THE WATER WHEEL

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IRRIGATED AGRICULTURE

Advances in drip irrigation promises even more water savings to farmers

WATER AND INNOVATION

From TAGs to Riches: Technology acceleration through partnerships

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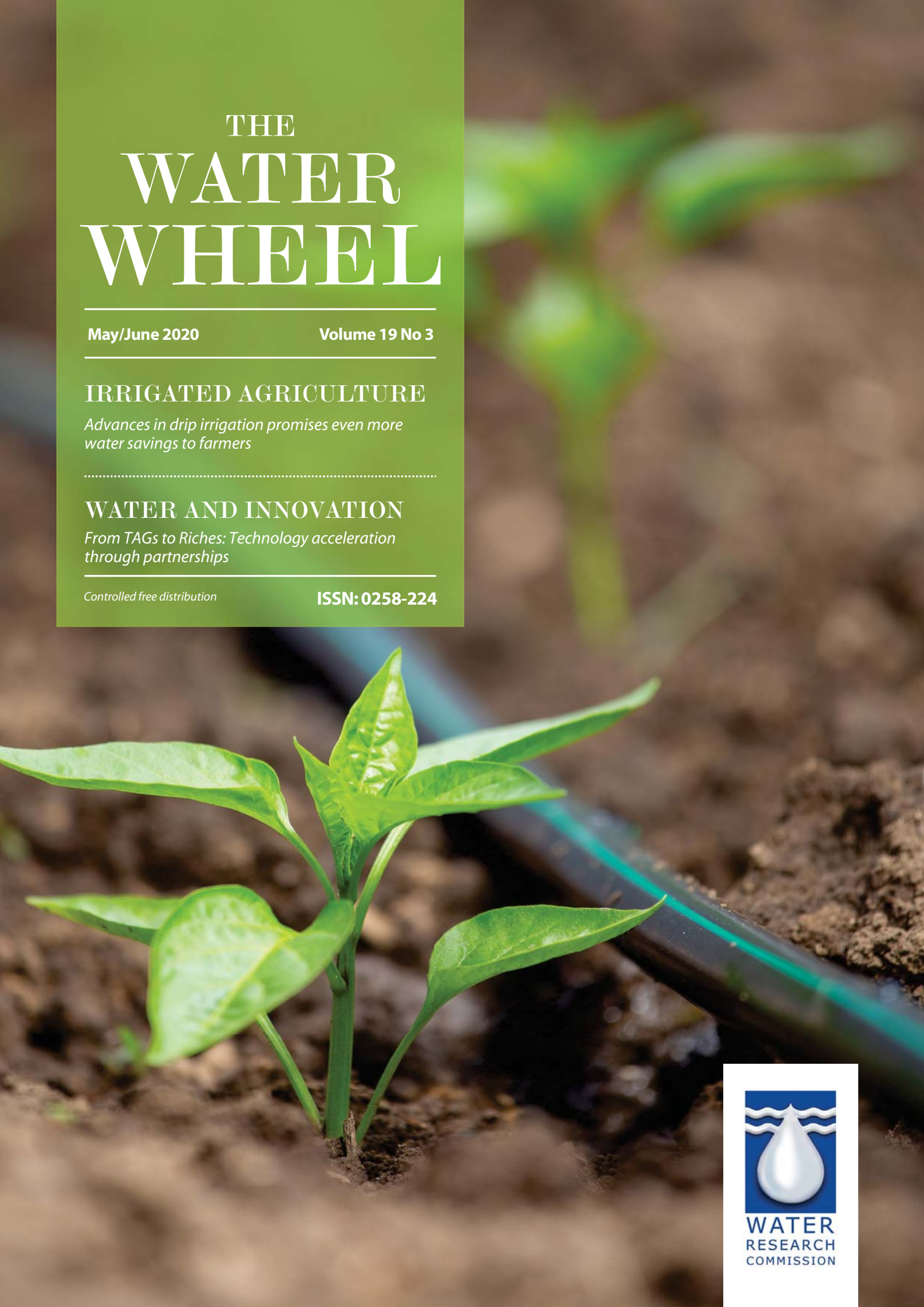

WATER RESEARCH COMMISSION

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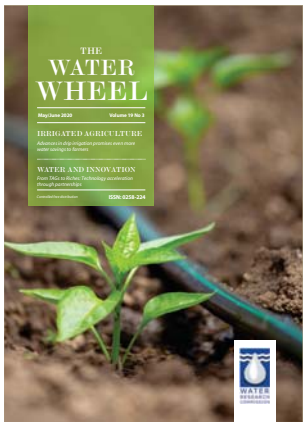

Low flow, low pressure drip irrigation is receiving increasing attention from South African farmers and researchers as a way to use irrigation water more efficiently. See article on page 12.

FLUID THOUGHTS

WRC CEO, Dhesigen Naidoo

The aloe ferox may not be this season's crop

This Fluid Thoughts article has been co-authored with economist and analyst, Xhanti Payi.

The aloe plant made yet another appearance in the budget speech this year, meant to symbolise an ongoing challenge in our country – growth and emphasing that, like the aloe, growth will be slow, long lived and resilient to water scarcity.

"For the Aloe Ferox to grow to its full potential, we need to do things that will help in the medium to long run". A long-term view supported by an economic resilience strategy is therefore key. The Minister of Finance then went on to mention the importance of the right amount of water, and how our money must be invested properly. There was a further announcement that Government would inject R10 billion into the infrastructure fund over the next three years to support the R200 billion capacity that is to be built under the Development Bank of South Africa.

"The Water Masterplan's comprehensive approach to realise a better water security future for South Africa is driven by a funding model that is highly susceptible to the Sovereign Credit Rating."

The National Treasury document, *Economic transformation, inclusive growth, and competitiveness*, offers some appreciation for the tautomeric relationship between water and the economy. The economy must invest in water security to enable further economic growth. The document cites the 2019 Budget review, noting that water infrastructure projects have been allocated R90,4 billion between 2019/2020 and 2021/22. That number is now R106,9 billion, allocated for the term 2020/21 to 2022/23, in spite of the fact that the National Water and Sanitation Masterplan is costed at over a trillion Rand. Recognising this, the government has touted the idea of not only private sector participation in the water sector, but now also private sector funding.

The downgrade of South Africa's investment rating by Moody's recently to sub-investment grade, as well as the further downgrade by Fitch Ratings, presents serious constraints to the government's own fiscal plans to fund water infrastructure. The impact of the downgrade is expected to be prolific. The Water Masterplan's comprehensive approach to realise a better water security future for South Africa is driven by a funding model that is highly susceptible to the Sovereign Credit Rating. Large infrastructure projects, like the Lesotho Highlands Water Project Phase II and the Umzimvubu Dam, have debt capital funding models with state guarantees. The contagion effect of a sub-investment grade rating is obvious, and puts both the institutions as well as the projects at the mercy of the markets and the DFIs. This puts both our ability to deliver on the social projects, like the SDGs, as well as make water available for economic growth and development at risk.

Then there is the second domain of new technologies and innovations. The 4IR toolbox that has the potential to take our planning, monitoring and control systems to a completely new level. Earth observation and remote sensing combined with smarter management of Big Data will enable real-time water and wastewater management prompting efficiency of use, more sustainable access and much higher levels of water security. The Brown Revolution, with new waterless and low water toilet systems feeding into non-sewered decentralised waste treatment, will not only ensure South Africa's ambition to meet the goal of universal access to safe and dignified sanitation, but also has the potential for us to supply a global market whose current shortfall in sanitation access is upward of two billion people.

If we add to this the great science that is enabling the beneficiation of the human waste to produce high value products – energy, chemicals, proteins and lipids – we have the genuine possibility of a new industrial platform with high performing businesses feeding a global market and creating new jobs and livelihoods and jobs for millions of South Africans.

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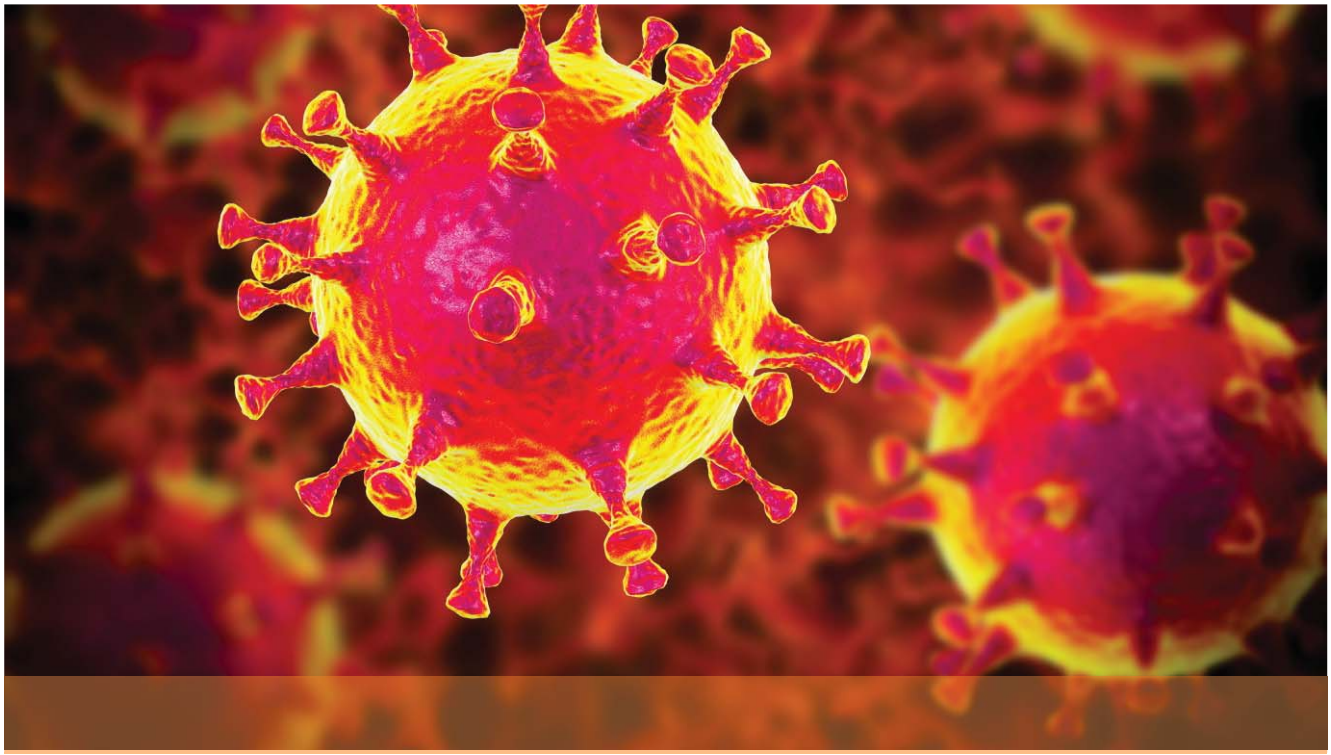
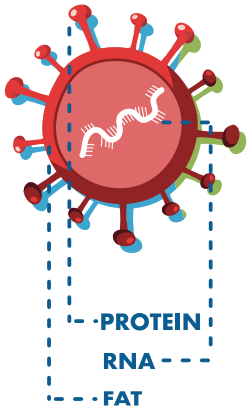
These have already been recognised as priorities in the Industrial Policy Action Plan (IPAP). But, to get these off the ground requires investment. Substantive investment – local and foreign! With potentially high returns. This enterprise is greatly affected by the knock-on effects of a Sub-investment grade sovereign credit rating. Makes one quite moody.

The question is how we avoid what water scarcity could cost us in GDP, which the World Bank has estimated to be up to 6.6% in some regions of the world. The question government must contend with is how a new model for water resource planning that not only takes into account the complexity presented by the ratings downgrade, but sees an opportunity that arises from the changing paradigm in the water sector globally, and thus water resource planning.

The Aloe Ferox may be a species in danger. What is true though, from minister Tito Mboweni's formulation, is the need to invest our money properly and wisely. If this is to be true in water, a more robust and collaborative strategy is needed. This may include a much more dramatic review of our institutional framework.



