# THE WATER WHEEL

September/October 2018 Volume 17 No 5

## CLIMATE CHANGE

*Protecting South Africa's national parks against the threat of climate change*

## WATER REUSE

*Guidelines pave the way for safe use of greywater*

*Controlled free distribution*

**ISSN: 0258-224**

WATER RESEARCH COMMISSION

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

WATER RESEARCH COMMISSION

wader
WATER TECHNOLOGIES DEMONSTRATION PROGRAMME
An initiative of the Department of Science and Technology and the Water Research Commission

# WADER - Your Water Innovations Partner

PARTNERSHIP

WATER RESEARCH COMMISSION

DEPARTMENT OF SCIENCE AND TECHNOLOGY

## PULLS TOGETHER

The applied research and development and pre-commercialisation stages of the water innovation continuum.

## ACTS AS AN INNOVATION INTERMEDIARY TO

Facilitate high-level, collaborative technology demonstrators from the public and private sectors to maximise the potential of the water innovation value chain.

## AIMS TO

Accelerate technologies to the market

## SERVICE OFFERINGS FROM WADER

01 Some funding for technology demonstrations

02 Access to information on a range of technologies

03 Credible technical information

04 Opportunities to connect/link with other entrepreneurs/innovators/ test bed partners

05 Matchmaking with municipalities, innovation players, funding organisations & investors

06 Growth of SMMEs and enterprise development

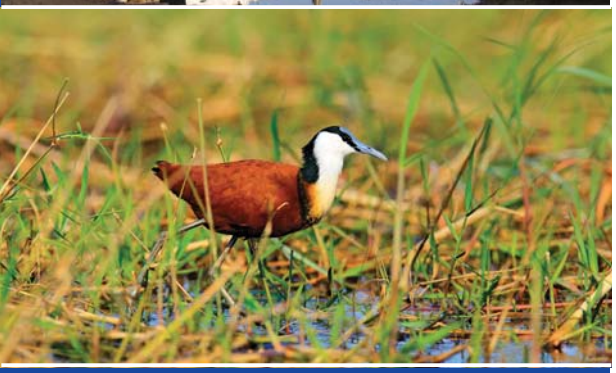
07 Technical advice using scientific protocols

08 Driving innovations in priority areas of the Water RDI Roadmap and the NWRS II

## KEY STAKEHOLDERS FOR WADER

- Entrepreneurs/ innovators
- Water boards/ utilities/municipalities
- SMMEs
- Investors/funders (local and international)
- Government departments
- Technical consultants

Website: www.wader.org.za



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) 761 9300. **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**: Dikeledi Molutsi,
E-mail: dikeledidk@wrc.org.za;
**Layout**: Anja van der Merwe,
**E-mail:** anjavdm@wrc.org.za
**Printing:** Oshiang Printers
**Email:** info@oshiangprinters.co.za

# Contents

04 **UPFRONT**

12 **CLIMATE CHANGE**
Protecting South Africa's national parks against the threat of climate change

17 **WATER AND THE COMMUNITY**
The salt whisperers – Study shows rural women not benefiting from indigenous knowledge to extract Baleni salt

20 **WATER REUSE**
Guidelines pave the way for safe use of greywater

24 **CITIZEN SCIENCE**
Suite of tools help citizens take control of freshwater management

28 **BIOMIMICRY**
Turning to nature to solve modern day problems

32 **WATER AND THE ECONOMY**
Transitioning to a circular economy – the role of innovation

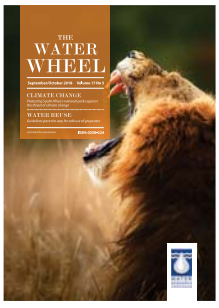
34 **GROUNDWATER**
Groundwater, boreholes and ethical issues

39 **KNOWLEDGE SHARING**
The South African National Wetlands Indaba - from humble beginnings to a well-established platform

42 **CAREERS IN SCIENCE**
What's stopping young African scientists from achieving their potential

44 **WATER KIDZ**
Take care, stay safe around canals

46 **LAST WORD**
No society can prosper without sustainable access to water




*South Africa's national parks are formulating strategies against the potential impacts of climate change. See page 14.*

# FLUID THOUGHTS

WRC CEO, Dhesigen Naidoo

## No woman, no cry

R*E*S*P*E*C*T demanded the queen of soul, Aretha Franklin, in what became an anthem for the struggle for gender equality in the 1970s and 1980s.

There was a rising optimism, globally, that perhaps finally we were gaining momentum toward gender equality. The year 1979 heralded the United Nations CEDAW (Convention of the Elimination of All form of Discrimination Against Women) and sixteen years later saw the adoption of the Beijing Platform for Action at the Fourth World Conference on Women. For a country like South Africa, then a one-year-old democracy having just thrown off the shackles of racism and sexism that defined the patriarchal Apartheid State, this was a historical point of inflection for the establishment of real equality in South Africa and the world.

And yet in 2018, Statistics South Africa's ***Crime against women in South Africa*** report shows a decline in transgressions against women compared with historical levels, but still unacceptably high levels in the major categories. Worldwide we see the strengthening of conservative right-wing movements, even in previous bastions of democracy in Europe and North America. One of the victims of this shift is women's rights and the position of women in society. It is achieved with both directed policy like restricting women's reproductive rights; and through more subtle means like making it harder to integrate women and the girl-child into streams and professions that were historically the domain of men. Utterance by folk in the leadership of influential organisations, like the South African Institution of Civil Engineering (SAICE), take the struggle for gender equality back decades.

The progress to overcome this is slow. The latest World Economic Forum's ***Global Gender Gap Report*** (published in November 2017) measures progress in four categories. The findings are expressed as a percentage, with 0% as maximum inequality and 100% being gender parity. In the categories of Educational Attainment as well as Health and Survival, the world has made great and rapid strides, with gap percentages of 95% and 96% respectively. We have indeed seen an increased access to education for the girl-child in most parts of the world, and the old adage of 'educate a woman, and you educate a village' has indeed proven to be true. Amartya Sen, economist and Nobel Laureate quoted Bangladesh as a prize case study where the economic fortunes of the country changed radically on the back of women's education. In fact, health and survival is, in fact, in many ways a direct result of this.

The other two categories in the Gap report fair far less favourably. The category of Economic Opportunity and Participation scores an unsurprising 58%. We all know of the barriers to entry and, even when women get in, they may face multiple glass ceilings. The cost of this to society is high. The cost to the economy is even more direct. In the World bank's ***Unrealised potential*** report, it is calculated that women account for only 38% of human capital wealth globally. The number drops to less than one third in low-income and lower middle-income countries. Part of the reason is limited opportunity for participation. The other is a complete lack of income parity even when women and men are in the same job performing at the same level. This area of transformation is proceeding at a snail's pace. In fact, it is estimated that at the current rate of change, it will take 217 years before gender-based income parity is achieved. The prevention of full economic participation of women in the economy has a wealth loss of US$23 620 for every one of the seven billion people on Earth today, according to the World Bank report. Globally, for the 141 countries that participated in the survey, the loss in human capital wealth notches up to US$160.2 trillion.

How can it be that we are currently in a prolonged global economic recession on the one hand, and an undeveloped and therefore unrealised human capital dividend, estimated at US$160.2 trillion, in the form of women and the girl-child on the other. The reason could lie in the fourth category of the Gap report, namely, Political Empowerment. This relates not only to women representation in political formations at various levels of governance, but also to general participation in decision-making at all levels. The political empowerment gap is at 23%. Loosely interpreted, this means that 77% of all the decisions that matter in the world today are taken by men. Enough said!

The current quagmire is influenced by the attitudes of the 1st and 2nd industrial revolutions that have been instrumental in determining the shape and attitudes of the modern economy. Traits of physical strength and specialisation in silos were deemed to be key, and tended to favour a male dominance. But, that was two industrial revolutions ago. The challenges of the twenty-first century society demands integration, synergy and social skills. The very traits that were previously regarded as the bastion of women, and a weakness. And, in particular, success in the twenty-first century economy demands high emotional intelligence. Does this mean that the 4th industrial revolution depends for its success on a much higher participation of women? Does this mean that the dividend of the Industry 4.0 can only be fully realised on the back of full and equal gender participation in the economy and in society? The arithmetic seems to indicate that this is, in fact, the only pathway to a prosperous and sustainable future.



BACK TO TOP

*Table 1. Examples of interventions to address constraints on women's paid work.*

| Constraints/Type of work | Wage employees | Farmers | Entrepreneurs/Self-employed |
|---|---|---|---|
| **1. Time use constraints** | | | |
| Basic Infrastructure | Access to basic infrastructure (cooking energy, water, electricity)<br>Access to safe and affordable transportation | | |
| Childcare | Access to quality, affordable, publicly sponsored or employerprovided childcare | | |
| Laws & technology | Workplace flexibility including parental leave | Time saving technology | Time saving technology |
| **2. Access to productive assets** | | | |
| Land | - | Joint titling | - |
| Skills | Bundled training (technical and managerial) including socio-emotional skills (persistence), and asset-specific training | | |
| Micro-credit (self-employed) | | | In-kind and cash grants |
| Credit (Small & Medium Enterprises) | - | Alternative collateral: moveable assets, payment history, psychometric tests | |
| Digital finance/savings and payments systems | Direct payments to accounts | - | Individual saving accounts |
| Other financial services | Bundled financial services for risk management including insurance products for business and health needs among others | | |
| Banking | Mobile/web banking and simplification of KYC (Know your customer) rules | | |
| **3. Market and institutional failures** | | | |
| Information | Payment transparency<br>Workers' rights | Innovations in rural extension<br>Engagement in value chains | Returns to traditionally male-dominated sectors |
| Social capital | Expanding social networks: mentorship and sponsorship, role models | | |
| Legal frameworks | Removing gender differences in business, labor and family laws, enforcing existing laws supporting gender equality | | |
| Taxation | Individual income tax | - | Differential VAT |
| Social norms | Preventing and mitigating gender-based violence<br>Building aspirations and self-confidence | | |

Source: Authors.

*Source: World Bank*

# WATER DIARY

**Groundwater**
**September 26-28**
The SADC Groundwater Management Institute, together with the International Water Management Institute and the Department of Water and Sanitation are hosting a groundwater conference under the theme 'Adapting to climate change in the SADC region through water security – A focus on groundwater.' The conference will be held at Birchwood Hotel and OR Tambo Conference Centre, on the East Rand. **Visit: www.sadc-gmi.org**

**Water management**
**October 3**
The Strategic Water Partners Network is hosting its 4th Annual Water Stewardship Conference in Sandton. **For enquiries Email: swpn.secretariat@thenbf.co.za.**

**Wetlands**
**October 8-11**
The National Wetlands Indaba will take place at the Mittah Seperepere Convention Centre, in Kimberley, Northern Cape. The theme of the conference is 'Drylands and wetlands: connecting and managing heterogeneity across landscapes'**. Visit: www.nationalwetlandsindaba2018.com**

**Municipal engineering**
**October 31-November 2**
The annual conference of the Institute of Municipal Engineering of Southern Africa will be held in Port Elizabeth with the theme, 'Innovative Infrastructure Solutions'. **Visit: www.imesa.org.za.**

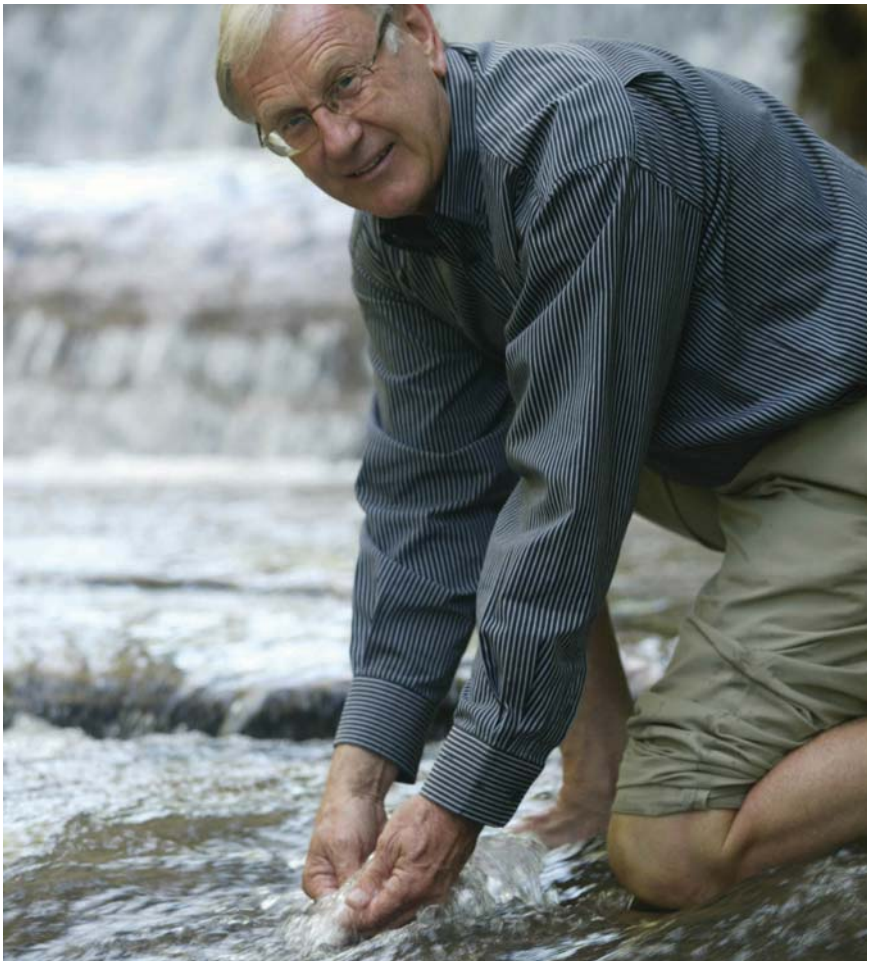
**Irrigation engineering**
**November 13-15**
The South African National Committee on Irrigation and Drainage (SANCID) will be holding its 2018 conference with the theme 'Opportunities to management climate change'. The conference will be held in White River, Mpumalanga. **Visit: www.sancid.org.za**

**Science and technology**
**December 3-6**
The 4th National Conference on Global Change will be held in Polokwane with the theme 'Sustainable futures through science and innovation'. The conference is hosted by the Department of Science and Technology and the National Research Foundation, in partnership with the University of Limpopo. Online registration is mandatory. **Visit: www.ul.ac.za/globalchange2018**

BACK TO TOP

# NEWS

## Prestigious lifetime achievement award for renowned hydrologist



Prof Roland Schulze, University of KwaZulu-Natal Hydrology Professor Emeritus and Senior Research Associate in the Centre for Water Resources Research (CWRR), received a Lifetime Achievement Award at the African Utility Week Industry Awards which recognises energy and water influencers in Africa.

Over 600 guests from 30 countries attended the glamorous black-tie event, many of them Africa's most renowned power and water industry professionals. Prof Schulze was selected winner of the Lifetime Achievement Awards by a panel of 22 international judges.

"This is a proud and emotional moment and a humbling experience," said Prof Schulze, who also reflected on the individuals and institutions who influenced his outlook and success, including his parents whose dreams were cut short by the Great Depression, leading them having to curtail their schooling at the age of 14 to start work.

Prof Schulze, who completed his studies at the then-University of Natal, began his career as a mathematics and science teacher, joining his almal mater in 1969 where he worked until his formal retirement in 2007. He piloted South Africa's first hydrology degree course in the early 1980s; the discipline grew under his leadership to form the CWRR. The centre now trains more than 150 undergraduate students and 30 postgraduate students a year from around the world.

Prof Schulze was also visiting professor at the IHE Delft Institute for Water Education in the Netherlands, and at the Swedish Meteorological and Hydrological Institute. He has been involved in more than 100 short courses on hydrological modelling and climate change in South Africa, Africa and Europe.

Prof Schulze's involvement in national and international level hydrological research spans more than 50 years. For the past 30 years he has been pursuing applied climate change research. Landmark achievements include development of the Agricultural Catchments Research Unit agrohydrological modelling system and the SCS-SA design hydrology simulation model.

He has over 600 varied publications to his name, from refereed journal papers to books and popular articles. He has further supervised 67 Masters and 20 PhD students, with eight students currently under his supervision.

Prof Schulze's accolades include a Fellowship of the University of Natal, a Fellowship of the Royal Society of South Africa, Life Membership of the International Water Academy in Norway, a South African Institute of Agricultural Engineers (SAIAE) Fellowship, Membership of the Academy of Science of South Africa and numerous 'Best Lecturer' awards. He is also the recipient of gold and silver medals from the SAIAE.



