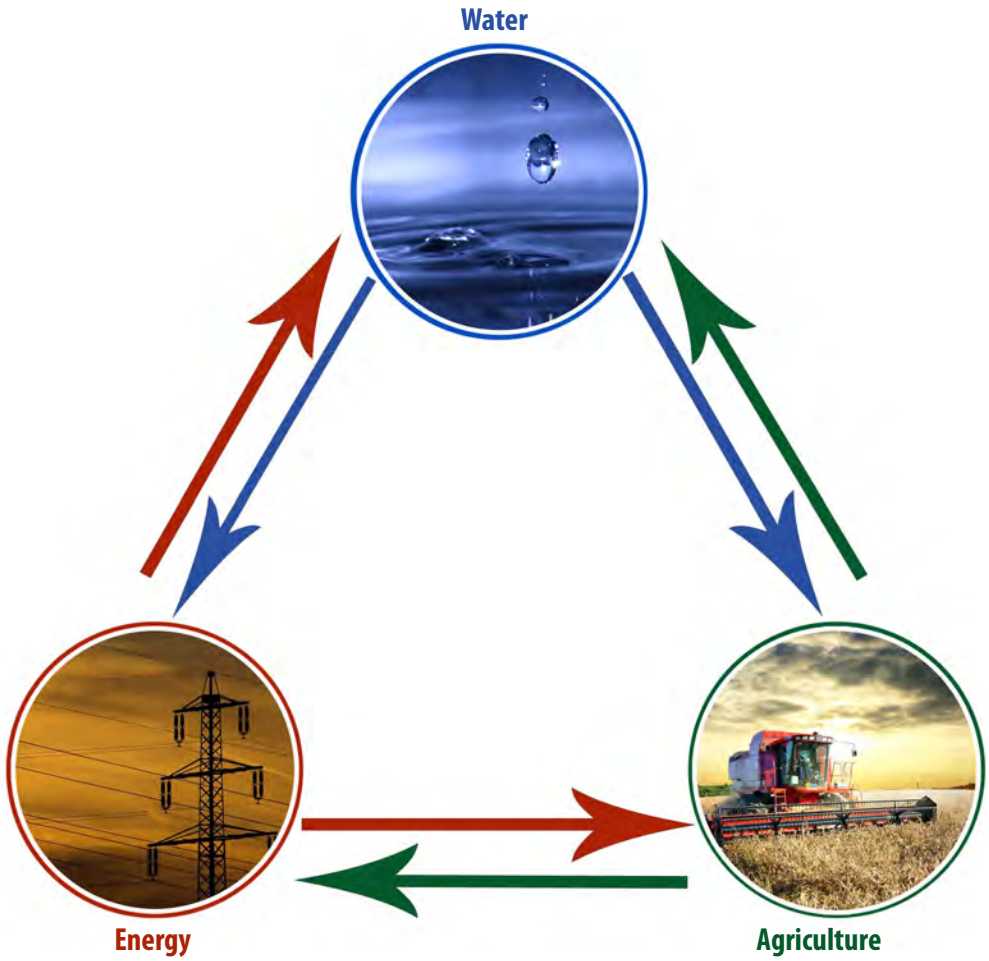


Figure 1
The inter-dependence between water, energy and food.

Driving the protection of our natural assets

With its well-known panda icon, the World Wide Fund for Nature (WWF) is an international non-governmental organisation that works on issues relating to the conservation, research and restoration of the environment. Christine Colvin, Senior Manager of the Freshwater Programmes WWF South Africa (WWF-SA) is leading many of the organisation's water-related initiatives in South Africa. Debbie Besseling spoke to her.

Water is an absolute necessity, with our basic human needs and economy depending on it. A new way of planning is required to protect our precious natural assets and to ensure that future generations inherit a healthy landscape that can provide them with water security. As a water-scarce country, our development has been constrained by our ability to overcome the difficulties of ensuring that water supplies are always readily available.

Much attention has been given to the provision of supplying more South African households with safe, reliable drinking water by bringing taps to homes and settlements that were previously marginalised. But, on this mission to dam and deliver water, we have lost sight of where our water comes from, and the critical role that nature plays in ensuring water for all.