Information resources on water and Covid-19



The following Covid-19 and water related resources are available:

- Water Research Commission
- International Water Association
- Global Water Research Coalition
- World Health Organisation
- Water Supply and Sanitation Collaborative Council

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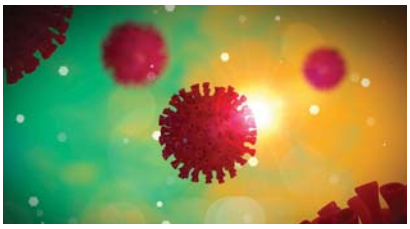
NEWS

Innovation Hub calls for innovative African solutions to flatten the curve



The global Covid-19 pandemic has caused countries across the world much health, social and economic distress, as even the most developed and advanced regions struggle to contain the spread of the highly contagious virus.

Amidst the distressing circumstances, the world has also seen creative and innovative ideas stemming from the urgency of the situation. "South Africa is no different, and we are taking this opportunity to call on local innovators to help our country fight this virus with solutions that take into account our unique challenges," says The Innovation Hub CEO, Advocate Pieter Holl.

The Innovation Hub (TIH) is calling on local innovators, entrepreneurs, scientists, SMMEs, research institutions, universities, and the public to submit their solutions relating to preventing the spreading of the novel coronavirus. Through its Open Innovation Solution Exchange programme, a platform and process which connects solution-seekers to solution-providers, TIH is offering successful applicants the opportunity to test, develop, incubate and commercialise their solutions.

Submissions should address the direct and indirect societal effects of Covid-19 and be proven concepts that need maturation, or existing solutions that can be adapted. "Furthermore, it is important that the solutions address the South African context. As a country, we are unique in many ways. Our solutions should be too," says Advocate Holl. Examples of solutions include, but are not limited to:

- Disinfection of the environment
- Information sharing tools and platforms
- Medical solutions
- Social distancing techniques
- Essential goods delivery
- Remote working solutions
- Solutions in the context of townships, rural areas and taxi ranks

Submissions can be made online at www.openix.co.za until 31 July 2020, and will be judged on a variety of scientific, technical and commercial criteria.

WRC Board member to lead newly-established Thabo Mbeki School

Deputy Chairperson of the Water Research Commission (WRC) Board, Prof Sibusiso Vil-Nkomo, has been appointment the interim Director of UNISA's newly established Thabo Mbeki School.

The School is associated with the Thabo Mbeki Foundation, and has been established with its collaboration. Prof Vil-Nkomo brings to UNISA national and global knowledge of academia as well as expertise in leadership, management and new knowledge generation. Prof Vil-Nkomo is the co-founder and chairperson of the Mapungubwe Institute for Strategic Reflection (MISTRA) a leading South African Think Tank. The MISTRA was ranked as having had a global impact – placed as one of the Top 10 Best New Think Tanks Globally, according to the 2013 Global Go-To Think Tanks Report produced by the Think Tanks and Civil Societies Programme at the University of Pennsylvania (TTCSP). MISTRA continues to attract leading national and global thinkers.

Upon acceptance of this appointment at UNISA he said: "This is a historic development to name the first trans-disciplinary School of significance after a living former President. Thabo Mbeki is an economist, leader, diplomat, peacemaker, scholar as well as an intellectual of high regard. This has been long overdue. We must create the Thabo Mvuyelwa Mbeki School as a magnet of excellence that is nationally and globally competitive. The School must combine theory with experiential learning and research. It must take its rightful place to be globally ranked because of its outstanding academic and applied work that is driven by leading academics and experiential teaching experts. UNISA cannot compromise on this distinguished name that is second-to-none in the world. The Thabo Mbeki Foundation has made a laudable contribution to the advancement of usable knowledge by sharing the name of the Former President with UNISA and supporting its founding."

Prof Vil-Nkomo obtained his BA degree (Magna Cum Laude) in Public Affairs and Economics from Lincoln University, USA. He was granted his MA and PhD by the University of Delaware. He taught and developed academic programmes at Lincoln University, Clarke University, and University of the Witwatersrand.

He has provided expert advice to the United Nations Economic Commission for Africa on the analyses of economic growth and inequality in Southern Africa. He continues to serve on boards, chair and advise on the development of major businesses and science councils like Subtropico Pty, LTD, Agricultural Research Council (ARC), and the WRC. He was among the founders of the successful Business Enterprises at the University of Pretoria and Continuing Education (now known as Enterprises at the University of Pretoria).

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Development of new dragonfly atlas underway

South African researchers are developing an atlas and phenology of dragonflies and damselflies in South Africa.

This project will produce a comprehensive atlas for the group of insects known as Odonata in South Africa. Odonata encompass dragonflies and damselflies, both potential indicators of healthy freshwater ecosystems.

JRS-supported efforts to use dragonfly status as a management and conservation indicator in Africa began in 2012 with a grant award for the development of a dragonfly freshwater health tool. A second JRS grant was awarded in 2016 to the University of Cape Town's Animal Demography Unit (ADU) to create an atlas and phenology of dragonflies and damselflies in South Africa to fill data gaps and to serve the needs of data users.

Led by Dr Leslie Underhill and supported by ADU's own citizen science project, OdonataMap, the ADU made strides toward achieving objectives during the first half of this project and Underhill will continue to lead this project, which is now managed from the Freshwater Research Centre (FRC). The FRC-University of Cape Town collaboration is expected to complete the atlas and related products in 2021, establishing Odonata as a practical indicator of freshwater ecosystem health, providing and promoting useful tools for decision-makers and advocacy, and improving freshwater health assessments.

The project, hosted at the FRC, will pick up where the University of Cape Town-hosted efforts left off to complete "The Atlas and Phenology of Dragonflies and Damselflies in South Africa". Specific objectives and activities include growing the number of Odonata records, using the DBI and distribution data to define Vital Odonata Areas of South Africa, contributing to the seasonal phenology of these species for inclusion in global climate change discussions, and mobilising all data and products. Amendments to the original project plan include the removal of a Red List of Odonata in South Africa (undertaken by the South African National Biodiversity Institute), the addition of PhD support, and efforts to increase database awareness and expand OdonataMap.

This project will close the remaining gaps in knowledge and data access in South Africa, and support freshwater resource mapping, climate change research, and more.

This project will help mainstream the conservation of the Odonata and the freshwater habitat they depend on. With the completion of the atlas and data tools, detailed information about the Odonata in Environmental Impact Assessments in South Africa could become the norm, as might the uptake of this information by government and into policy decisions regarding water resources, the FRC says on its website.

"The knowledge gained and shared will also support climate change research and other studies that require baselines against which change can be measured. As the atlas grows, so will the importance of Odonata as an indicator taxon for freshwater quality, and the number of people in Africa able to use this knowledge for the development of policy and development guidelines. Efforts will also be made to increase awareness of the database and the importance of Odonata and establish an OdonataMAP initiative across Africa."

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GLOBAL

WHO accelerates research and innovation for new coronavirus

The World Health Organisation (WHO) has convened a global research and innovation forum to mobilise international action in response to the new coronavirus (2019-nCoV).

Harnessing the power of science is critical for bringing this outbreak under control," noted WHO Director-General, Dr Tedros Adhanom Ghebreyesus. "There are questions we need answers to, and tools we need developed as quickly as possible. WHO is playing an important coordinating role by bringing the scientific community together to identify research priorities and accelerate progress."

The forum, which was held 11-12 February in Geneva, Switzerland, was organised in collaboration with the Global Research Collaboration for Infectious Disease Preparedness. The forum brought together key players, including leading scientists as well as public health agencies, ministries of health and research funders pursuing 2019-nCoV critical animal health and public health research and the development of vaccines, therapeutics and diagnostics, among other innovations.

Participants discussed several areas of research, including identifying the source of the virus as well as sharing of biological samples and genetic sequences. Experts are building on existing SARS and MERS coronavirus research and identifying knowledge gaps and research priorities in order to accelerate scientific information and medical products most needed to minimise the impact of the latest coronavirus outbreak.

The meeting produced a global research agenda for the new coronavirus, setting priorities and frameworks that can guide which projects are undertaken first.

Source: WHO

Using sewage to monitor scale of coronavirus outbreak

More than a dozen research groups worldwide have started analysing wastewater for the new coronavirus as a way to estimate the total number of infections in a community, given that most people will not be tested.

The journal ***Nature*** reports that the method could also be used to detect the coronavirus if it returns to communities, say scientists. So far, researchers have found traces of the virus in the Netherlands, the United States and Sweden.

Analysing wastewater is one way that researchers can track infectious diseases that are excreted in urine or faeces, such as SARS-CoV-2. One treatment plant can capture wastewater from more than one million people, says Gertjan Medema, a microbiologist at KWR Water Research Institute in Nieuwegein, the Netherlands.

Monitoring influent at this scale could provide better estimates for how widespread the coronavirus is than testing, because wastewater surveillance can account for those who have not been tested and have only mild or no symptoms, says Medema, who has detected SARSCoV-2 genetic material — viral RNA — in several treatment plants in the Netherlands. "Health authorities are only seeing the tip of the iceberg."

"The South African actuality programme, Carte Blanche, featured in insert on wastewater monitoring.

Click here to watch.

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Heat stress may affect 1.2 billion people annually

By the year 2100, heat stress from extreme heat and humidity will annually effect areas now home to 1.2 billion people, assuming greenhouse emissions remain the same, researchers report.

That is more than four times the number of people affected today. It is also more than 12 times the number who would have been affected without industrial era global warming.

Rising global temperatures are increasing exposure to heat stress, which harms human health, agriculture, the economy and the environment. Most climate studies on projected heat stress have focused on heat extremes but not considered the role of humidity, another driver.

"When we look at the risks of a warmer planet, we need to pay particular attention to combined extremes of heat and humidity, which are especially dangerous to human health," says senior author Robert E. Kopp, Director of the Rutgers Institute of Earth, Ocean and Atmospheric Sciences and a professor in the earth and planetary sciences department at Rutgers University-New Brunswick.

"Every bit of global warming makes hot, humid days more frequent and intense. In New York City, for example, the hottest, most humid day in a typical year already occurs about 11 times more frequently than it would have in the 19th century," notes lead author David Li, a former Rutgers postdoctoral associate now at The University of Massachusetts.

The body's ability to cool down properly through sweating causes heat stress. Body temperature can rise rapidly, and high temperatures may damage the brain and other vital organs. Heat stress ranges from milder conditions like heat rash and heat cramps to heat exhaustion, the most common type.

The study, published in the journal, Environmental Research Letters, looked at how combined extremes of heat and humidity increase on a warming Earth, using 40 climate simulations to get statistics on rare events. The study focused on a measure of heat stress that accounts for temperature, humidity and other environmental factors, including wind speed, sun angle and solar and infrared radiation.

Annual exposure to extreme heat and humidity in excess of safety guidelines are projected to affect areas currently home to about 500 million people if the planet warms by 1.5 °C. and nearly 800 million at 2 °C. The planet has already warmed by about 1.2 °C above late 19th century levels. An estimated 1.2 billion people would be affected with 3 °C of warming, as expected by the end of this century under current global policies.

To read the original article, Visit: https://iopscience.iop.org/article/10.1088/1748-9326/ab7d04

Global water event cancelled

World Water Week assembles over 500 co-convening organisations and 4 000 participants from more than 130 countries in Stockholm every year.

This world-leading conference on water is now cancelled due to the global spread of COVID-19 and the measures taken by national and local authorities to contain the spread of the disease. World Water Week was due to take place 23-28 August in Stockholm.

World Water Week is organised by Stockholm International Water Institute (SIWI) and has been held annually since 1991. However, the organisation has decided to cancel this year's conference after closely monitoring the spread of COVID-19 around the world. Given that the COVID-19 outbreak has been declared a pandemic by the World Health Organisation (WHO), holding a major event like World Water Week would pose a critical threat to the health of visitors and would result in an unacceptable risk of spreading the disease.

The decision was taken formally by the Board on March 31. SIWI's Executive Director, Torgny Holmgren, states: "We are, as always, committed to serving our community in the best possible way. Organising the world's leading conference on water comes with big investments in time and money for everyone involved. We believe that an early decision is better than a wait-and-see-approach – for everyone."

World Water Week is the latest in a number of global events that have had to be cancelled due to the COVID-19 pandemic. In South Africa, the biennial conference of the Water Institute of South Africa, due to take place at the end of May has now been postponed to December 2020.