BACK TO TOP

## Highly invasive freshwater crayfish found in Free State freshwater

A highly invasive alien freshwater crayfish species has been discovered in the Free State Goldfields.

The Department of Environmental Affairs is working closely with the Free State Department of Economic, Small Business Development, Tourism and Environmental Affairs (FS DESTEA) as well as local and district municipalities in the Goldfields area to eradicate and stop the spread of red swamp crayfish. The species, which is native to northern Mexico, and southern and southeastern United States, is considered highly invasive.

Acting on a tip-off from a member of the public in Welkom, FS DESTEA aquatic scientist, Dr Leon Barkhuizen, discovered a large population of red swamp crayfish (***Procambarus clarkii***) in a dam in the Free State Goldfields. The identification of the species was confirmed by Prof Linda Basson from the University of the Free State's Zoology and Entomology department. The reason for the presence of this species in the dam is not clear, but anecdotal reports indicate that it might have been released by members of the public.

During two sampling periods in June, Dr Barkhuizen caught 53 individuals. From the preliminary results it is clear that it is an established and breeding population due to the large number of juveniles that were collected. It seems that the crayfish have been present in the area for a number of years, considering that two large individuals were found in a swimming pool in the area in October last year.

The red swamp crayfish has spread throughout the world where it decimates indigenous crayfish species and other aquatic organisms. The species is also a carrier of the highly infectious crayfish plague which has wiped out indigenous crayfish species in parts of Europe. Females may carry up to a thousand eggs at a time. Adults dig tunnels with depths between 30 to 90 cm and can reach lengths up to 40 cm. Due to this digging behaviour, these crayfish hold a specific threat to irrigation canals and dams.

According to reports, there are people in the Goldfields are that catch the crayfish and sell them. This action must be stopped immediately to prevent the further spread of this highly invasive species. According to legislation, it is an offense to be in possession of the red swamp crayfish, guilty persons may be fined up to R10 million or jail time upon conviction.

Various meetings and onsite inspections are being undertaken to determine the exact extent of this invasion.

## Technical experts to assist distressed municipalities

The Cooperative Governance and Traditional Affairs (COGTA) Department has appointed 81 new engineers and town planners in an effort to assist distressed and dysfunctional municipalities to get back on track.

The appointment follows a report by Auditor, Kimi Makwetu, detailing the dire state of municipalities, with 87 municipalities classified as dysfunctional.

In a bid to provide support to the municipalities in the nine provinces, COGTA announced an intervention programme focusing on three areas, namely governance and administration, service delivery and infrastructure as well as financial management.

"The ability of municipalities to plan, deliver, operate and maintain infrastructure is dependent to a greater extent on the capacity of officials to execute their responsibilities. The technical nature of the responsibilities demands requisite levels of expertise and skills, mainly in the field of civil engineering," noted COGTA Minister, Zweli Mkhize.

The cohort of technical experts has been appointed as part of District Technical Support Teams in affected municipalities.

The teams comprise:

- Nine provincial managers, most of whom are engineers
- Thirty-six civil engineers
- Fourteen electrical engineers
- Sixteen town and regional planners
- Seven candidate civil engineers, who are experienced engineers in the process of completing their professional registration

The placing of the teams is being done by the Municipal Infrastructure Support Agency.

*Source: www.sanews.gov.za*

BACK TO TOP

# GLOBAL

## Tunisia launches drone data collection project

Tunisia and the African Development Bank have signed an agreement for the launch of a pilot project to use drones for data collection to enhance management of agricultural projects in the country.

The project, to be implemented over ten months, would receive technical management and assistance from South Korea, Minister of Development, Investment and International Cooperation, Zied Laadhari, announced during the signing ceremony in July.

The pilot project will focus on agricultural operations in Sidi Bouzid in central Tunisia, under the management of Busan Techno Park, a Korean government agency based in Busan, South Korea. Laadhari said that the agency would provide equipment – drones and associated computer systems-training, as well as technology transfer.

The agency has already tested the drones for efficacy in managing similar urban projects. Korea is a leading country in the development and use of unmanned aerial vehicles for real-time data collection and processing. Drones have been used in agriculture to provide fast and accurate data, helping to improve decision-making at all stages of a project, from preparation to implementation and evaluation.

According to Laadhari, the project was expected to benefit piloting and monitoring of irrigated areas, management of water resources, water tables as well as the effects of climate change in the pilot area.

## Freshwater species in Africa's largest lake threatened

Seventy-six percent of freshwater species endemic to the Lake Victoria Basin, including many species important to local livelihoods, are threatened with extinction, an IUCN-led report has found.

The report, ***Freshwater biodiversity in the Lake Victoria Basin***, assesses the global extinction risk of 651 freshwater species, including fishes, molluscs, dragonflies, crabs, shrimps, and aquatic plants native to the Lake Victoria Basin in East Africa. The assessment found that 20% of these species are threatened with extinction. Of the freshwater species assessed, 204 are endemic to the lake area and three-quarters (76%) of these endemics are at risk of extinction.

Freshwater species are important sources of food, medicine and construction material for millions of people living in the basin and provide resources for communities who cannot access or afford market goods. The African Lungfish (***Protopterus aethiopicus***), for example, is declining in the Lake Victoria Basin largely due to overfishing, poor fishing practices and environmental degradation as wetlands are converted to agricultural land. The lungfish is considered a delicacy for some local communities and is an important local medicinal product, used to boost the immune system and treat alcoholism. The lungfish is also traded at market, making it important to the local economy.

"The Lake Victoria Basin is incredibly rich in unique species found nowhere else on Earth, yet its biodiversity is being decimated. The effects on communities that depend on the lake for their livelihoods could be disastrous. We hope this report will drive more sustainable land and water management in the basin by informing policy-makers and conservation programmes," noted Will Darwall, Head of IUCN's Freshwater Biodiversity Unit and co-author of the report.

To view the publication, Visit: https://portals.iucn.org/library/node/47642



BACK TO TOP

## Hospital bacteria are starting to tolerate hand sanitiser

Strains of bacteria have developed increased tolerance to the alcohols in hand sanitisers, which requires hospitals to rethink how they protect patients from drug-resistant bacteria.

A new study finds that strains of ***Enterococcus faecium***, a notorious healthcare-associated bacterial pathogen, have emerged since 2010 that are ten times more tolerant of alcohol-based hand sanitisers than older strains.

A strict regime of hand washing with alcohol-based sanitisers before and after patient interactions has been in place in hospitals around Australia, and many other countries, since 2002, to curb a rise in deadly MRSA, an antibiotic resistant form of ***Staphylococcus aureus*** (i.e. golden staph).

"Really regimented infection control ensures medical professionals, visitors, or patients themselves aren't spreading bacteria around the hospital," says lead author Prof Tim Stinear from Austin Health and the Peter Doherty Institute for Infection and Immunity, a joint venture of the University of Melbourne and the Royal Melbourne Hospital. "That's been highly effective at getting rid of golden staph. Rates of golden staph infection have been decreasing for the past 15 years."

But while MRSA infections have dropped considerably, Prof Paul Johnson, Director of research at Austin Health and co-lead author of the latest research, noticed a rise in infections of ***Enterococcus faecium***.

As reported in ***Science Translational Medicine***, the research team took 139 different strains of ***E. faecium*** and treated them with isopropanol solution, an alcohol commonly used in hand sanitisers. "We started testing to see whether they had any tolerance to alcohol, and sure enough, the new isolates were more tolerant to alcohol exposure than the older isolates," said Stinear. This is an unfortunate side effect of the hygiene programme, he says.

"Alcohol use in hospitals has gone from hundreds of litres a month to thousands of litres a month of these alcohol-based disinfectants. Anywhere we repeat a procedure over and over again, whether it is in a hospital or at home or anywhere else, you are giving bacteria an opportunity to adapt, because that is why they do, they mutate. The ones that survive the new environment better then go on to thrive."

To view the original article, Visit: http://stm.sciencemag.org/content/10/452/eaar6115

## Africa on the right path to eradicate plastics – UN Environment

The ongoing global movement for eliminating plastics is gaining momentum in Africa.

Several countries are now taking steps to eliminate the production and distribution of single-use plastics, some adopting a total ban on the production and use of plastic bags. Cameroon, Egypt, Eritrea, Ghana, Kenya, Mauritania, Morocco, Nigeria, Rwanda, South Africa and Tanzania have taken the lead, others, like Botswana and Ethiopia, are following suit.

UN Environment and its partners are working closely with African governments to establish policies and create programmes that are geared towards a plastic-free continent. The campaign Beat Plastic Pollution has mobilised the continent to come together and clean up plastics in land and water ecosystems. The campaign also encourages governments to adopt the initiative and come up with regulations to curb plastic pollution.

Partnerships with governments, private sector companies and the general public are key to eliminate plastic pollution. In Kenya, for example, UN Environment has partnered with Safaricom and the National Environment Management Agency to establish an end-to-end plastic waste management programme. The partnership will see the creation of a working group that brings together stakeholders, mostly manufacturers, waste collectors and plastic waste recyclers, to formulate a comprehensive solution to hard plastic waste.

In South Africa, citizens have been mobilised through campaigns such as Bring Your Own Bag, which encourages people to reduce the use of disposable plastic bags. In Chemba Town, Tanzania, a group of young people turned plastic waste to their advantage with an innovative solution: they collected plastic bags and repurposed them into mattresses.

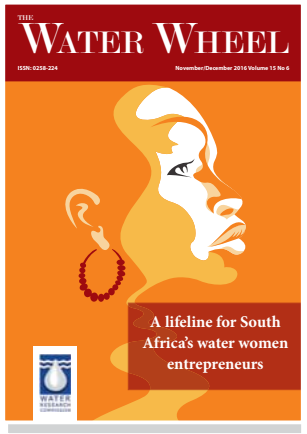
BACK TO TOP

# THE WATER WHEEL

## SUBSCRIPTION

☐ Request ☐ Renewal ☐ Address change






### Contact Details

Name: _____

Company: _____

Designation: _____

Postal Address: _____

_____

Tel: _____

Fax: _____

E-mail: _____

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

_____

_____

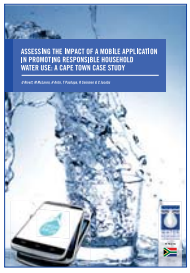
Would you be willing to pay for the Water Wheel? _____


WATER RESEARCH COMMISSION

**The Water Wheel**

Tel: +27 (0) 12 761-9300
Fax: +27 (0) 12 331-2565
E-mail: laniv@wrc.org.za /www.wrc.org.za
Physical address: Lynnwood Bridge Office Park, Bloukrans Building, 4 Daventry Street, Lynnwood Manor
Postal address: Private Bag X03, Gezina, 0031

# NEW WRC REPORTS




### *Assessing the impact of a mobile application in promoting responsible household water use: A Cape Town case study*

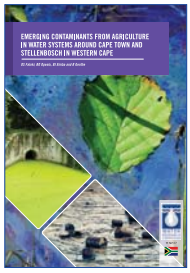
Research anticipates that water demand in the South African municipal sector will peak by 2035. In large municipalities, domestic water demand contributes approximately 26% to the total water demand. At the same time, mobile phones (and other forms of information and communication technology) have become ubiquitous in households around the world, and have been identified in many contexts as being useful tools for providing citizens with contextual information to help steer behavioural change. This study assessed the effect of water-related information provided by a mobile phone application on water conservation participation at domestic or household level through a case study in the City of Cape Town.

**Report No. TT 753/18**


### *A multisectoral resource planning platform for South Africa's estuaries*

The Oceans (Blue) Economy initiative is posing further demand on coastal and estuarine space and resources. On the other hand, the increased commitment to biodiversity conservation means serious multi-user conflicts emerging within these environments. In South Africa, estuarine resource management still has a strong single sector focus (e.g. fisheries, conservation, water and waste, marine aquaculture). As a result, the use of natural resources (i.e. land, water and estuarine biodiversity) are planned and managed by different authorities through sector-specific statutory systems or mandates. The focus of this study was to address multi-sector strategic resource planning in South African estuaries.

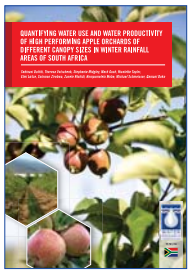
**Report No. TT 748/18**




### *Emerging contaminants from agriculture in water systems around Cape Town and Stellenbosch in Western Cape*

In recent times, residues of chemical products and contaminants, such as pharmaceuticals, have been found in aquatic ecosystems. Given the paucity of information on the occurrence of veterinary pharmaceutical residues in water resources in Africa, it becomes imperative to undertake the assessment and monitoring of these emerging contaminants. The data obtained from such studies may play a key role in policy formulation that will ensure proper use and monitoring of veterinary pharmaceuticals; thus, preventing humans, biota and the environment from their harmful effects. In this study, a High Performance Liquid Chromatography coupled to ultraviolet detector method was optimised and validated for the separation and detection of selected pharmaceuticals identified from a screening programme.

**Report No. TT 747/17**




### *Quantifying water use and water productivity of high performing apple orchards of different canopy sizes*

The deciduous fruit industry is a multibillion Rand industry in South Africa with apples accounting for about 30% of the area planted. High yielding apple orchards (≥ 100 t/ha) have become common in recent years as a result of improved plant material and orchard management practices. International literature has shown that high crop loads are associated with high water demands. However, no information existed on the water requirements of high yielding apple orchards in South Africa prior to this study. The study focused on the main apple growing regions of the Koue Bokkeveld and Elgin/Grabouw/Vyeboom/Villiersdorp. Water supply in these regions are experiencing significant strain and the situation is expected to get worse in future as demand outstrips supply.

**Report No. TT 751/18**

**To order any to these reports contact Publications at Tel: (012) 761-9300, Email: orders@wrc.org.za or Visit: www.wrc.org.za to download an electronic copy.**

BACK TO TOP

# CLIMATE CHANGE

## Protecting South Africa's national parks against the threat of climate change

*An assessment of the vulnerability of South Africa's national parks to climate change is informing the development of adaptation strategies. Article by Sue Matthews.*

Sue Matthews

We like to think of our national parks as refuges where plants and animals are largely safe from human interference, apart from the minor disturbance caused by park visitors and staff, and all the infrastructure required to support them. The reality, of course, is that national parks are subject to many of the same pressures facing natural environments beyond their borders, such as the spread of invasive alien species, reduced water quantity and quality in rivers flowing through the park and – far more insidious and difficult to remedy – the threat of climate change.

In 2016 South African National Parks (SANParks) published ***Taking Stock of Parks in a Changing World***, an assessment of six drivers of environmental change – climate change, land-use change, disease, alien species, change in freshwater systems and resource use – in the 19 parks. The report emphasised that these drivers influence and interact with one another, so climate change should not be seen in isolation, but it was recognised that a climate change adaptation strategy was needed for the parks.

SANParks' Landscape Ecologist, Dr Mmoto Masubelele, based at the Cape Research Centre, was given overall responsibility for developing this strategy.

"Initially it was planned to be a broad document that identified priority actions around species and ecosystems, such as establishing migration corridors and restoring ecosystem services," he explains. "Subsequently it was realised that an implementation plan for each of the parks was more appropriate."

The process was informed by collaboration with Prof Wendy Foden of the University of Stellenbosch, who chairs the Climate Change Specialist Group of the IUCN Species Survival



BACK TO TOP

Commission (SSC). She also led the development of the IUCN SSC Guidelines for Assessing Species' Vulnerability to Climate Change, published in 2016, and currently coordinates the African component of the Spatial Planning for Protected Areas in Response to Climate Change (SPARC) project, which is funded by the Global Environment Facility (GEF) and implemented by Conservation International.

"The globally accepted approach for developing adaptation strategies has essentially four steps: identify conservation targets, assess vulnerability to climate change, identify management options and then implement them. Ongoing monitoring, review and revision of each step is essential for ensuring that strategies are effective, particularly as understanding of climate change impacts and the adaptation approaches grows. Assessing vulnerability to climate change is extremely important, because if you don't know what's likely to go wrong, how can you know what to do about it?" she says.

"Vulnerability is a combination of how exposed you are – what change is coming your way – how sensitive you are – your ability to stick it out where you are – and your adaptive capacity – whether you can escape, either by moving or by changing yourself or your behaviour. From a species perspective, the approach that many conservation organisations internationally have taken is to examine how much climate change each species is exposed to, and then to look at its traits, such as those relating to dispersal and physiology, to figure out how sensitive and adaptive that's going to make it."