Engineered infrastructure is critical in the water supply chain, however it cannot deliver if we do not take care of our ecological infrastructure, that is the catchments, rivers and aquifers that feed our dams and water schemes.

Research has established that 8% of South Africa's land area provides 50% of the surface water. Colvin discusses the background and highlights of this work: "We worked with Dr Jeanne Nel and Geographic Information System specialists at the CSIR to assess the distribution of runoff in South Africa. We know that rainfall is unevenly distributed in South Africa and highly seasonal. This work helped to define which catchments contribute the most runoff on a national scale and showed where the landscapes are that we need to focus on protecting and restoring, if we are to maintain healthy water supplies into our managed and engineered systems that supply us all.

"Only 16% of this area is formally protected, so the in the next few years it is going to be critical to increase the protection of these areas and to ensure that the farmers, foresters and miners who are working there understand that these areas are critical for our national water security. This helps to make spatially explicit the aims of the National Development Plan – to ensure we have sufficient water to enable economic growth and food security," explains Colvin.

CAREER HISTORY

Colvin holds a BSc Honours in Geology, from the University of Southampton, in the United Kingdom, which she acquired in 1989 and an MSc Hydrogeology, University College London, UK, completed in 1994. She gives an insight into how she got involved in this sector and some of the milestones of her career. "Travelling in Africa in the early 1990s introduced me to the importance of groundwater in village water supply. This had immediate appeal and as a geologist I had found my niche – hydrogeology. I worked in Namibia on a drought relief programme and learned about drilling and geophysics as the sharp end of emergency water provision in arid environments. After returning to London to complete my Masters I worked in heavily polluted sites in the United Kingdom and Eastern Europe, remediating contaminated land. When I returned to South Africa in 1995 I worked with Dr Gideon Tredoux's groundwater group at the CSIR. I loved the research environment, the ability to dig deeper into problems and work across disciplines with ecology colleagues, such as my mentor Dr David Le Maitre, on the importance of groundwater in eco-hydrology."

After many years in research, Colvin wanted to see her work having greater impact and influence decisions that impact water security. "I moved to lead the freshwater programmes at the WWF. Here we are focused on protecting our water source areas, working with business in water stewardship and pioneering new work with the South African National Biodiversity Institute on securing ecological infrastructure for water. We have well established programmes like the Mondi Wetlands Programme and the Water Balance Programme that continue to grow and pilot new ways to include communities in catchment care."

"On this mission to dam and deliver water, we have lost sight of where our water comes from, and the critical role that nature plays in ensuring water for all."

In her current role, leading and coordinating WWF-SA's programmes on freshwater, Colvin is responsible for the liaison with the international WWF network, agents of change in the South African water sector, business and key funders. She is also involved in developing a strategy of relevant work with impact for South African water security, as well as ensuring successful delivery, financial sustainability and professional excellence of employees and consultants working on freshwater projects.

Colvin is involved in a number of programmes and projects at the WWF-SA, some of these include: South Africa's Water Source Areas, which involves the identification and protection for national water security; the Umgeni Ecological Infrastructure Partnership, a project on the role of private finance in water risk; the Water Balance Programme, involving Nedbank, SonaeNovabord and Woolworths; the De Beers Shared Water Risk and Catchment Security in the Limpopo. Two specific projects are discussed in more detail below.

THE JOURNEY OF WATER INITIATIVE

Colvin has been extensively involved in the Journey of Water, which is all about sharing the complexity of water's journey to people's homes, reconnecting urban users with the natural landscapes that make up their catchments. "'Water doesn't come from a tap' and we wanted to emphasise the role of nature and healthy landscapes in providing people and the economy with water. Supported by Sanlam, we walked over 80 km from the Berg River Dam to Cape Town with a group of passionate celebrities and media who could tell the story with us. We've since shown an advertisement on the Journey and a mini-documentary made by Derek van Dam at eNCA and we've had thousands of hits on the website www.journeyofwater.co.za which shows people where their water comes from," Colvin explains.