For more information, Visit: www.siwi.org

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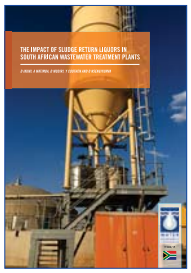
NEW WRC REPORTS



The impact of sludge return liquors in South African wastewater treatment plants

The main goal of the research study is to improve the knowledge on the impact and mitigating measures of the sludge return liquors from anaerobic sludge digestion on the wastewater treatment process. During the anaerobic digestion, the organic matter in the sludge is converted into biogas with the stored nutrients in the biomass being released into the water phase. This sludge return liquors should be recycled to the main process train, usually to the head of works or biological reactors, instead of being discharged into ponds or water bodies without any treatment. The additional load from the sludge return liquors may result in a deterioration of the plant effluent quality, due to an overloading of the plant, increase the energy requirements (for aeration) and increase the chemical dosage (metal salts to precipitate phosphorous). Therefore, it is crucial to understand the side-stream technologies available and recognised worldwide, as efficient means to reduce nitrogen and phosphorous concentrations in the sludge return liquors.

Report no. TT 800/19

An integrated approach to assessing and implementing ecological water requirements

South Africa has a rich history of research on Ecological Water Requirements (EWR), even before the development of the National Water Act (Act 36 of 1998, NWA) introduced concepts such as the Ecological Reserve. The implementation of EWR in integrated water resource management has been lacking, largely due to a lack of capacity but also in some regards due to the lack of methods and research on how to integrate the EWR within existing water resource management strategies. Integration, in the context of this project, was defined as the technical integration of driver and responder data together with the stakeholder vision for a catchment using a holistic method. This method has the capability to include riverine, wetlands and groundwater information and to determine what the risks to achieving the catchment vision or endpoints are. Therefore, this project used a case study catchment to look at integration and implementation of EWR using a holistic methodology.

Report no. 2738/1/20

Development and assessment of an integrated water resources accounting methodology for South Africa: Phase 2

The current status of water resources in South Africa requires a change in emphasis from infrastructure development to better water management, resulting in more effective and efficient use and allocation of water resources. It is widely recognised that good water management is strongly dependent on the availability of good data and information. The intention for this study was to build on the work completed in an earlier project (WRC Project K5/2205). In addition to reviewing water accounting frameworks, these projects had two general objectives. The first was to demonstrate the use of a water resource accounting framework in order to help understand water availability and use at a catchment scale. The second was to develop an integrated and internally consistent methodology and system to estimate the water availability and sectoral water use components of the water resource accounts on. This is also true for successful cooperative governance and stakeholder participation.

Report no. 2512/1/19

Development of water-energy-food nexus index and its application to South Africa and the Southern African Development Community

Since 2011 significant attention has been given to the water-energy-food (WEF) nexus in academic, policy, regulatory and development fraternities. The WEF nexus is a multi-centric lens through which to assess sustainable development and integrated resource management. This approach has direct links to the Sustainable Development Goals (SDG), principally SDGs 2, 6 and 7. Because the WEF nexus has constituents that are measured in different units, and at different spatial and temporal scales, there is a need to normalise indicators from each of these sectors before integrating them. One such method is the development of a composite indicator (or index), and this report presents the development of an index with the WEF nexus as its guiding framework. The methodology that has been employed in constructing the proposed composite indicator is that of the Joint Research Centre's *Competence Centre on Composite Indicators and Scoreboards* (JRC-COIN).

Report no. 2959/1/19

Knowledge review and agenda setting for future investments in research on water governance in South Africa

Water governance, simply put, is a set of systems that control decision-making with regard to water resources development and management. An analysis of global trends in water governance shows a need to address a worsening water crisis, compounded by climate change, rising urbanisation and population growth. Closely aligned to these trends, but distinct in its own trajectory, South Africa's water governance dynamics have evolved through a period of considerable socio-political change marked by inequitable resource allocation and water scarcity. This report presents an overview and analysis of the state of water governance research in South Africa from 1990 to 2019, with the overall aim of supporting the future research agenda for the Water Research Commission (WRC).

Report no. 2911/1/20

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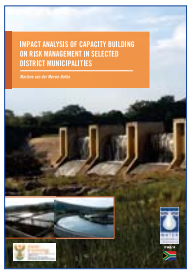

Impact analysis of capacity building on risk management in selected district municipalities

A capacity building support project was implemented during 2014-2016 which assisted selected District Municipalities in KwaZulu-Natal and the Eastern Cape to prepare risk-based plans using existing tools and guidelines, while developing technical capacity through a learn-and-adapt approach. The municipalities experienced a number of water services and human resource challenges at the time. The project methodology made provision to measure the impact of the capacity building project by comparing the Blue- and Green Drop results 'before' and 'after' the project. With the halt of the national Drop Certification programme, the impact could not be measured. Subsequently, the WRC commissioned a special study in 2018 with a two-fold purpose: 1) to determine the impact of the risk-based capacity building pilot project at the selected municipalities; and 2) to conceptualise a framework for the roll-out of risk-based capacity building on national scale, by considering the lessons learnt from the WRC capacity building pilot project, as well as other support studies.

Report no. TT 803/19

Resource efficient and socially responsible approaches for the integrated management of mine waste: Understanding the risks, opportunities, enablers and barriers

An alternative mine waste management approach, and one that is more consistent with the goals of sustainable development, focuses on the generation of mine wastes that can be re-purposed for other uses. This so-called valorisation approach goes beyond the recovery of targeted value recovery, both removing intra- and inter-generational waste burden and simultaneously optimising efficient utilisation of mined resources. This study set out to support the development and implementation of such an approach for the management of large volume mine waste in the Southern African context, by developing an enhanced understanding of the key drivers, barriers and opportunities involved.

Report no. 2580/1/19

Mlalazi estuary and floodplain: Hydrology and vegetation dynamics

South Africa has 280 estuaries, of which about 75% are classed as Temporarily Open/Closed Estuaries (TOCEs). The ecology of TOCEs is very much dictated by mouth closure events, the frequency of closures, how long the mouth remains closed each time and how much backing up of water occurs behind the closed mouth. This study focused on the Mlalazi Estuary. Its purpose was to understand and model the evolving relationship between fluvial and marine conditions that control the mouth dynamics and estuarine vegetation. TOCEs are very much influenced by catchment inflows – both the frequency and magnitude of inflow events. These influence the mouth closing process and the natural beaching. A component of this study focused on the rainfall of the Mlalazi catchment area and the patterns of flows entering the Mlalazi estuary/floodplain basin to establish a reliable estimate of the depth-duration-frequency of flows and sediment into the estuary using a calibrated and validated hydrological model.

Report no. 2541/1/19

Climate change and South Africa's blue carbon ecosystems

Blue carbon habitats include living and non-living biomass of mangroves, salt marshes and seagrasses. These habitats form the interface between land and sea, and provide numerous ecosystem services such as coastal protection, fish nursery habitats, nutrient filters and carbon storage. In South Africa, blue carbon habitats occur in sheltered estuarine environments where their integrity and biodiversity are threatened by increasing freshwater abstraction, development pressures, poor water quality, climate change and sea level rise. This study generated knowledge on blue carbon stored by South Africa's estuarine habitats. It quantified the extent and loss of these habitats and their ecosystem services and describes responses to climate change. The final report presents the trends of surface elevation in two salt marsh and two mangrove systems and discusses the long-term survival and expansion of mangrove forests and surrounding salt marsh areas. The research contributed to the National Biodiversity Assessment of 2018 and included information on the distribution and health of estuarine habitats. It also informed the compilation of estuary management plans required by the Integrated Coastal Management Act.

Report no. 2769/1/19

To download a free copy of these reports Visit: www.wrc.org.za.

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IRRIGATED AGRICULTURE

Advances in drip irrigation promises even more water savings to farmers

Low flow, low pressure drip irrigation is starting to make waves, though the mechanics behind the technology is still under investigation. Petro Kotzé investigates.

Farmers' attempts to work ever more efficiently with their share of water has gone hand in hand with improved irrigation technologies. The irrigation sector is by far the largest water user in South Africa, and improvements here ripple beyond the agricultural community to all other water user groups in the country.

Improvement of irrigation technology, in turn, results from better understanding of soil physics and crop water requirements. Accordingly, the future of drip irrigation has been described by some as low flow drip technology. This entails the delivery of a signigicantly low, consistent volume of water over a long period of time. Data on the implications are scarce, but it has now become the topic of a new research project on citrus.

Though some of the elements behind the success is not yet fully understood, farmers have already achieved substantial water savings, coupled with increased yields and smoother farming operations, as a result.

The development of low flow drip irrigation

There are various types of irrigation in use in South Africa. Of these, drip irrigation is widely recognised as the most water efficient. The technology started in the 1970s in water scarce countries such as South Africa, Israel, Australia and Mexico. It involves the delivery of water and fertilizer (fertigation) across a field in pipes called dripperlines, emitted through drippers. The enriched drops of water are delivered directly to the plant's

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root-zone, in theory, in the right amount and at the right time.

Commonly, drippers emit flow rates of 3.5, 2.3 or 1.6 litres per hour. Research has shown, however, that we are irrigating too fast for the active root zone, especially in more sandy soil types. According to Chris Malan, South Africa's Agronomy Manager for global irrigation manufacturer and distributor, Netafim, this results in wasted water.

Dr Eduard Hoffman, head of the Department of Soil Sciences at the University of Stellenbosch, says that in gravelly or sandy soil in particular, the commonly applied 2.3 or 4 ℓ/h drippers result in the water running straight through the soil. As a consequence, some farmers prefer the less water-efficient micro spray system, where water is emitted through a small spray nozzle over a larger soil area than drip irrigation.

To combat the loss of water when practicing drip irrigation in sandy and gravelly soils, irrigation is scheduled to take place in short pulses of less than an hour per day. This practice has, however, led to its own challenges, including over saturated sub-soils, leaching of fertilizer, inefficient hydraulics systems, some water losses when the systems needs to be drained, and blockages in the pipes delivering water.

Now, low delivery rate drippers have been developed. In comparison, these emit less than one litre of water per hour over one irrigation shift that lasts several hours. This irrigation system applies water at the rate of the maximum daily water use of the crop over a day. Malan explains that a while a crop's water demand will typically follow a bell curve over the day, the rate of water emitted during continuous irrigation remains constant. There is thus an oversupply of water early and late in the day and an undersupply in mid-day, which coincides with the crop's peak water consumptive period. This is compensated for by the 'buffer' of water created before and after. In theory, water is thus applied at the same rate that the roots extract it.

The design of a continuous, low-flow irrigation system entails a number of changes to the farming operation. It runs from a central pump house, includes dedicated mainlines and is technology driven. Because of the lower amounts of water extracted, the technology also allows the entire field or farm under irrigation to be watered simultaneously.

Agronomist Gerhard Mostert, founding partner and consultant for Agriwiz, who has been spearheading the technology, explains that some of the big changes of the 'new' system are that there are no control valves in the field anymore. Instead, the entire system of irrigation and fertilization can be handled by a manager and an attendant in the pump house (where all the valves are located). Mostert says that the enriched water that is delivered to crops is another key to the system's success. "We are moving from volume-based application of fertilizer to applying the optimal concentration of fertilizer."

Malan explains that this creates conditions similar to those in a greenhouse, where a concentrated amount of fertilizer is provided, instead of simply the crop's required amount, in order to create the optimum production environment.

More developments include that peroxide is now regularly run through the pipe system, to prevent the headache of blockages, commonly associated with lower emission drippers.

The system promoted by Agriwiz is technology driven, and focuses on ultra-low flow, fertigation systems that include variable speed pumps and automated soil moisture probes. The fully automated system links farmers to a cloud-based research and development platform that helps create a comprehensive weekly irrigation plan moderated by the expected rainfall and temperatures for the week. It takes water use, yield, climate, history and soil types in mind.

Farmer and co-owner of ***Ysrivier Farm*** just outside Patensie, Merwe van der Watt, has been running this system on his citrus orchards for around three years. "I only set my irrigation programme twice a week," he says. Based on the weather forecast, I will irrigate 14 hours on some days, and as little as four on others."

"Once an orchard is established, it is more difficult and costly to switch to a new system."

Yet, Malan cautions that there are still questions that remain

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Low flow drip irrigation system in a citrus orchard.

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Dripperline for a low flow irrigation system.