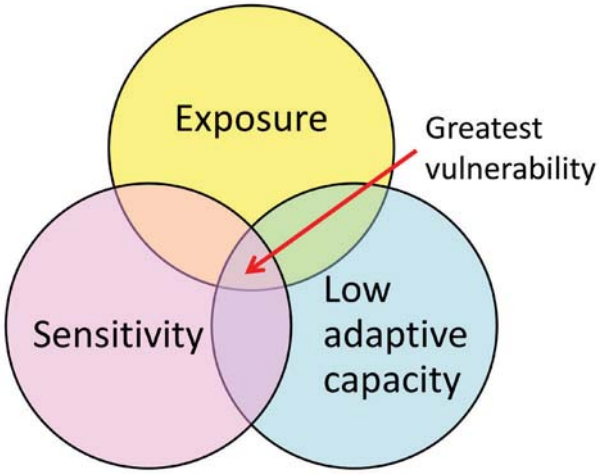
A presentation by Prof Foden to the 2017 Masters students at the University of Cape Town's African Climate and Development Initiative (ACDI) piqued the interest of Kevin Coldrey, who approached her about applying the SSC Guidelines for a vulnerability assessment of protected areas for his MPhil research project. Rather than just focusing on species, though, he decided to expand the scope of the vulnerability assessment to include the socio-economic impacts of climate change that affect the conservation mandate of protected areas. This would entail developing a new methodology, which he would apply to the 19 national parks as a test case.

Ultimately, he selected five categories of impact to investigate – species, ecosystems, infrastructure, tourism and neighbouring communities. The approach recognises that climate change is likely to cause shifts in the distribution of species and biomes, and further threaten vulnerable species, potentially resulting in the disappearance of some species from particular national parks and a change in dominance from, for example, grassland to savanna. Apart from these direct biodiversity impacts, the three socio-economic categories may indirectly impact biodiversity by negatively affecting the finance and governance of a protected area, which makes conservation more challenging.

Park infrastructure will in future be at increased risk of being damaged by extreme weather events, sea level rise and fire, which will have a knock-on effect for tourism when road networks and accommodation are affected. Tourism is predicted to be negatively impacted by climate change in several other possible ways too, such as higher temperatures, raising discomfort levels to the point that tourists avoid visiting a park during the summer months, the loss of charismatic species from particular parks and/or increased bush encroachment – both of which impede the game-viewing experience – as well as altered malaria risk, even at parks that were previously malaria-free. Lastly, the 'neighbouring communities' category refers to poor communities in the vicinity who might demand access to a park's natural resources for food, firewood, traditional medicines and craft materials – or simply resort to poaching or illegal harvesting – as they become increasingly stressed by climate change.

Coldrey's methodology relied on a number of different indicators, models and datasets to assess these impacts, but one of the first tasks was to consider how different each park's temperature and rainfall regimes might be in the future, compared to the present day. The 2016 SANParks report included a retrospective analysis of available weather station data up to 2009 to identify temperature and rainfall trends, which had produced some startling results. It was found, for example, that the average maximum temperature at Twee Rivieren in the Kalahari Gemsbok National Park had risen by 1.95°C between 1960 and 2009. There was a corresponding increase of 36 additional days per year when the temperature had exceeded 35°C, while minimum temperatures no longer fell below 0°C as often as they used to. No changes in total rainfall were detected in the rest camp's 90-year historical rainfall record, but some of the southern parks had experienced a reduction in rainfall, and rainfall intensity had increased in several parks. In many cases, however, trend analysis was compromised by the availability or accuracy of data, with data gaps, short time-series, and monthly rather than daily rainfall data all presenting problems.

"Based on the information we had, our report looked at how climate had actually changed, with some speculation as to what that might mean," says lead author, Dr Nicola van Wilgen. "Kevin's study takes it a step further, and asks how vulnerable that makes us."




*According to the IUCN SSC Guidelines for Assessing Species' Vulnerability to Climate Change, the greatest vulnerability occurs when species are exposed to large and/or rapid climate change-driven alterations in their physical environment, are sensitive to those changes, and have low adaptive capacity.*

BACK TO TOP


Wikipedia

*South Africa's national parks*

*"It is important for park managers to analyse the results of the individual assessments for their parks so as not to overlook or misinterpret the aggregated scores," he notes. "They also need to bear in mind that each potential impact category has its own level of uncertainty."*

Coldrey first developed a dataset of projected temperature and rainfall for each park in the year 2050, based on outputs of the CSIR's simulations of future climate over southern Africa at 50-km resolution using the conformed-cubic atmospheric model (CCAM). He used the 'worst case scenario' – the RCP 8.5 scenario of very high greenhouse gas emissions adopted by the Intergovernmental Panel on Climate Change (IPCC) in 2014 – which predicts that by the period 2046–2065 global mean surface temperature will rise by an average 2°C, with a likely range of 1.4-2.6°C. By comparing his projected data with current climate variables, Coldrey could determine the expected change in mean annual temperature, mean annual minimum temperature, mean annual maximum temperature, days hotter than 35°C and high fire danger days, as well as mean annual rainfall, heavy rainfall days (>10 mm within 24 hours) and extreme rainfall days (>20 mm within 24 hours).

Notable findings were that the Golden Gate National Park had the largest percentage increase in all five temperature variables, while the Kruger National Park had the most marked increase in mean annual rainfall (8.8% change), and was only surpassed by Mapungubwe National Park in having more days with heavy or extreme rainfall in future. The Namaqua, Richtersveld and Tankwa Karoo National Parks were all projected to experience a 14-18% reduction in mean annual rainfall by 2050.

But what are the implications of these changes for species, ecosystems, infrastructure, tourism and neighbouring communities? The impact assessment required that various assumptions and choices be made in the modelling exercises and the weighting of aggregated indicators, so the results should be interpreted with caution. Nevertheless, the Bontebok National Park scored highest in terms of total species impact because the park was projected to contain unsuitable habitat for a number of vulnerable amphibians and the range-restricted Cape sugarbird by 2050. The Camdeboo and West Coast National Parks scored highest for ecosystems impact, with dramatic changes in biome representation.

With regard to infrastructure, the Kruger National Park had the highest value of infrastructure at risk, largely due to the potential flood damage caused to bridges over rivers, given the predicted increase in extreme rainfall. Yet it was the West Coast National Park that had by far the greatest proportion of total infrastructure at risk, because many of the park's assets lie below the 5 m contour line, and would thus be threatened by storm surge events associated with sea level rise.

The tourism impact score for each park was determined by summing four separate scores for lower occupancy rates due to discomfort related to high temperatures, malaria risk, bush encroachment and loss of charismatic species. Mapungubwe and Marakele National Parks had the highest total scores, but for different reasons. While Marakele was projected to experience an increase in malaria risk, with more than 65% of the park area expected to be stable for malaria transmission by 2050, Mapungubwe was expected to become nearly devoid of malaria. However, Mapungubwe shared the top spot with Augrabies Falls National Park in terms of potential loss of charismatic species, neither park being climatically suitable for leopard and zebra under projected conditions. Bush encroachment, partly a result of rising carbon dioxide levels, was predicted to have the most significant impact at the Addo Elephant and Marakele National Parks, while Mapungubwe and the Kruger National Parks scored highest for tourism impact due to discomfort caused by high temperatures.

"Although all parks were predicted to have at least a 25% increase in days over 35°C, this doesn't mean they will all experience an overall decline in tourism demand owing to discomfort," says Coldrey. "In fact, some parks stand to gain tourism demand. This is because the marginal decline in occupancy levels due to extreme hot temperatures in the summer months will be outweighed by the higher occupancy rates associated with increased temperature during the winter months, when the cold historically deterred people from visiting."

Another somewhat counter-intuitive result, given its urban setting, is that Table Mountain National Park scored highest in the neighbouring community impact assessment. This can be attributed to the high number of poor households in the vicinity of the park. Realistically, however, communities in urban areas will be less likely to depend on park resources than those in rural areas, because they have better access to basic services.

All of these impact scores, together with the projected temperature and rainfall, are an indication of the national parks'



BACK TO TOP

Sue Matthews

*Both the climate envelope model and the dynamic global vegetation model predict that the Camdeboo National Park is likely to experience a significant change from its current biome representation, translating to a high ecosystem impact.*

exposure and sensitivity to climate change, but the remaining component of the vulnerability assessment is the adaptive capacity of the parks to respond to these threats. Two measures of management performance for each park, as well as its capacity for expansion into climate-resilient corridors, were combined to give an overall adaptive capacity score. Only the Namaqua, Tankwa Karoo, Karoo and Mountain Zebra National Parks scored reasonably well in terms of their capacity to expand, based on the indicators selected. The overall adaptive capacity scores were quite uniformly spread within the 40-55% range, with Bontebok National Park scoring highest.

Sue Matthews

*The availability of suitable land to expand the Mountain Zebra National Park means that this park has a high adaptive capacity, and its overall vulnerability to climate change is relatively low.*

Finally, the impact assessment scores and adaptive capacity scores were used to compute a vulnerability score. The West Coast National Park scored highest, suggesting that it is the park most vulnerable to climate change, while the Karoo National Park had the lowest ranking. Coldrey highlighted a number of caveats in his thesis discussion, however, given the constraints of the modelling approach and the omission of many other potential impacts of climate change.

**"**It is important for park managers to analyse the results of the individual assessments for their parks so as not to overlook or misinterpret the aggregated scores," he notes. "They also need to bear in mind that each potential impact category has its own level of uncertainty."

He concludes by noting that the next step would be to identify the adaptation options available to the different park managers, based on the results of the study. Dr Masubelele confirms that a process is under way, as the vulnerability assessment has been incorporated as an initial stage of the comprehensive framework he has drawn up for the SANParks climate change adaptation strategy.

"We sit with the park management teams and ask them what issues around climate change concern them most, working on the ground. Where there is corroboration between their concerns and Coldrey's findings, those are the priority areas we would focus on in terms of our implementation actions for adaptation."

BACK TO TOP

Dr Masubelele notes that park managers have a good understanding of endemic species in their areas and the current threat status – described in the management plans for each park – and existing management actions such as alien-clearing will improve the resilience of ecosystems to climate change. Land expansion and corridor development is also ongoing, even though it is often motivated by the need to meet biodiversity conservation targets, rather than climate change adaptation. Likewise, a park manager who reroutes a coastal hiking trail inland because it is repeatedly damaged by storm seas sometimes has to be reminded that this is effectively an adaptation action against sea level rise. In addition, greening initiatives are being implemented to reduce the environmental footprint of park infrastructure, and visitors are alerted to the need to save water and electricity, which can help alleviate the threat of climate change.

"Kevin's study has helped us identify possible future scenarios to enable us to think about the problem," adds Dr Van Wilgen. "Whether or not these scenarios will be realised, it's about putting measures in place to make sure that they don't happen, or that we are prepared for what's going to happen. We have to think about novel ways of managing a situation that wasn't there a decade ago!"

Since completing his MPhil thesis, Coldrey has been contracted by Conservation International to apply the methodology to


Sue Matthews

*The vulnerability assessment indicated that Addo Elephant National Park may experience a reduction in tourism demand by 2050 because game-viewing would potentially be impeded by bush encroachment, largely due to higher atmospheric carbon dioxide levels that favour the growth of woody plants over grasses.*

1 500 tropical protected areas across Africa, Latin America and South-East Asia, and by WWF to use it as part of a broader study of threats to Kenya's Masai Mara National Reserve. He will also be applying it to 13 of Ezemvelo KZN Wildlife's largest nature reserves, and will present the results at the Symposium on Contemporary Conservation Practice in November, where he will convene a special session on climate change in protected areas.

Sue Matthews

*The West Coast National Park was found to be the park most vulnerable to climate change, because it scored highly in the ecosystems and infrastructure impact categories, and poorly in the adaptive capacity assessment.*



BACK TO TOP

# WATER AND THE COMMUNITY

## The salt whisperers – Study shows rural women not benefiting from indigenous knowledge to extract Baleni salt

*Coaxing salt from mud may not be the average South African's everyday skill set. But it's a tradition that's been handed from mother to daughter for generations among a handful women living near the Baleni hot springs, about half an hour's drive from Giyani in Limpopo Province. Leonie Joubert reports on a Water Research Commission project investigating the value of this indigenous knowledge.*

It's not just the technical knowledge relating to their specific method of salt extraction that they share amongst themselves, though. They also hand down the rituals which they believe will appease the ancestral spirits as they go about the task of mining salt, and they are careful in their induction of inexperienced women into the salt-harvesting guild.

This women-only practice goes back an estimated 1 700 years, and involves a simple but effective process of scraping a crust of salt-laden soil from the dry riverbed during winter months, which is then extracted from the mud by dissolving it in water. The brine is filtered through baskets of mud, and then heated until the water evaporates, leaving behind pure salt crystals. The women of the Mahumani community, who are guardians of this knowledge and the wetland where they have traditionally mined the salt for generations, either exchange their salt for groceries at nearby markets, or sell it for cash to local traders or traditional healers.

With the recent growth in the high-end market for artisanal culinary products, a bigger commercial opportunity has opened up for Baleni salt. As much as a third of this salt is now going into an external market value chain, where it fetches nearly four times the price of the salt sold locally by women traders. This premium

BACK TO TOP

*A salt miner tends to a xinzhava filter, used to extract brine from salt crust collected from the vicinity of the Baleni hot springs.*

price is based on a markup that's linked with its heritage value. A single commercial salt company now dominates the external value chain into which this product is now being sold.

> *"This knowledge, and the technology relating to extracting the salt, belongs to these women, and yet they're not significant beneficiaries of the value chain."*

However, a recent study of value chains into which the Baleni salt is being sold, shows that the women who are keepers of the knowledge of the salt extraction are not getting maximum benefit from the profits of their efforts or their tradition knowledge skills. A significant portion of the final price that the product fetches once it reaches its urban market, is collected by a series of 'agents' and 'brokers' in the value chain.

"We estimate that there are about 30 women in the Mahumani community who are mining salt from the Baleni wetlands on the Klein Letaba River," reports Prof Edwin Muchapondwa, a resource economist from the Environmental Policy Research Unit (EPRU) at the University of Cape Town. Prof Muchapondwa headed up the team of four researchers who were commissioned by the WRC in 2016 to do a full value-chain analysis of this small industry.

"The women are harvesting about two tons of salt per year. Those women who are selling their salt locally, are getting about R20 per kilogram. Those who are selling into the more affluent market are getting about R36 per kilogram. But people who are buying this salt are paying R135 per kilogram," says Prof Muchapondwa.

Some of the takings along the value chain must go towards the high cost of getting the project to market, but the women are nevertheless not getting maximum benefit of their knowledge and the exclusivity of their product.

Salt mining in the Baleni wetland usually happens in the winter months, between June and July, and according to the team's findings, the women are collecting between 50 kg and 80 kg of salt usually over a two-week harvesting period. They mostly package that into 500g plastic packets that sell for about R10 a bag at the local market.



BACK TO TOP

"But, since getting into the high-end markets, this salt is now being used by some Michelin chefs. It's being sold in attractive packaging by a specialty salt shop in Amsterdam. It's even been included in the Slow Food's Ark Taste, and profiled at the Terra Madre shows in Turin,"notes Prof Muchapondwa. "And yet, our value chain study shows that it's these women's indigenous knowledge that allows their product to fetch a premium. This knowledge, and the technology relating to extracting the salt, belongs to these women, and yet they're not significant beneficiaries of the value chain."

The report recommends that the women could benefit more from their product if they exploit its uniqueness, which is based on the heritage value of how it is mined, and the indigenous knowledge that their community has conserved for so many generations. Recognising its full value might also help them be more assertive in fixing the price of their product. One further way to protect these women miners' livelihoods, and prevent the loss of their knowledge, could be through registering their processing technology and knowledge as their intellectual property.

**Greater protection for nature's free services**

"The other question that comes through from this study, is the need to protect the natural systems that give us the ecological services that we as communities benefit from," explains Prof Muchapondwa.

The purpose of this study was partly to feature a case study that demonstrates the water-linked goods and services that nature provides society, free of charge.

The salt-laden soils in this wetland provide a free resource to the women of the Mahumani community, but how much can they safely harvest before possibly undermining the healthy function of the wetland that they depend upon for their livelihood? And what is the current state of health of the wetland system from which they are getting the free resource?