WATER STEWARDSHIP PROGRAMME

The UK retailer, Marks and Spencer, assessed their global supply chain and found that fruit coming from the Western Cape was one of their highest risk areas. Peaches and nectarines (stone fruit) require irrigation and this is a semi-arid and water stressed area.

Colvin elaborates: "We were working here with our own retailer, Woolworths, who are also concerned about better farming methods and protecting water resources. With these two corporates, the commercial and emerging farmers in the fruit sector and the Breede-Overberg Catchment Management Agency (BOCMA), we are now developing a plan for stewardship which will help reduce water risk. Farmers here are already working incredibly efficiently. The Water Research Commission research showed that farmers are only using 33 ℓ per fruit which is way below the global average of 140 ℓ. Now they need to look beyond the farm fence to see what they can do together to restore and protect their catchments and to enable each other to operate with minimum impact."

THE WWF WATER RISK TOOL

The WWF also developed a global tool called the Water Risk Filter. The latest version was launched in March and can be accessed for free on www.waterriskfilter.panda.org.

Colvin explains that the tool helps companies and farmers to scope their water risk by leading them through a detailed questionnaire. It includes global (coarse) data on water scarcity and information on 120 crop types. "It's really useful to get farmers, the biggest consumers of water, to start understanding their water risk and to initiate better practices, including improved efficiency, less impact and water stewardship. Multinational corporates are also using it as a scoping tool to understand where they need to focus water management efforts. We can't leave water management to government and catchment management agencies. Water impacts on everyone and it really is everyone's business. This is a practical way to include it in everyone's business plan and risk mitigation strategies." ❑

Top left: *Christine with Eric Bezuidenhout of the Faure Wastewater Treatment Works, Cape Town, explaining the Journey of Water.*

Middle left: *Christine with intern Imelda Haines on the Journey of Water.*

Bottom left: *Next to the Eerste River in Stellenbosch with a news filming crew in the background and Department of Water Affairs river monitors in the foreground.*

At 87 Dr Rayner still contributing actively to aquatic science

At a time when the debate is raging about when academics should retire, Dr Nancy A Rayner is proving all the critics wrong. Article by Deidre West.

Liesl van As

In April 2012, following years of retirement, the active and enthusiastic Dr Rayner was appointed Research Associate at the Department of Zoology and Entomology at the University of the Free State (UFS).

Dr Rayner is an aquatic scientist (with many publications behind her name) and one of only a handful of specialists in the identification of zooplankton in South Africa. In 2011 she became co-supervisor of a PhD project focusing on the zooplankton of the Okavango Delta and other water bodies of northern Botswana. She has proved to be irreplaceable in helping with identifications and in giving advice. Dr Rayner has also attended the last three conferences of the Southern African Society of Aquatic Scientists (SASAqS) as well as the Orange River Basin Symposium in 2012.

Ever since she reappeared on the aquatic sciences scene she has been swamped with requests to help with identifications of zooplankton collected at various sites in South Africa, and has received many scientific articles to review, despite having turned 87 in January this year. She is a true example of what institutions, and students, are 'losing' when academics are not supported after reaching retirement age.

We asked her a few questions about her experiences as an aquatic scientist in South Africa…

Tell us about your academic career. How did you get involved in aquatic science?

I graduated with a BSc in Zoology under Prof Laurie Richardson in 1947 at Victoria College of the University of New Zealand (now the University of Wellington). After that I worked for three years in the Animal Ecology Section of the Department of Scientific and Industrial Research in Wellington.

A colleague and I collected all the information and did all the maps and diagrams for the now sought-after book *Introduced Mammals of New Zealand* produced by Dr KA Wodzicki. Even today, I am deeply upset at the introduction of mammals to a country which, because of its long geological isolation, had no mammal species. The devastation caused to the native bush and especially the flightless birds has never been overcome.

I came to South Africa in 1949, and for the next 20 years was devoted to my husband and family. My husband, Arthur Rayner, was the first professor of Biometry at the then University of Natal. In 1972, while with my husband on sabbatical leave in the United States, I took a course in Animal Ecology at the University of Colorado in Fort Collins.