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A low flow drip irrigation system installed in an avocado plantation.

to be answered around the technology. "We still need to understand exactly what we are working with," he says. For example, is it true and correct that water is over-supplied in the morning, for the plant to use the reserve later in the day? And, are the results really due to the shallow application of water close to the rootzone?

With support from Netafim, these questions will now be answered during a research project at the University of Stellenbosch's Department of Soil Sciences.

Investigating the mechanics of ultra-low flow drip irrigation

"I want to know exactly what the mechanisms are," explains Hoffman, in reference to their recently launched project. Hoffman, with student, Herbst van der Merwe, are investigating the water content distribution in soil during continuous drip irrigation under two sets of drippers; the first emitting 0.7 ℓ/h, and the second, 0.4 ℓ/h, both for eight to 12 hours at a time. Though the 0.7 ℓ/h emitters are available commercially, the 0.4 ℓ/h emitters are only experimental at this stage, says Malan, as they would like to investigate their performance.

Except for the distribution of water in the soil, the researchers will also investigate salt distribution as well as root growth and distribution. The testing ground is a plantation of Nadorcott mandaring trees established on sandy and gravelly soil in the Hex River Valley (Western Cape). Since most research on root growth and distribution under drip irrigation so far has been done on South Africa's main crops under irrigation, such as maize, wheat and tomatoes, the project will play an important role to fill the knowledge gap that exists in the characterisation and quantification of the root growth of citrus trees under low emitter discharge rates.

"We want to see where the water goes," says Hoffman. If they understand the vertical and horizontal movement of water in soil, they will be able to inform the ideal placement of the drippers, for example. Then, they will be looking at the plants' root development. Hoffman says that there is anecdotal evidence, for example, that the trees' roots concentrate in the upper soil initially and then developed deeper as it grows older.

Understanding irrigation is really about understanding soil physics, notes Hoffman, and the combination of water, light and chemicals. Should they decipher the movement and distribution of water in the soil during continuous drip irrigation, they will know if drainage and unnecessary leaching is taking place. Results will clarify if the root growth and distribution in the volume of wetted soil is enough to sustain good tree performance and how management can be adapted accordingly.

The research project will also shed light on the question if the trees experience stress during the mid-day, when the application rate of the enriched water stays the same regardless of increased evapotranspiration. Hoffman explains that this is only the first phase of the project. In future, they will investigate if evaporation increases from the soil, since it is constantly wet. If so, the question needs to be asked if we are really saving water, he says.

Still, though the technology can be applied to any crop, it might not work for all farmers.

A specialist system that needs expert management

The South African citrus industry experienced an era of tremendous growth, says Malan. This boom resulted in the new development and planting of large blocks of orchards, where new technologies like low flow drip irrigation could be installed. In places such as Israel, for example, they did not experience this boom, and concurrently, did not have the same opportunity to install new irrigation systems on large scales.

Ideally, the planning for this system should take place before the orchard is planted. Once an orchard is established, it is more difficult and costly to switch to a new system and for crops like vineyards, for example, only one block at a time would commonly be replanted.

Even in the citrus industry, low flow, continuous drip irrigation is probably best suited to the so-called 'leader' farmers, maintains Malan. These large-scale, commercial farmers are more likely able to apply the newest technologies, and justify the expenses with quicker returns in competitive export markets.

Furthermore, correct maintenance of the system is critical, as is technical knowledge of the various aspects of the system. "You have to know exactly what you are doing," explains Hoffman. The dripper lines must regularly be flushed out, and

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One of the benefits of continuous low flow irrigation is that the entire farm can be irrigated at once.

oxidation treatments applied. Because technology, and technical knowledge is so important for this to work, it might not be suitable for upcoming farmers, he says.

Though it leads to savings over time, as well as potential yield increases, the initial cost is also higher in comparison to more traditional drip irrigation systems. Speaking on the topic at a recent presentation at Stellenbosch on water savings in agriculture, Mostert pegs the cost at double that of a micro-irrigation system. The cost for a low flow drip irrigation would be around R65 000 to R70 000 per hectare in comparison to R35 000 for a micro-irrigation system, he notes. Yet, he points out that the capital cost leads to decreased running costs, including for management, labour, water and electricity. In his own experience, the only cost that increases, is for fertilizer.

However, for those that have successfully gone down the route of this new technology, the general consensus is that the benefits far outweigh the disadvantages.

Low flow irrigation shows good results

"It has changed my entire viewpoint of farming", says van der Watt of the system. It allows him to apply precision farming, and improved his use of resources like water and fertilizer. "The margin for error is getting smaller and smaller," he adds.

According to information supplied by Netafim, trials on tree crops showed that continuous irrigation solved many of the mentioned management challenges associated with drip irrigation. It has also shown that the actual water requirements of certain tree crops are much lower than traditionally thought as orchards are showing constant and even higher yields with much lower, yet more efficient water application. The concept has already found increasing application in the South African citrus and macadamia industries especially. Mostert says his clients have been running 0.7 litre per hour drippers for the past eight to nine years, resulting in water savings of up to 50%.

Van der Watt adds that he was motivated to switch to a lower flow irrigation system because he noticed that they were over-watering their trees, which can lead to root rot. Before installing his new irrigation system around three years ago, he was already familiar with the concept, having run his tobacco fields on 1 ℓ/h drippers with great success. Switching to that from spray irrigation led to enormous improvements in yield, he says.

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Part of the new system includes that all valves fertilizer is moved to a central pump house.

Benefits of switching to 0.7 ℓ/h drippers in his citrus orchards, for which he also built a new pumphouse to accommodate the new system, has led not only to water savings, but improved management of the irrigation system and concurrent resources used, he says. So far, he can say that the root development of the trees under 0.7 ℓ/h dripper are looking good.

In fact, due to the pressure on water resources, van der Watt is planning to experiment with 0.4 ℓ/h drippers in the near future, when he plants new orchards.

Is this the future of irrigation in South Africa?

Malan thinks carefully before answering. "We'd like to say that this is the future of tree irrigation," he says. According to Malan, the future does lie at low delivery drippers to keep water within the root zone. This, he adds, is open to any farmer that irrigates, regardless of the scale of his farming operation.

Yet, there is still some way to go forward. Malan explains that, except for research, training on the concept is necessary, and the approach to irrigation scheduling must change. Mostert agrees. "You cannot expect the farmers themselves to drive it." Instead, such a change to broad-scale adaptation of a new technology takes time, and many roleplayers, including the irrigation system designers, the fertilizer providers, researchers to provide data and support and consultants. Even with knowledge and leadership, it takes years to establish a new culture.

Yet, for farmers like van der Watt, it is clear in which direction they are moving. Ten years ago, farmers in the area didn't even want to try 1.6 ℓ/h hour drippers, he says, "but look at where we are now."

Sources:
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WATER INFRASTRUCTURE

Illegal discharges threatening urban water quality

A research project funded by the Water Research Commission (WRC) aimed to outline technically feasible and cost-effective procedures for detecting and removing illegal discharges into stormwater systems, and to provide guidance to municipalities tasked with controlling this source of water pollution. Article by Sue Matthews.

Polluted inflow from stormwater systems is the main cause of poor water quality in urban aquatic environments, but identifying the source of contamination is notoriously difficult. Where informal settlements occur in a drainage area, the lack of waste services and infrastructure typically means that sewage, greywater, solid waste and runoff all merge into one waste stream entering the stormwater system. But even in well-resourced areas, leaking sewers, blockages causing overflows, pump station failures and other inadvertent spills are major contributors to the pollution load, despite the fact that individual events may be intermittent or transitory. And then there are the deliberate illicit actions, such as connecting sewerage systems or factory floor drains to stormwater pipes, disposing of paint, used motor vehicle fluids and other wastes by pouring them down stormwater drains, as well as routinely discharging industrial effluent into the stormwater system.

Most of the above are illegal discharges, because according to municipal stormwater management bylaws in South Africa, no person without written consent from the Council may discharge – or permit to enter – anything but stormwater into the municipal stormwater system, with a few exceptions that include fire-fighting solutions and insignificant sources of pollution.

Municipalities are obligated to enforce the bylaws because the National Water Act requires that reasonable measures be taken

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to prevent substances other than stormwater from entering any stormwater drain or watercourse. Furthermore, waste and wastewater discharge and disposal into a water resource require a licence unless permissible under Schedule 1 of the Act or a General Authorisation, in which case particular limits and conditions apply. Effluent discharge into estuaries and the sea is also subject to the Coastal Waters Discharge Permit Regulations issued under the Integrated Coastal Management Act. All of this means that municipalities are accountable for the end-of-pipe discharge from their stormwater systems.

Locating individual pollution sources and tracking down transgressors of the law is easier said than done though, particularly since stormwater systems often have vast drainage areas, and most of the infrastructure is underground. Recently, a research project funded by the WRC aimed to provide guidance to municipalities by developing cost-effective procedures for what is widely known as IDDE – illegal discharge detection and elimination – in stormwater systems. The project was awarded to the Cape Peninsula University of Technology, with senior lecturer in the Department of Civil Engineering and Surveying, Yaw Owusu-Asante, leading a team of undergraduate and postgraduate students.

Discharges in informal settlement are typically diffuse, chronic and pervasive due to physical, institutional and socio-economic factors, and cannot be addressed through the normal municipal enforcement process.

The research began with a review of international literature, which revealed a key factor for successful implementation of IDDE programmes, especially pertinent to municipalities operating with limited resources and expertise. "An effective IDDE programme is founded on one basic principle," notes Owusu-Asante. "It ought to progress along a hierarchy of locations and procedures, commencing in higher potential risk areas in a catchment before moving to lower risk areas, and from using desktop assessment through to exploratory techniques and then confirmatory procedures."

Methodologies were therefore developed for each of these stages, and applied in a local case study to verify their feasibilities and challenges. Cape Town's Diep and Kuils River catchments were used for the case study, because they include the entire spectrum of land uses, socio-economic variations and housing types found in typical South African cities, and were ranked most vulnerable to pollution and of high priority for management intervention in a 2011 study undertaken for the municipality by PDNA. Guidelines were also provided for corrective measures to remove illegal discharges – the 'elimination' component of an IDDE programme – but these could not be tested given that the research team had no jurisdiction to access business properties for inspection purposes.

Risk mapping

The first stage of the recommended IDDE programme is a desktop assessment, which relies on existing datasets, reports and anecdotal information, along with maps showing stormwater and wastewater systems, as well as land uses or zoning. The research team used ArcGIS to compile all this data into spatial layers, each representing one of the 10 risk factors selected for the study – residential, commercial and industrial land use, population density, development age (or age of stormwater infrastructure), outfall density, aging sanitary infrastructure, drainage density, density of potential generating sites (fuel stations, restaurants, industrial plants and other facilities) and infrastructure access density (the number of access points to the stormwater system per square kilometer).

First, however, the risk factors were subject to a metric ranking process incorporating statistical analyses, so that each could be represented as low, medium or high risk of occurrence of illegal discharge. For population density, for example, areas with less than 580 people per square kilometre were classified as low risk, while those with more than 2 052 people per square kilometre were considered high risk, with anything in between falling into the medium risk category. In the case of the outfall density risk factor, sub-catchments with an average of less than 4.5 outfalls per kilometre of stream were classified as low risk, while those with an average exceeding 57 outfalls were considered high risk.

These individual spatial layers were each overlain by a spatial layer representing complaints records of past discharges, differentiated into four types – water, greywater, wastewater and solid waste. This allowed the risk factors' performance in predicting the occurrence or location of each type of illegal discharge to be tested through statistical analyses. The risk factors' relative 'weights', or importance in predicting the risks, were then determined and used to derive a composite score for each sub-catchment.

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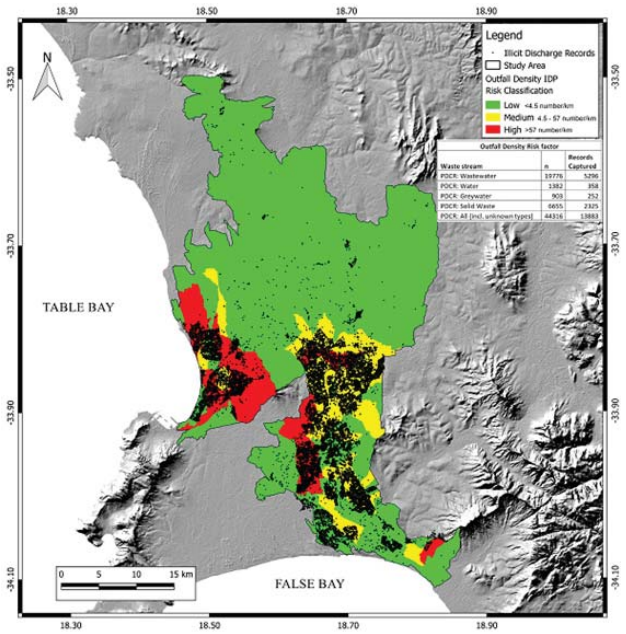
Tony Carnie



The spatial layer for outfall density illegal discharge potential, showing high (red), medium (yellow) and low (green) risk levels, overlain by records of illicit discharges (black).