According to Prof Muchapondwa, a prospecting exercise done in the 1940s calculated that this hot spring and surrounding wetland has about 2 300 metric tons of salt available for exploitation. This suggests that there is a threshold to how much salt people can mine from here, although Prof Muchapondwa says there is need for further research to gauge the current capacity of production.

"We need greater certainty about the potential yield, which will say something about the extent of the vulnerability of the miners and entrepreneurs who are at the helm of the project."

Like many of the Limpopo Province's rivers, there is a risk that the quality of the water in the Klein Letaba River is poor for human consumption. However, previous testing by the CSIR showed that the sample had 'good elements'.

"The Baleni salt being scraped from the riverbed may contain impurities and toxic substances in concentrated form. We need ongoing assessments of water quality here, and whether the quality of the salt can be guaranteed for human consumption. In any case, it's important to have special quality control measures introduced upstream to prevent the local salt from being affected,' Prof Muchapondwa maintain.

The full report, ***Rural development and the governability of water-linked ecosystems in transitioning economies: The Market Value Chains of Baleni Salt in Limpopo*** by Prof Edwin Muchapondwa, Felix Chidavaenzi, Herbert Ntuli and Barbara Nompumelelo Tapela will be available from the WRC later this year.

# WATER REUSE

## Guidelines pave the way for safe use of greywater

*Today, it is widely acknowledged that demand for water will grow, while the resources we have left to draw it from are dwindling. In places where water scarcity is common, new water resources are urgently being investigated. One that's being eyed as of potential significant value, is the water that we have already used. Greywater is being thrown into the mix as a viable source of water, and an important, available tool in the arsenal to increase water security, particularly during drought. Petro Kotzé reports.*

Kathy Eales

Greywater is untreated household wastewater from domestic processes like taking a bath and shower, washing your hands, doing the dishes and the laundry. It excludes water from the toilet.

In South Africa, a person's experience with greywater is vastly different, depending on where they live. In serviced areas, where homes have taps and sewerage systems, water enters the house to be used, and it is washed away again after it has been dirtied. In some serviced suburbs impacted by drought, like parts of Cape Town, residents recently started making use of greywater extensively. Instead of washing the water away, residents are catching it in a bucket, and diverting it to other needs, such as flushing the toilet. This is often the case in severe droughts, when there are no other alternatives.

People living in informal settlements where there are generally no municipal sewerage and water services supplied to homes already use greywater extensively, both in times of drought and when water is plenty. Water collected from a tap could be used multiple times – first to bath, maybe for more than one person, and then perhaps to do laundry and wash the floor, before being discarded outside.

Still, in South Africa, though direction is provided by municipal guidelines, there is no national legislation to govern its safe use. A recent Water Research Commission study has laid the foundations for the way forward. ***Guidelines for greywater use and management in South Africa* (Report no. TT 746/17)**, has been written by researchers from the Future Water Research Institute at the University of Cape Town (UCT), and the Division of Community Health at Stellenbosch University.



BACK TO TOP

The aim of the document is to provide a South African context for the inclusion of greywater as a viable, alternative, non-potable resource. The guidelines are based on existing knowledge and expert opinion, and are intended as background information to national and local government policy-makers for the drafting of appropriate legislation and local-level guidelines.

**The risk of using greywater in South Africa**

Project team leader, Dr Kirsty Carden, senior research officer at Future Water, explains that the current drought has sharpened people's minds to alternative water resources such as greywater. But in South Africa, the management and risk of greywater is different than in many other countries where it is commonly used, because we generally do not make use of greywater treatment systems.

Here, most greywater is collected by hand with a bucket from the shower or bath, or some people might have a small system installed to divert the water from their house to the garden, for example.

"The quality of this water can be very poor, and certainly not without health concerns," she says.

As the routine testing of the quality of greywater produced in a household is not feasible, it is commonly classified according to where the water is generated. This is divided into light (class 1 and class 2) and dark (class 3) greywater, as follows:

- Class 1a: Bathroom greywater – greywater sourced from showers
- Class 1b: Bathroom greywater – greywater sourced from basins and baths
- Class 2: Laundry greywater – greywater sourced from laundry basins and washing machines
- Class 3: Kitchen greywater – greywater sourced from kitchen sinks and dishwashing machine.

The study excluded class 3 as a potential resource because it can be highly alkaline and contains high concentrations of organic material, fats and oils. Still, around 50% to 75% of water used in a household can potentially be reused instead of being washed down the sewer. According to the project report, household potable water use in South Africa could be reduced by up to 50% should greywater be used for toilet flushing and garden irrigation.

The quality of greywater is highly variable and depends to a large extent on the household in which it is generated – particularly the number of people living in the house, their lifestyles and ages. Households with babies, small children and pets produce greywater that contain higher counts of faeces and urine. Households with inhabitants suffering from acute diseases, such as gastroenteritis, eye / ear infections or jaundice can produce greywater with considerable loads of bacteria. Even if the kitchen sink water is excluded, soaps and detergents, fabric softener, medicines, disinfectant, food particles, pesticides, cosmetics and fibers can make their way into greywater. Saliva, sweat, body oils, hair, blood and some urine and faeces matter are all part of the potential mix of greywater content. As such, the use of greywater poses significant potential risks to both human health and the environment.

Pathogens in greywater can potentially cause disease when people come in direct contact with the water, or when irrigated produce is eaten. The high sodium content from soaps, shampoo, body wash and other substances can result in soil degradation, potentially causing long-term problems. Zinc from some hard soaps can also accumulate in the soil, and leaching can lead to groundwater contamination. Interestingly, studies have not found clear indications that so-called eco-friendly products are more suitable for greywater irrigation systems than conventional cleaning products. In addition, there is potential for the sewerage system to become blocked due to reduced flows and higher solids content in the sewage.

Children, people with compromised immune systems, the malnourished, elderly and pregnant women are all more likely to become ill from consumption of contaminated water and from exposure via recreational activities. In South Africa, this collection of people is a sizable portion of the population.

*"Around 50% to 75% of water used in a household can potentially be reused instead of being washed down the sewer."*

Photo supplied

*In informal settlements water may be used multiple times before being discarded.*

*Greywater is untreated wastewater from domestic processes, such as taking a bath and a shower.*

The study concludes that "not enough is currently known about the long-term effects of greywater use on human health and the environment to make definitive decisions about this practice." The ranges of contaminants and their potential health impacts under South African conditions is an area of research that needs further attention. Even then, the use of greywater could always pose some health risk and therefore, a well-planned greywater policy should include a decision on what frequency of contamination incidents and/or water-related diseases constitute a sufficient level to sound the alarm for reassessment of the continued use of greywater in a community.

**A summary of guidelines for the use of greywater in South Africa**

The report states that greywater is most appropriate for activities such as watering the garden (untreated greywater) and flushing the toilet (treated and disinfected greywater). It should be noted that the long-term impacts on the environment of irrigating with greywater have not yet been determined.

As a rule, untreated greywater should never be used where it can easily come into contact with susceptible individuals and/or ingested. It should never be used for:

- Drinking or cooking
- Irrigating of any food eaten raw or minimally processed (leafy vegetables and root vegetables)
- Washing of pavements, especially when water drains into the stormwater systems
- Irrigating gardens during or immediately after rainfall
- Irrigating areas in gardens where children play, like lawns.

When greywater is used, the following rules should always be adhered to:

- Avoid human contact with greywater, or soil irrigated with greywater. Children and pets should be kept away from areas that are irrigated with greywater.
- Water that comes into contact with a toilet, urinal or a toilet fixture such as a bidet should never be used as greywater.
- Water that has been used to wash nappies or other clothing soiled by faeces and/or urine should not be used;
- Water generated by cleaning in the laundry or bathroom, or when using hair dyes or other chemicals should not be used.
- Water from the kitchen sink or used in the kitchen to wash dishes or food should not be used.
- Greywater generated by washing clothes / brushes used for painting or for maintaining machinery and vehicles should not be used.
- Greywater should not be used if anybody living in the premises is suffering from diarrhoea, ear or skin infections.
- Water used to wash animals, such as domestic pets, should not be used.
- 'Low risk' greywater, such as warm-up water from hot taps, rinse water, bath or shower water is preferable.
- Untreated greywater should not be stored for longer than 24 hours (otherwise it should be treated)
- Use signs to indicate greywater reuse, and label all pipes
- Ensure that hands are properly washed after contact with any form of greywater and reuse system.

**Potential uses for greywater in South Africa**

The study found that, if managed correctly, greywater reuse can potentially still be a promising alternative water resource, particularly in low-density, high-income areas where health concerns are less pronounced and more greywater is generated.

Greywater is most suitable for activities such as toilet flushing and irrigating sections of the garden where there is limited contact with people. However, there is potential for health risks when toilets are flushed, as water droplets may be aerosolised and could land on nearby surfaces, or dispersed into the air and transferred through hand to mouth contact if proper hygiene practices are not followed.

Greywater can also be used for small-scale irrigation, as long as appropriate barriers to risk are in place. Installing such a system is complex, however. This can prevent large-scale adoption in urban catchments.

Greywater use is not recommended in un-serviced settlements in South Africa. As it is already reused many times before it is disposed of in areas where there is commonly no form of drainage, it often merges with toilet water and other effluent flows, creating a toxic mix of contaminated water that poses a danger to human health and the environment. As a result, the quality of greywater emanating from non-sewered settlements often resembles black water (sewage), and is hazardous from a pathogenic and chemical perspective.

"There's no further use for greywater in informal settlements," says Dr Carden. The paradox here is that greywater offers great



BACK TO TOP

potential for improvement in household nutritional status and social functioning in poor rural settlements, and in urban and peri-urban settlements around the major metropoles of South Africa. The challenge lies in identifying conditions and limitations under which greywater could be used beneficially.

In South Africa, the most promising domain for institutionalising greywater reuse at this stage appears to be in large buildings such as office blocks, public buildings and hostels as it can be collected and treated under proper supervision.

**Moving forward to a future with greywater**

How greywater should and could be used very much depends on the context, says Dr Carden. The key message is that peoples' health and the environment should be protected first.

In informal settlements, our first priority should be providing proper services. In serviced areas, people should be able to use greywater as they see fit, but under certain conditions. In large buildings, properly run systems capable of disinfecting water should be put in place.

Dr Carden says that following the study, she would not promote greywater as a viable, safe alternative source of water in South Africa under current circumstances. However, she adds that the report was written before they were in the throes of the current drought. "In that context we were pretty conservative." As the drought continued, she says it became clear that people were already using their greywater, regardless of the lack of guidance.

There is a sense that greywater use will happen no matter what, notes Dr Carden. The aim is to provide enough information to management authorities, in order for them to provide the best guidance to residents on how to do this. Still, if the country is to seriously start thinking of greywater as part of the resource mix, research on the long-term impacts on people, the environment and policy must continue.

"There are gaps in our knowledge of what could happen, particularly in lower income communities that don't have access to good services and often use greywater. In general we don't have a good understanding of the impact of greywater – not only on human health, but also on the environment in the long term."

Yet, the inclusion of greywater as an alternative resource as part of the water supply mix is one of the basic premises of creating more resilient cities in the future. Traditionally, water is pumped into a city, used and dirtied, and then pumped away again to be disposed of. "We should think about this differently," says Dr Carden. Instead, the quality of water already within a city should be matched with an appropriate use (called fit-for-purpose water). In South Africa, it is common to use freshwater of a drinkable standard for everything from washing clothes and cars, to flushing the toilet, watering the lawn and drinking. But it's not necessary to use water of the same quality for all of these functions. Yet, potable water is mostly the only option currently supplied.

As we are becoming ever more aware that we have to plan for uncertainty, and build resilience into systems that have emerged as being vulnerable to crises such as drought, the development of guidelines on the safe use of greywater is an essential step in the right direction.

*The study recommends that management of greywater in informal settlements in South Africa should be geared towards safe disposal, rather than further productive use.*

# CITIZEN SCIENCE

## Suite of tools help citizens take control of freshwater management

*Citizen science tools developed under a Water Research Commission-funded project facilitate learning, increase knowledge and encourage co-management of water resources. Article by Sue Matthews.*

*Endangered Wildlife Trust Eco-ranger, Nduduzo Khoza, takes a reading with the water clarity tube during the Karkloof River Walk.*

When members of the Karkloof Conservancy decided to host a river walk last year to assess the health of the Karkloof River, they were confident that they had simple but reliable tools at their disposal to accomplish the task. As part of a WRC-funded project conducted by GroundTruth and the Wildlife and Environment Society of South Africa (WESSA), a variety of water-resource monitoring tools had been developed for use by so-called 'citizen scientists'. These allow anyone with an interest in the management of water in their surroundings to improve their understanding of water-related issues and problems, which helps empower them to respond to such challenges.

The core team that set off on 26 March 2017 for the Karkloof Catchment to Confluence River Walk was made up of staff from the Karkloof Conservancy, WWF-SA, Endangered Wildlife Trust and GroundTruth, but during the six days it took to cover the 64 km from the river's upper reaches to its confluence with the uMngeni River, representatives of various landowners in the area – including SAPPI, tourist resorts and farming operations – joined them for part of the walk. More than 35 river sites were assessed along the way, using three of the citizen science tools developed or refined within the WRC project.

**The miniSASS tool**

The mini Stream Assessment Scoring System (miniSASS) is a citizen science version of the SASS5 biomonitoring method that is used by aquatic scientists and environmental practitioners to assess river health. While SASS5 requires the identification of



BACK TO TOP


*The 'river walkers used the citizen science tools to assess the health of the Karkloof River in the KwaZulu-Natal Midlands.*

*The velocity plank can be used to determine flow velocity of a stream, as well as depth and discharge.*

over 90 families of macroinvertebrates, miniSASS involves only 13 broad groups, such as worms, crabs, snails, dragonflies, and bugs and beetles. Depending on which groups are found, a total score is calculated for the Present Ecological State of the river site, equating to a health category ranging from 'natural' to 'very poor'. Results can be uploaded to a Google Earth layer via the miniSASS website (www.minisass.org) or an Android app, with the health status of sampled sites depicted as different coloured crab icons.

**The Riparian Health Audit tool**

The RHA tool enables citizen scientists to assess the habitat integrity of a river by evaluating the condition of a section of the river margins, known as a riparian reach. It considers eight different types of impact – exotic plants, rubbish dumping, bank erosion, inundation, flow modifications, physico-chemical modifications, vegetation removal and channel modifications. These are rated according to six levels of impact, after which a mathematical model is used to calculate the ecological health of the riparian reach, ranging from 'natural' to 'critical' condition.

**The water clarity tube**

The clarity tube is a metre-long clear tube that gets filled with sample water to obtain a measure of suspended solids. Although suspended solids include soil particles, planktonic organisms and organic matter that occur naturally in the water column, pollution and other impacts of human activity – such as those mentioned in the previous bullet – can increase their concentration significantly. This not only degrades water quality, but also disrupts biological communities by reducing light penetration, smothering plants and bottom-dwelling animals, and clogging the gills of fish and invertebrates. While the clarity tube is not a South African invention, some design improvements were made to the locally made units during the WRC project, and calibration tests were conducted to determine the relationship between water clarity and alternative indicators of suspended solids, namely turbidity and total suspended solids, which require more sophisticated and expensive equipment.

The Karkloof river walkers had the added benefit of access to a water quality monitoring instrument, so they were able to measure pH, dissolved oxygen, electrical conductivity and temperature at each site. They also collected water samples for laboratory-based analyses of nitrates, phosphates and ***E. coli*** bacteria. This additional data helped interpret the findings from the citizen science tools, and all results were written up in a comprehensive report by GroundTruth. The results indicated that the river was in a fair to good condition, with minor impacts distributed over wide reaches and more intense impacts being very limited in extent. Invasive alien plants – particularly bramble, black wattle and bugweed – and diminished water quality due to nutrient enrichment and ***E. coli*** contamination were the main impacts.

In a separate project, GroundTruth was also involved in a year-long flow-monitoring study of the Karkloof River to inform irrigation management. Weekly field work was conducted using a traditional flow meter, but farmers were also shown how to use a velocity plank so that they could monitor river flow on their own. This was another of the citizen science tools tested during the WRC-funded research project.