On return to South Africa, Prof Waldo Meester accepted me for an Honours degree. I thought I would return to what my then teenage son called my 'boring life', but Prof Jan Heeg tempted me with an Masters project on Lake Midmar. I knew absolutely nothing about freshwater systems, but by the beginning of 1977 I agreed to take it on. For two years, Andy Scholtz and I undertook monthly sampling at Midmar.

We had four stations, one in the main basin, in two inlets and one in the Umgeni River. We collected all the physical and chemical data and with a Clarke Bumpus sampler we collected zooplankon which we could translate into numbers per litre. Our first collections were in March when numbers and diversity were at a maximum. Back in the lab, I had absolutely no idea of what I was looking at!

This was a low point and then Mother Nature took pity on me, the lake temperature dropped to 10°C and with low diversity and numbers I began searching for manuals and references. I could recognize *Copepoda, Cladocera, Rotifera* and insect larvae. I was intrigued by this magical world that had caught the imagination of scientists from the time the microscope was perfected.

In 1889, Hudson and Gosse wrote their book on the *Rotifera* "if we could shrink into living atoms and plunge under the waters of what a world of wonders we should then form part!" The examiners for my thesis were Profs Brian Allanson and Charles Breen. I was awarded a distinction. I completed my PhD on *Calanoid Copepoda* in 1991. My examiners were Dr Geoff Boxshall of the British Museum of Natural History and Dr Tom Bowman of the Smithsonian Institute. When I saw Dr Boxshall in Thailand at the WAC conference, he said he was still using my thesis.

Tell us about your work experience after you completed your PhD up until your retirement.

After my PhD, my husband passed away and I came to live in Kloof. I was asked to lecture

invert zoology at the University of Durban Westville (UDW) to second years. Thinking back, I am amazed that I agreed. It was a good decision and I continued doing courses whenever there was a need. After that I concentrated on my calanoid research. It was all cut short when UDW and Natal merged as non-permanent staff lost their accommodation.

What was the sector like when you started?

In respect of people involved in zooplankton research, there were very few people. Profs Allanson, Rob Hart and Evelyn Hutchinson (from Harvard) had tried to keep up interest in zooplankton studies. However, the political isolation of South Africa was reflected in reluctance of overseas scientists to become involved in research in South Africa. I was not welcomed for requests for material from overseas institutions. However, visits to the British Museum of Natural History and the Smithsonian helped immensely as they generously allowed me to look at their copepod material for a week in each case.

What did you enjoy doing most during your years as an aquatic researcher and what did you miss most about your work after initial retirement?

I loved looking at zooplankton and finding new species to South Africa. There were always questions to ask. I enjoyed studying zooplankton, especially helping colleagues with requests for identifications. It worked both ways as I also obtained material and we sometimes produced joint papers. Except for Midmar, I had an army of collectors! I have other interests and just accepted retirement, but was sad when looking at all the material I had stored in my spare room.

How many new species did you describe and did you give any of them unique names?

I described six new species, three *Paradiaptomus* and three *Tropodiaptomus*. *Paradiaptomus hameri* is named for Michelle Hamer who collected material over the Cape Province and Namibia looking for her fairy shrimps. She always had some calanoids for me, one a new species. *Paradiaptomus warreni* is named for Dr Warren, the first Director of the Natal Museum. He collected this species in 1960 from the Drakensberg and misidentified it. It was in fact a new species.

Which group of zooplankton is your favourite and why?

I like all of them, but I suppose the calanoids have taken most of my time. Very special was the freshwater meducae in the Midmar isolation columns. Although not zooplankton, who could not like Triops?

What do you consider the highlight of your career, and the greatest challenge?

My book *Copepoda. Calanoida. Paradiaptominae* published by Backhuys in 1999 was definitely a highlight. The greatest challenge was probably to go back to studying again after a 25 year break.

Liesl van As

Dr Nancy Rayner providing some advice to PhD student, Deidre West, and supervisor Prof Jo G van As, Head of the Department of Zoology and Entomology at the University of the Free State.

Did anything funny happened at conferences?