These sub-catchment scores were in turn used to produce composite maps for the Kuils and Diep River catchments for each of the four types of discharge, as well as for the combined discharge. The maps revealed that illegal discharges were concentrated in areas with high population and drainage densities, probably because they provide more opportunities for illegal connections, dumping and spills to enter the stormwater system. Commercial areas seemed to have a higher risk of all four types of illegal discharge than the other categories of land use. Interestingly, development age and aging infrastructure did not appear to influence the locations of illegal discharges.

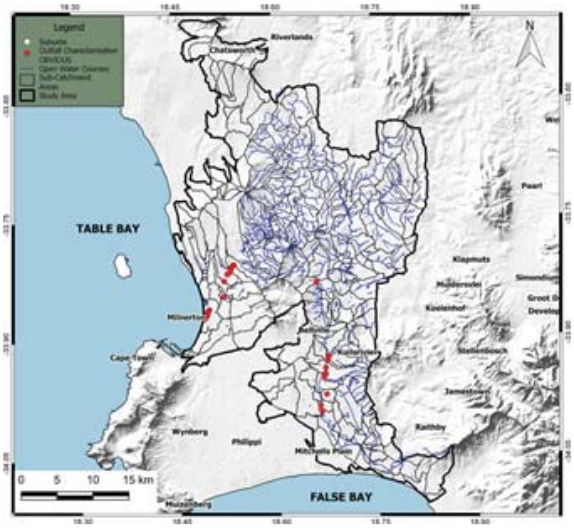
"This was a surprise because older developments occur in both the Diep and Kuils River catchments, and illegal discharges associated with failing infrastructure were expected," says Owusu-Asante. "The reasons for these weak associations could be attributed to infrastructure upgrade and replacement in recent times. Also, massive new developments may have masked the effects of aging infrastructure in the older parts of the catchments."

Outfall inspections

The desktop assessment and the resulting map would enable municipalities to prioritise high-risk areas when conducting the subsequent stages of the IDDE programme, beginning with the detection of illegal discharges at outfalls and monitoring of flow types. Initially, though, all outfalls should be inventoried as part of a screening run, so the research team set out to inspect every outfall within the metro area that discharged directly into the Diep and Kuils Rivers, or anywhere within their riverine corridors. This fieldwork was done at least 48 hours after runoff-generating rainfall to ensure that only non-stormwater flows were detected.

Using the City of Cape Town's stormwater plans as field maps, the team members walked along the rivers and located just under 200 outfalls. Non-stormwater flows were observed at over half of these – in fact, 21% had substantial flows exceeding 5 ℓ/s. All flows were sampled for laboratory analyses, and a comprehensive inspection form filled in to record the details of each outfall. This included any notes about the colour, odour or turbidity of the flow, as well as evidence of toilet paper, faecal matter, detergents, oil or grease, and excessive plant growth.

Since these observations and the physico-chemical parameters measured in the samples might not be sufficient to identify the type of discharge at the outfalls, samples of tap water, spring water, irrigation water from sprinkler runoff, car wash and laundry wastewater, four types of industrial effluent, and raw sewage inflow at a wastewater treatment works were also analysed so that a 'fingerprint library' could be developed. The analytical data were used to create box and whisker plots that allowed the various flow types to be identified. For example, the ammonia/potassium ratio for sewage was found to significantly different when compared to all the other flow types, while irrigation waters could be distinguished from sewage and wash-waters by ammonia, detergent and turbidity, and tap water and spring water could be differentiated on the basis of conductivity. However, detergent proved to be the parameter with the best overall potential as an indicator of illegal discharges because it classified all flow types.



The research team identified outfalls where illegal discharges were obvious, based on a screening inspection of outfalls in the Diep- and Kuils River, as well as laboratory analyses of outfall and reference samples.

Using this information, the research team developed a flowchart as a decision-making tool for identifying illegal discharges specific to Cape Town. This would ideally allow outfalls to be prioritised for long-term monitoring, but security concerns and the project's time constraints meant that two outfalls – both receiving discharges from Du Noon informal settlement in the Diep River catchment – were selected for intensive monitoring over a period of seven days. At these outfalls, a flow meter logged flows at 10-minute intervals, while an automatic water sampler installed in a nearby manhole collected samples at one-hour intervals. The monitoring results revealed that the discharges were mainly sewage, and most likely due to illegal connections to stormwater system drains.

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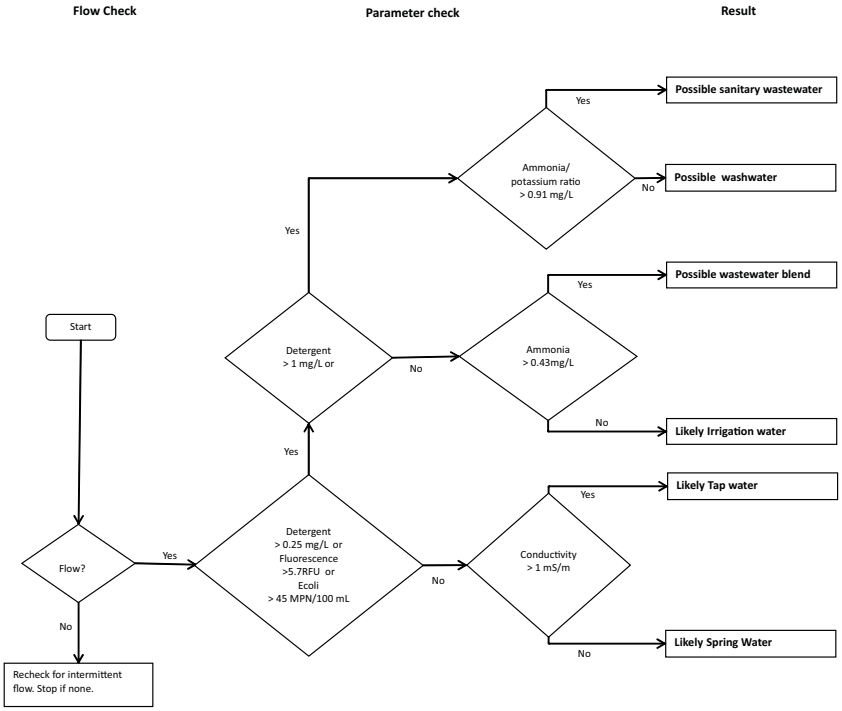

A flowchart was developed as a decision-making tool to identify illegal discharges in Cape Town.

Source tracking

The next stage in the IDDE programme involves isolating or tracing the source of illegal discharges. This could be conducted if an illegal discharge has been detected through an outfall inspection, or even if a complaint has been received about a persistent problem. A combination of techniques might be needed to find the source, such as inspecting manholes, damming the flow with sandbags, using dye or smoke tracers, and conducting CCTV inspections of stormwater pipes.

The research team had already established that the discharges in the Du Noon informal settlement were diffuse, chronic and pervasive due to physical, institutional and socio-economic factors. Since it was recognised that the 'National strategy for managing the water quality effects of settlements' and supporting operational guidelines (DWAF, 1999) remains the most appropriate approach for dealing with such pollution, an alternative area was sought for the case study.

"For reasons including project time, budget constraints, safety and security, it was recommended in the Project Reference Group meeting that the source tracking investigations should be focused mostly in industrial and commercial areas," says Owusu-Asante. "Again, as there are no established legal authority to enable the research team to undertake inspection and monitoring at private and business properties, it was further recommended that the source tracking investigation should be confined to public roads that are accessible to the research team. In essence, this translated to tracing sources to segments of pipe mains rather than to the very sources where the discharges originate."

The investigation identified certain drainage areas and segments of the stormwater system that would allow the sources of illegal discharges to be pinpointed, if followed up by municipal staff. Apart from sewer overflows, the research team found evidence of dairy waste discharges and wash-water effluent from car wash centres.

Corrective action

The ultimate goal of an IDDE programme is to remove illegal discharges, and a mix of education and enforcement is the most common and cost-effective way of achieving this. Generally, a municipality would begin the enforcement process only if education has failed to achieve the desired outcome. The first step would be to send a summary letter to the property owner, explaining the problem and requesting that corrective measures are implemented within a specific time limit. Follow-up action, such as issuing summons and fines, would proceed in the event of non-compliance.

Sometimes, simple plumbing projects are all that is required to correct a problem, but others involve major excavation works and structural modifications, done by certified contractors with specialised equipment. Where the property owner fails to take corrective action even after the enforcement process has been completed, the municipality would be entitled to commission the work and recoup the costs from the property owner in accordance with the polluter pays principle.

Owusu-Asante points out that the research project provided a good starting point for a systematic methodology for detecting and removing contaminated discharges to urban watercourses, but there is a need for similar IDDE studies in other municipalities.

"A benchmarking survey of these future studies would result in an improved guidance manual that integrates results and other knowledge gained," he says. "More work is also needed to better quantify the pollutant removal and costs associated with correction of illegal discharges, to evaluate the effectiveness of proactive prevention strategies that rely on systematic inspections of the system rather than outfall monitoring and tracking, and to develop improved strategies for tracking down and eliminating these discharges."

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WATER AND SOCIETY

Water reuse – what does the public know?

Water reuse is one of the strategies proposed in South Africa's recent policy documents to stretch the country's scarce water resources, but what does the public know about it? And do they support it? Jorisna Bonthuys reports on the latest research supported by the Water Research Commission (WRC).

With a fast-growing population, recurring droughts and water risks due to climate change, it has become critical to plan for the increasing demand for freshwater.

Climate change prediction models suggest that average temperatures will rise, and rainfall events will become more infrequent, but also more intense, thereby increasing the unpredictability of water availability. Not only the likelihood, but also the severity of extreme climate events are expected to increase in the near future.

Events like the recent multi-year drought are becoming the 'new normal' in southern Africa due to unfolding climate change. Many of South Africa's municipalities would be at risk if there were to be a serious multi-year drought.

Water reuse is considered one of the ways that South Africa can avoid a projected 17% water deficit by 2030. Currently, it is one of the strategies proposed in the National Water Resource Strategy 2 and the National Water and Sanitation Master Plan. But what, if anything, does the public know about using water more than once? And, do they support it?

A recent report titled, ***Water reuse – what does the public know*** (**WRC Report no. TT 807/19**), discusses this topic. The report highlights the findings of the baseline assessment of public knowledge of water reuse and related aspects, which was undertaken in 2019.

The study, funded by the WRC, has provided valuable insights for water managers and policymakers alike. The research was

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undertaken by Dr Sarah Slabbert and Nadja Green from BHI 32, a development communication and research consultancy based in Johannesburg. This is the first study of its kind to test the South African public's awareness and understanding of water reuse and related aspects. The survey also determined which actions people are likely to support in a severe drought situation.

The report discusses the findings of a national survey, which was conducted as part of the OMNIBUS syndicated survey of Nielsen South Africa. The survey covered adults, aged 15 years and over, from all race groups. The sample included 2 519 urban respondents and 800 rural respondents. Personal at-home interviews were conducted in English.

The questionnaire comprised two grid-style questions and one closed pre-coded question. The questionnaire was designed to cover knowledge that was identified in the literature review and the stakeholder consultations as essential for the public to have. This includes the following aspects:

- Knowledge of terminology such as 'wastewater', 'treatment', 'greywater' and 'potable water'
- Knowledge of the water cycle
- Knowledge of water and wastewater treatment and municipal responsibilities in this regard
- Knowledge of ***de facto*** water reuse
- Knowledge of safety aspects of water reuse
- Common myths and misconceptions
- Knowledge of the effect of climate change on the availability of water
- Knowledge of South Africa as a water-scarce country

Public knowledge of water reuse and related aspects was tested with the closed question on greywater and 18 statements, which respondents had to mark as true, false or not sure. The composite result was presented as an index score out of 20 (with 0 being the lowest and 20 the highest score). The second grid-style question asked respondents which actions they would support in the event of a severe drought in a city like Johannesburg. Respondents could select multiple responses from eight options.