**The velocity plank**

The velocity plank is a locally made version of the Transparent Velocity Head Rod (TVHR), which originated in the USA. It is a transparent plastic board with a measuring ruler that is used to determine flow velocity of a stream. By standing the board vertically on the streambed, the depth of the water can be measured, as well as the water level on the upstream and downstream side of the plank. The difference between these two water levels is used to predict flow velocity. Multiple measurements taken across the width of the stream can be used to calculate depth-averaged flow velocity (metres per second) of the stream, as well as its discharge (discharge = velocity x depth x width). During the WRC project, a calibration study was done to produce conversion tables that are included in the manual for this tool.

BACK TO TOP

The citizen science 'toolbox' developed within the WRC project also includes a number of other tools.

**The wetland assessment tool**
This tool describes a method for assessing the ecological condition of a wetland based on land-cover type. It uses the same approach as the vegetation component of WET-Health Level 1 – a desktop assessment method used by wetland scientists – with impact scores assigned to various types of disturbance. The tool comprises a technical document outlining the scientific basis of the method, and a user guide that directs users to select either a simple tool to map the impacts on the wetland, or a more detailed tool that ranks impacts according to their severity and effect on wetland functioning. Based on the input from the ranking system, a present ecological status is automatically calculated using the provided Excel workbook.

**The estuary tool**
Estuaries are complex and dynamic systems that require some degree of understanding before appropriate monitoring parameters can be identified for a specific estuary. The WRC project therefore focused on developing an educational resource for a one-day visit to an estuary by school groups and other potential citizen scientists. The theoretical component of the resource is a written guide highlighting the key characteristics of estuaries, such as tides, salinity, river flow and estuary mouth dynamics, as well typical ecological features. The practical component includes activities such as measuring salinity and temperature, observing tidal patterns and mouth dynamics, and monitoring water flows. Data collection sheets are provided for these monitoring activities.

**The spring tool**
The spring tool begins with background information on springs, which are not only important for rural water supply in many areas, but may also have cultural, religious or tourism significance. A health index then leads the citizen scientists through a number of steps, from determining the location and type of spring to investigating the surrounding land use and geomorphology of the area. Next, the citizen scientists rate the intensity of 10 different kinds of impact on the spring, including livestock grazing, pollution, vegetation removal, soil erosion and groundwater withdrawal. Finally, a datasheet is completed that allows the citizen scientists to calculate the Ecological Condition of the spring as the percentage of change that has occurred compared to its natural (original) condition.

**Weather monitoring tools**
A variety of simple weather monitoring tools were tested during the WRC project, and calibrated against scientific instrumentation and a Davis home weather station. These include a rain gauge constructed from a two-litre Coca-Cola bottle, and a wind pressure plate made from plastic corrugated board and PVC electrical piping to measure wind speed and direction. Manuals for these tools have been developed, and information made available on why weather data is important to citizen scientists.

**School lesson plans**
School lesson plans and other resources in support of citizen science activities were developed or updated to comply with the Curriculum and Assessment Policy Statement (CAPS). These will enable teachers to plan, produce and conduct effective fieldwork experiences focused on rivers, wetlands and catchments. Specific lesson plans are provided for the Intermediate Phase (Grade 4-6), Senior Phase (Grade 7-9) and Further Education and Training (FET) Phase (Grade 10).

*Uptake of the tools has been promising, thanks to a concerted effort made by the project team and others to publicise them through seminars, training days and events*

*Councillors and traditional leaders use miniSASS during the fieldwork component of the leadership seminars offered by WESSA in partnership with the Department of Cooperative Governance and Traditional Affairs.*



BACK TO TOP

**Enviro Picture Building game**

The WESSA Share-Net Enviro Picture Building game portrays environmental issues as pictures on cards, with supporting information on the reverse side. It encourages participants to visualise and interpret the impacts that various land-use types and human activities have on water resources. In this way it helps participants understand a more holistic and connected view of the environment in which they are studying.

The WRC project entailed not only developing, refining and testing these tools – all of which are available from GroundTruth or via the miniSASS website – but also researching their potential to effect meaningful change in water resource management. Dr Jim Taylor of WESSA headed this part of the project, but a number of postgraduate students and interns were involved in various aspects.

During this research, an adaptation of an open process framework was used to engage community groups in fieldwork activities and provide training on the citizen science tools. The 5T Model allows a matter of concern, or 'nexus', to be identified by the group as the main focus or issue to be addressed, after which the 5T's can be done in no particular order. These are 'Tuning in' (careful and collaborative planning), 'Talk' (dialogue), 'Touch' (real-life encounters such as fieldwork), 'Think' (reflection) and 'Take action'. The model will assist citizen scientists in working to resolve a water-related challenge they face or to learn more about an issue that interests them.

The project team also explored and identified the enabling factors that resulted in citizen science tools being readily understood, accepted or adopted, as well as the limiting or inhibiting factors that discouraged or prevented their use. These 'successes' and 'barriers' were grouped into social, technical, financial or geographic factors, but with appropriate training and support most of the barriers could be overcome, and even transformed into successes. The WRC project report provides examples of ways to achieve this.

Using a number of case studies, the project team demonstrated that the action-oriented learning that took place through use of the citizen science tools was more likely than passive awareness-raising to encourage local action by civil society, with positive outcomes for both social change and water resource management.

Uptake of the tools has been promising, thanks to a concerted effort made by the project team and others to publicise them through seminars, training days and events associated with National Water Week and Nelson Mandela Day. Presentations and workshops at national and international conferences have also helped spread the word, with the result that the tools are increasingly being used in neighbouring countries and further afield.

The miniSASS tool is especially popular, and has already been translated into isiZulu, Afrikaans, Swahili and French. It is being promoted by the Global Action Plan's Water Explorer programme – operating in 11 European countries and South Africa – that encourages students aged 8 to 14 to take action on water issues. Targeting an older group, Dr Taylor led a miniSASS workshop in June 2018 at the Empowerment for Climate Leadership programme held in Arusha, Tanzania, where 24 young climate activists from India, Tanzania and Germany came together to explore ways of implementing the Sustainable Development Goals and Agenda 2030. Subsequently, he hosted a telepresence video-conferencing session on citizen science while in Delhi in July, with participants from other parts of India, Singapore and Australia.

"Invertebrates were in existence before the dinosaurs, and long before Gondwanaland split up, so the same broad groups can be found on other continents," he points out. "The 13 taxa used in miniSASS therefore allow for easy identification and understanding of river health, irrespective of where you are in the world."

- The report, Development of citizen science water resource monitoring tools and Communities of Practise for South Africa, Africa and the world (**WRC Project No. K5/2350**) will be available later this year.
- A video on the Karkloof River Walk, as well as a daily blog and the results report by GroundTruth, can be accessed at https://karkloofconservation.org.za/karkloof-river-walk/
- Read more about miniSASS and other citizen science initiatives in the May/June 2014 issue of ***The Water Wheel***.

Sue Matthews

*Learners identify aquatic invertebrates using the miniSASS tool.*

# BIOMIMICRY

## Turning to nature to solve modern day problems

*A Water Research Commission project has been piloting a nature-inspired sustainable and ecological wastewater treatment system in Langrug township in the Western Cape. Article by Petro Kotzé.*

Photo supplied

As populations grow and settlements expand, the landscape is rapidly changed and increasingly modified to accommodate people. Green areas are replaced with grey infrastructure, and necessary natural resources, such as water and soil, are polluted, impacting the wider environment. Grey infrastructure developments require expert knowledge to construct and maintain, are vulnerable to natural disasters and fluctuating climatic conditions and can create bigger problems should they fail.

In many parts of the world, engineers are now looking back to nature to build resilience into designs for more sustainable solutions. Incorporating plants and other natural elements into infrastructure have been proven to have many benefits in comparison to traditional building methods. Construction material is often cheaper, can create added benefits to communities, such as fodder and thatching, increases in strength over time, and is easier to maintain – a plus for local residents in difficult-to-reach places. Knock-on benefits are improved local biodiversity and a more beautiful landscape.

There are various terms for this movement, but bio-inspired is one, sometimes used as an umbrella term for design approaches that use biology as a resource for solutions. There is a broad range of applications, from those copying biological processes, to others simply incorporating nature into the design, and a combination of almost everything in between. This is according to Biomimicry South Africa founding director, Claire Janisch. The



BACK TO TOP

*Before wastewater created uncomfortable and unsanitary conditions. After installation of the disposal points, the impact of the project on the surroundings were soon clear.*

*Conditions in the Langrug settlement visibly improved after installation and construction of the project.*

Western Cape Government

organisation defines biomimicry as "the practice of learning from and emulating nature's genius to create products, processes and systems that are sustainable and resilient – even regenerative". As a formal profession, biomimicry only emerged in the last 15 to 20 years, but the practice of individuals or communities looking to nature for inspiration has been around for centuries, she says.

The concept is growing in recognition in South Africa too, one example of which is an ongoing project in the Western Cape piloting the application of biomimicry to treat heavily polluted wastewater. A WRC-funded project monitored and evaluated the treatment system, and found the technology to have substantial potential to improve service delivery and quality of life in areas in South Africa where it is needed most.

**An novel approach to service delivery**

Langrug is an informal settlement located on a mountain slope in scenic Franschoek, outside of Stellenbosch. The settlement was established in the 1990s, when migrants from the Eastern Cape flocked to the area for job opportunities in the surrounding wine industry. Though originally established illegally, the municipality has since provided basic sanitation services, such as toilets and taps. Some of these have broken or fallen victim to vandalism, resulting in even fewer assets where those available were already stretched to the limit. Reports indicated that by 2011 about 10% of the 91 toilets were out of order. The Community Organisation Resource Centre reported in 2012 that there was one toilet for every 50 people in Langrug.

Sewage is not the only challenge here. Langrug residents have to collect water from communal taps. Residents use water extremely efficiently, and water is usually used multiple times before it is discarded. The resulting highly-concentrated greywater flows down a matrix of unsanitary channels, delivering the untreated wastewater to the bottom of the hill, and into the Berg River.

The impact of these challenges at Langrug reverberate much further afield. Water from the Berg River is used to irrigate orchards and vineyards, the products of which are also meant for exports. The potential economic impacts, the declining state of the river, and the social circumstances at Langrug made the settlement the ideal area to pilot a sustainable and ecological wastewater treatment system.

**Cleaning wastewater with nature's helping hand**

The project is a partnership between Biomimicry South Africa, John Todd Ecological Design (JTED), Greenhouse Systems Development, Maluti GSM and Isidima Design and Development. The system constructed at Langrug, which treats greywater from the source to eventual disposal into the river, is part of a project funded by the Western Cape Government, called the Western Cape 110% Green Initiative. The Biomimicry Genius of Space system in Langrug is a flagship of this project. Due to unexpected delays, a section of this system (which provides final treatment) was not completed in time for the WRC funded study, resulting in monitoring and evaluation of a similar system, treating water of a similar quality, built on the Plankenbrug River in Stellenbosch.

The Langrug system serves 115 households in two blocks of the settlement. Greywater is collected at disposal points serving about five households each, explains Jonny Harris, founder and director of Isidima Design and Development. A filter removes

BACK TO TOP

solids like tissue paper and food scraps, before the water is led through a narrow, flexible pipe, allowing it to curve around the bends and turns of the surrounding infrastructure. Along the way, small gardens have been constructed, which are actually micro-wetlands that provide biological filtration and maintain an aerobic condition. The water is then led to a series of tree gardens. As each tree bed becomes saturated, water overflows into the next. The deep pit tree wells purify the greywater through absorption, decomposition and microorganisms and fungal communities. Nutrients and organic material are removed from the greywater and converted to humus, allowing purified effluent to infiltrate back into the ground.

In the process, the tree garden and sewer system feed off the water and nutrients, creating a sustainable green corridor through the settlement. Over time, the system will leave behind a network of deep planted tree wells with rich, high-carbon soils.

*Results indicate that biomimicry systems could treat polluted effluents similar to that of Langrug to a quality that complies with the general authorisation limits for the discharge of treated effluent back into the river.*

*Tree pits just after installation at Langrug informal settlement. In a couple of decades these will be a outstanding feature of the settlement landscape, while still serving as a wastewater management system.*

From here, the water is treated in a system based on biomimetic and ecological design principles. The design is based on the EcoMachine concept developed by Dr John Todd, and relies on biodiversity and natural processes to create mechanically simple but biologically complex systems to treat contaminants and human waste streams. In a nutshell, nature is employed to clean wastewater.

The EcoMachine consists of multiple cells divided into three trains. Within each of the cells, all five kingdoms of life are represented, from microbes, bacteria and fungi to higher life forms such as snails and fish. Combined, these organisms work together to metabolise, degrade and sequester organics, pathogens and heavy metals from the wastewater.

To the naked eye, the cells are "beautiful, robust water gardens". Anaerobic digestion, aerobic digestion, nitrification and denitrification are all microbial processes that take place within the solar aquatic cells – a series of cells through which effluent is treated by mimicking natural water purification within wetland ecosystems. Microbial films grow on a mass of suspended solids and plant roots (flocculants). Nitrification occurs in the biofilms which attach to the media. Phosphorus is removed through luxury uptake by bacteria. Pathogens are reduced due to predation by zooplankton and animals, and heavy metals are accumulated in the attached algal biomass that forms on the sides of the tanks.

**Initial performance indicates great potential**

The pilot greywater filter system was completed in September 2016 and initial observation and water quality tests confirmed that highly-polluted greywater is effectively being separated from stormwater. This water can successfully be used to create green space within the informal settlement.

Secondly, the tree gardens were successfully reducing the greywater flows from the prototype system. As was expected at the time when the study report was written, the water was only treated minimally throughout the system, but it did prevent solids from entering the pipes and causing obstructions. At the time of writing, the EcoMachine had just been commissioned downstream of Langrug to treat water flowing into the Stiebeul River, which is heavily polluted by urban run-off from Langrug and the neighbouring Groendal community. The successful testing of this system will demonstrate the completion of the greywater treatment train to collect polluted greywater, use this to promote greening within the community and then further purify this water so that it can used to sustain urban agriculture and other forms of beneficiation, says Harris.

This has been proven by the results from water quality tests conducted at the treatment system installed at the Plankenbrug River. Results indicate that biomimicry systems could treat polluted effluents similar to that of Langrug to a quality that complies with the general authorisation limits for the discharge of treated effluent back into the river.

According to the final project report, the water quality samples taken at Plankenbrug have confirmed a 99% reduction in the *E. coli* through the system from greater than 10 million *E. coli* per 100ml to 4 700, with effluent concentrations reaching as low as



BACK TO TOP

*One of the greywater disposal points in Langrug settlement.*

16 ***E.coli*** per 100ml for lower flow rates. A comparable reduction in Ammonia and chemical oxygen demand (COD) was also observed.

The project team found that indigenous ecologies performed the treatment functions well. "For obvious reasons, we did not want to use invasive plants like water hyacinth," says Harris. Based on their initial findings, the use of indigenous ecology has certainly proven to be promising and enable the required treatment performance.

**Elements that contribute to the successful pilot run**

This process was, and continues to be a learning experience, says Harris, but a number of promising aspects have already been identified that could be repeated at different sites in future. The project was designed, for example, in close collaboration between the project team, the community and government, and developed with the use of rapid prototyping.

"We could visit the site with concept drawings that would change and develop over time," Harris notes. "This is very unusual for a project, but we could follow this approach because we had Stellenbosch Municipality and the Western Cape government on board. This co-design process contributed greatly to the success of the project."

Community involvement is highlighted as another element of success, and is reported as the base of the necessary building blocks. Janisch says that this was a question that they wanted to answer when they started the pilot project – whether you could have community involvement throughout the project, and for maintenance of the system. To help facilitate this, the community was engaged throughout the process, explains Harris. Community members provided valuable input to the initial design of the project, and were provided employment to construct and maintain the system. "They could do this with relatively little external support," he says.

Social buy-in required a conscious commitment from the team that implemented the system, and time to allow for the benefits to transpire, adds Harris. The Langrug community realised that the project team was serious as time progressed and they remained committed to the project. According to Harris, the immediate benefit of local employment also helped to gain community support, and the project was purposefully designed to be labour intensive to facilitate this. The social component turned out to be a huge part of the overall process, says Janisch, which added another layer of complexity to the project.

**A return to green from grey**

Harris says that the system has proven to have many promising benefits to informal settlements. In terms of service supply – if you are working in an area where there are currently no treatment systems, any system is better. However, a 'green' option such as the pilot system also requires minimal energy input, and can work in the absence of mechanical parts. Maintenance is thus prompt, straightforward, and much easier than for conventional treatment systems.