I remember that when in Windhoek, Dr Jackie King did some funny sketches of delegates after lunch trying to pretend they were not falling asleep. They were shown to us at some stage. In Swakopmund in the early days we were literally accommodated in informal 'shacks' on the beach.

What do the other ladies in your complex think you do in your home with ethanol, tiny bottles and a mini-lab?

My complex is not a retirement one, I am friendly but never discuss my scientific background. They know me as a gardener and an embroiderer!

What made you decide to return to academics?

I was tempted by a brilliant student, Deidré West, who was working on the Okavango Delta. How could I refuse that! The University of KwaZulu-Natal lent me a microscope and lab materials. Deidré managed to find my email address somehow when she needed assistance with her zooplankton identifications. After sending mails back and forth myself, Deidré and her two supervisors, Prof Jo van As and Prof Liesl van As, met up at the SASAqS conference at Ithala Game Reserve in Natal to discuss her PhD project. It was here that I agreed to get on board with the project and a few months later I was appointed at UFS.

What advice would you give young people wanting to enter this sector?

This is a difficult question. Everything has changed. Today students wish to put everything on computers or do DNA analysis and I am not sure that they would recognise a new species if they saw it. At the Copepoda conference in Thailand in 2008, we were dazzled with all the students could produce digitally, but as the chairman said, you still have to identify the copepod.

What is your life motto?

I was blessed with wonderful parents, and a father who showed my brother and I the wonders of the natural world. Maybe a good motto is: Just do your best! ❑

Protecting nature, protecting ourselves: How a healthy environment can prevent disasters

Lisa van Rooyen

An intact riparian buffer area on Touws River.

How do scientists translate the value of ecosystem services to general members of the public? A group of environmental and conservation scientists are aiming to do just that in the Wilderness, in the Southern Cape. Article by Klaudia Schachtschneider.

The scientific approach is a much used way of generating knowledge. It begins with curiosity which leads to discovery and then to translation of this knowledge into concepts that are understood and can be used by society. Bringing scientific knowledge into everyday life to build a better place for humanity to live in – is a real and challenging endeavour.

A group of environmental and conservation scientists from the CSIR, the Nelson Mandela Metropolitan University (NMMU), South African National Parks (SanParks) and the World Wildlife Fund (WWF-SA) are grappling with this problem, and are trying innovative ways of communicating with

stakeholders in the Wilderness area. Their aim is to help people change the way they look at water in the Wilderness area where they live and have summer holidays.

This new understanding may help people to choose to involve themselves in improving the state of their surroundings. If they do, it could reduce the risk of being negatively exposed to water-related events, such as droughts, floods, sea storms or pollution.

Translating 'science to action' in this study focuses on the value of ecological infrastructure – An example is a piece of natural vegetation that forms a protective buffer. At the beach these buffers consist of coastal fore dunes that act as useful barriers in coastal storm events, protecting people and their homes. Upstream, along rivers, these buffers consist of narrow strips of plant growth that look different from vegetation in the rest of the landscape.

They are called 'riparian buffer zones' and are typically made up of a mix of plants, animals and micro-organisms that form an ecological filter through which water moves. Plants trap soil with their roots, minimising erosion. Plants, micro-organisms and soils also absorb or immobilise pollutants. Flood water is slowed down by the dense mat of vegetation, reducing flood risk downstream. The combination of good, absorbing soils, held in place by dense vegetation, will also retain moisture for longer, resulting in a slow and steady release of water, thereby reducing the effects of drought.

So, intact buffer zones perform very valuable services, but ongoing developments have resulted in the removal or degradation of many of these critical buffer zones. In the Wilderness area land is used for farming, forestry, residential and tourist development. Whilst these land-uses produce multiple benefits, they often negatively affect buffer zones and the services they perform for us.

Abigail Crisp

Dune erosion with mid-air staircase evident on Wilderness Beach, with housing developments in the background.