Only 35% of South Africans interviewed knew that greywater is the term for wastewater from bathing, washing clothes and dishes.

Unpacking the results

"On average, South Africans scored 12 out of 20 (on the index score)," Slabbert points out. "Since the questions tested very basic knowledge, one would expect at least an average score of 14 out of 20 from an educated public. This means that, on average, South Africans have insufficient knowledge of water reuse and related aspects."

There were some demographic differences in the public's knowledge of water reuse and related aspects, but these differences were small.

Even for the highest LSM groups (LSM 8-10) and for people with a post-Grade 12 qualification, the average scores were 13,05 and 12,65 respectively. This implies that a public education campaign on water reuse should target all demographic groups, according to the report.

Three sub-indices were also calculated. On these sub-indices, South Africans scored as follows:

- 1,32 out of 3 for knowledge of the water cycle. "The low percentage of correct answers for the three statements on the water cycle indicates that South Africans' knowledge of the water cycle is particularly poor," Slabbert says. From the pilots it was clear that respondents interpreted messages of water scarcity, and even climate change, as indicative that the Earth's water is becoming less.
- 1,81 out of 3 for knowledge of safety aspects of water reuse. On some aspects, knowledge was good (75% or more); on other, knowledge was poor.
- 4,58 out of 6 for knowledge of water and wastewater treatment. "This result shows that respondents have applied the explanation that they got in the showcard," Slabbert says.

Spotlight on terminology

The survey further found that South Africans across all demographic groups have poor knowledge and understanding of the basic terminology that is needed for a meaningful public discourse on water reuse.

Knowledge of terms like 'wastewater' and 'treated wastewater' was so poor that these terms had to be explained upfront in a showcard before respondents could be asked any questions. Slabbert contributes this to a lack of a comprehensive water curriculum, starting at the primary school level. "There is no systemic build-up of knowledge (about water-related issues) in our country. Often, learners finish school without a basic understanding of water-related issues and terminology," she maintains.

Greywater reuse is a common practice in South Africa. Yet, only 35% of South Africans know that greywater is the term for wastewater from bathing, washing clothes and dishes. People in the higher LSM and education groups are more familiar with the term, but not more than 50% of people in these groups know the term.

In the Metros, 41,2% of people know the term greywater; in other urban areas, 34,1% of people know the term. Only 28,2% of the rural population know that wastewater from bathing,

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SUSANA

The vast majority of survey respondents (90%) know that is not safe for children to play in untreated wastewater.

washing clothes and dishes is called greywater. Differences were statistically significant.

One in every five South Africans (80,9% of respondents) indicated that they would support at least one of the water reuse actions (greywater reuse, industrial recycling, direct potable reuse) in a severe drought.

The Coloured, Indian and White populations had the highest correct scores for familiarity with the term greywater (46,6%, 48,5% and 51,6% respectively). The Black population scored significantly lower (31,6% correct answers), but it is likely that especially rural respondents were not familiar with the English term 'greywater'. This emphasises the need for a common term that all South Africans can understand and relate to, the researchers point out.

The term 'potable water' is widely used by policymakers and water scientists, but only 28,3% of South Africans know what this term means. As with the finding for greywater, the percentage of people who are familiar with the term potable water (water that is safe to drink) is higher for the higher LSM groups, but not more than 33,6% of people in these groups know the term.

Contrary to the result for greywater, people from other urban areas are more familiar with the term 'potable' than people from the Metros (31,6% versus 27,8%). The difference was not statistically significant. Rural people got the lowest number of correct answers, namely 26,4%.

Many uncertainties about water reuse

The survey results showed that South Africans are unsure of many aspects of water reuse. South Africans seem to be unsure of the realities of using water more than once. Only 50,5% of people marked the statement that treated wastewater gets mixed with rainwater in rivers and that municipalities reuse this water as drinking water after treating it as 'true'.

Two out of every three people (66,5%) know that the municipal tap water in the kitchen is the same as the water that is in the toilet's water tank. The rest think that the water is not the same or they are unsure of the answer.

Almost half of South Africans (47,6%) believe that water should be free because it comes from the rain. Many South Africans (31,5%) still don't know that seawater can be treated to the drinking water standard.

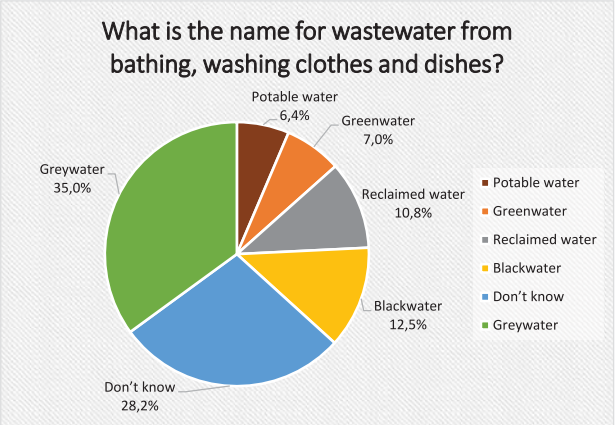
Knowledge of the safety of water reuse also varied. The safe use of greywater got low scores: 46,1% correct responses for the false statement: ***It is safe to eat vegetables from plants that were watered with wastewater from bathing, washing clothes and dishes***. Most people (90%) know that is not safe for children to play in untreated wastewater; on the other hand, only 44,7% know that it is unsafe for cattle to drink untreated wastewater.

The statement about climate change's effect on the availability of water had 78.6% correct answers. Slabbert points out: "Climate change is consistently in the news; this could have attributed to the high score." On the other hand, 68,7% (that is 10% less) of people think that it is true that South Africa has water scarcity problems. In stakeholder interviews that the research team conducted, it was mentioned that it is difficult to convince urban consumers, in particular, of water scarcity when they have water in their taps.

Water reuse in a severe drought

The survey indicated that South Africans would support water reuse in a severe drought situation, including direct potable reuse. Almost one in every two respondents (48,5%) mentioned direct potable reuse as something that they will support. As expected, the support for direct potable re-use was lower than the support for industrial and greywater reuse, but the difference was less than 10%.

People from urban areas showed slightly more support for direct potable reuse of water than those from rural areas. People from higher LSM groups showed more support for the direct potable reuse of water (53.8% for LSM groups 8-10 compared to 42,5% for LSM groups 1-4). 54,6% of people with a post-Grade 12



Survey respondents' familiarity with the term 'greywater'.

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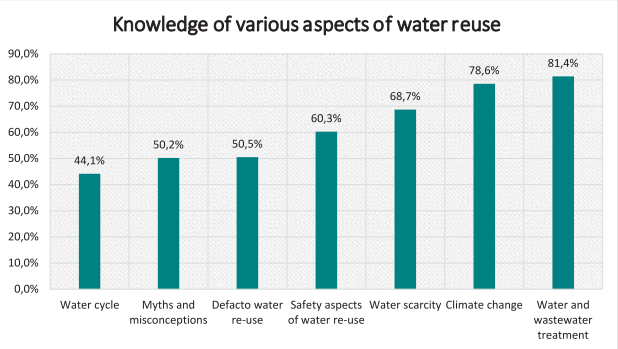
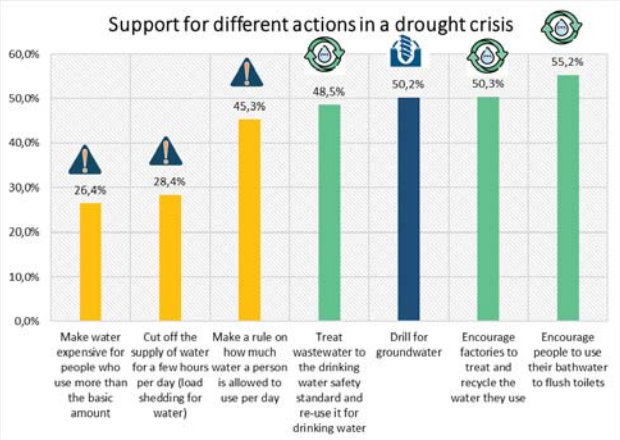
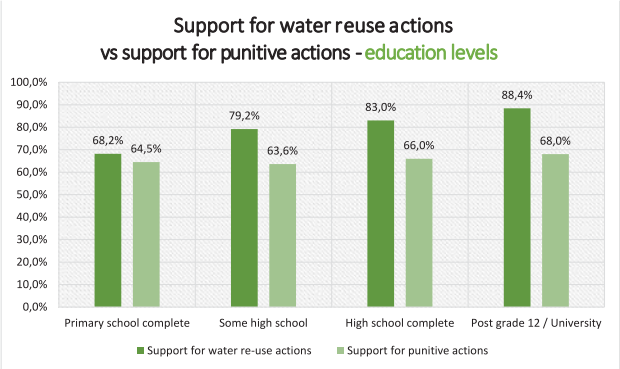


Respondents' knowledge of various aspects of water reuse.



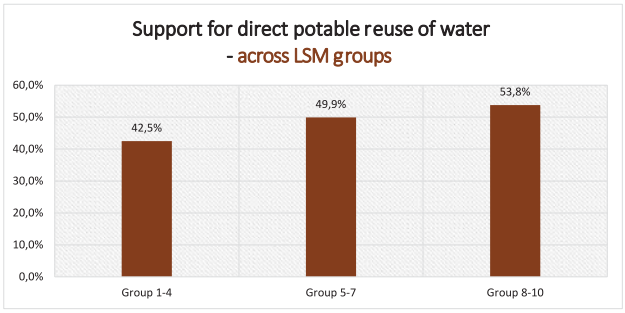


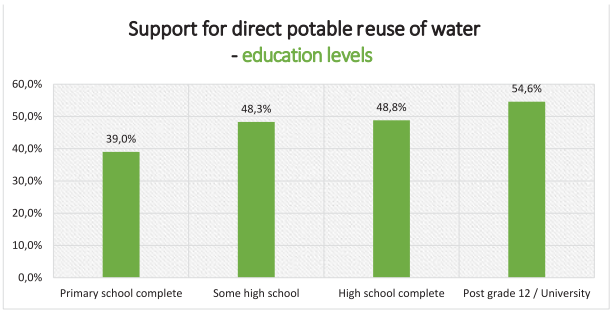
qualification support direct potable reuse in a severe drought, significantly more than people with only primary education (39%). This is a very important finding, Slabbert believes.

One in every five South Africans (80,9% of respondents) indicated that they would support at least one of the water reuse actions (greywater reuse, industrial recycling, direct potable reuse) in a severe drought. In contrast, only 65,4% indicated that they would support at least one punitive action (high tariffs and penalties for people who use more than the basic quantity, load shedding for water, restricting water use to a specified quantity per day). The action 'drill for groundwater' was supported by 50,2% of South Africans.

Moving forward

The study confirmed the predictions of stakeholders interviewed that there are serious gaps in the public's knowledge of various aspects of water reuse and related aspects.





Key knowledge areas that will have to be addressed are the terminology of water and wastewater, the water cycle and the safety aspects of domestic water reuse. In this regard, it is important to find common terminology that citizens are familiar with. "However, it would be dangerous to encourage domestic water reuse without the public being informed about its safety aspects," says Slabbert.

In the survey, knowledge of water reuse and related aspects correlates positively with support for water reuse. Although the correlation is weak, these findings support the conclusions of the literature. "One can, therefore, expect that improved public knowledge will have a positive outcome," says Slabbert.
The research results will now inform the development of a communication strategy for a sustainable public education programme on water reuse. "This proposed strategy will lay the foundation of public knowledge and understanding of water reuse," Slabbert indicates. "Implementing organisations can use this to inform their communication campaigns."

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GROUNDWATER MANAGEMENT

Ideas for mainstreaming groundwater

Groundwater, a critical resource that South Africans often treat as 'out of sight, out of mind,' has gained widespread attention following recent extreme droughts such as the one experienced in Cape Town. However, the precious time and resources invested in groundwater drought relief projects over the last few months will become meaningless, unless a concerted effort is made to use the data generated for future planning purposes. This is according to a working paper authored by Yazeed van Wyk and Eunice Ubombo-Jaswa of the Water Research Commission.