At Langrug, maintenance can be conducted at community level, by the community members. This is partly because, says Janisch, maintenance for a living system, such as this for project, becomes a gardening more than an engineering activity, for which technical expertise is necessary. She adds that they were told that the involved community members had shared the project with another community, which is part of the proof of how much they see the benefit in it. And further into the future, 20 to 50 or so years from now, the face of Langrug would be improved much by the presence of the big trees.

Just as importantly, Janisch says that the project team were allowed to, and were able to push new boundaries, with innovative thinking.

Challenges to moving forward with the broad scope of bioengineering applications are, however, still ample, she says. Traditional building standards, laws and norms are some. Successful application of such systems also necessitate technical expertise often across multiple disciplines. And, the implementation and maintenance of the system is hugely dependent on social support, often just as necessary or even more than technical know-how.

Janisch reports that as they are training more young professionals, and getting more biomimicry systems incorporated into projects, familiarity and support are already increasing. Really, she says, we cannot simply look at conventional solutions any more. For a more sustainable future, one in which nature is part of the solution "we have to change the way we think."

BACK TO TOP

# WATER AND THE ECONOMY

## Transitioning to a circular economy – the role of innovation

*Within the man-made water cycle, wastewater is a carrier of 50% to 100% of waste resources lost, mostly in the form of unrecovered water, energy and materials which are three key interrelated pathways to achieving circular economy principles in the water sector. Although the South African water sector has not yet fully transitioned to a circular economy, the need to respond to various challenges have placed the sector on the road to a circular economy underpinned by innovation. In this regard, water utilities need to be early adopters of technologies and business practices that support the circular economy in response to various threats and challenges the sector faces.*
*Article by John Ngoni Zvimba and Eustina Musvoto.*

In recent years the circular economy concept has received significant attention on various platforms. In contrast to the current conventional linear economic model (take-make-consume-dispose), the circular economy concept is a development strategy that enables economic growth while aiming to optimise the chain of consumption of materials. Adoption of the circular economy, however, requires significant transformation of production chains and consumption patterns in order to keep materials circulating in the economy for longer.

While there are some elements of circularity in South Africa, such as recycling and composting in the linear economy, a circular economy goes beyond the pursuit of waste prevention and waste reduction to inspire technological, organisational and social innovation across and within the value chains. In this regard, numerous potential benefits are derived from the transition to a circular economy, with innovation playing a key role in support of such transition.

While there are significant benefits associated with adoption of a circular economy, transforming the linear economic model that has been dominant for a long time is a big challenge, which entails transformation of current production and consumption patterns. However, innovative transformational technologies, such as digital and engineering technologies, in combination with creative thinking, have been identified as key factors that may drive fundamental changes across entire value chains that are not restricted to specific sectors or materials. Such a major transformation would, in turn, result in significant impacts on the economy, environment and society, with an understanding of these impacts crucial for researchers and policy-makers in designing future policies.

For the South African water sector, the current water and wastewater business cycle is predominantly based on the linear economy approach (Figure 1). In order to address current and future water security challenges in a sustainable manner,



BACK TO TOP

there is a need to rethink the water and sanitation value chain and identify the role of innovation in transitioning to a circular economy. Moreover, the transitioning to a circular economy within the South African water sector is in line with the United Nations Sustainable Development Goals (SDGs). In this regard, water has a dedicated goal in SDG 6 (ensure availability and sustainable management of water and sanitation for all) and its attainment will be reliant upon contributing to and benefiting from the attainment of other SDGs, most notably in the context of the circular economy, SDG 12 (ensure sustainable consumption and production patterns). This interdependence across goals manifests at a national level in highlighting the need for greater cooperation amongst sectors, incentivised innovation and enabling meaningful engagement with citizens.

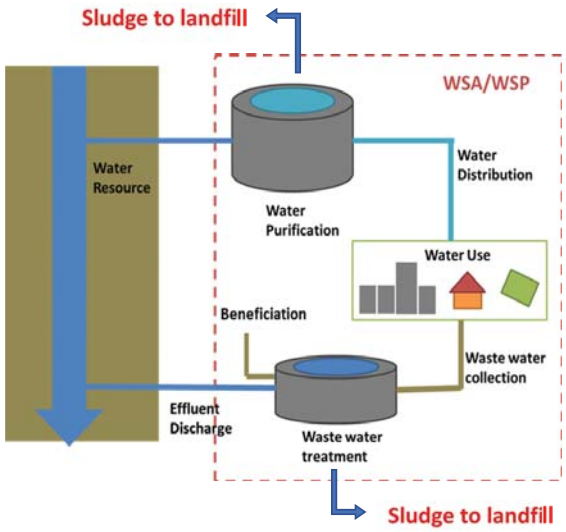



*Figure 1: Linear approach for the water and wastewater business cycle*

One key technology or innovation that has the potential of driving the three key interrelated pathways (water, material and energy) to achieving circular economy principles within the South African water sector is based enhanced hydrothermal polymerisation, generally referred to as polymeric carbon solid (PCS). PCS is a catalytic-driven technology that converts a wide range of biomass into a multi-use hydrochar. One of the key products is a green biofuel in which an extra 3 – 5 GJ are unlocked for every tonne of PCS biofuel produced.

In South Africa, technical pilot evaluations processing mostly municipal sludge carried out to date using sludge from wastewater treatment plants have confirmed the net gain of 3 – 5 GJ/kg using the PCS technology. Moreover, economic evaluations based on cost benefit analysis using net present value as evaluation criteria for a 50 tDS/d greenfield site suggest favourable economics for beneficial use of ash compared to disposal of ash to landfill. Depending on the energy content, the biochar can also be used as an absorption media for tertiary effluent treatment, soil conditioner and building materials. Currently, further technical and economic pilot evaluations of processing mixtures of biomass that include municipal solid waste are underway, and outcomes are anticipated to further strengthen adoption of circular economy principles by the water sector.

The feasibility of incorporation of PCS technology into the existing South African wastewater treatment infrastructure presents further opportunities for supporting implementation of circular economy principles at wastewater treatment facilities as part of sustainable wastewater management. This can have significant benefits as it has potential of catalysing conversion of current wastewater treatment facilities into future waste resource recovery centres, not only treating wastewater for effluent compliance, but fostering innovation and mutual beneficial partnerships with communities. In this regard, the conceptualisation of PCS technology as accelerator for adopting circular economy principles in the wastewater sector, representing a paradigm rethinking of the water and sanitation value chain is illustrated in Figure 2.

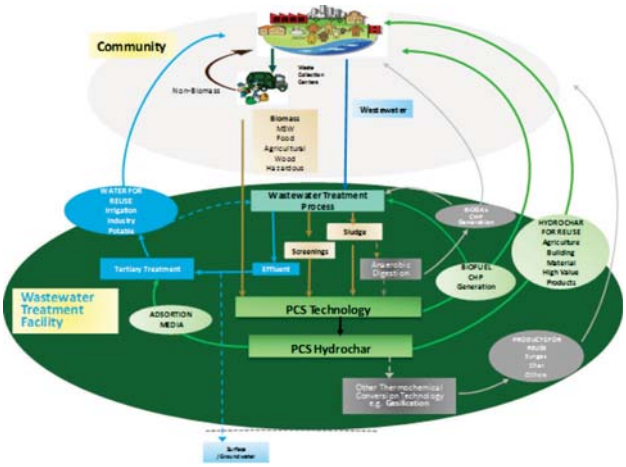



*Figure 2: Transitioning to Circular Economy using PCS technology*

It is believed that the use of innovation to transition to a circular economy based on the above concept has significant potential to of creating new business models and jobs, including developing new skills and investments in communities as well as reducing the carbon foot print, thereby mitigating the impacts of climate change. In this regard, municipalities need a rethink their sludge management strategies, so that they adopt disruptive innovations to benefit from resource recovery in support of circular economy principles implementation within the South African water sector.

**What is meant with a 'circular economy'?**
A circular economy is an alternative to a traditional linear economy (make, use, dispose) in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life.

# GROUNDWATER

## Groundwater, boreholes and ethical issues

*Sharing of groundwater produced by boreholes may be a generous and praiseworthy idea, but is it really feasible in practice? Handré Brand explores.*

It is logical to expect that during the drought situation in the Western Cape the demand for boreholes would increase significantly. Sometimes it may also happen that homeowners with boreholes fail to install proper borehole notices on their gates. The provision of visible borehole notices is, in fact, prescribed by municipal regulations.

Why would some borehole owners not be willing to cooperate and comply? Psychological ownership is the conviction that a person acknowledges that a particular target for ownership is indeed his. In such a case, the borehole is the target of ownership. It is also known that the construct of psychological ownership varies on a continuous scale from higher to lower values. It may well be that a borehole owner with relatively lower psychological ownership identifies less intensely with his possessions because it is not strongly associated to his self-identity. As a result, the installation of notices is simply not an important issue for such a borehole owner.

Owners with strong psychological ownership of property, on the other hand, may show a different reaction pattern, for example, it is my property and my borehole. "If I violate a regulation, it is my concern, it is my privilege to choose whether to display a notice or not".

It is possible that such a reaction may indicate an attitude of self-righteousness or self-entitlement, in other words, an inherent and excessive self-determination to make an own decision. It comes down to self-assertion of the right to violate local borehole regulations. Of course, there should always be a caution against generalisation. Various variations on this theme of psychological ownership are possible, but the issue is directly linked to ethical awareness and ethical responsibilities of borehole owners.

During a recent conversation with a friendly drilling technician about the depth at which a good supply of groundwater might



BACK TO TOP

be found, it was indicated that in this specific municipal area water is usually found in granite rock between 70 m and 100 m. Such a borehole may cost around R100 000 depending on the depth, including the pumps and additional equipment.

The technician further states that about six hundred drilling machines in South Africa are actively drilling for water every day. If one argues that 400 successful holes are drilled every two to four days by these operators, then it is a large number of new boreholes that are added annually to the existing total. However, the technician does not know exactly how many boreholes have already been sunk in South Africa.

There are specific regulations regarding drilling of boreholes, and the regulations differ for boreholes on farms and municipal areas. The piles of soil that lay in a neat pattern on the pavement are soil samples taken every few meters of minute rock splinters blown out during the drilling process.

The brown piles are gravel (unconsolidated and weathered rock); the blue is granite (solid rock or bank) and then the mud piles (the structure or shift) that indicate the depth at which water has been found. A borehole sank into certain types of underground rock structures can be problematic due to the dewatering of rock openings and caves.

The unknown nature of the underground water flow and the vibration of the drilling process may cause cracks and cracks in the walls and structures of buildings or houses. The actual effect of the extraction of water will only be seen long after the borehole is drilled. In such a case, the borehole can be filled with cement in order to cut the supply of water from the borehole, and the further implications are the owner's responsibility.

In theory it is possible to consider the possibility that each resident of a particular town could each drill a borehole on their own premises. What will be the consequences if bursts in rock formations arise underground and create conditions for earthquakes and sink holes and craters? What the effect on the available underground water resource will be remains an open question.

Knüppe (2011) identified four key challenges to adaptive and sustainable groundwater management in South Africa. These are: the undervaluation of groundwater importance and significance; the need for expertise and information at all scales; the centralisation of power; and the disregard of ecosystems and the associated goods and services.

A first step to improving the respect for groundwater may be if neighbours share groundwater extracted by boreholes, because whose water is actually flowing into a borehole? Groundwater is a national asset. Sharing water will promote the ethical principle of humanity and compassion in our society.

The free market principle, of course, determines that those who are financially capable can buy themselves out of water constraints, while the rest must reduce their water consumption. It is also well-known and commendable that neighbours already share borehole water in several towns and villages. Some divide the total costs between them, but there are also examples where borehole owners have offered to share water with their neighbours despite the cost.

These are truly innovative and valued ideas, but will groundwater self-righteousness and the willingness to share groundwater over the long term become truly compatible and sustainable bedfellows in everyday life?

**A pilot study**

The hypothesis explored in this pilot study was that a group of ratepayers or property owners in a specific municipal area will differ in terms of their perceptions of and attitudes towards the management and sharing of groundwater extracted by means of private boreholes.

A semi-structured questionnaire was constructed as a research instrument. The primary questionnaire items (N=19) were categorical and of a forced choice design, but the respondents could also motivate their answers if they preferred to do so. The instrument could either be used as a face-to-face framework for the verbatim recording of the respondents' answers and motivations or as an online questionnaire sent via email.

It was decided to use a convenient or available non-probability sampling method for the purposes of this study. A convenient sample consists of subjects who are easy to reach, and is obviously not the best way of sampling, but for the purposes of this study (a private project with a zero budget) it was regarded as the best option to approach the matter.

Two nearby and accessible neighbourhoods in a town located in the Winelands District of the Western Cape were identified for sampling purposes. In total there were 280 plots owned by individual ratepayers in these two neighborhoods used for the purposes of this study. One single plot number from the municipal valuation roll and was randomly selected and was regarded as a logical and objective point of departure for this exploratory study.

The owner of this randomly selected property was contacted by the researcher to discuss the nature, aim and procedure of the prospective survey. This respondent was asked whether he was willing to take part in an individual interview and would be willing to refer the researcher to a next possible respondent (or

respondents) in the same neighborhood. The procedure was repeated for all 20 respondents taking part in this study.

Some participants preferred to summarise and finalise their motivational responses and to return their questionnaires via email. Eight possible participants declined the invitation to take part in the study. Following this procedure the 20 individual semi-structured interviews were conducted over a period of three months. The obtained response frequencies and percentages are summarised in Table 1.

**Results**

According to Table 1 the property owners which were included in the sample were mostly male (90% male and 10% female). In terms of chronological age the sample mostly represented the 60 plus age group (80%).

Twenty five percent of the respondents owned a private borehole and 10% was previously an owner of a private borehole. The yield of the boreholes varied from 3 000 to 20 000 litres per hour. All the owners of boreholes were highly satisfied with the performance of their boreholes.

Seventy percent of the respondents were intensely concerned about the long-term impacts of the extraction of groundwater by means of boreholes on the water table, while 20% were not concerned about the impact and 10% were uncertain about the effects. Most respondents (75%) were of the opinion that it is a good idea to share groundwater between neighbours. However, on the question whether there shoud be a municipal by-law forbidding the sharing of groundwater the response pattern changed to Yes (45%); No (45%) and Uncertain (10%).

Most respondents (75%) said that the receiver of shared groundwater should contribute to the installation and running cost of a borehole owner. Fifty five percent thought that a formal contract between borehole owner and the sharer of the groundwater should be negotiated, 15% said "No" and 25% "Preferable".

*There was general agreement among the respondents that the willingness and ability to share is a positive and universal humanistic characteristic.*

Eighty percent of the participants stated that boreholes should be officially registered and 15% of respondents were of the opinion that registration is not at all a good idea, while 5% were uncertain on this issue. Sixty five percent of respondents were of the opinion that a borehole owner should install a visible borehole notice or sign on his premises, while 25% did not agree with the statement and 10% were uncertain on this matter.

Most respondents (70%) preferred desalination of seawater to the extraction of groundwater by means of boreholes, while 10% preferred boreholes and 20% were uncertain about the pros and cons of the two options.

As expected there was consensus that the humanistic value of sharing between people in general is an important human characteristic (100 % of respondents agreed on this statement). Most (75%) also agreed that those who identify strongly with their belongings would be less inclined to share a commodity such as groundwater. The relative importance of the common good principle showed a wide range of responses and was rated as very important by 45% of the respondents, important 20%, less important 30% and uncertain 5%.

**Discussion**

A convenient sampling procedure was used in this study, and surprisingly gave a relative accurate indication of the characteristics of the neighbourhood demography that was identified for research purposes. Most property owners were from the older, white, and higher-middle class sector of the population. The obtained results of this study should therefore be interpreted within the context of this observation.

Five respondents were current owners of private boreholes representing 2.6% of the total number of registered boreholes (N=195) according to the Manager of Water Affairs, local municipality) for this specific town. Boreholes were generally perceived as valuable assets by their owners. Borehole yield covered a wide spectrum. Respondents pointed out that boreholes contributed to the added value of their properties and also were a reliable source and provider of groundwater as an important commodity during the dry summer months.

Most respondents agreed that receivers of groundwater should contribute to the capital cost and running cost of borehole owners. Some said that the owner should contribute proportionally more than the receivers, and others were of the opinion that receivers could not only contribute in monetary terms, but also contribute in other non-material ways for example good neighbourliness, childcare, sharing expert advice and even gardening services.