As the buffer zones degrade, they become less and less capable of buffering their surroundings from the effects of floods, storms, droughts and pollution. In a way one can liken it to a body with a compromised immune system. At a human level we understand and value a healthy immune system, as it keeps us resilient against many bacterial and viral onslaughts. A compromised or absent immune system can make us susceptible to any illness, and a common cold can become life-threatening. Living with high levels of risk and vulnerability is very challenging. The same is true of living in a compromised landscape as it also affects our vulnerability and resilience and exposure to risk – but it does so collectively and at a larger scale.

Scientific proof regarding the maintenance of a healthy human immune system has been successfully communicated within our society and we are encouraged to look after our own immune system by observing a healthy lifestyle. The researchers of the Wilderness project would see it as a true success if the value of ecological infrastructure, such as buffer zones, was equally understood and integrated into people's everyday knowledge. So that the inhabitants of the area would be motivated to maintain the buffer zones of their rivers and their coast, and to continue to enjoy the benefits of greater resilience and reduced risk. ❑

Abigail Crisp

View from Pig's Head toward Nature's Valley showing intact coastal buffer dune.

UKZN Centre developing tomorrow's WATER RESOURCE CHAMPIONS

CWRR

Building a large enough skills base to deal with South Africa's water challenges – both now and in the future – remains a significant focus for the Water Research Commission (WRC), and one which it can only achieve with the assistance of academic partners. One of the most enduring and successful of these relationships is with the Centre for Water Resources Research (CWRR) at the University of KwaZulu-Natal (UKZN). Lani van Vuuren reports.

Global change and its impact on Africa's water resources is a critical concern. Africa is experiencing rapid changes in land use (such as urbanisation) with a corresponding degradation of its soil and water resources.

Change is a consequence of the continent's own economic development needs, as well as a strong demand from international role players' intent on securing land for future production of food, fuel, fibre and fodder. Whilst the imperative for development is clear, it is equally clear that Africa needs to develop its soil, land and water resources in a sustainable way and that this requires rigorous scientific input to inform policy, strong governance systems to ensure sound decision making and enhanced human capacity.

It is with the intention of providing the education and training of individuals and the technological advances to meet these challenges that the CWRR was established in 2012 out of a cohesive group of academics specialising in hydrology and water resources research since 1984. It is also since that time that the group has collaborated on WRC-funded research.

The Centre undertakes water-related research across a range of topics. Broadly, these are arranged as earth observation and hydrological process studies; model development and application (including design flood estimation); agricultural water use; global change and water resources (including land use and climate change) as well as water resources governance.

At the time of writing, the Centre was completing no less than seven research projects with funding from the WRC, with another seven underway. This is in addition to research projects being undertaken with funding from other institutions. All of these projects involve post-graduate students.

According to the Centre's Prof Graham Jewitt, who is also the Umgeni Water Chair of Water Resources Management, the academic programme in hydrology is the core feeder for CWRR's post-graduate programmes. "Over the past few years we have seen significant growth in numbers in this programme. For example, this year we have 14 Honours students, compared to only 9 in 2012 and only 6 in 2011. In turn, there are 40 students currently undertaking third year Hydrology compared to 35 last year, and the numbers are growing." Today, the Centre boasts

80 students in second year, compared to only 25 five years ago.

Over the past three years the Centre has also seen an increase in the number of students meeting Masters entrance requirements. "This year we are delighted that 9 of the 14 Honours students have progressed to Masters. They are joining another 35 students this year," notes Prof Jewitt.

The challenge of attracting good students to continue with post-graduate studies turned the Centre's attention to building skills within its own programmes, with efforts particularly focused at Honours students. Students are part of a broader research team, including the Honours students. In this way, students are able to interact with each other and share ideas. Having Honours students linked into a broader team of post-graduate students (from Masters to post-PhD) allows students to see the progression through the academic ranks, and also share in the enthusiasm generated by these students and their supervisors.

"The effort we have put into the Honours class also means that junior staff members who do not have PhDs yet can gain experience in research supervision – so the benefit works both ways," notes Prof Jewitt.

In addition, undergraduate students are encouraged to become 'vac students' – working on research projects during the longer vacations. Undergraduates are also exposed to the research through second- and third-year level field trips, which take them to several of the research study sites as well as get them into contact with research contract staff teaching their specialisation.