South Africa needs to incorporate lessons learnt and develop better mechanisms that will allow for the proper management and use of groundwater systems in their sustainability plans. A case in point is the drought the City of Cape Town has been experiencing over the past few years. Notwithstanding the importance record low rainfall events had on triggering the water crises, the severity of the drought could have been alleviated by good governance.

The Eastern Cape has also been affected by the drought with the Coega Development Corporation (CDC) increasing its water conservation efforts in a bid to tackle the water crisis as it reached dire straits in the Nelson Mandela Bay Metro. A number of artesian boreholes were drilled in the CDC area, and will be used as part of the future water supply of the town.

Regulatory context

The National Water Resource Strategy 2 (NWRS 2) incorporates groundwater in a meaningful way, enabled by the National Groundwater Strategy. South Africa has some of the best

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legislation, policies, regulations, guidelines and strategies at its disposal. However, efficient management of groundwater relies on the effectiveness of applicable legislation and institutional arrangements, as well as good understanding of the behaviour of an aquifer or wellfield being managed.

There is generally a lack of skilled technicians and other operation and management specialists, particularly in small towns needed to make informed decisions at the local wellfield scale. A recent research study conducted by researchers at the University of the Free State's Institute for Groundwater Studies (IGS) showed that all municipalities rated groundwater as a critical resource, yet there is little planning nor capacity available to do the actual work.

Recent reforms within government have placed the responsibility for the coordination of education, training and skills development across sectors in the Department of Higher Education through the various Sector Education and Training Authorities (SETAs). The SETAs should therefore be seen as the main drivers that can address the skills gap by funding relevant workplace based training and mentoring strategies.

Groundwater governance is a critical issue requiring worldwide attention. Groundwater management often lacks the financial and human capacity needed for the investigation of the resource characteristics and functions, especially in developing countries and, as a consequence, there are shortcomings in terms of reasonable legal provisions and pricing systems. The dynamic nature of both socio-economic development and predictions of global climate change makes groundwater management complex, uncertain and often unpredictable.

The invisible nature and complexity of aquifers has meant that groundwater resources do not easily lend themselves to inform policy for the necessary building of resilience. This suggests that groundwater can only gain a role as a strategic resource where an integrated approach to urban water management and governance acknowledges the importance of all available resources and moves away from the focus on large infrastructure and centralised water supply solutions.

The future management of our water resources requires that decisions concerning resource allocation and use are made transparent through informed public participation and by fully considering ecosystem requirements, inter-generational equity and precautionary principles.

The invisible nature and complexity of aquifers has meant that groundwater resources do not easily lend themselves to inform policy for the necessary building of resilience.

Managed aquifer recharge

When considering issues of changing climate and rising intensity of climate extremes, managed aquifer recharge (MAR) can become an increasingly important water management

Ashraf Hendricks/GroundUp

Drilling for groundwater during the height of the Cape Town drought.

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Groundwater plays a crucial role in especially rural water supply.

strategy, alongside demand management, to maintain, enhance and secure stressed groundwater systems and to protect and improve water quality. MAR or artificial recharge of groundwater is the intentional storage of water underground to reduce evaporative losses and utilize the porous aquifer media for water conservation and decontamination

MAR has been practiced in South Africa since the mid-1970s at the Atlantis aquifer, however, much more work is needed to document the costs and benefits of MAR. This will include doing work in relation to alternative water supplies or places of storage and in identifying scenarios where MAR is likely to produce the least-cost water supply and greatest benefit accounting for all objectives.

Groundwater quality

Knowledge of groundwater's chemical and microbial quality is critical when attempting to predict its use. In general, little is known about the microbial quality of groundwater, especially in the case of privately owned wells or boreholes in rural areas.

Groundwater might not be suitable for drinking and other uses without prior treatment in these areas. In urban areas microbial groundwater quality is increasingly compromised due to rapid expansion of informal settlements and inadequate waste management practices from various anthropogenic activities that result in the contamination of groundwater.

In South Africa, saline groundwater resources are not well understood, but could present significant sources of water for both industrial and mining applications. Saline groundwater is often termed a nuisance, however, given the current drought situation this water could potentially become an important source to the water supply-mix in the future coupled with desalination or other emerging water treatment technologies.

In conclusion, there appears to be plenty of opportunities for groundwater to be considered a mainstream resource if managed in a holistic manner. This article recognises the strategic role of groundwater resources for the effective management and mitigation during periods of drought.

Fundamental to its application is generating a sense of urgency in order to rally the political will to secure effective groundwater governance at all levels. Hydrogeologists, and other professionals involved in groundwater, are a key component in creating such a sense of urgency by raising public awareness in terms of opportunities and threats.

The appropriate appraisal of groundwater resources, with which diverse stakeholders can identify, should be considered as a vital precursor to its sustainable management. Last but not least, good policy design alone is insufficient for effective groundwater governance. Rather, implementation requires sufficient investments, reliable science, accurate data, good leadership, and equitable decision-making.

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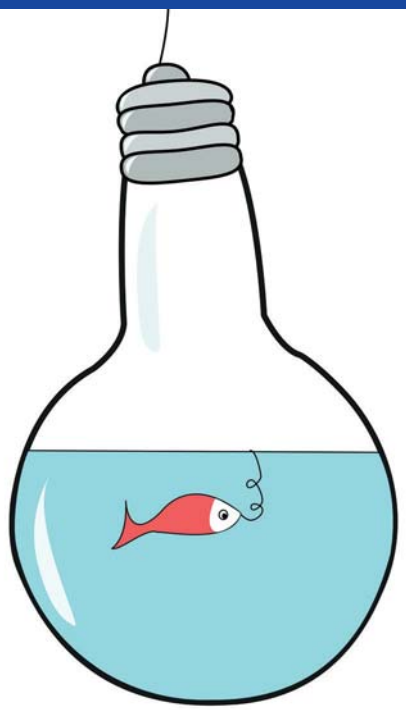
WATER AND INNOVATION

From TAGs to Riches: Technology acceleration through partnerships

While innovation holds the answers to many of South Africa's water and sanitation challenges, there is work to do to accelerate the solutions, says Jo Burgess, senior technology consultant at global technology and innovation consultancy, Isle.



The average time for new technologies to become mainstream is 15-20 years – too long if they are to have the impact that is urgently needed.

The high-profile water scarcity issues that began in 2014 have prompted a huge amount of activity and there are hundreds of people offering water treatment solutions to municipalities and government. It is impossible for the sector to assess all technologies in detail and differentiate the good tech from the repackaged old tech and the low-quality tech.

There is a long-term skills shortage in the water sector and with so much technology out there it is difficult for staff to keep up. We can – and must - move faster by closing the communication gaps between technology developers and technology users and investors.

Isle works closely with the water sector to introduce pre-assessed new technologies. Key to this are Technology Assessment Groups (TAGs), collaborative innovation forums for technology users. We have several TAGs worldwide, each operating on the same principles but tailored carefully to its location, acting as launchpads into different markets.

We have South Africa TAG (SA TAG) for the water sector itself and an industrial TAG (iTAG) for non-water sectors such as power, food and beverage, pulp and paper, mining, and pharmaceuticals. There are other TAGs around the world which

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are routes to overseas markets for SA technologies.

Isle has a team of about 60 scientists and engineers scouting for emerging technologies from research centres, universities, backyard inventors – anywhere. The technologies are put through our technical assessment. We look at pilot or trial data, under non-disclosure agreement if necessary, and then put the technologies that pass the assessment into Isle's online innovation portal.

The TAGs meet twice a year. Before each meeting we match the innovation needs of members to the technologies that have emerged since the previous meeting. We then interview those technology companies about their readiness to support business in South Africa, if they are not established there already. At the meetings they give technical presentations followed by a Q&A and collaborative audience review.

The meetings produce opportunities for collaborative trials, which are designed, tracked and progressed by Isle. There are great benefits to be had from streamlining collaborative trials – one company can trial a new product and others be provided with an independent report, for example.

For the technology provider, it means more than one potential client sees the product and saves time and resources by removing the need for repeat trials. For the tech users, it means the cost of a trial is shared and they can be confident of independent, evidence-based analysis.

Trialling products in this way is a direction all industries should be moving in if they are to help pave the way towards much needed progress – but even with this acceleration, bringing new technologies into widespread use is still a long process. However, it can be done, and furthermore it can be done here.

Here are two examples of technologies that went from TAGs to riches.

SMARTSAN

The SMARTSAN is a decentralised domestic wastewater treatment package plant developed by Nano Water Technologies Africa in Randburg. It is scalable to treat effluents from single household systems up to groups of houses and small communities.

The Recycle Reactor model incorporates the recirculation of treated effluent for flushing for conventional flush toilets, in a near closed-loop system. The system consists of three reactor tanks and a fourth elevated cistern-filling tank.

The reactor tanks are configured one inside the other, with flow between the three tanks having to pass through a nanofilter assembly before entering the next tank. This ensures 100% removal of all dissolved contaminants such as nitrates and phosphates.

The process uses bacteria to remove the biological oxygen demand (BOD) load as well as provide nitrification and denitrification. This allows the treated effluent to be either safely discharged to the environment or reused to refill the toilet cistern. A unique cap filter in the ventilation system removes all odour.

The system has a small footprint, making it well suited to rural and peri-urban sites where no sanitation infrastructure is available. It can be totally off-grid and powered by renewable energy, although it can also be connected to the grid.

Sales are strong in South Africa, Namibia, Zambia and Mozambique and licensing has allowed for greater expansion at faster rate, using existing networks. Nano Water Technologies was selected to give a presentation to 16 water utilities at the European Wastewater TAG meeting in Utrecht, The Netherlands, in July 2016, resulting in requests for direct introductions by clients in Europe, and trials.

Dynamic Vapour Recovery (**DyVaR**)

The eMalahleni Water Reclamation Plant (EWRP), in the Nkangala District Municipality in Mpumalanga, has the capacity to treat 50 megalitres of mine water per day. More than 99% of the influent is recovered as potable water through a multistage treatment process and provides drinking water to the local community.

The remaining <1% is recovered as a highly concentrated brine – an environmental liability which requires extensive treatment before it can be disposed of. A trial was hosted by Anglo American at EWRP, with funding from Coaltech, which focuses on cleaning up waste generated by mining, to determine whether Dynamic Vapour Recovery (DyVaR) technology is a viable option for treating the concentrated brine.

DyVaR is engineered by Dutch company, Salttech, and provided in South Africa through Tecroveer Pty. It is an advanced system that recovers salts from concentrated brine through evaporation and crystallisation. Tecroveer presented the DyVar technology to Anglo American, among others, at an industrial TAG meeting in 2018.

Brine is treated in a one-step continuous process, producing fresh water and salt solids. The system is modular and consists of multiple units that each have a capacity to produce 50 litres of clean water per hour.

The pilot trial with the Salttech DyVaR technology successfully treated the reject brine from EWRP and a mixed concentrated brine. Clean water recovery of 88% was achieved. Now that the building of new evaporation ponds for brine storage or treatment is no longer an option, DyVar and technologies like it have become critical to South Africa.

Acknowledgements: with thanks to the organisations named in this article for their permission to share their case studies.

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EMERGING FARMERS

Developing a farmer information package: a success story

After many years of water allocation reform, emerging farmers are still lagging behind as far as equity and access to water resources is concerned, and their participation in water user associations is still limited or passive. Recent collaboration between researchers and the water sector aimed to improve this situation in the Breede-Gouritz catchment management area. Article by Dr Bongani Ncube of the Cape Peninsula University of Technology (CPUT).

In 2013, the Breede-Gouritz Catchment Management Agency (BGCMA), the Cape Peninsula University of Technology (CPUT) and the University of the Western Cape (UWC) signed a memorandum of agreement (MOA). The main objective of the agreement was to develop and implement joint research and capacity building programmes based on the BGCMA research and training needs.

Under the auspices of the MOA a project was conceived jointly by CPUT and BGCMA. At the end of 2013 CPUT was awarded a Water Research Commission (WRC) funded project (**K5/2310**) entitled 'Approaches for Emerging Farmer Participation in Water Resource Management: The Case of the Breede-Gouritz Catchment Management Agency (BGCMA), Western Cape'. Dr Bongani Ncube was the project leader. The project ran from 2014-2017, but activities continued until the end of 2019.