Most respondents were of opinion that a formal and written contract between receivers and owners should be negotiated bilaterally. Preventing unforeseen legal issues during the changing of ownership between properties was given as a reason in favour of a binding contract. A different opinion was that an understanding between neighbours concerning the sharing of groundwater should be based on goodwill and not on a formal contract. There was also uncertainty whether a formal contact between role players would be based on private law or public law principles.

Participants were less in agreement about whether visible borehole notices for properties are important or not. Some owners said they do not want to "stand out", or to be "placed on a pedestal". They thought that honouring the integrity of borehole owners is more import than the controlling and identification of owners by means of signs and notices.

There was consensus that the registration of boreholes should be compulsory. Some of the motivations were:

- "There has to be a correlation between groundwater extraction (usage) and rainfall which should be monitored"
- "Yes, and the extraction thereof should be determined



BACK TO TOP

beforehand, through a meter"
- "Registration implies more effective monitoring and management of ground water"

Compared to the extraction of groundwater more respondents indicated that desalination of sea water would be a better option of water management in future, mainly because the negative effects on nature are limited to a greater extent by desalination.

Although most of the participants (70%) agreed that the extraction of groundwater will impact negatively on the water table**,** 20% of the group was not concerned about the possible negative impacts and 10% was uncertain about the possible effects. This question created a varied response pattern among the participants.

Some of the respondents motivated their responses as follows:
- • "No, the water table differs from area to area. Boreholes cannot therefore have a constant effect on the water table. Drought has a bigger effect on the water table when compared to boreholes"
- • "Uncertain, we simply do not know enough about the effects of boreholes and the extraction of groundwater on the water table"
- • "Yes, consequences of increased extraction of groundwater results in vanishing soil moisture and hence fertility. Aquafers tend to follow fault lines and generally take the shortest route between two points. Over time, there will be vacuums within fault lines, leading to land collapse and the possibility of damaged property"

There was general agreement among the respondents that the willingness and ability to share is a positive and universal humanistic characteristic. Consensus consisted about the issue of whether strong identification with belongings will result in less willingness to share groundwater. Strongly developed psychological ownership is thus seen as a contravening factor regarding the development of share-ability as a human trait. A more diverse response pattern (less agreement) was noted concerning whether the common good principle should be regarded as an important or less important issue.

When an ethical dilemma or epistemic conflict in terms of voluntary groundwater sharing was introduced (i.e. whether or not to abide by a bylaw forbidding groundwater sharing between neighbours) an equal split in the response pattern was observed (45% =Yes; 45% =No; 10% =Uncertain). Some of the respondents, who were willing to share groundwater despite a regulation not to share, overrode the ethical dilemma by questioning the validity and reasonableness of such a municipal regulation.

They were of the opinion that the selling of water to the public is an important source of income for municipalities, and that a regulation forbidding the voluntary sharing of groundwater should be seen in this context. Other respondents reacted in a more law-abiding manner and were not willing at all to act in any contradictory way to legal matters. This interpretation is in accord with the work of Jagers, Berlin and Jentoft (2012), who found that compliance/non-compliance was based on respondents' own benefit; whether they feel morally compelled to do one way or another; whether compliance is believed to create a negative impression among peers and also whether they accept the justification given for introducing the rules.

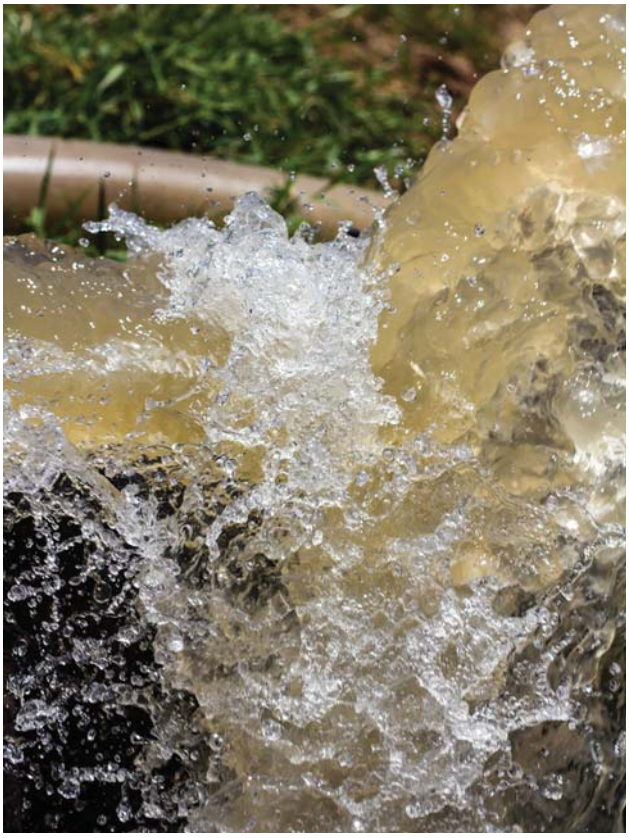
The interaction between Kohlberg's stages of moral reasoning (see Froming, 1978) and compliance behaviour, particularly Stage 3 (moral judgements are significantly influenced by the attitudes and opinions of others), Stage 4 (strict adherence to laws and rules of society) and Stage 5 (moral judgements are guided by internal standards and principles) may be relevant to explain the differences in the observed response patterns.

**Summary**

In this study, responses obtained by means of a semi-structured questionnaire for a relatively small convenient sample of property owners concerning sharing of groundwater were qualitatively analysed. The results indicated that sharing of groundwater between neighbours was generally perceived as a good idea and that sharing is an important human characteristic. Strong identification with one's own belongings contributes to the inhibition of the willingness to share.

Limited support for the common good principle were expressed by the participants. Whether or not to share when a regulation forbids the sharing of groundwater can be rationalized by cognitively overriding the dilemma by means of questioning the validity of such regulations in the context of municipal monetary policies. In general support was obtained for the research hypothesis that the sharing of groundwater is associated with specific and complex ethical issues as discussed in this study.

- A summary of the additional comments made by respondents on the different questionnaire items as well as the references are available from the author.



| Questions | Variables | | | | |
|---|---|---|---|---|---|
| 1. | Gender | Male<br>18(90%) | Female<br>2(10%) | | |
| 2. | Age group | <40 | 41-50 | 51-60<br>2 (10%) | 60+<br>16 (80%) |
| 3. | Are you a borehole owner (currently)? | Yes<br>5 (25%) | No<br>15 (75%) | | |
| 4. | Were you a borehole owner previously (in a different setting)? | Yes<br>2 (10%) | No<br>18 (90%) | NA | |
| 5. | Residence: City, Town or Farm | City | Town<br>20(100%) | Farm | |
| 6. | Capacity of your current borehole (litre per hour) | 3000lpu<br>4500lpu<br>20000lpu<br>3(15%) | Litre per hour | NA<br>15 (75%) | No idea<br>2 (10%) |
| 7. | Are you satisfied with your current borehole? | Yes<br>5 (100%) | No | Uncertain | |
| 8. | Are you worried about the long-term effects of the extraction of groundwater on the water table? | Yes<br>14 (70%) | No<br>4 (20%) | Uncertain<br>2 (10%) | |
| 9a | Is the sharing of borehole water (groundwater) between neighbours a good idea? | Yes<br>15 (75%) | No<br>2 (10%) | Uncertain<br>3 (15%) | |
| 9b | Would you be willing to share groundwater even if a municipal by-law prohibits sharing? | Yes<br>9 (45%) | No<br>9 (45%) | Uncertain<br>2 (10)% | Unreasonable Question |
| 10. | Should neighbours as sharers of groundwater contribute to the installation and the running cost of a borehole? | Yes<br>15 (75%) | No<br>3 (15%) | Uncertain<br>2 (10%) | |
| 11. | Is it advisable to draw up a formal contract between neighbours sharing groundwater? | Yes<br>11 (55%) | No<br>3 (15%) | Uncertain<br>1 (5%) | Preferable<br>5 (25%) |
| 12. | Should all boreholes be registered? | Yes<br>16 (80%) | No<br>3 (15%) | Uncertain<br>1 (5%) | |
| 13. | Which is the best alternative: boreholes or desalination of sea water? | Boreholes<br>2 (10%) | Desalination<br>14 (70%) | Uncertain<br>4 (20%) | |
| 14. | Is the ability to share, an important human characteristic? | Yes<br>20 (100%) | No | Uncertain | |
| 15. | A person who identifies strongly with his/her belongings, would be less inclined to share groundwater. | Yes<br>15 (75%) | No<br>3 (15%) | Uncertain<br>1 (5%) | Not in a position to answer<br>1 (5%) |
| 16. | Is it important for borehole owners to attach visible borehole signs to their properties? | Yes<br>13 (65%) | No<br>5 (25%) | Uncertain<br>2 (10%) | |
| 17. | Do you regard the "common good principle" as an important concept in general? | Very important<br>9 (45%) | Important<br>4 (20%) | Not important<br>6 (30%) | Neutral or uncertain<br>1 (5%) |



BACK TO TOP

# KNOWLEDGE SHARING

## The South African National Wetlands Indaba – from humble beginnings to a well-established platform

*NP Gola, F Eggers and I Bredin provide an overview of the history, success and importance of the National Wetlands Indaba – an annual national gathering of wetland experts and stakeholders.*

The National Wetland Indaba grew from a small group of people meeting informally to discuss wetland-related issues. The group formed into the South African Wetland Action Group (SAWAG), which held its first meeting in Nottingham Road, in KwaZulu-Natal, in 1998. The annual meetings later grew into the National Wetland Indaba, which was first held in 2005.

Over the years, participation in the Indaba has increased from a handful of wetland specialists to an annual event which attracts hundreds of people from varying disciplines with a common interest in wetlands. The Indaba allows for a range of people with varying experience and interests, keeping the balance between science and practice, across the country to come together and share knowledge. The sharing of knowledge has allowed the wetland field of practice to develop and strengthen.

Beyond the Indaba, regional/provincial wetland forums have been active from 2000. The forums serve as platforms where cooperative governance issues relating to wetlands can be coordinated. The forum meetings also serve as a regular convergence of persons involved in the wetland field of practice, including government authorities, consultants, non-profit organisations, and academics. These forums have further taken on the responsibility to rotate the organising and hosting of the National Wetlands Indaba (Table 1).

BACK TO TOP

**Table 1. Overview of the various locations SAWAG/ National Wetlands Indaba has been hosted**

| Year | Host Province | Venue |
|---|---|---|
| 1996 (Inaugural meeting) | KwaZulu-Natal | KwaZulu-Natal Midlands, Rawdon's Pub |
| 1997 | Mpumalanga | Dullstroom |
| 1998 | Eastern Cape | Pirie |
| 1999 | Free State / Northern Cape | Sterkfontein Dam |
| 2000 | KwaZulu-Natal | Vryheid |
| 2001 | Limpopo | Nylsvley |
| 2002 | Western Cape | Cape Town |
| 2003 | North-West | Barberspan |
| 2004 | KwaZulu-Natal | St Lucia |
| 2005 | Limpopo | Modimolle |
| 2006 | Eastern Cape | Stutterheim |
| 2007 | Gauteng | Kempton Park |
| 2008 | Mpumalanga | Skukuza |
| 2009 | Western Cape | Langebaan |
| 2010 | Free State / Northern Cape | Kimberley |
| 2011 | KwaZulu-Natal | Didima |
| 2012 | Limpopo | Bela-Bela |
| 2013 | Eastern Cape | Cape St Francis |
| 2014 | Gauteng | Lanseria |
| 2015 | Western Cape | Worcester |
| 2016 | Mpumalanga | Swadini |
| 2017 | KwaZulu-Natal | Wild Coast Sun |
| 2018 | Northern Cape | Kimberley |

**The 2017 National Wetlands Indaba**

The 2017 National Wetland Indaba, held on 16-19 October at the Wild Coast Sun on the outskirts of Port Edward KwaZulu-Natal, attracted well over 200 delegates. National delegates comprised scientists, students, practitioners, decision-makers and experts from all over the country. In addition, the Indaba also attracted international delegates from institutions in the Netherlands and United Kingdom.

The theme for the Indaba was 'Wetland communities: Networking towards better practice'. The Indaba provided an opportunity for delegates to engage and interact over four days, where sessions included presentations, workshops, field excursions, and panel discussions. The KwaZulu-Natal (KZN) Wetland Forum, in partnership with the South African National Biodiversity Institute (SANBI) and Water Research Commission (WRC), convened two facilitated panel discussions on the final day of the Indaba. The objective was to elicit a robust debate on a topic that could in many ways be connected to several key themes covered throughout the Indaba. The topic was 'Ecological infrastructure (EI) in the context of water security, exploring the application of trans-disciplinary approaches to enhance the uptake of the EI message'.

The panellists included representatives from the Institute of Natural Resources NPC (INR), Forestry South Africa (FSA), the National Business Initiative (NBI), the Department of Water and Sanitation (DWS), the Department of Environmental Affairs (DEA), the Department of Agriculture Forestry and Fisheries (DAFF), SANBI, eThekwini municipality, and the South African Environmental Observation Network (SAEON). The discussions were facilitated by representatives from SANBI and the WRC.

The intention was not to identify the impacts on EI, as these are largely known, but rather to identify ways in which the wetland community can support and thus create an enabling environment for effective management of EI. As such, the primary objective of the panel discussions was to identify collective actions for strengthening support for the role EI plays in enhancing water security.

**Ecological infrastructure for water security**

The issues covered in the panel discussions were around mechanisms applied for securing ecological infrastructure to improve water security and reduce associated barriers and challenges. The discussions also covered the extent to which the EI message has been taken up and embedded in each of the sectors, and touched on the opportunities for alignment and coordination across the research-policy-implementation continuum. The wetland community considered ways in which it could assist in creating an enabling environment to strengthen the uptake of the EI message.

**Key Actions**

A list of potential actions was identified:

- *Working towards a common understanding of the definition of EI*

It appears that not everybody understands the term EI and therefore there is a need to adjust and simplify the language used to define this term to align with different sectors. The definition of EI should not only be limited to the ecology but also incorporate nature as an asset which provides specific ecosystem services. Ecological infrastructure should also be defined in the broader context taking into account the benefits it delivers for example in the face of climate change (extreme events such as floods and droughts) and other challenges. The definition of EI should also take into account its contribution to improving people's livelihoods, food security, water security, etc. Defining EI in formal scientific language seems to be easier than explaining it to the general public, using simple terms and language. There needs to be a simpler way of explaining the meaning of EI.

- *Developing effective communication mechanisms*

There is also a need to transform the language to ensure that the EI message is spread across sectors and across all levels of society so that everyone can be on the same page regarding effective management of EI. Communication needs to be broader, using a wider range of mechanisms than just generating



BACK TO TOP

*The National Wetlands Indaba was established out of government initiatives, such as Working for Wetlands.*

scientific products such as technical reports and journal articles. Researchers and practitioners must step out of their comfort zone towards transformative science that incorporates an understanding of how people outside the environmental sector understand EI. Researchers must engage with the private sector and government officials in order to build trust and find a middle ground and identify shared values when it comes to management of EI.

There seems to be disconnection between the information required (particularly by the private sector) and the scientific information generated. The science community must look at the type and format of data that is produced and align that with the needs of the various sectors including the private sector.

- *Developing a business case for ecological infrastructure*

It is important to demonstrate the value and benefits of EI, particularly for the private sector. People are more likely to invest and conserve EI if they are aware of the benefits they receive from it. There is a need to engage those with money and power. Building relationships and trust leads to long-term investments that contribute towards adaptation to the 'new normal'. Regulators must also be adaptive and flexible and come up with regulatory mechanisms that incentivise the private sector (particularly industries) in order to balance economic development with environmental management needs.

- *Developing a shared vision*

It is important that we demonstrate the value of EI and find a shared vision for the public and private sector when it comes to managing EI. There needs to be a common understanding of where we come from and where we want to go. The loss of EI such as wetlands, may have negative impacts on water security. Wetlands enhance water security in a number of ways, including slowing down water during flood events, improving water quality, and maintaining stream flow. People realise the importance of water and the scarcity of the resource, but the investment in water resource management does not adequately reflect its importance. There is a bias and emphasis on built infrastructure and distribution of water to households, with little focus on catchments as the source of water when it comes to investment (both in terms of human and financial resources).

- *Using the socio-ecological approach*

There is a need to integrate social and ecological aspects. Ecological issues are intricately linked to social aspects. Ecosystems for the most part do not degrade on their own, they are degraded by people, and the responsibility to restore and rehabilitate remains with people. Social aspects such as rural to urban movement result in land-use change that impacts on EI. Ecological infrastructure can also be linked to resilience and the ability of communities to adapt to climate variability. There is an opportunity to bring EI into the discussions around events such as droughts and floods. People can relate to the impacts of these events.