Building skills in the water sector has not come without its challenges. "As our student numbers have increased, we have seen a decline in student literacy and numeracy," reports Prof Jewitt. "This was probably worst about three years ago, but we are now seeing an improvement."

The Centre has identified literacy – particularly scientific writing – as a major shortcoming. As a result all Honours students now have a scientific writing course and a dedicated writing tutor who works with them throughout the year. This has made a huge difference; the standard of work submitted has substantially improved, and students who were scoring poorly because of their poor oral and written communication skills are now meeting the post-graduate entrance requirements.

Another challenge the Centre has had to overcome is its limited supervision capacity. The CWRR is fortunate to have a number of well qualified, contract staff among its members. These members are focused on the research projects which fund them, but also contribute to the undergraduate hydrology programme in their field of expertise and supervise students working in their projects.

According to Prof Jewitt, these members play an enormous role in supporting the Centre's teaching and research. "Without the support of the WRC and other funders, there is no way that we could sustain the levels of supervision needed for our current student numbers."

Another aspect which limits student progression is a lack of funding. Through the WRC projects they are involved in, students are assured that their research project will be adequately funded. However, the Centre also directly funds both their subsistence and research if they do not have another bursary.

This begins at Honours level, where the Centre pays tuition fee level bursaries and then to Masters and PhD level where the bursaries cover full living expenses. "UKZN offers a full fee remission for one year to full-time Masters students and three years for PhD students, which makes a big difference to the affordability of studying further," notes Prof Jewitt.

Prof Jewitt ends with the following advice for students considering a career in the water sector: "Study as far as you can while you are in the academic system. Very few part-time students complete their degrees, but most full-time ones do. It is incredibly difficult to complete a research degree while you have a full-time job."

WRC Research Manager, Wandile Nomquphu, comments on the importance of skills development, particularly in the field of hydrology: "Hydrology forms the basis for water resources management. Hydrologists monitor (by collecting data), manage and protect the water environment (through the interpretation and analysis of the data), and inform decision-making. The capacity of a country to manage its water resources is largely determined by its capability in hydrology, and this capability is a function of the ability of universities to train knowledgeable hydrologists."

Continues Nomquphu: "The function to academically train hydrologists resides with the universities that should be purposely supported financially to churn out these scientists consistently. Centres of excellence [such as the CWRR] have proven to be a sustainable mechanism through which to nurture competent hydrologists who keep the national capability at the cutting edge." ❑

CWRR

Third-year hydrology students undertaken practical work.

WATER Kidz

ENERGY – a thirsty resource

Above: *Roughly 75% of all the water used for industrial purposes are used for energy production.*

Much is being said about the 'water-energy-nexus' these days. But what does the term mean and what does the one have to do with the other? And why should we care?

Basically what 'nexus' means is that water and energy are closely connected to one another. On the one hand, our power plants need water to generate electricity, and on the other hand, energy is required to treat, transport and distribute our water.

Consuming too much of either can lead to resource depletion, pollution and an overall price increase for each. For example, drought diminishes energy production, while lack of access to electricity limits irrigation possibilities. We are already use six times as much energy as we did in 1950, and this is only going to increase as the population increases and more people get access to electricity services, putting more pressure on our water resources.

About 75% of all industrial water withdrawals are used for energy production. All types of electricity generation consume water – either to process the raw materials used in the facility or fuel, constructing and maintaining the plant, or to just generate the electricity itself. Renewable power sources, such as wind power, might require little water to produce energy, but still need water in the processing of the raw materials and in the building of the turbines and solar panels.

SOURCES

- www.eskom.co.za
- http://en.wikipedia.org/wiki/Water-energy_nexus
- www.worldwaterday.org
- www.unwater.org
- www.glendalewaterandpower.com/save_money/tips/energy_savings.aspx

DID YOU KNOW?

It takes 1.5 cubic metres of water and almost 10 megajoules of energy to produce 1 kg of wheat and around ten times more water and 20 times more energy to produce 1 kg of beef.