The main objectives of the research were to assess the progress in accessing water by small-scale and emerging farmers, challenges faced by the farmers in participating in water resource management, to explore the opportunities for engaging the farmers in water allocation processes. The research focused on the whole CMA, with detailed consultation with farmers in the Barrydale area andemerging farmers from Hex River Valley Water User Association.

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There were huge differences between emerging farmers who were water user association (WUA) members and those who were non-members. None of the 34 members of Barrydale small-scale farmers were part of a water user association, and this was true most of the smallholder farmers.

Water user association members had access to land and water, and they actively participated in the water allocation processes, while non-members farmed on small pieces of insecure leased land (maximum 12 hectares). Water user association members were represented at all levels including in the BGCMA board, and they had access to grants and subsidies. Non-WUA members had limited access to irrigation water, and they had access to few grants. They also shared infrastructure and were mostly passive participants in water related issues.

At the CMA level the water allocation reform process also faced huge challenges, namely

- The slow implementation of the BGCMA water allocation reform strategy. The process faced human capacity limitations/shortages which limited effective implement of the strategy.
- The water use registration and licensing process was also faced with human capacity limits. The licensing process took much longer than expected, and the coordination of the process was also a challenge. In addition, the BGCMA is a water scarce CMA and, in many cases, there was no water to allocate.
- The verification and validation process was took much longer than anticipated due to funding limitations as well as the need to use appropriate methods.

During the course of the project, results were presented to water-related institutions that worked with or supported emerging and smallholder farmers. A workshop was organised in October 2015 to share some of the initial findings of the project. In attendance were the BGCMA, the Department of Water and Sanitation and Western Cape Department of Agriculture (WCDoA).

There was a realisation at the workshop that support to the emerging and smallholder farmers was uncoordinated, complicated and ineffective. The institutions decided that there was need for a bigger consultation where all institutions that supported smallholder farmers could discuss the way forward.

Further consultation also continued with the farmers who identified priority issues that they felt needed to be addressed urgently. These were:

- Shortage of water for productive use (agriculture)
- Lack of information e.g. the licensing process
- Lack of funding (access to grants and start-up programs)
- Land shortage (lease agreements were too short)
- Lack of participation in water user associations

Through further meetings and dialogues, the institutions committed to finding solutions to some of the identified challenges. The institutions worked around three questions: 1) What is the problem with the current farmer support systems? 2) Do we need to develop a process for engaging emerging farmers? 3) Do we need a coordination institute or forum?

Plan of action

There was realisation that it would take time to address land and water issues due to the different policies and mandates of the institutions. However, the information gap could be addressed immediately since all institutions had information on their activities and sources of support.

During the CPUT/UWC/BGCMA Water Seminar in March 2016 the institutions and farmer representatives came up with a plan of action and agreed on the following activities:

1. Develop a comprehensive information package, including information from all institutions
2. Combined workshop to refine the package
3. Plan for a roadshow to pilot the package in Barrydale in November 2016
4. Develop a free website to house the package for continuous use

All the institutions committed to send the farmer support information by the end of June 2016. At the end of August 2016, a combined workshop was held to refine the package as planned. A comprehensive information package was therefore compiled. Participating institutions included, the BGCMA, Department of Water & Sanitation: Berg-Olifants Proto CMA, Western Cape Department of Agriculture, Department of Rural Development & Land Reform, and the African Farmers Association of South Africa.

CPUT played the project leadership, coordination and facilitation role. The institutions then agreed to test the package through a pilot roadshow in Barrydale in November 2016. Draft copies of the package were printed by the BGCMA for distribution during the pilot roadshow. There was a good turnout of about 62 farmers and institution representatives. Farmers expressed gratitude that they could now access the officers from the institutions and access information without travelling long distances.

Seeing the huge success of the pilot roadshow the BGCMA decided to set aside funding to reach out to all the small-scale and emerging farmers in the catchment management area. The approach of the roadshows changed from presentations into information cafes led by the different institutions, with farmers moving from one café to the next.

An issue log of problems raised by the farmers was compiled by each institution during the roadshows for follow-up. Follow up meetings were also organised to assess progress in addressing the issues raised during the roadshows. By the end of 2018 a total of 11 roadshows and report back meetings had been held in almost all the BGCMA mandated areas.

A commitment was made by the BGCMA to host and regularly update the information package through their website. The Water Research Commission committed to fund the development of the website and translation of the package from English into Afrikaans and IsiXhosa. The website is freely accessible and it can also be accessed via the mobile phones. The package is also downloadable in the three Western Cape languages. For the farmers who do not have smartphones the

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package has been printed into hardcopies for free distribution via the participating institutions.

Launch of the website

The website was officially launched by the institutions and representative farmers on the 12 November 2019.

BGCMA website landing page showing the link to the Farmer Support Package

Front page of the Farmer Support Package

The launch of website was a great achievement and a dream come true for both the CPUT researchers, the BGCMA and collaborating institutions. When the project started in 2014 there was a lot of mistrust between the smallholder farmers and the BGCMA, but through dialogue over the project years the BGCMA and the other water institutions and have become go-to places for help for the smallholder farmers.

During the the launch it was however clear that this work cannot be complete until all smallholder farmers have been reached and have access to water. It was recognised that the Extension Officer remains a crucial on the ground link with all farmers. The Western Cape Department of Agriculture officials requested that presentation by be made at one of their strategic meetings so that more extension officers could participate and be able to work with other institutions in their areas. The Berg-Olifants Proto-CMA officials also made commitment to start roadshows in their area in early 2020. The need to engage municipalities was also emphasised.

Lessons learnt

The project facilitated engagement and partnership building between BGCMA and other water related institutions that support smallholder farmers in the in the Western Cape Province

CPUT benefits from this project include research capacity development and student bursaries. Three female research assistants were trained and two of them have completed Masters degrees through funding from the project. In 2017 Dr Ncube won the Water Research Commission (WRC) Knowledge Tree Award in the 'Empowerment of Communities' Category, a recognition of the impact of the project on both the smallholder farmers and institutions.

Access to water is still a huge challenge at the farm level. The farmer support package is providing access to information, but there is need for solid commitment and engagement at higher policy level. There are different types of smallholder farmers with different needs, therefore, support systems cannot be one-size fits all.

BGCMA information Café with smallholder farmers from Ceres, October 2018.

For more details:

- Website link: http://www.breedegouritzcma.co.za/EFSP/index.html
- Final Report: http://www.wrc.org.za/mdocs-posts/2310-1-17-2/2310-1-17-3/
- Article: https://doi.org/10.1016/j.pce.2018.05.012

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Water KIDZ

Celebrating the Earth – the only planet we have!

On 22 April people around the world celebrated Earth Day.

All over the world, we have an effect on the environment through all our actions or even by simply living as we do. We use electricity and water, use of transport such as cars, taxis, buses and aeroplanes to go to school or work.

Remember that also by eating the food we need for surviving we all affect our environment, as that food is planted and harvested, transported to a store near you by big trucks who also pollute the environment. The waste we produce and the way we dispose of our waste is creating many problems.

Earth Day reminds us that we need to take care of the planet we call home. It is a day to reflect on our planet, our environment and what we can do to help keep them healthy. In 1970, an American politician from Wisconsin created this national day in the USA to raise awareness of the environment and how we treat nature. Today, this day is celebrated as an international event in nearly 200 countries. This year marked the 50th anniversary of Earth Day.

How can you help celebrate Earth Day?

Plant a tree

People are building up excess carbon dioxide in the atmosphere through all their industrial and agricultural activities. Harmful carbon dioxide or CO_2 contributes to climate change. Trees help fight it. They absorb CO_2, removing it form the air and storing it while releasing oxygen. Trees are our main survival tools – only one tree can produce enough oxygen for four people. Trees

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also purify the air by absorbing pollutant gases such as nitrogen oxides, ozone, ammonia, and sulphur dioxide.

Take a walk in nature

Look around and appreciate the beauty of nature that the Earth has given us. It doesn't have to be some spectacular National Park – a simple natural area, like a nature trail or a walk along a stream will do. An even better idea is to go camping – even if it is in your own backyard! That way, you can enjoy all the wonderful sights and sounds of nature during the night and day, like birds chirping, and the stars.

Learn how recycling works

Recycling is how we take trash and transform it into new products. There are several types of recycling processes that allow some materials to be used one or more times. Recycling is good for us and the environment because it reduces the use of new raw materials to product new products. It also reduces the energy we use, improves the quality of air and water, and fights climate change.

All sorts of things can be recycled. Some of the most common processes used today recycle plastics, glass, metals, electronics, newspapers and magazines, and cardboard, to name a few. Cooldrink cans, plastic water bottles, plastic milk cartons, newspapers, cereal boxes and old computers are just some of the common items that are recycled every day. If all of us were to recycle just a few items per day that we throw away, we can go a long way to improving the environment for our futures and future generations.

Use less plastic

Plastic is an amazing man-made material used to make all kinds of important things. Bike helmets, car airbags and many medical supplies made with plastic save lives, and plastic water bottles can bring clean drinking water to people who don't have it.

The problem is that most of us use more plastic than we need to, and ***half*** of the plastic we produce is designed to be used just once and thrown away. This so-called 'single-use plastic' is used to make all kinds of items, such as shopping bags, straws, food wrappers and various packaging . And because plastic takes ***over 400 years*** to decompose (break down), it stays in the natural world, causing damage, for a very long time.

Do you really need that straw to drink that cooldrink? Audit the plastic use of your family at home by counting how many plastic containers, wraps, bottles and bags you purchase. You can start cutting down on this plastic use by taking your own reusable shopping bags to the store, using reusable water bottles, and refusing plastic straws and utensils at takeout food outlets.

There are various other things that you can do to save the Earth every day. This includes throwing all trash in the bin (and not littering!), saving water, saving electricity and being kind to animals and plants. Every little action counts. Let's make every day Earth Day!

- *To learn more about Earth Day, click here*
- *To learn how recycling works, click here*
- *To learn about plastic pollution, click here*

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FUNDUDZI – SOUTH AFRICA'S SACRED LAKE

South Africa has few natural lakes. Arguably one of the most well known natural lakes in South Africa is Lake Fundudzi.

Remotely located in the Venda region in Limpopo Province, in the foothills of the Soutpansberg Mountains, Lake Fundudzi measures about 140 ha. The lake is estimated to be at least 10 000 years old, and is filled by the Godoni and Mutale rivers. Mysteriously, with no obvious outlet, the lake never overflows.

It is reported that the lake was created by an ancient landslide blocking the course of the Mutale River. The lake and its resident crocodiles as well as the nearby forest of Thathe Vondo, are regarded as sacred by the Vhatavhatsindi, the People of the Pool, who are part of the Venda people.

Folklore around the lake abound. One legend tells of a python god living in the mountain that protects Lake Fundudzi. The Venda pay homage to this god by annually performing a puberty dance, in which adolescent girls of the tribe take part. The fullness of the lake and its colour are said to reflect the temper of the ancestors, and the possibility of rain.

Lake Fundudzi and the Thathe Vondo forest are recognised South African treasures are protected by the South African government under the National Heritage Resources Act.

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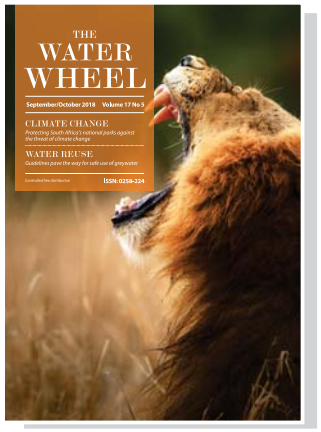
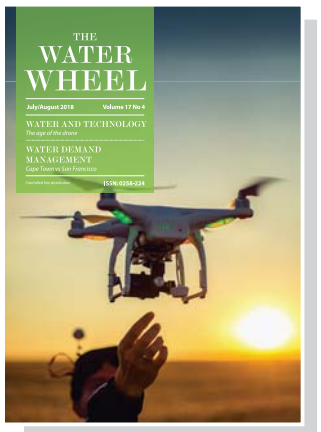
THE WATER WHEEL

SUBSCRIPTION





Contact Details

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WATER RESEARCH COMMISSION

The Water Wheel

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DEEPLY ROOTED IN SOUTH AFRICA WATER SOCIETY

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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.

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