- *Improving governance approaches and mechanisms*

Governance mechanisms and approaches need to be adaptive. Some of the challenges we are facing are outcomes of poor governance rather than poor management. There is a need to think of mechanisms that allow for collective and collaborative governance, and do away with the silo mentality. Government needs to not only be a regulator, but also an enabler when it comes to effective management and conservation of EI.

- *Developing and maintaining strategic partnerships*

There is a need for a strategic approach to create awareness, engage stakeholders, and develop and maintain partnerships to support EI. There is no one-size-fits all-approach. Engagement must take place at all levels, from high level officials to local communities. Partnerships should involve the public and private sector.

**The future of the National Wetlands Indaba**

While the National Wetlands Indaba has developed into a well-establish platform for the sharing of knowledge, there is still much that can be done to strengthen and enhance the Indaba's profile as the primary platform for engaging on all wetland related topics, both nationally and regionally. If we are to see a continued strengthening of the Indaba, then the South African Wetland Society and the provincial wetland forums have some important decisions to make in the coming years.

As a way of reflecting on the growth of the Indaba it would be valuable to review the identified collective actions for strengthening support for the role EI plays in enhancing water security. A review of the implementation of the key actions discussed above, in five years' time, would be a good indicator of the value of the National Wetlands Indaba.

This year's National Wetlands Indaba is taking place from 8 to 11 October in Kimberley.

BACK TO TOP

# CAREERS IN SCIENCE

## What's stopping young African scientists from achieving their potential

*Young African scientists face persistent barriers which cause them to leave their own countries, and even academia. This means the continent's workforce loses highly trained people who are crucial for scientific and technological advancement, and for economic development. So write Anna Coussens, Abidemi James Akindele, Badre Abdeslam, Fridah Kanana and Mona Khoury-Kassabri on The Conversation.*

It is estimated that 20 000 highly educated professionals leave the continent annually – with up to 30% of Africa's scientists among them.

A number of factors contribute to this trend. The extreme factors include war and political instability. But the more common 'pushes' are a desire for higher pay, better opportunities, and the search for a conducive research environment – one where infrastructure and management help drive careers and research potential.

To identify all the barriers and develop strategies to address them, the Global Young Academy – an organisation of 200 talented young scientists and 200 alumni from 83 countries – established the Global State of Young Scientists Africa (GloSYS) project. Working with local research partners and international higher education experts, the project aims to identify the challenges and motivations that shape young scientists' career trajectories.

Initial findings point to a lack of mentoring, resources and funding as key issues young scientists face across the continent. Using this data, the academy will be able to identify critical areas in which young scientists need support and develop innovative strategies to alleviate these challenges.

The project comes at an important time as, over the past few years, African countries have initiated programmes to increase the number of PhD graduates. But if governments don't simultaneously develop support structures for graduates, and increase access to critical teaching and research infrastructure, these young scientists are set up to fail.



BACK TO TOP


NextEinsteinForum/flickr

*Global Young Academy members ran a GloSYS workshop at the Next Einstein Forum Global Gathering in Kigali.*

**The study**

The Global State of Young Scientists Africa project uses an online survey and in-depth interviews to gather as much detail as possible. It looks at young scientists' motivations, career ambitions and the barriers they experience in fulfilling their career aspirations.

It targets researchers and scholars who have earned a Masters or PhD within the last ten years, irrespective of their current employment status and sector. It is also open to current PhD students in Africa and African scientists and scholars currently living in the diaspora.

Having this wide range of participants means the data will reflect a broad range of experiences. From early-career researchers with a history of moving within and out of Africa, to those who have never left their home countries. From departmental heads, to researchers who have trouble finding work despite their high qualifications. The team is also particularly interested in hearing from early career researchers outside of academia, as this helps them understand their reasons for not pursuing a career in research.

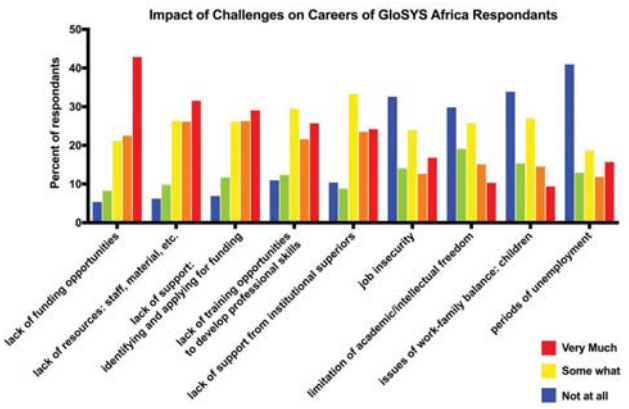
From the preliminary survey results – drawn from more than 700 young scientists' responses – it has been found that, even with diverse backgrounds, early-career researchers have a great deal in common. A lack of mentoring, infrastructure, resources (staff and material) and funding for research and resources are key reasons for not pursuing a career in academia. There is also a strong desire for more training in grant writing and professionals skills.

Using this information, the GYA plans to develop programmes to address the challenges, as the researchers have previously done.

This is the third survey done under the Global State of Young Scientists umbrella. The first was a global study of young scientists from 14 countries across five continents. The second was a regional study which focused on four Southeast Asia countries.

A major challenge identified from those two studies was the desire for training in leadership skills. As these young scientists began to grow their own research groups they needed the tools to deal with the challenges of integrating research, teaching, and fundraising. In response, Global Young Academy members developed and implemented science leadership programmes in Africa and Asia, in collaboration with creative facilitators KnownInnovation and Future Africa.

Obtaining these new skills created an incentive for the young scientists to pursue their career in academia. The fellows found, for instance, the science leadership programmes to be one of the most significant workshops of their careers.




*Career challenges young scientists from Africa are experiencing*

**From barriers to action**

The African leg of the survey continues. Once common challenges have been identified, the team will then work with policymakers in Africa as well as with international funding bodies to develop evidence-based initiatives to address them.

It is hoped that the Global State of Young Scientists Africa project will highlight further areas of need, so that the Academy can develop new innovative programmes in collaboration with science and education policymakers to improve young African scientists' prospects.

This article was first published by TheConversation (www.theconversation.com)

BACK TO TOP

# Water KIDZ

## *Take care, stay safe around canals*


In South Africa, we make use of hundreds of kilometres of water canals to move water from its source to places where it is required. While the water in these canals can look extremely inviting, especially in the hot summer months, they can be dangerous, and people should steer well clear of them.

For the safety of all, swimming, fishing, playing and/or other recreational activities are not allowed in or around canals. Unfortunately, it is very difficult to keep people out. Most canals do not have protective barriers around them. It is very difficult to build a fence around a canal that is hundreds of kilometres long! Canals are usually full during the warmer months of the year when irrigation water is needed most. This is when they are at their most dangerous.

The majority of the country's open canal systems were designed and constructed many years ago, and are located in remote, rural areas. However, today, as communities grow and encroach onto canal servitudes, many of these canals now form part of urban and suburban landscapes. This increases the risk of people and animals drowning in canals.

In 2017 alone, six people drowned in the Addo-Kirkwood irrigation canal in the Sundays River valley. The 300 km-long canal runs past the backyards of many communities who live near the banks of the Sundays River. Community livestock have also been swept away by the water.

Why are canals so dangerous? Canals contain water that is quick-moving. There are no obstructions in the waterway to slow it down, or to provide visual cues to how fast the water is moving. Fast-moving water in a narrow channel can knock a person off



BACK TO TOP

*Animals also have a way of finding their way into canals.*

their feet. Even water that is only a few centimetres deep, if it is moving fast enough, can cause a person to lose their balance and carry them away. In addition, debris (trash and garbage) and other dangerous things can be found in canals.

Canals can have deep water. If a person cannot swim or if they are hurt, falling into deep water could prove fatal. In addition to swift currents, irrigation canals may have undertows and turbulence that could drag even a strong swimmer under water. Many canals have steep slopes and slippery walls, which make them difficult to climb out of. Canals also have grates, culverts, spillways and in-water energy dissipation devices, which people can get caught up in. Pipelines and sidegrates in canals can cause a suction effect that can trap a person underwater.

Dry canals are not safe either because there is no way to know when water may be released and a person may be trapped by a surge of water.

Drowning is not the only risk people take by swimming in canals. Irrigation water may contain high levels of contaminants. Often these contaminants are not visible to the naked eye. While swimming or playing in canal water it is possible to ingest faeces, pesticides, insecticides, and other toxins that may make us ill or even have fatal consequences.

Canals are not recreational areas. They contain deadly hazards – both visible and invisible. Have fun, stay cool and be safe this summer.

**If you live near a canal it is best to keep the following in mind:**

- Fast-moving water can knock you off your feet and carry you a long way, even if it is only a few centimetres deep!
- Swift undercurrents and turbulence can drag you under and keep you there, even if you are an excellent swimmer.
- The sides of a canal, whether concrete or dirt, are often steep and slippery, which makes them almost impossible to climb.
- Stay away from grates, culverts and spillways. They can also be hazardous.

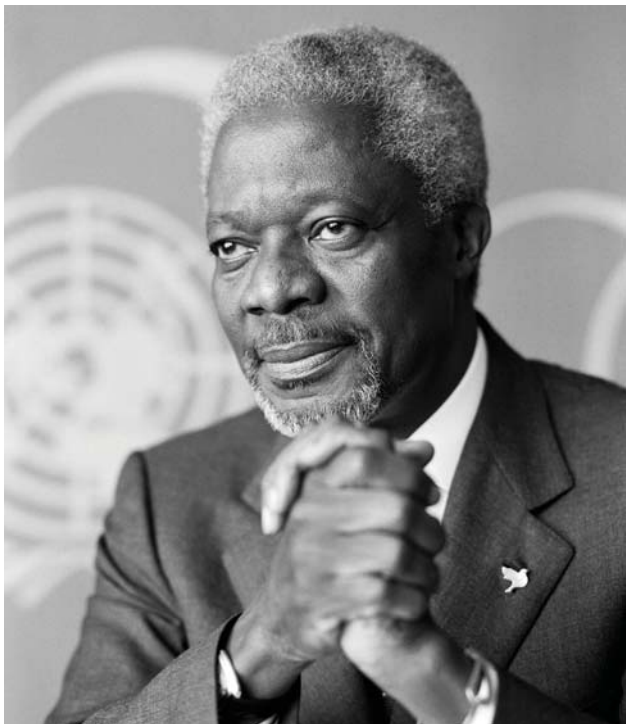
*Many canals may contain fast-running water, which raises the risk of drowning.*

*Sources*
*www.dws.ogv.za | www.kid.org | www.tid.org*

BACK TO TOP

# NO SOCIETY CAN PROSPER WITHOUT SUSTAINABLE ACCESS TO WATER

UN Photo



*[In this issue we end with the words of former UN Secretary-General, Kofi Annan, who passed away on 18 August 2018. – Ed]*

Water is a fundamental element in our lives and for our planet, and it deserves our utmost attention. Yet this precious and limited resource is facing unprecedented challenges in our rapidly transforming world. Global population growth, rapid urbanisation, and unsustainable production and consumption patterns are exerting increasing pressures on our Earth's freshwater resources.

Water scarcity currently affects more than 40% of the global population, and this figure is projected to rise. Millions of people, most of them children, die every year from diseases linked to poor hygiene and unsafe water. Climate change is adding to these pressures: in water-scarce regions, the increasing and competing demands for water are leading to instability, forced migration and conflict.

With the adoption of the Sustainable Development Goals, the global community has agreed on a compelling vision with ambitious targets, including one on water. Let me set out a few priorities in this area as I see them.

First, the complexities of today's challenges call for a holistic, cross-sectoral approach rather than siloed action. Water is critical for human health, food security, the environment, stability and prosperity; we therefore have to put water at the core of all of our peace and development efforts.

Second, we need to put a much bigger emphasis on the effective, equitable and sustainable management of our water resources. By investing in sustainable water infrastructure and technologies such as water harvesting, desalination and wastewater treatment, we can significantly improve water security and efficiency. It is important that richer countries provide poorer countries with know-how and financial resources to improve water security and peoples' access to safe water sources.

Third, we must urgently respond to climate change, which is placing an even greater stress on water supplies and increasing the risks of extreme weather events. Experts predict that by 2050, water-related climate impacts could depress GDP growth by as much as 6% across much of Africa, Asia and the Middle East. We have to deliver on the promises of the Paris Climate Agreement and build resilience to the climate effects that are already visible across the world.

Finally, to address the critical challenges related to water, we must work in close collaboration and partnership. Intelligent water management should create benefits for everyone, as no one society can prosper long without sustainable access to clean and sufficient freshwater. If sustainably managed across sectors and societies, water has the power to build trust between communities and contribute to the broader establishment of peace and development efforts.

- This article is based on a speech given by Kofi Annan on 25 June 2018 at the World Meteorological Organisation



BACK TO TOP

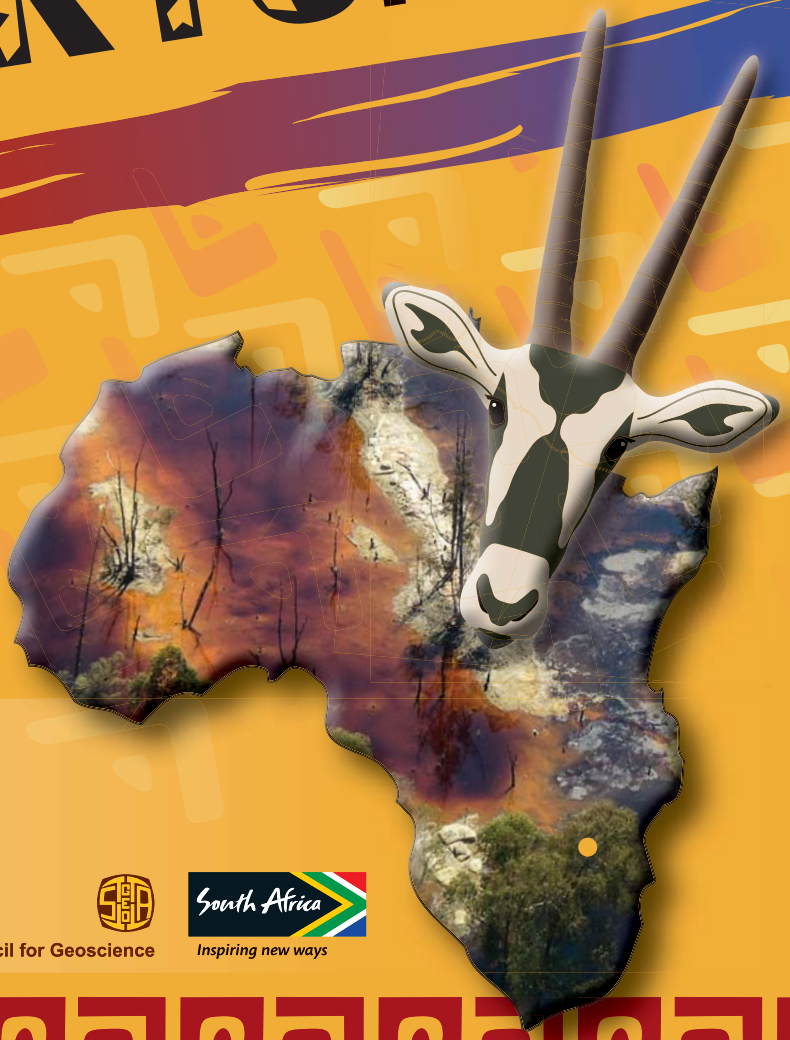
11th ICARD | IMWA 2018 Annual Conference
South Africa

# 11th ICARD | IMWA 2018 Conference

**International Conference on Acid Rock Drainage**
**International Mine Water Association**
**WISA Mine Water Division**

**10 – 14 September 2018**
**CSIR International Convention Centre**
**Pretoria, South Africa**

# RISK to OPPORTUNITY



**A Green Conference**

**www.ICARD2018.org**

**www.IMWA2018.info**

INAP

Tshwane University of Technology
We empower people

WISA MINE WATER DIVISION

Water Institute of Southern Africa

WATER RESEARCH COMMISSION

Council for Geoscience

South Africa
Inspiring new ways

# DEEPLY ROOTED IN SOUTH AFRICA WATER SOCIETY

www.wrc.org.za

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

The knowledge generated by the 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, in 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