We just have to look at the water use of South Africa's largest power utility, Eskom, to realise how important the relationship between water and energy is. Eskom generates about 95% of the electricity used in South Africa and about 45% of the electricity used in Africa. It is also one of the ten largest electricity utilities in the world by generation capacity. With its 27 power stations, Eskom is also a large consumer of freshwater, accounting for about 1.5% of the country's total water consumption every year. The utility's power stations run constantly – without water this would not be possible. A special network of pipelines and dams ensures that Eskom's power stations never run out of water.

To improve its water use, Eskom has introduced all sorts of water technologies. This includes dry cooling (which uses 15 times less water than conventional wet-cooled power stations), treatment of polluted mine-water for use at the power stations, and technical improvements on the way water is treated to maximise the beneficial use of water. In so doing, Eskom manages to save more than 200 million litres of water every day.

We have all seen or heard Eskom's advertisements telling us to switch off appliances when we are not using them. This does not only save electricity, but water as well. According to Eskom, for every kilowatt hour of electricity that is saved, about 1.32 litres of water is also saved. So start switching off those lights!

Just as energy requires water, water supply and sewage disposal needs energy. Drinking water must be pumped to the treatment plant and then pumped to consumers following treatment. In areas where freshwater is scarce and drinking water must be brought in from a long distance (like Gauteng, which gets its water all the way from Lesotho), the energy footprint for this drinking water can be very high.

So what can you do to save water and energy? In the kitchen, use your dishwasher only for full loads. If you have a second refrigerator or freezer that is not really used, switch it off. Rather keep one refrigerator stocked full – a full refrigerator uses less energy.

In the bathroom, don't let the hot water run while washing or brushing your teeth. Tighten or plug leaking joints in hot water pipes. Install compact fluorescent lightbulbs (CFLs) – they use as much as 75% less energy than standard light bulbs. When doing your laundry, wash and rinse in cold or warm water instead of hot water whenever possible (remember, energy is used to heat the water and run the washer). ❑

Just as power generation plants use water, water treatment plants use electricity.

By keeping your fridge full you will conserve energy, and so save water.

Sector specialists meet to ponder future of SA hydrology

Considered the backbone of water resource assessment and planning, hydrology in South Africa faces an uncertain future as it grapples with challenges of declining capacity, dwindling hydrological data and unreliable funding. This was one of the key messages emanating from a recent meeting of hydrology experts at the Water Research Commission (WRC). The high-level dialogue titled 'The State of Hydrology (Research) in South Africa: Towards a 10-year Science Plan' included representatives from universities, governments departments and science councils. According to WRC Research Manager, Wandile Nomquphu, the ability of South Africa to manage its water resources will largely be determined by its capability to deliver world-leading hydrology science to support national strategic needs, and to respond to emergencies such as floods and droughts. "Research and development activities are key to keeping such capability at the cutting edge. Unfortunately, the country does not seem to have a long-term strategy to ensure a constant supply of hydrologists with a strong foundation in science and engineering." The importance of hydrological science is further emphasised by pending challenges such as climate change. The outcomes of the dialogue are feeding into a hydrology sector audit to be executed by the WRC. This audit is expected to inform and guide the development of the discipline for the next 20 years.

All photographs by Lani van Vuuren

Prof Roland Schulze, Professor Emeritus of Hydrology at the University of KwaZulu-Natal (UKZN).

Prof Graham Jewitt (with microphone), Umgeni Water Chair of Water Resources Management at UKZN.

Achuo Enow of the National Research Foundation.

Henry Roman of the Department of Science & Technology.

THE WATER WHEEL

Subscription

❒ Request

❒ Renewal

❒ Address change

Contact Details

Name:.....

Company:.....

Designation: .....

Postal Address:.....

.....

Tel: .....

Fax: .....

E-mail:.....

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

.....

.....

Would you be willing to pay for *the Water Wheel*? .....

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

DEEPLY ROOTED IN SOUTH AFRICAN WATER SOCIETY

www.wrc.org.za

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

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

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

FOLLOW US ON

WATER RESEARCH COMMISSION

THE POWER OF KNOWLEDGE TO THE PEOPLE